A RISK MANAGEMENT SYSTEM FOR HEALTHCARE FACILITIES SERVICE OPERATORS

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ABSTRACT

The 24-hour post-modern society in which the NHS delivers healthcare today in the UK as a business has resulted in purchasers and providers of non clinical/FM services continuing to face more and more service delivery and operational risks (Payne and Rees, 1999). These business risks are mainly caused by uncertainties in customer supply and demand service chain, limited support resources (human, capital, modern healthcare facilities and information technology) and the dynamic NHS servicescape (environment). This has resulted in non clinical service decisions being reached in an ad-hoc manner and often with no effective business strategy. Furthermore, this approach has led to disastrous business planning and caring consequences, particularly in a highly politicised and consumer-sensitive environment like healthcare service provision (Wagstff, 1997).

These risks are also mainly attributed to the apparent lack of best practice guidelines that are available to assist FM service operators in identifying and managing non-clinical service operations effectively. In addition, there is evidence from NHS literature that clearly indicates the lack of best practice models for managing business risks associated with hotel, estates and site (non-clinical/FM) services delivery (Okoroh *et al.*, 2000; DoH, 1999; CFM, 1993; Smith, 1997; Featherstone, 1999; HFN 17, 1998). To date, no research has been carried out in the NHS using FM service operators' (domain experts) knowledge to develop an integrated risk management system for managing non-clinical services using modern business approaches.

This thesis presents research findings from healthcare executives and FM experts on business risks faced by service operators (purchasers and providers) when managing non-clinical services effectively in the UK NHS. The research methodology used were, a detailed analysis of a best practice hospital case study, structured interviews with domain healthcare FM experts, pilot and major questionnaire surveys and Repertory Grid interviews.

The research has established that in managing non clinical/FM services in the NHS, there are seven major common management-related risk classes identified as critical; customer care; financial and economic; commercial; legal; facility-transmitted; business transfer and corporate. Further research using second factor analysis established that these classical non-clinical risk factors could further be subdivided into forty-eight (48) constructs/sub-attributes highly rated by healthcare facilities executives. Using these risks factors and sub-attributes the research has developed a decision support system for risk management that can be used by FM operators to manage business risks in NHS trust hospitals.

ABBREVIATONS

ACE	Association of Consulting Engineers
AI	Artificial intelligence
ANN	Artificial neural network
ANNs	Artificial neural networks
BEHU	Centre for the Built and Human Environment
BIFM	British Institute of Facilities management
BIMS	Building information management systems
BOOT	Build-Own- Operate-Transfer
BPF	British Property Federation
BPN	Back-propagation network
BRP	Business re-engineering
Bsc (hons)	Bachelor of Science Honours degree
C. Eng	Chartered Engineer
C++	Computer programming language
CART	Classification and Regression Trees
CCT	Compulsory competitive tendering
CD-ROMs	Compact Disk "Read-Only Memory"
CEs	Chief Executives
CFM	Centre for Facilities Management – Strathclyde University
CFM	Centre for Facilities Management
CHAID	Chi Square Automatic Interaction Detection
CIB	Construction Industry Board
CIOB	Chartered Institute of Building
CNBR	Co-operative network of building researchers
COBRA	Construction and Building research conference
CPA	Critical path analysis
CRFs	Critical risk factors
CSFs	Critical success factors
DE	Domain expert
DEGW	International workplace consultancy firm
DHSS	Department of Health and Social Services
DoH	Department of Health
DOS	Disk operating system
Dr.	Doctor
DRI	Derby Royal Infirmary
DSS	Decision support system
DSSs	Decision support systems
DTI	Department of Trade (UK)
EC	European Community
EFQM	European foundation for quality management
EPRs	Electronic patient records
ES	Expert system
et al.,	And others (authors)
EU	European Union

FM	Facilities management
FMGC	Facilities Management Graduate Centre
FMGC	Facilities Management Graduate Centre
FM-X	Facility Management Exchange
FTRs	Facility transmitted risks
GAs	Genetic algorithms
GFM	General Facilities Manager
GPs,	General practitioners (medical doctors working in surgeries/clinics)
HAIs	Hospital acquired infections
HEFMA	Health Estate Facilities Management Association
HFC	Healthcare Facilities Consortium
HFN 16	Health Facilities Notes 16
HFN 17	Health Facilities Notes 17
HMSO	Her Majesty's Stationery Office
HRM	Human resources management
HSE	Health and Safety Executive
IBM PC	International business machine processing computer
IFMA	International facilities management association (USA)
IHS	Integrated Healthcare Service
ISO	International Standards Organisation
JAVA	Computer programming language
KBS	Knowledge-based system
KE	Knowledge Engineer
KPIs	Key performance indicators
MA	Master of Arts Degree
MA (Cantab.)	Master of Arts Degree - Cambridge University
MAPE	Mean absolute percentage error
MAPM	Member, Association of Project Managers
MBIFM	Member, British Institute of Facilities Managers
MCIOB	Member, Chartered Institute of Builders
MERA	Multiple Estimate regression
MEV	Maximum Expected Value
MICE	Member, Institute of Civil Engineers
MPCs	Multidisciplinary pathways of care
MPE	Mean percentage error
MPL	Multilayer perceptron
MR	Multiple regression
MRA	Multiple regression analysis
Msc	Master of Science Degree
MT	Market testing
NAO	National Audit Office
NHS	National Health Service
NHSFRES	National health service facilities risk exposure system
NLP	Nuero-linguistic programming
No.	Number
P.Grad. Cert	Post Graduate Certificate

PCA	Principal component analysis
PCGs	Primary Care Groups
PCT	Personal construct theory
PCTs	Primary Care Trusts
per ser	Intrinsically
PERT	Project evaluation review technique
PEs	Processing elements
PEST	Political, Economical, Social and Technological
PFA	Principal factor analysis
PFC	Patient-focused healthcare
PFI	Private finance initiative
PhD	Doctor of Philosophy Degree
PM	Project Management/Manager
pp.	Page numbers
PPP	Public private partnership
PRAM	Project risk analysis and management
Prolog	Computer programming language
PSC	Patient service charter
QRA	Quantified risk assessment
QTs	Quantitative techniques
RG	Repertory Grid
RGT	Repertory Grid Technique
RIBA	Royal Institute of British Architects
RICS	Royal Institute of Chartered Surveyors
RICS	Royal Institute of Chartered Surveyors
RII	Relative importance index
ROCE	Return on capital employed
SBUs	Strategic business units
SHA	Strategic Health Authority
SLAs	Service level agreements
SME	Small to medium size
SPSS	Statistical package for Social scientists
SWOT	Strengths, Weaknesses Opportunities
TFM	Total facilities management
TQM	Total quality management
TUPE	Transfer of Undertakings Protection of Employment Legislation
UK	United Kingdom
UN	United Nations
US	United States
VFM	Value for money
Vol.	Volume
VRE	Vancomycin resistant enterococci (disease causing organism)
W70	World Conference Number 70
WWW	World Wide Web
Y2K	Year 2000

RELATED PUBLICATIONS

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The **RICS FM Faculty prize for Best Paper on Sustainability in FM** was awarded to: Michael Okoroh, Benedict Ilozor, Peter Gombera & Amir Alani for their paper on *Healthcare Facilities Management Operations and Organisation Decisions.* For background on the award see www.caber.org.uk.cibw70/rics.asp

The **BIFM Best Paper on FM Innovation** was won by Nicola Brackertz and Russell Kenley for their paper on *Moving Towards an Integrated Facilities Management Tool to Evaluate Facilities for Service Performance in Local* Government. Also commended were papers by Barry Haynes and If Price; by Michael Okoroh, Benedict Ilozor, Peter Gombera & Amir Alani; by Dilanthi Amaratunga & David Baldry; by Jim Smith, Ray Wyatt & Norm Jackson; and by Peter Williams. For background on the award see www.caber.org.uk.cibw70/bifm.asp.

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CHAPTER ONE

RESEARCH PROPOSAL AND INTRODUCTION

1.1 INTRODUCTION TO THE SUBJECT MATTER

The 24-hour post-modern society in which the NHS delivers healthcare today in the UK as a business has resulted in purchasers and providers of FM services continuing to face more and more service delivery and operational failures/risks (Payne and Rees, 1999). These strategic and competitive risks are mainly attributed to uncertainties in customer supply and demand service chain (consumerism), limited input resources (human, capital, modern healthcare facilities and information technology) and the dynamic NHS servicescape (environment). Hence, FM strategic and competitive decisions are usually reached in an ad-hoc manner and often with no effective business strategy to pursue. Furthermore, this approach has led to disastrous business planning and caring consequences, particularly in a highly politicised and consumer-sensitive environment like healthcare service provision.

These risks are mainly attributed to the apparent lack of best practice guidelines that are available to assist FM service operators in identifying and managing non-clinical service operations effectively. In addition, there is evidence from NHS literature that clearly indicates the lack of best practice models for managing business risks associated with hotel, estates and site (non-clinical/FM) services delivery (Okoroh *et al.,* 2000; DoH, 1999; CFM, 1993; Smith, 1997; Featherstone, 1999; Healthcare Facilities Notes 17, 1998). To date, no research has been carried out in the NHS using FM service operators' (domain experts) knowledge to develop an integrated risk management system for managing non-clinical services using modern business approaches.

According to the HFN 17 (1998), the introduction of effective business performance/risk management systems in managing the FM service process in the NHS has been long overdue. As a result of this, the HFN 17 report recommended that a business performance management model needs to be developed that adds value for money to the strategic management of NHS non-clinical services. According the HFN 17, the developed model must also represent the domain customer service problems to be managed: i.e. the need for effective FM services delivery to customers.

Furthermore, this performance management tool should also be flexible enough to identify, measure and manage key service provision risks, and the uncertainty associated with the continuous improvement of high quality non-clinical service solutions delivered in NHS trust hospitals.

1.2 PROPOSED RESEARCH AIM

The research aim is to develop an intelligent business performance and risk management system for healthcare FM operations in the NHS.

1.3 OBJECTIVE OF THE RESEARCH

In view of the discussion above, the main objective of the research was to develop a risk management system that uses FM business knowledge elicited from leading FM experts and healthcare facilities managers working in the NHS.

In addition to the main objective, the research had the following sub-objectives:

i) to investigate key risk factors faced by FM service operators (purchasers, in-house and, or external providers) when providing best value FM services that underpin the delivery of responsive and seamless clinical services in NHS trust hospitals;

ii) to develop a DSS that provides a systematic and objective approach to risk management of healthcare FM operations;

iii) to establish an acceptable risk action plan for managing effectively healthcare FM operations.

1.4 METHODOLOGY OF THE RESEARCH

This research arose out of a perceived need to understand, evaluate and possibly control (manage) potential risks that are faced by FM service operators when delivering high quality non-clinical services in the NHS. To start with, the researcher conducted an extensive literature review of primary and secondary sources to establish the theoretical background of this FM investigation.

This was followed by several meetings and interviews held with domain FM experts working within the FM and NHS sectors, both nationally and internationally. To build on more background knowledge to the research, a best practice case study FM contract involving one of the top performing NHS Acute hospitals; DRI was used as a preliminary study.

The DRI FM contract was used to evaluate innovative service delivery approaches and pertinent business process risks faced by FM service operators in the NHS. Furthermore, the identified FM knowledge (risks) from the DRI case study was used as the best practice experience for benchmarking FM excellence. This information formed the basis for the developing the conceptual framework and research methodology. The rest of the research was divided into five main stages shown below;

i) development of techniques and procedures for data collection;
ii) data collection;
iii) data analysis;
iv) development of model; and
v) validation of the model.

1.5 A GUIDE TO THE THESIS

CHAPTER TWO

Chapter two provides a critical review of literature relating to the business scope and strategic relevance of managing non-clinical services in the NHS.

CHAPTER THREE

Chapter three examines the concept of risk management and its potential application to effective decision making in healthcare FM in the NHS.

CHAPTER FOUR

Chapter four provides a critical review of literature related to DSSs and their potential application(s) in solving strategic and competitive non-clinical service decisions in healthcare operations. This chapter also examined the process of knowledge acquisition, implementation and development of DSSs in the NHS.

CHAPTER FIVE

Chapter five discusses the research methodology, the scope and methods of data collection. The methodology used for this research consisted of five integrated phases. These five stages have already been described in section 1.5, and were set out as follows:

i) extensive literature review;
ii) interviews with leading FM experts;
iii) data collection; the analysis;
iv) development and validation of the model and;
v) production of research findings.

CHAPTER SIX

Chapter six discusses the results of the pilot survey analysis conducted on NHS trust hospitals in the UK that practiced an integrated FM approach. The results formed the background information to the major survey that followed in chapter seven.

CHAPTER SEVEN

Chapter seven presents the results of the major questionnaire survey conducted on FM purchasers, in-house and external providers working in the NHS.

CHAPTER EIGHT

Chapter eight presents results of the Repertory Grid interviews of FM purchasers, in-house and external providers in the NHS.

CHAPTER NINE

Chapter nine describes the risk management system: NHSFRES that was developed using FM data collected from the pilot survey, major survey and Repertory Grid interviews. The artificial intelligence technique used for data modelled is ANNs.

CHAPTER TEN

Chapter ten describes the procedure adopted for the validation of NHSFRES. The results of the validation tests and the application of NHSFRES were also presented in this chapter.

CHAPTER ELEVEN

Chapter eleven provides the conclusion and summarises the main findings of the research. This chapter also outlines proposals for further research.

1.6 FINDINGS OF THE RESEARCH

This thesis presents research findings from healthcare executives and FM experts on business risks faced by service operators (purchasers and providers) when managing non-clinical services effectively in the UK NHS. The research has established that in managing the non-clinical business process in the NHS, there are seven management-related risk categories faced by FM operators that are critical. These risk classes are customer care; financial and economic; commercial; legal; facility-transmitted; business transfer and corporate.

Further research using second factor analysis allowed these classical non-clinical risk factors to be further sub-divided into forty-eight (48) constructs/sub-attributes.

Using these management-related risk categories and sub-attributes, the research has developed a risk management system - NHSFRES; that can be used by FM service operators to manage business risks in NHS trust hospitals. The main technique used for developing the DSS was ANNs. NHSFRES functions as a novel DSS for modelling risk management factors that can improve the delivery of high quality support services to customers in the NHS.

CHAPTER TWO

LITERATURE REVIEW OF HEALTHCARE FM SERVICE OPERATIONS

2.1 Introduction

This chapter provides an overview of the reforms introduced in the UK NHS and the main types of non-clinical service approaches used by trust hospitals to front the delivery of clinical services. In particular, this chapter highlights issues surrounding the effective and competitive delivery of integrated healthcare services using the MPC approach to customers throughout the continuum of care in the NHS.

2.2 Definition of healthcare non clinical/FM services

The main objective of FM in the NHS is to support healthcare business development in trust hospitals. In order to achieve this, trust hospitals have to re-engineer their business processes towards meeting their healthcare customers' needs and thus allowing them to compete commercially. FM in the NHS and other related working environments cannot be precisely demarcated and performance measured with accuracy (Akhlaghi, 1996; Pearson, 1998) and hence it is extremely difficult to define the functional and service boundaries to which FM enhances the core (clinical) business objectives. This is because FM is noticed by progressive outsourcing and downsizing in most NHS trusts (Kitchen, 1998). Therefore FM in NHS trusts can only be viewed as a business support (non core) service model that is dynamic in nature for both the enhancement and creation of best value healthcare using the MPC approach. FM should integrate strategic knowledge and operations management issues that are environmentally sustainable and flexible to the ever-changing business environment in which healthcare services and deals with the strategic design and management of the service interface between the clinical (core) and the non-clinical (non core) services.

Much debate about the business scope of FM as discipline in the NHS still continues. This is connection with the view expressed earlier above that FM in the healthcare and other working environments cannot be precisely demarcated and performance measured with accuracy (Akhlaghi, 1996; Pearson, 1998). The argument raised by most business managers has been that of where FM starts and ends, and who is the "best fit" service purchaser or provider in any organisation? (Nutt, 1998; Hanson and Hinks, 1998; Wagenberg, 1997; Parry and Collins, 1993).

HFN 16 (1997) suggests that the purpose of FM in the NHS is to increase the value of healthcare services, either by improving the quality of services for the same cost, or delivering the same services at a lower cost, or a combination of the above. In order to attain this level of standard, healthcare facilities service operators must have broad intelligence of the clinical service quality standard to be delivered by any Trust hospital. In addition, they should also consider the range and scope of support services offered by the competitive markets, and the business infrastructure (facilities) of any trust hospital. This research extends this business thinking, and reiterates the need to consider innovative ways in which healthcare facilities contribute to healthcare services performance and effective business delivery strategies in the NHS. FM can be considered by NHS Trust hospitals as the integrated management approach of patronising the entire range of "non core/clinical" services and their progressive outsourcing and insourcing (Hanson and Hinks, 1998), while providing a basis for best guaranteeing NHS Trusts service quality and value for money in provision. In contrast, the "progressive" aspect is the one that makes it more difficult to define FM using a universal framework, while maintaining service development in healthcare operations from one hospital Trust to another.

However, while FM competencies, business ethics and service development continue to remain universal issues to be resolved under this "new" discipline in general (Grimshaw, 1999; Nutt, 2000; Featherstone and Baldry, 2000), a handful of "standard" working definitions are now increasingly being commercially used. These have been developed to define various FM service delivery situations encountered in the NHS (Webber, 1994). The first universal definition to be examined is the one proposed by the International Facility Management Association (Powell, 1991: pp.2);

"The practice of co-ordinating the physical workplace with the people and work of the organisation; (it) integrates the principles of business administration, architecture and the behavioural and engineering sciences"

This definition highlights three key facets of FM that are applicable to the NHS:

(a) It is a supporting function to the core (clinical) business of the organisation;
(b) It focuses on the interface between the physical workplace (healthcare facilities), the technology and the people (service operators and stakeholders); and

(c) It requires a multi-disciplinary business approach (innovation service delivery approaches)

However, the CFM (1992) and HFN 17 (1998: pp.23) considers FM as;

" *the process by which an NHS Trust creates and sustains a caring environment and delivers quality hotel services to meet clinical needs at best cost*"

Although support services in the NHS are often refereed to as "hotel services" (Randall and Senior, 1994), the CFM's definition being a standard model does to some extent suffice the "bundled/integrated functions approach embodied in the healthcare FM approach, proposed by most authors such as Rees (1997) and Alexander (1992). The general consensus within the FM profession (i.e. healthcare facilities mangers, practitioners and scholars) at large is that, facilities management is concerned with the integration of multi-disciplinary support services within the built environment and the management of their impact upon people, technology and the workplace. It also encompasses the development of business facilities from inception to completion (project management) and finally the management of the built asset whilst in use until they have reached their total life cycle (asset management). Other definitions considered in this research which appropriately define FM as a support function in the NHS are summarised in Webber's (1994: pp.7) work. These are elaborated below;

"Comprehensive management of all facilities and associated services and resources which support the primary purpose of the organisation"

(NHS Estates Department of Health, 1992)

"The management of premises and buildings together with facilities services and people contained therein"

(Association of Facilities Managers *[now BIFM]*, 1992)

"The process of outsourcing all or part of a company's non-core business activity to a third party"

(Strachan, 1992)

"Facilities management refers to buildings in use, to the planning, design and management of occupied buildings and their associated building systems, equipment and furniture to enable and to enhance the organisation's ability to meet its business or programmatic objectives. Facility management thus refers to organisational effectiveness". (Becker, 1990)

From the definitions above, it seems that the business-operating environment (servicescape) within which NHS Trusts administer their business, design their products or deliver their healthcare services effectively represents the main framework for facilities management. The first definition recognises the importance of the overall co-ordination of this physical environment and this only seems to capture non-clinical services objectives and healthcare facilities management; and provides a narrow view of the operating environment. The second and third definitions, perhaps as a result of the continuous service development of facilities management in the NHS, seem to represent a more cross-sectional view, by indicating the overall direction or aim of facilities management. Becker's (1990) definition is more explicit regarding the actual life cycle of co-ordination, in terms of design, planning and delivery of healthcare services. He also views facilities management s having a broad co-ordinating image activity but one that causes business and service quality enhancement of an organisation's business strategy and competitive status. Becker (1990) however perhaps failed to mention the relationship between the performance of healthcare services, in terms of enabling and/or enhancing the business operating environment, and their associated costs (Bridges and Baldry, 1996). Becker only contemplates hospital buildings as the working environment. The CFM's (1992) definition, whilst not as explicit about the process of delivery and sustaining the working environment, does give purpose to facilities management by noting the requirement for quality working environments and support services. The CFM definition recognises the performance and cost trade-off by stating that service quality is achieved at best value. This also suggests the CFM views the working and customer service environment in the NHS is far wider than simply hospital buildings. On the business performance side, this definition limits the scope of FM to meeting only the organisation's objectives. In this respect, Becker's definition might be preferred as it raises business expectations of facilities management as a means to exceed stated organisation's objectives through the enhancing capability of support services.

Becker's definition identified five prime drivers of change in service organisations that use FM as a management tool for improving their businesses - these are:

1. *Global competition;*
2. *Increasing/high cost of business and working space;*
3. *Employee/customer increased service expectations;*
4. *Service innovation and technology, i.e. IT and;*
5. *Increasing cost of service mistakes that expose organisation to business risks.*

Although all the above definitions give a clear overview structure of FM in the NHS, Bridges and Baldry (1996) further established a more proactive framework definition based on business service objectives shown in Table 2.1. They suggest that facilities managers have a range of business strategies available to improve healthcare services value that are represented by the improvement of the performance to cost relationship or ratio. For a given unit of expenditure a higher return is received and then improvement relates more to adding value to the trust hospital's service operations and consequently the facilities services would be more effective. Where, however, for a given level of performance, a lower unit of expenditure is achieved and thereby improving on value for money for facilities services. Then improvement relates more to providing value for money for facilities services. In this case the facilities service would be interpreted as being more efficient and, therefore, enabling the NHS trust.

The management of operational facilities services is gaining increasing recognition as a significant factor in determining the level of corporate success achieved by a variety of healthcare organisations whose primary business is other than the management of property and its support services. A critical feature of this professional management function is the policy decision making concerning the source from which other facilities services may be procured. Fundamentally, the choice lies between the establishment or continuation of a directly employed and resourced service organisation, frequently referred to as *insourcing,* or the procurement and appointment of a range of external service providers, each bound by a formalised contractual relationship, commonly regarded as *outsourcing.* The choice is determined by the perceived benefits, which are likely to be consistent with the particular philosophy held by the FM directorate or organisation responsible for providing FM services to the host organisation. In the NHS, there seems to have been an initial trend towards *outsourcing*, during the early 1990's.

More recently, there appears to be an increasingly discerning attitude toward *insourcing*. It is as though we are observing dynamic movements to and from *insourcing* and *outsourcing* which are working themselves to some equilibrium point, given changes in the operating environment.

Table 2.1: Definition framework for FM

Element of Facilities Management Definition	**Definition**
Essential purpose/mission of Facilities	i) To enhance (exceed) and enable (meet) organisational aims and objectives.
Aim of Facilities Management	i) To employ a performance to cost profile to ensure FM services enhance and/ or enable a Trust hospital's aims and objective, whereas; ii) Added value or effective of a service is taken as a means of enhancing the organisation iii) Value for money or efficiency of a service is taken as a means of enabling the organisation.
Objective of Facilities Management:	i) To procure (design, plan, co-ordinate/deliver) and manage FM services to achieve the appropriate performance to cost profile.
Context of Facilities Management	i) To achieve the mission, aims and objectives of Facilities Management within the context of the current and developing working/operating environment.

Source: (Bridges and Baldry, 1996).

This shift might be attributed to the evolutionary process of trial and error as facilities organisations responsible for providing FM services adapt and mature against a climate of accelerating change. This process may not, however, be satisfactory to some trust hospitals that under intensifying competition are unable to allow their future to be subject to such a precarious survival mechanism. A strategic partnering approach to the procurement of facilities services would seem therefore to be required (Pearson, 1998).

2.3 Schedule of services and functions

There are no explicit schedules of FM functions as in reality there is no "standard" hospital.

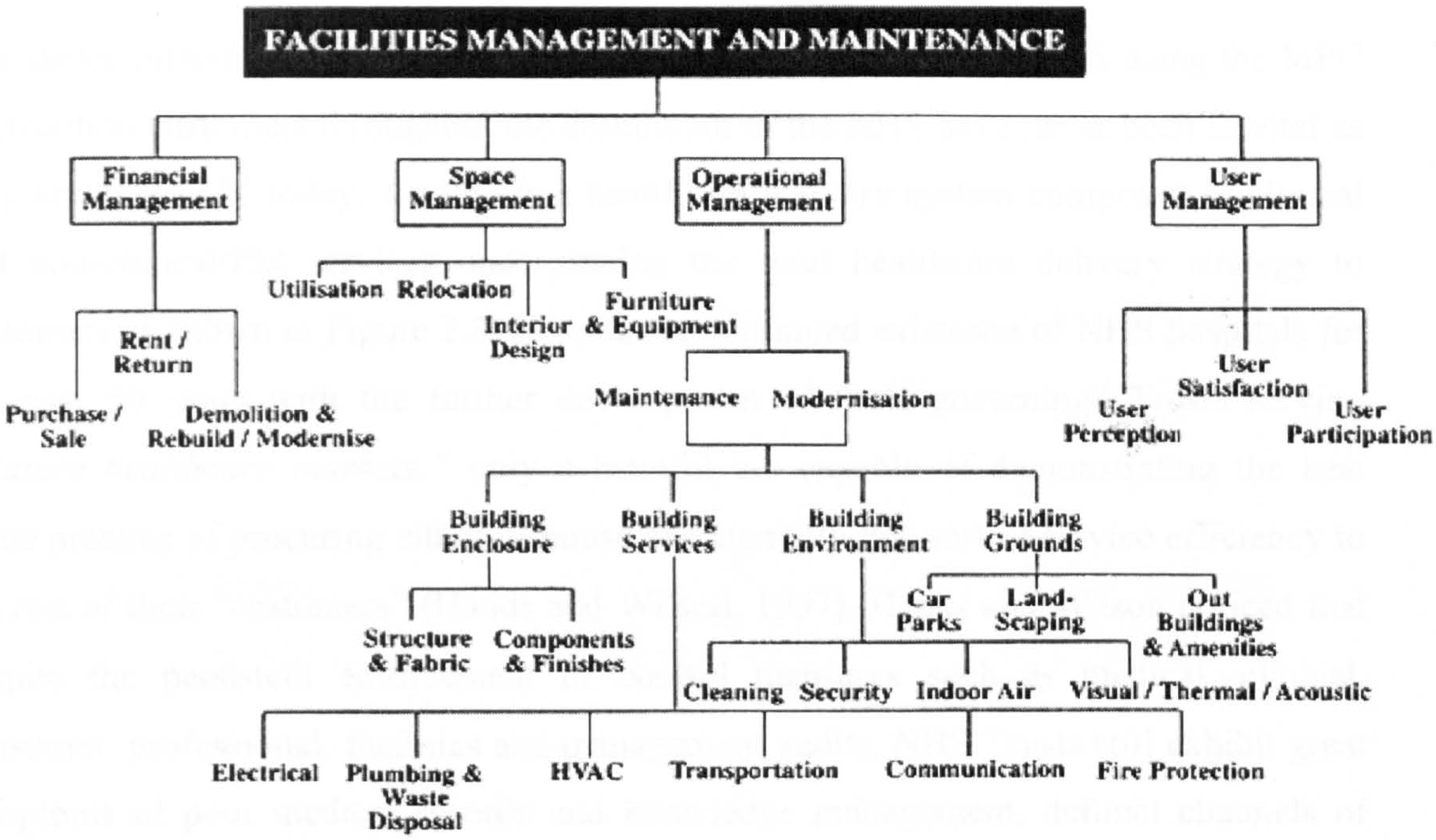
The management of non-clinical services tend to differ from NHS Trust hospital to another (Kitchen, 1998). The variations in functions are mostly attributed to different hospital service types and their overall strategic planning considerations. Webber (1994) and Alexander (1993) offer what might be termed as a generic schedule of the main non-clinical services that are generally classified under the healthcare FM "umbrella". According to Quah (1998) these functions can be further split into four main classes shown in Figure 2.1 that are:

(a) Strategic resources management;
(b) Site services management;
(c) Operations management and;
(d) Stakeholder services management.

In comparison to Webber and Alexander's classification, the above FM functions are not an exhaustive list. In overall FM in Trust hospitals is continuously subject to service cultural change, management involvement, planning and approval of the entire service delivery strategy of non-clinical services. Once a decision strategy has been adopted, and the principles of an integrated management of ancillary functions that support the "core" or primary business in a hospital or a Trust have been agreed upon. Many more support services can be incorporated into a single management directorate. In addition, Okoroh *et al.*, (2001) developed a schedule based on FM surveys that can be regarded as a generic FM services model in the NHS (see Figure 2.2). This schedule encapsulates the business scope of healthcare FM operations and provides a "one stop" strategy of patronising the entire range of "non core/clinical" services. This approach can be seen as delivering high quality facilities that underpin the delivery best value healthcare services, while also using FM as a strategic risk management tool for managing customer-focused healthcare service solutions in the NHS.

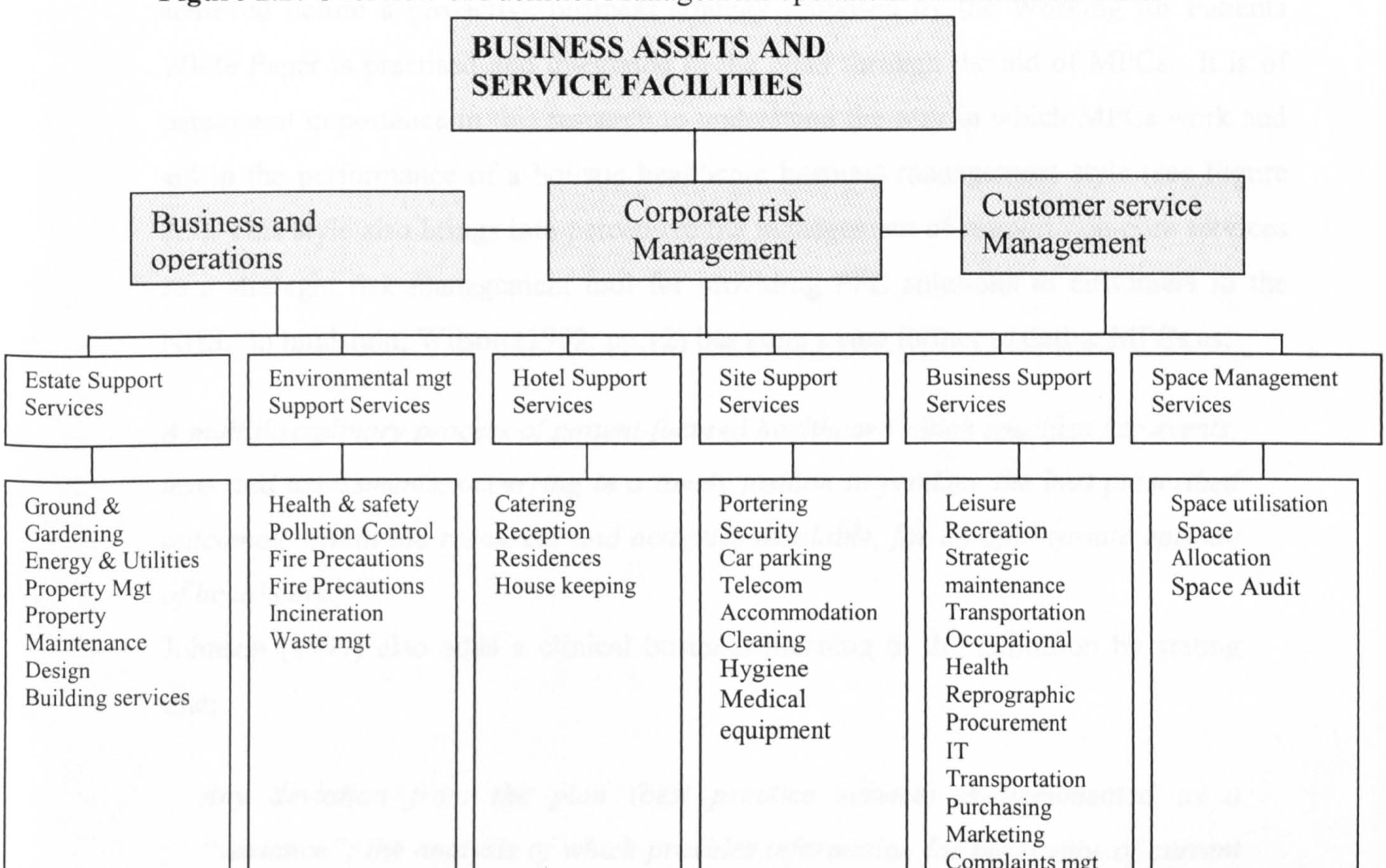
The business intelligence behind this model seems to suggest that, as more FM service operators become customer-focused in pursuit of service excellence, healthcare managers are increasingly becoming knowledgeable that a safe environment (the estate and modern healthcare facilities), clean surroundings (healing environment) and an appropriate diet (hotel and catering services) are all integral parts in the diagnosis, treatment and recovery of those customers who are ill in hospitals (Rees,1998).

Figure 2.1: Overview of the realm of facilities management and maintenance



Source: (Quah, 1998)

Figure 2.2: Overview of Facilities Management operations in healthcare sector



Source: (Okoroh *et al.*, 2001)

2.4 Healthcare services delivery in NHS Trusts

The issues surrounding the effective and competitive delivery of an HIS using the MPC approach to customers throughout the continuum of the NHS have never been as vital as they are in the UK today. An IHS is a healthcare delivery system composed of clinical and non-clinical/FM services underpinning the total healthcare delivery strategy to customers as shown in Figure 2.3. Despite the continued existence of NHS hospitals for the past 50 years with the further development of "self governing" Trusts serving *"mature healthcare markets,"* only a handful are capable of demonstrating the best value practice of procuring either in-house or externally this sort of service efficiency to the rest of their "customers" (Hands and Wilson, 1997). Hands and Wilson noticed that despite the persistent enforcement of control measures such as medical, clinical, consumer, professional, facilities and management audits, NHS Trusts still exhibit great symptoms of poor medical records and knowledge management, defunct channels of communication and time wasting on unplanned business activities.

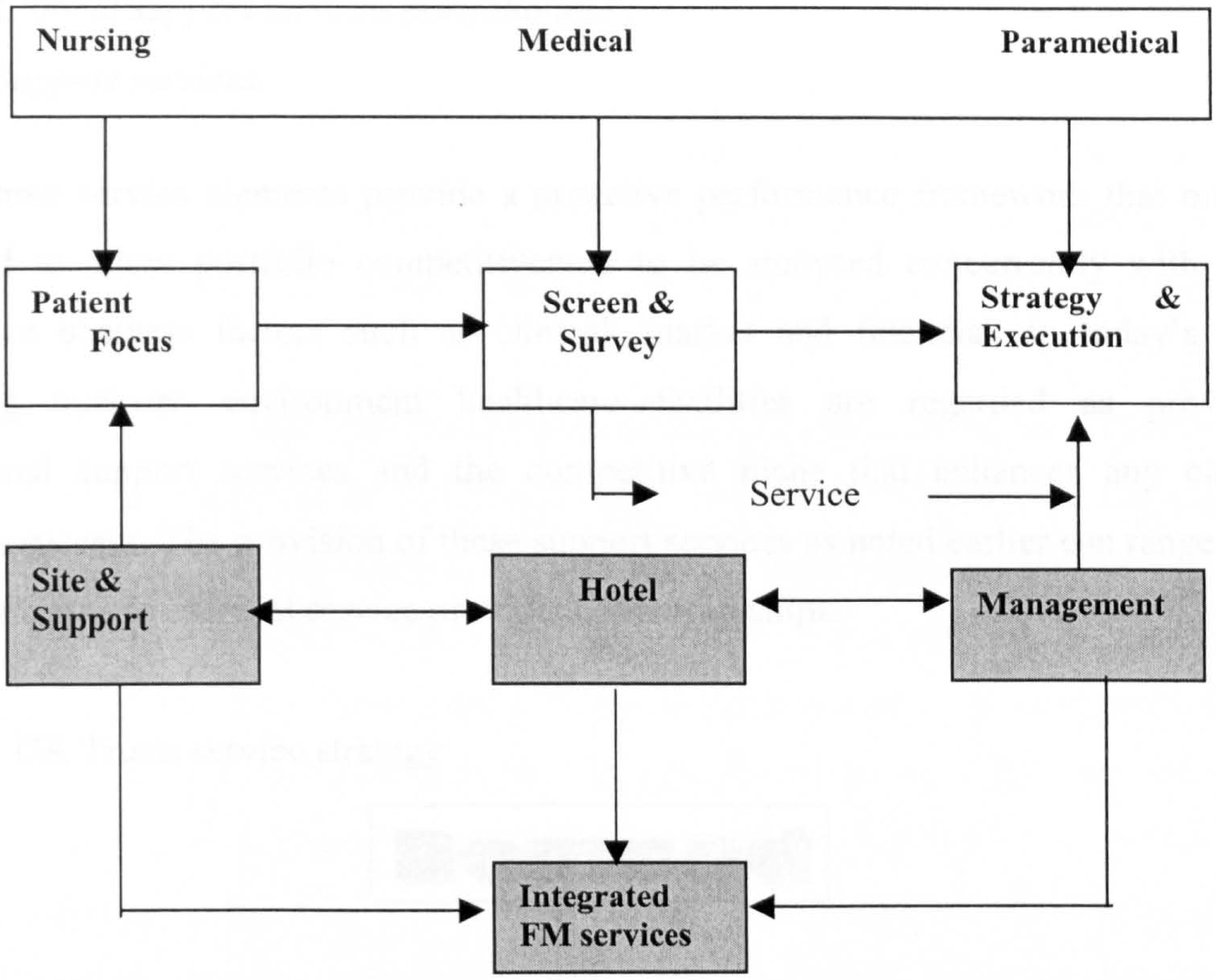
The argument above seems to suggest that there are still milestone tasks that need to be achieved before a pro-active business strategy proposed by the Working for Patients White Paper is practised and integrated in the NHS through the aid of MPCs. It is of paramount importance in this research to understand the way in which MPCs work and aid in the performance of a holistic healthcare business management style (see Figure 2.3). This style also brings into perceptive the management of support/non-core services as a strategic risk management tool for providing PFC solutions to customers in the NHS. In hindsight, Wilson (1992: pp.12) has gone a step further to define MPCs as;

A multidisciplinary process of patient-focused healthcare which specifies key events, tests and assessments, occurring in a timely fashion to produce the best prescribed outcomes, within the resources and activities available, for an appropriate episode of healthcare.

Johnson (1997) also adds a clinical business meaning to the definition by stating that;

> *Any deviation from the plan (best practice service) is documented as a "variance"; the analysis of which provides information for the review of current practice.*

Fig 2.3: An integrated healthcare service system using MPCs



Source: Hands and Wilson (1997)

The MPC approach provides the "best value" care where all the parties (stakeholders) with a vested interest in healthcare business can take part to improve service quality and operational excellence. Furthermore, it identifies, measures, monitors and integrates all aspects of clinical service delivery while the optimum usage of healthcare facilities by customers from the pre-admission clinic, receiving treatment until discharge from hospital becomes a major business niche. The need to follow a MPC route can only be the way forward where there is a good symbiosis between the clinical (core) and non-clinical (FM) services. This business episode also allows clinical services to be integrated and centralised to suit the needs of a rapid changing healthcare business environment, where Trust hospitals are managed along the lines of their core capabilities and competencies (Prahalad and Hamel, 1990). This issue was highlighted in the 1996 NHS White Paper, and is also supported by Johnson (1997), and Hands and Wilson (1997). In addition, Piper *et al.,* (1997) also proposed a corporate strategy that values three types of service portfolios that are integral towards the effective management of any Trust hospital. The three service portfolios shown in Figure 2.4 are;

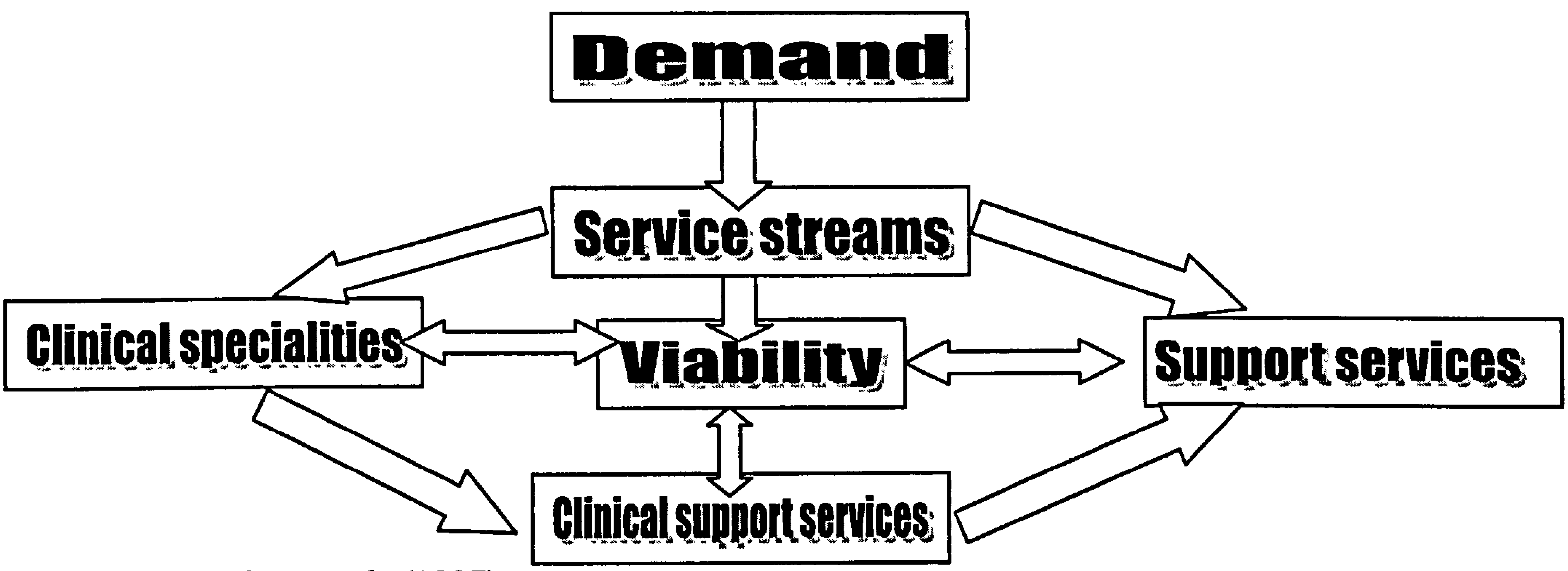
(a) *Clinical services portfolio;*

(b) *Clinical support services portfolio and ;*

(c) *Support services.*

These three service elements provide a proactive performance framework that may be designed to allow portfolio competitiveness to be analysed concurrently with other healthcare business factors such as clinical, market and financial. In today's ever-changing business environment healthcare facilities are regarded as providing operational support services and the competitive niche that enhances any clinical business success. The provision of these support services as noted earlier can range from in-house teams to external service providers or partnerships.

Fig 2.4: UK Trusts service strategy



Source: Piper *et al.*, (1997)

As a result of the above business approaches in the NHS, the management of site, estates and hotels service as a single directorate (Integrated FM) has emerged, as a new business paradigm of post-modern management style in both commercial (Alexander, 1992; Alexander, 1993; Price and Akhlaghi, 1999; Payne and Rees, 1999; and Rees, 1998). An integrated FM approach advocated by many healthcare FM writers has proved to be an effective business performance and risk management tool for benchmarking best practice experiences and cutting costs in the healthcare sector (Smith, 1995; Featherstone, 1999; Akhlaghi, 1997; Payne and Rees, 1999; Bell, 1999; Okoroh *et al.*, 2001).

Akhlaghi (1996) confirms that most healthcare FM executives will be adding value to healthcare service solutions being delivered throughout the whole continuum of care to customers. This approach is based on commercial management systems of integrating non-core (support) services into a single business unit. The past decade has seen commercial organisations starting to influence thinking and organisation system structures in the NHS (Porter, 1985; Prahalad and Hamel, 1990).

Porter's (1985) value chain impressed the need that the overall workplace environment in any business organisation (i.e. NHS trust hospital) must support the primary objectives of that organisation and to integrate resources management as the main "enabler/driver" of business and services performance. In order to begin to understand how working environments contribute to business performance; it is useful to break an organisation into its constituent parts, and to consider where workplace resources add value. Porter has considerably aided this task through his work on "value-chain analysis". The provision of a working and "safe" environment may be seen as part of Porter's business "support activities" which contribute across the organisation's core (clinical) activities. Lack of consideration for overall organisation functional strategy would result in service "marketing myopia" as noted by Theodore Levitt (1960). The management of support services under a single directorate has only just emerged as a new paradigm of cost reduction and service improvement on most profit centre services to make them competitive and be considered as cost centres. This has also allowed FM to have both a corporate and strategic (service operations) position in the planning and management of clinical (core) services. Integrated FM as a new business model is progressively finding its way in the NHS sector where so much evolutionary changes have taken place in terms of a constant shift from public participation to the private sector and delivering best value for money services (see Figure 2.12). As a result of the private sector participation, there has been a constant increase in healthcare FM operations that are estimated to have a workload of over £9 billion pounds each year, and expected to increase by 15% each year in the NHS estates (Bell, 1998).
Howell *et al.,* (1999) defines hospital facility as a complex organisation with many departments that are all inter-dependent in delivering healthcare, signifying that it needed to be managed commercially and effectively.

Furthermore, healthcare facilities service operators continue to be under pressure from customers (patients, staff and visitors) and stakeholders to deliver the best clinical service quality they can offer 365 days a year. In reality they are being requested to provide value for money healthcare through stringent resources by customers who cannot afford to risk the quality of their healthcare and lives. Public sector services, including the NHS, are experiencing pressures as a result of financial constraints, legislative changes, criticism of standards and political tensions over possible privatisation. These factors, coupled with internal pressures, such as local management changes and increased research and technology advances, have increased the quest for best in class service quality. The opportunities for improved service quality in the NHS rest with the recommendations given in the Griffiths Report (1983) and the NHS review White Paper "Working for Patients" (DoH, 1989) about placing the importance of customers' needs first in the NHS. In addition, a Patients Charter (1992) that contains a variety of promises and encourages all potential patients to expect certain standards has been introduced and distributed to every household in the UK. Furthermore, the shift in government policy from bulk procurement of healthcare services (service contracts) to internal market testing has seen the formation a "purchase/provider split" market which is based on understanding the NHS customer's needs through service level agreements (SLAs). This has encouraged private sector providers to participate and allow FM competition and service innovations towards providing best value healthcare services to NHS customers in trusts.

2.5 Core business development in the NHS

The past decade has witnessed a major twist of events regarding market-orientation of the public sector, where competition and efficiency *per ser*, levels have been lagged behind the highly competition-geared private sector. This ideology is centred around United States and UK academics and management practitioners who have undertaken extensive studies on the competitiveness of public service organisations (Prahalad and Hamel, 1990; Senge, 1990; Doyle, 1994; Unland and Kleiner, 1996; and Porter, 1985). For sometime now NHS trusts as public organisations have been lacking support service innovation, competition, learning 'managerialism' and entrepreuaships skills to reduce their propensity to spend.

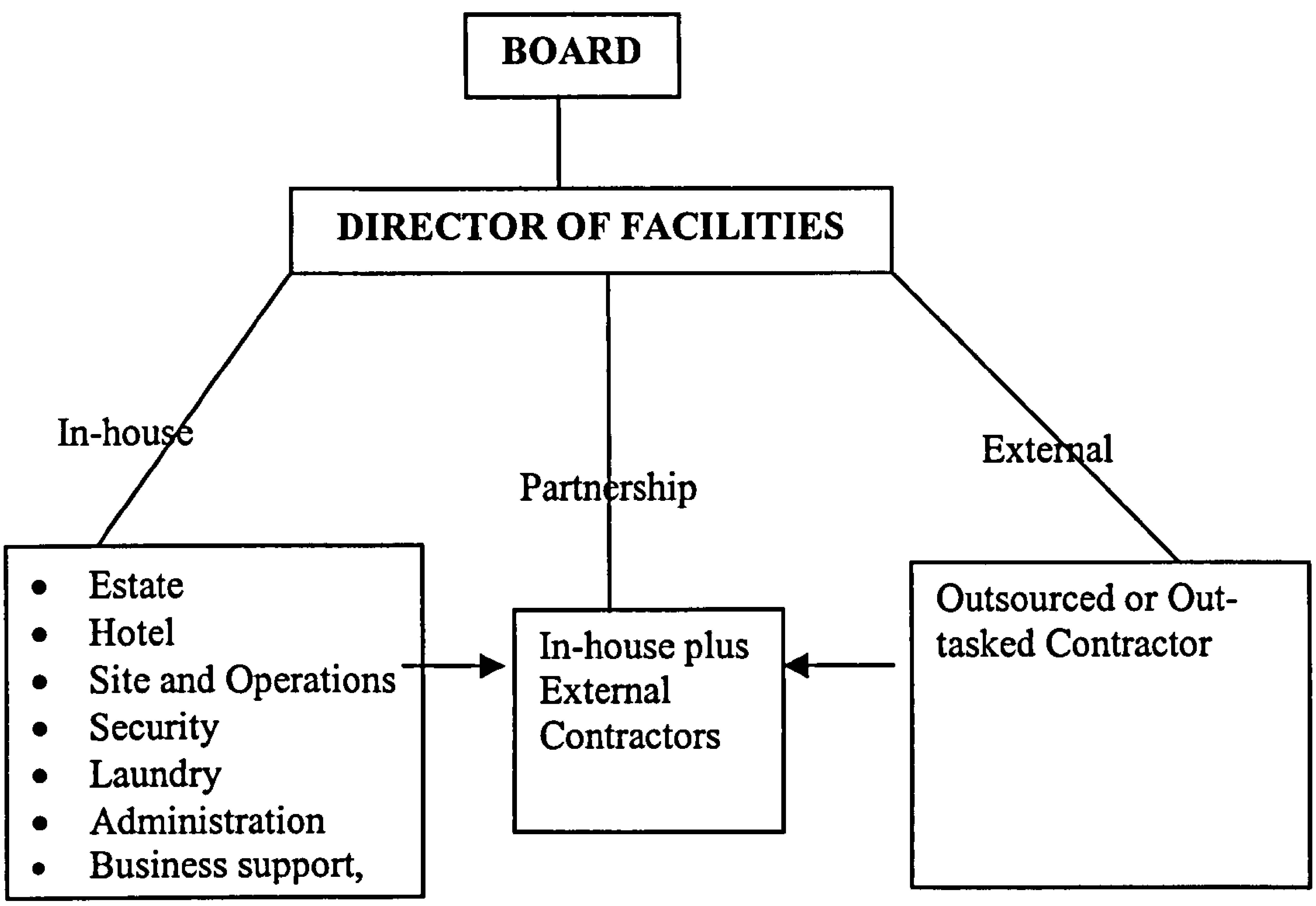
All these aspects as argued by Bacon and Eltis (1976) reflect the need for central government to reduce public sector expenditure and introduce competition in a sector where such economy control measures are highly political and sensitive. The NHS has a virtual monopoly on the provision of healthcare services in the UK. Although there is a thriving private healthcare sector, the NHS provides the bulk of the healthcare services needed by customers in the UK. Invariably these services can be divided into integrated, acute, teaching and mental services. In all types of hospitals, a multidisciplinary team of healthcare professionals provides these care services, each of which deals with a different aspect of the clinical process delivery. The range of professionals includes clinical (i.e. consultants, psychologists, nurses, occupational therapists and doctors) and non-clinical (i.e. facilities, risk and business managers) staff. Clinical business is treated as the core of any NHS Trust hospital, while any other service that is not core is treated as non-core/clinical. These non-clinical services have been in the past retained by hospitals, but now are being contracted-out to attain the best value for money. In relation to this, Howell *et al.*, (1999) provided a classification of two major types services found in "typical general hospital" namely clinical and non-clinical. Piper *et al.*, (1997) further developed this service delivery model based on three healthcare services portfolio. These inter-linked services have been discussed earlier and are shown in Figure 2.4.

2.6 Hospital facility services management

Hancock (1997) states that it seems convincingly clear that a hospital facility should be a healing environment, a healthy place to work and flexible enough to do business, should not harm the health of the environment and should contribute to and be a source of health in the community, but argues that hospitals have not paid a great deal of attention to many of these support service issues until now. Recently, NHS hospitals have learned to be inwardly focused on creating physical, mental and social environments that foster the good health of customers (patients, staff and visitors), while being organisationally effective and environmentally responsible corporate organisations (Hancock, 1997). The physical environment (healthcare facilities) in Trust hospitals has had a vital role to play in the social and mental well being of NHS customers consuming high quality clinical services, while the social environment can affect their physical state.

With such an uncertain situation, NHS hospitals have developed increasingly a service brand of being considered as healing environments for those customers requiring medical treatment and caring. In turn, customers have also been fast at analysing the way hospitals and their healthcare facilities are managed with a view of having repeated business (customer-care) with hospital service providers. Hence those putting customers' needs up-front have been regarded by Hancock (1997), as *customer-passionate* as well as being *"healthy hospitals"*. The concept of healthy hospitals has been gaining support in today's *"modern and dependable NHS"* (DoH, 1997). Hancock reaffirms that a healthy hospital is one that creates a healing environment for customers, a healthy working-place for staff and acts as an environmentally responsible corporate citizen.

Figure 2.5: "One stop" management of non clinical/FM services



Source: (Webber, 1994)

In this case, a hospital is considered healthy by valuing the system upon which its healthcare facilities and business support services were designed, constructed, and managed in order to prevent any transmission of HAIs to customers (patients, staff and visitors).

Another panoramic angle of viewing the "healthiness" of these hospitals would be to evaluate the best practice experiences in which non-clinical services are integrated to sustain and create a patient caring environment (Webber, 1994). This approach is highly recommended by the "Clean Hospitals Initiative" Report and NHS Plan that aim to improve the way hospital facility services continuously support the delivery of clinical services in the NHS (DoH, 2000).

According to Payne and Rees (1999) and Gallagher (1998), integrated FM approach in NHS trusts has provided a "one stop" management strategy for healthcare executives and a competitive niche for delivering cost effective and responsive support services to NHS customers (see Figure 2.5). The implication for those healthcare executives tasked with the management of healthcare facilities and support services would include among others, greater emphasis on healthcare service quality control, value for money audits and detailed cost cutting measures for elements of the provision of those services. In so doing, FM services will be underpinning the "mission critical" (clinical) events of providing healthcare needs in Trusts where increasing market-driven forces and competition signs of providing a service have increasingly caused disadvantages in the NHS.

Lately, healthcare services in NHS Trusts have been re-engineered towards encompassing all the necessary best/better business practices in order to compete for service delivery with commercial competitors and healthcare providers such as GPs, Primary Care Groups and external service providers. In order for NHS hospitals to compete effectively, they have been pushed by central reforms and market forces to deliver healthcare services using an integrated approach that involves using multivariate business skills and expertise in a sector where operating resources are not always adequate. Great domination of clinical governance and effectiveness has been the main focus at the expense of good business management and service continuity in the NHS.

In support of the White Paper Working for Patients and the NHS Plan regarding non-clinical services management, Scot-Thomas (1998:pp.19) categorically states that, *"It has always been relatively easy to monitor the costs of healthcare facility services and manpower but quality of service is a major issue in the Government's White Paper, this also will now be very much part of the management process"*.

Scot-Thomas' remarks clearly point out for any strategic healthcare service delivery analysis to be made in the NHS, it must be based on rationale business decision-making and on integrating support services to front clinical services, in order to add value to the delivery process (care pathways) used by the healthcare executives in a hospital.

2.7 Business scope and stakeholdership of healthcare FM operations

Healthcare FM services are often delivered by a mixture of best multi-disciplinary service providers and purchasers to stakeholders. Providers can either be the in-house teams, external contractors or a mixture of in-house and external contractors in partnership to supply best value for money support services that enable the purchaser (Trust) to achieve its clinical business objectives. Purchasers in healthcare FM operations are trusts procuring non-clinical services to supply their internal clinical directorates, customers, staff and visitors to a hospital facility. Stakeholders exist side-by-side with service providers in the supply of service quality FM and value chain. Stakeholders are parties with a vested interest in the design and delivery of high quality support services to the rest of the healthcare consumers. They can be the clients/purchasers (Trusts), Primary Care Trusts, GPs, Social Services, contractors/providers, the public, government, politicians, and customers. FM stakeholders are vital for the meeting the successful delivery of the support services that underpin the delivery of a patient-focused healthcare system in NHS hospitals.

2.8 FM service purchaser/client/customer

In healthcare FM service operations the client or purchaser of non-clinical services in the NHS will usually be a NHS Trust. There may be some instances where a clinical function is involved, where the purchasing Health Authority may wish to assume the intelligent client's role as part of their contracting or operating role. Invariably, a Trust or Health Authority may act as the client not only for itself, but also in an "Agency" capacity for other service providers (GPs, PCTs or Community healthcare service providers) and customers (internal directorates). In such cases, the service specification, accountability and responsibilities have to be clearly spelt out in the service contract initiation period and comprehended by the parties involved. This is because FM services can be delivered on multi-sites that have varying service needs and possibly different manpower resource requirements across the trust.

However, other instances may occur where the ostensible client may outsource FM services by contracting out preparatory work to be executed by an external provider, including FM facilitators, consultants or government bodies/agencies. This does not shift the prime responsibility of the client from the total FM operations, but in some cases the Strategic Health Authority may also act directly as the service purchaser or client in certain centrally funded (blocked or targeted capital) FM operations. These are regarded as PPFI and PPP projects, where a certain percentage of work could be carried out in Trusts or the PCT.

2.9 FM service providers/contractors

FM contractors employed by NHS Trusts to manage non-clinical services are often regarded as service providers in FM contract terms. These potential contractors can either be one of the following;

i) In-house resource teams or directorate.
ii) External commercial contractors
iii) Strategic partnerships (mixture of both in-house and external contractors)
iv) NHS Estates or other central agency, local and community authority, Primary healthcare groups or GPs.

2.10 FM service In-house providers/contractors

Traditionally, the in-house estates, works and hotel departments have competitively delivered the majority of non-clinical services required by hospitals. It was until recently, when most of the support services were market tested to include external commercial contractors. This was also in compliance with the European Union Services Directive (1993) regarding Public Supplies and Procurement tenders to be Market tested. This approach changed all customary practices and even the in-house service providers had to compete for work with external service providers; and also had to demonstrate that they could provide best value for money and high quality services. The demonstration would prove beyond doubt and act as a performance guarantee for securing future FM service delivery operations. It has always been a custom in the NHS not only to protect the employment position of the in-house staff as far as possible, but also that they can be afforded a fair competitive advantage.

Protection has been provided through a set of rigorous processes of formal consultation with directly the staff themselves or with trade unions that represent staff in matters relating employment relations with NHS Trusts. It can be argued that in business, effective market competition can be maintained through the use of extensive utilisation of documentation and formal processes acceptable to most bidders, with the exceptions of restrictive clauses such as those of requiring the service provider to have an in-depth or prior knowledge of the support services functions to be provided. In some cases in-house resources have approached the provision of support services by either bidding for management or employee buy-outs becoming SBUs and any strategic decision would be based on use of management decision support systems to allow the in-house directorates to reach a conclusive decision of whether to proceed with this process or not. Decision-making would aid service providers to pre-judge the implications of proceeding with the tender process successfully. It would help to assess their position in situations where they might have lost the bid to manage the FM services. In such a case, the role of the most senior healthcare executive (Facilities Director) of the support services directorate may need to be clearly defined and understood. As a result of service provision competition, some in-house FM providers/directorates have been transformed into SBUs that are autonomous and financially independent of the main purchaser/NHS trust' cost budget. In these instances the in-house providers would have to resource and manage their FM units to become profit centres whilst moving away from being cost centres that rely on funding allocation from the main purchaser/trust. This is necessary, as the in-house team will become part of the preparation of service specification and tendering process but equally, the process of the service bids is time-consuming and a laborious task which require an input of multi-disciplinary skills from healthcare to commercial FM experts (i.e. corporate PFI projects). The high level of competency may not only be required for the bid preparation, but also for the continued maintenance and operation of the day-to-day FM operations already available which requires constant strategic management.

2.11 External commercial providers/ contractors

All most all competitive FM services contracts will involve external service providers. External providers normally posses abundant direct expertise and support resources in healthcare service provision and operations.

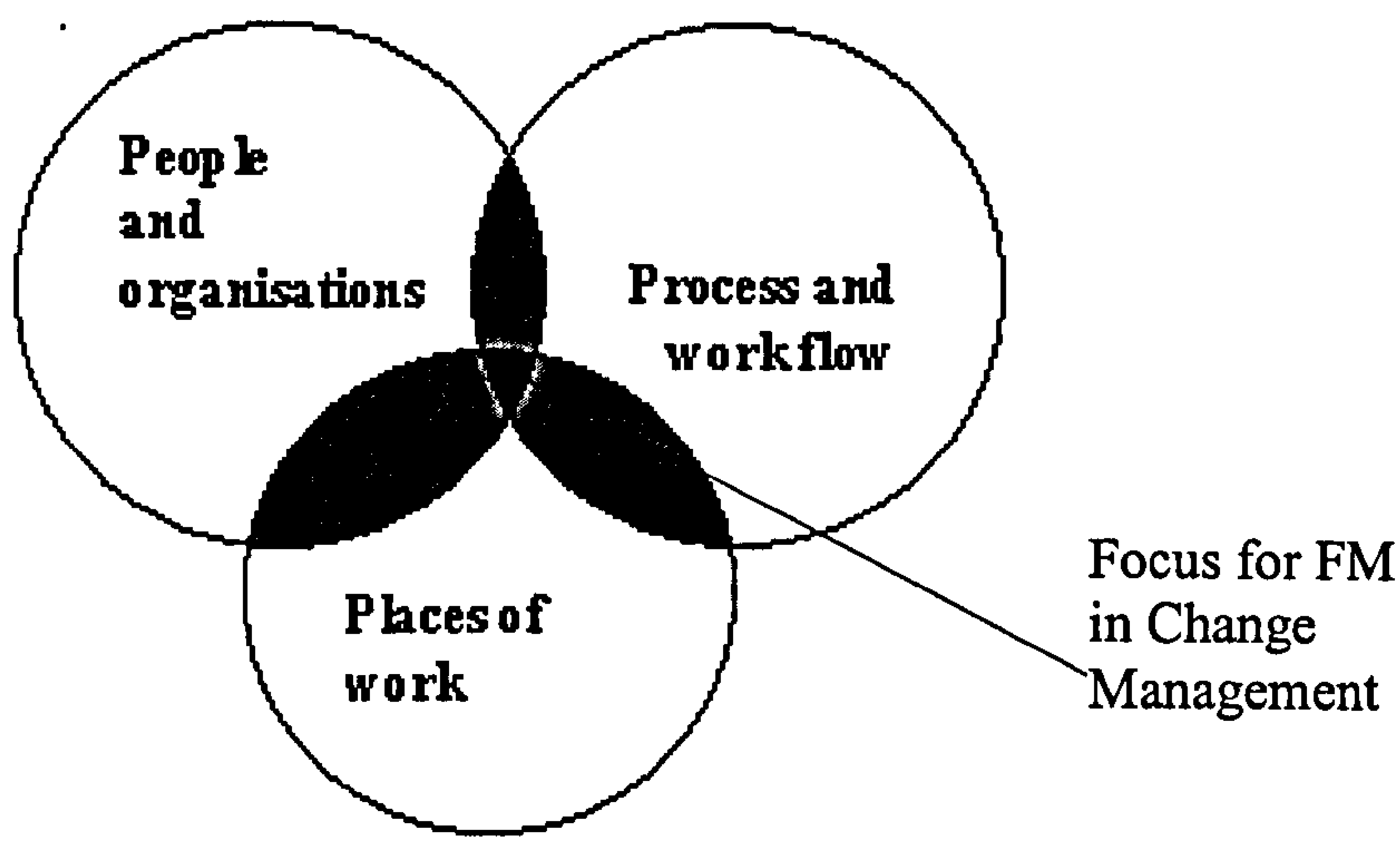
This experience is normally relevant to a particular non-clinical function or an integrated service package to be delivered to purchasers and customers. In this case, the purchaser or customer will be the NHS Trust procuring FM services to support the delivery of clinical services to its consumers (public). As part of the FM provider selection process, Trusts should be able to implement selection methodologies or DSSs that will carefully evaluate the ability of the FM provider to deliver the best value support services. The selection can include a quantitative evaluation of the provider's performance using a variety of resource variables established in Webber's (1994) work. If a quantitative approach is used for pre-qualifying the FM provider on major FM projects using these variables, a business model can be used to aid the selection and decision making process of the "best fit" FM provider for the Trust. In recent cases most NHS Trust hospitals have resorted to using commercial providers as a means of providing extra innovative resources such as funding, expertise, physical and intellectual assets. This arrangement has made it possible for Trusts to share and transfer risks to their external providers either in strategic partnering or completely under the PPP and corporate PFI (Jones, 2000). There are a number of examples in the NHS where strategic partnering or partnerships and PFI arrangements have been formed through market testing (Okoroh *et al.*, 1998). Detailed framework and guidelines information of implementing PFI projects in the NHS are available through the NHS Estates. The NHS Estates is an agency of the NHS Executive dealing with estates and facilities service provision issues in the UK.

2.12 Types and models of Facilities organisations and value improvements

In search for more healthcare business flexibility and excellence in providing responsive healthcare to patients, staff and service-users, several models of delivering FM services in Trusts have been developed. These FM service models are based on the competitive scope of delivering FM services to various segments of customers in the NHS. Various researchers and practitioners have also proposed a number of FM organisational and operating models. The most popular one is the DEGW model of FM shown in Figure 2.6. This model is based on business factors that have evolutionary led to the development and operational changes within NHS hospitals. The model neatly encapsulates the role of facilities managers as that of being a change agent or project manager.

While changes in healthcare organisations are continuous at the same time can be due to other influences, the FM directorate must focus on meeting the support needs of the trust. This challenge will allow the trust to be flexible to adapt to future changes on the market place and the business environment. The focus on the changing business environment will bring with it a handful of strengths and opportunities for the facilities manager to practically co-ordinate and package the required portfolio of property, goods and services that best support the organisation's needs (Payne and Rees, 1999).

Figure 2.6: The DEGW model



Source: Payne and Rees (1999)

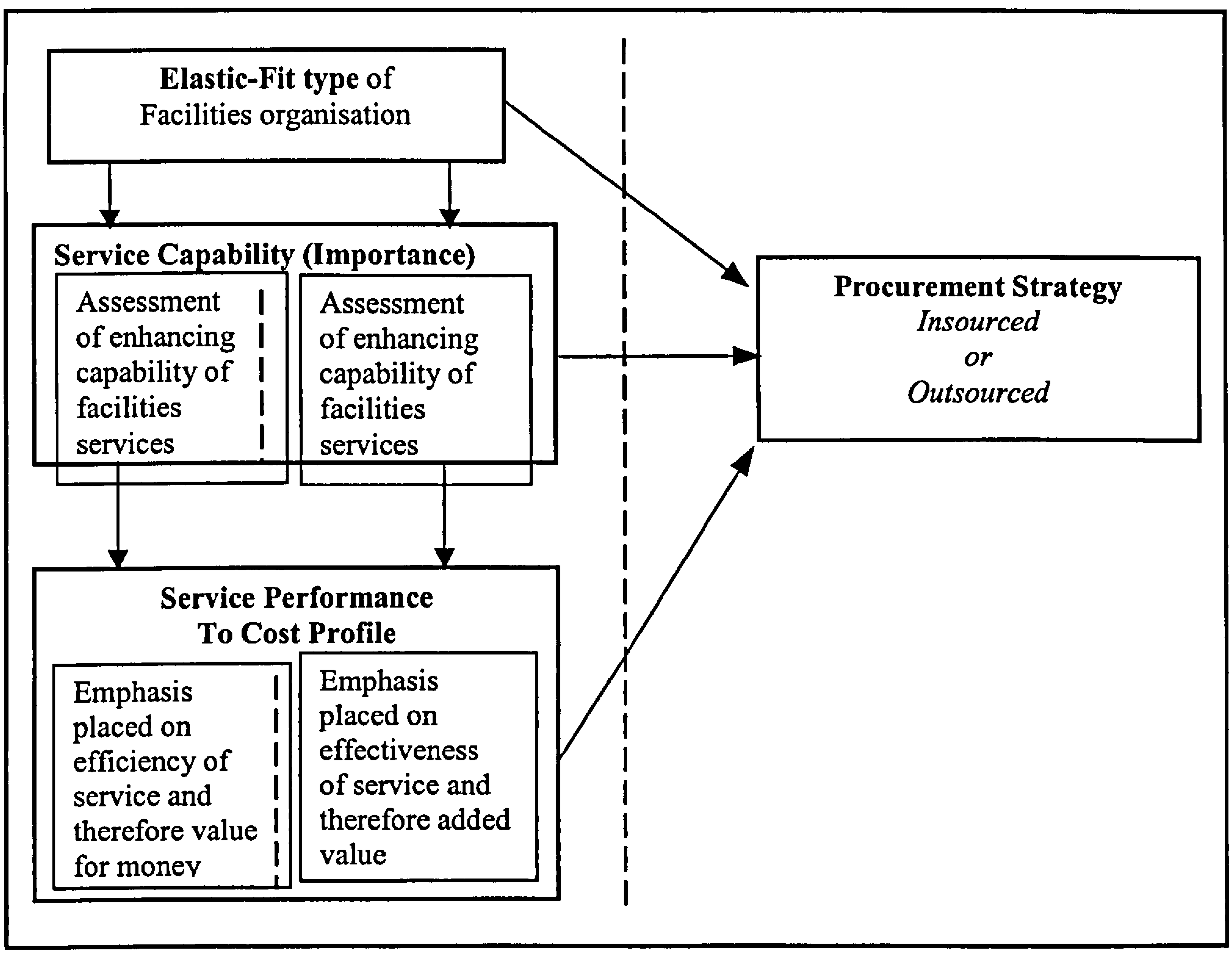
In modification of the DEGW model, Payne and Rees argue that the healthcare facilities manager must have clear focus of changes taking place and those that are relevant within the NHS. Bridges also developed his own model based on facility procurement decisions from *insourcing* to *outsourcing* shown in Figure 2.7. Brigdes (1998) regarded this process of procurement shift as moving towards "maturity" stage in FM organisational behaviour. As an extension to Bridges' work, the Health Facilities Notes 17 (1998) also developed a FM organisational model applicable to FM directorates in the NHS. This model is based on the analysis carried out by the CFM (1996) regarding the market of facilities management in the NHS. Webber's (1994) work also constitutes vital contribution towards the establishment of FM organisational models. Varcoe (1996) proposed his model based on the service marketing and niche analysis of the scope of the FM industry. This model seems to correspond with the CFM's (1996) model already described above.

Other proponents of FM models are Barrett (1995) and Williams (1996) whose models are all based analysing the FM service value chain and providing competitive customer services to a business organisation.

Bridges Model – ***Loose-fit***

This type of facilities organisation was believed to be a SME or "start-up" service organisation providing FM services to its customers in a basically stable business environment.

Figure 2.7: Theoretical framework under the NHS market conditions



Source: Bridges (1998)

The strategic intent of such an organisation would be on facilities service effectiveness. According to Brigdes an organisation of this nature would tend to focus on insourcing a wide range of FM services under its portfolio.

This scenario would be typical to those hospitals that manage their FM services using in-house resources to supply both their internal clinical directorates and external customer (patient, staff service users) with FM services. The in-house team will then be able to meet the core (clinical) service objectives by formulating various internal service level agreements with the hospital departments for which the service is delivered to. The external FM provider will take up agency for the trust towards the manning the healthcare facility and support services.

Tight fit

This type of facilities organisation was believed to be a "large organisation" operating in turbulent business environments. The competitive strategy for such organisation would be to economise on facility services operating costs and efficiency. This situation is typical to acute trust hospitals concerned with maximum facility service utilisation for business success. These types of trusts would tend to free up their in-house resources and conserve them for those support service functions that enhanced a hospital's flexibility and service development. According to Brigdes such hospitals would tend to strategically focus on contacting out (outsource) the provision of FM services.

Elastic fit

These are organisations such as NHS hospitals that are concerned with continuous service improvement by adopting a "mixture portfolio" which combines both insourcing and outsourcing of facility services. In other words such hospitals were concerned with delivering multi-FM services to customers at best value (Akhlaghi, 1997).

2.13 Webber Model

The Webber model established four generic models of FM organisations in the NHS which are listed below;

i) *traditional approach-* managing facility services through in-house contracting (in-sourcing). A small package of specialist FM service contracts may be patronised by a single FM directorate under the leadership of a Facilities Director who has the task of integrating the services in small manageable units.

ii) *balanced approach* – by using both in-house resources and outsourced functions, including specialist contracts. In this model, the integrated services such as site, estate and hotel may be outsourced, while some are retained in-house.

iii) *Total FM outsourcing* – a complete procurement of the majority or key (hard and soft) FM services from an external provider. This may also involve the transfer of FM business including human and technical resources to the external contractor or sub-contractors. In most cases an in-house FM directorate is retained to offer strategic focus on healthcare FM operations.

iv) *Private Finance Initiative* – This FM model involves a total outsourcing of all deliverable FM services by a hospital trust from a commercial provider. In this service transaction the private sector provider uses private sector resources such as finance and manpower got from perfect markets. The provision of integrated/turnkey services or TFM is achieved through an effective project management contract of designing, constructing and operating and or ownership transfer of the healthcare facility. The management of healthcare facility services by the external provider is purely treated as a full business case that needs approval from both the responsible Strategic Health Authority and the central government Treasury's PFI Unit.

2.14 Health Facilities Notes 17 Model

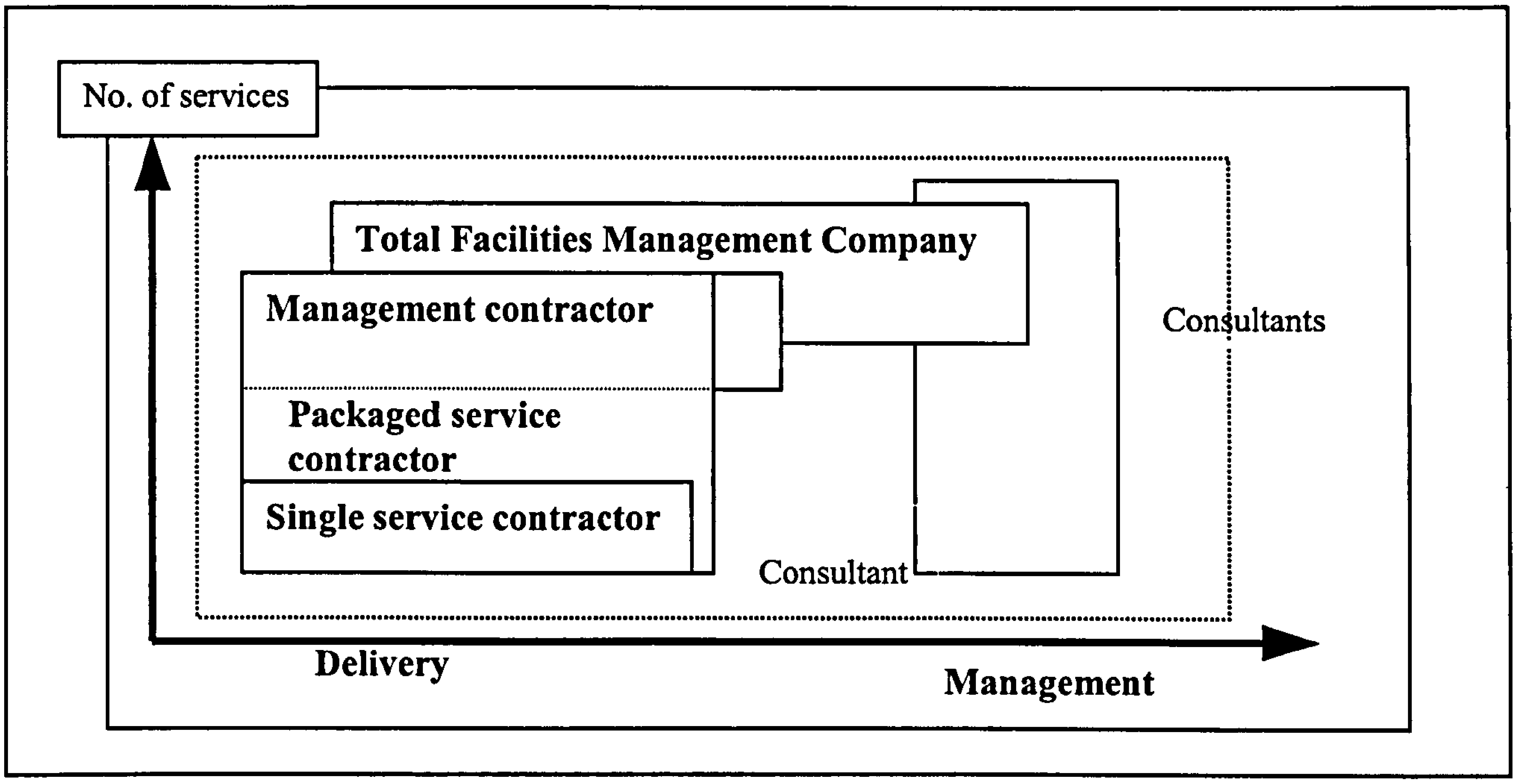
The Health Notes 17 model is based on the scope of FM in business with hospital trusts. In this model the various strategic FM options in healthcare are valued against the Trust's business needs. The trust will then have to justify the use of any chosen procurement approaches shown in Figure 2.8. The approaches that might be utilised by a Trust do vary in terms of how knowledgeable/smart the Trust (client) is regarding the procurement and delivery its FM services. Basically, the model conforms to a variety of service provision options available in the NHS that can either be;

i) *Single service contracting* – FM service providers who specialise on providing a single (out tasking) value added support service function.

ii) *Packaged service contractor* – FM providers come together to draw up a variety of FM functions that they can provide to the purchasers individually.

iii) *Total FM* – FM providers may deliver and manage a wide range of non-clinical services either directly or by sub-contract. In this type of service provision, FM providers also offer an integrated day-to-day approach to the trust by taking over management responsibilities from the trust

Figure 2.8: Framework of the FM industry



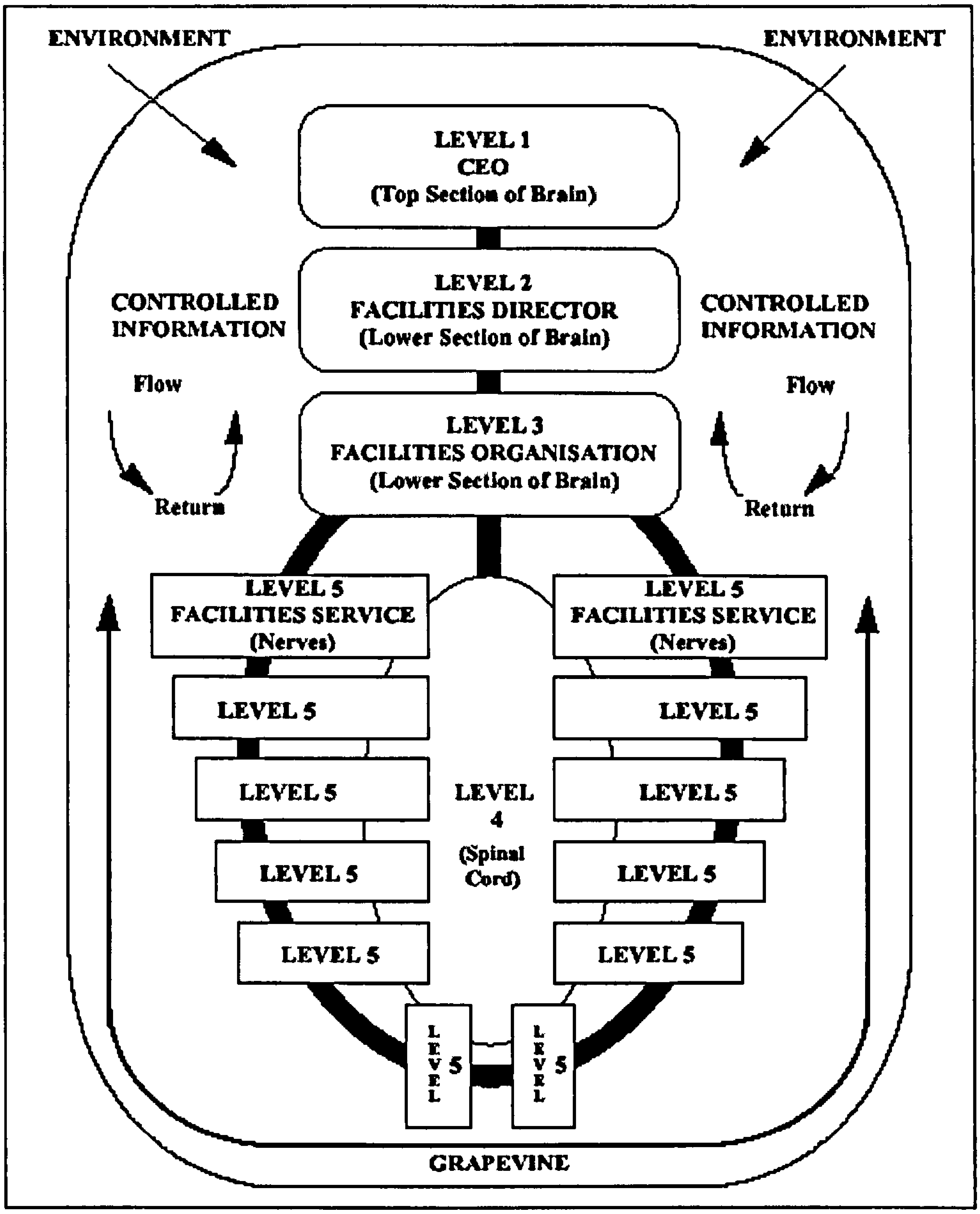
Source: CFM (1996)

iv) *Management agency* – Project Agents or FM consultants are appointed by trust to provide a PM only of FM services to trust hospital. Delivery of other FM services will be through entering into a FM contractual agreement with the Project Manager.

v) *Consultants* – FM consultants offer advice across a range of support services and also become facilitators of the new FM business process to the trust. Consultants are always the first point of contact in a FM outsourcing process, or may be called in at a later stage (transitional periods) to facilitate and implement the effective management of the FM contract.

Another intriguing business model that represents FM service delivery in NHS organisations was developed by Bridges and Baldry (1995) and is based on the "human nervous system".

Figure 2.9: FM organisational service delivery structure



Source: Barrett (1995)

The original architects of this model are Beer (1972) and Bennett (1991). Bennett and Beer found out that the human nervous system provides a highly complex technical model of the role of conscious and sub-conscious knowledge that is applicable in FM decision-making. In this case the human nervous system performs functions, which are in relation to its environment (body system). Beer and Bennett's models apply to the control process in human nervous systems to humans, and can be easily adapted to reflect today's facilities service organisations.

In particular, this model can also be used to depict management control processes in support services management as shown in Figure 2.9. For an overview outline of how the nervous system can be used to illustrate an FM organisational service delivery structure, Bridges and Baldry (1995) provide more theoretical knowledge.

2.15 Generic FM Model

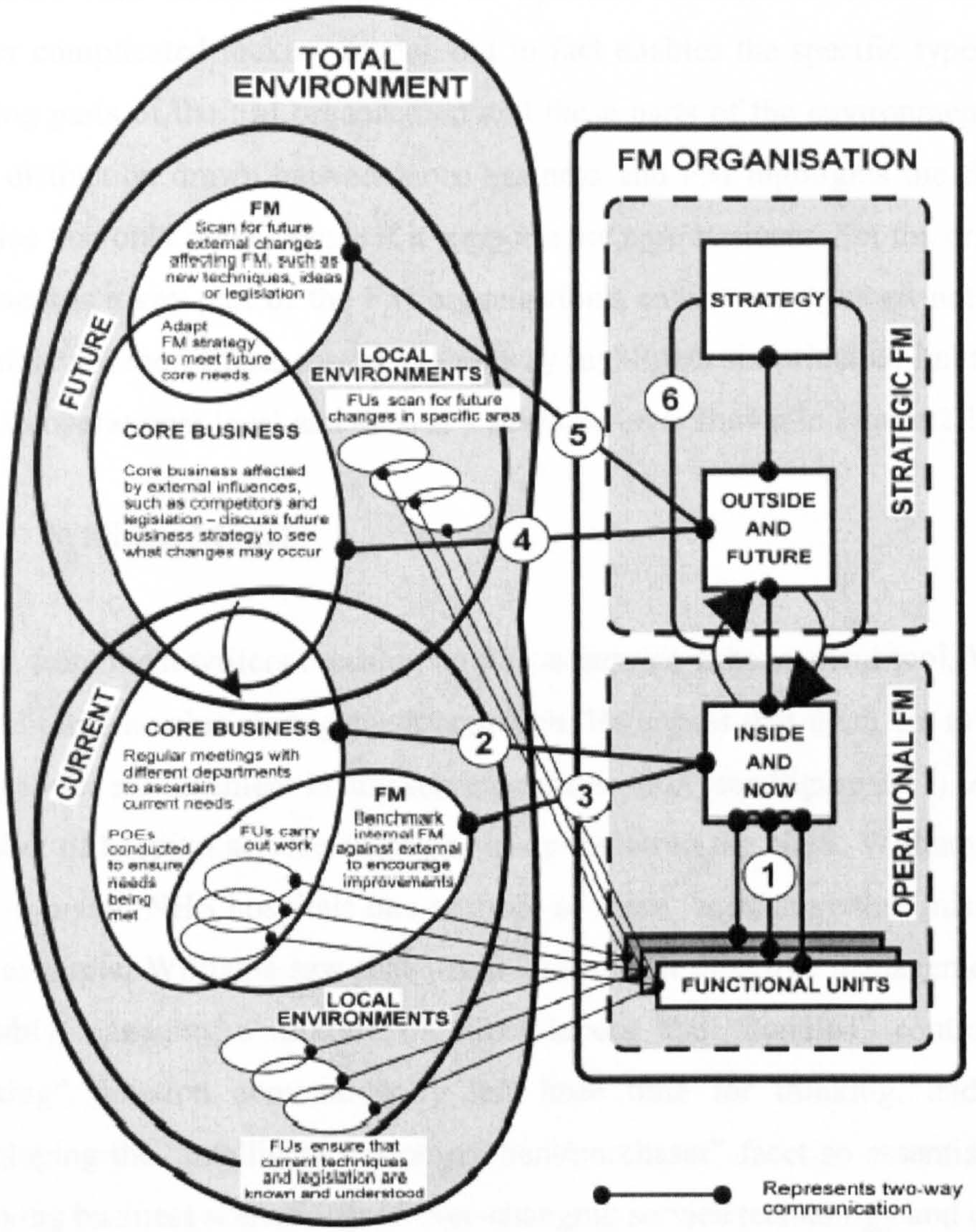
Barrett (2000) views FM as the only function or system of an organisation that is capable of adjusting its business and competitive strategy on the service market. As service organisations have been stretched to their limit in terms of competition and their quest for service quality and customer satisfaction, the need to use FM as a value adding element in delivering an organisation's core services to its customers becomes unavoidable at all times. An example of a systems model in facilities management proposed by Barrett (1995) in Figure 2.10 shows the function of facilities management in an organisation as comprising a complex network of the total business environment and performance (holistic) relationships. If the holistic approach is favoured, it implies that performance of the whole business services must be assessed, because it would not be the same as the sum of the performances of its parts. Therefore, using Barrett's arguments on total (holistic) business performance management, a generic model of facilities management based on extensive collaboration between FM service operators and service management experts can be developed. The model was created through iteration between theoretical modeling and a range of case studies in a form of soft systems analysis (Beer, 1985). The theoretical background of the model is in business information systems management. The basic approach to this model is balancing of information flows through consideration, and these are applied to FM organisations stressing two fundamentally simple ideas (Barrett, 2000).

i) An organisation's servicescape can be divided up depending on time scale, ranging from immediate to very long-term, and the organisation has to respond appropriately to inputs from each zone. These inputs will vary quite considerably in their characteristics with very broad conceptual data related to the long-term, contrasted with detailed, factual information about many short-term, issues.

ii) Each interaction between the organisation and its business environment will be in balance through the use of *"attenuators"*, for example, summary reports, and *"amplifiers"*, for example, photocopiers. The same applies to the interactions between different parts of the organisation.

Simplifying, at a very general level Barrett suggests that there will be mechanisms for managing the *"inside and now"* and the *"outside and future"*, with *"strategy"* balancing the two.

Figure 2.10: Generic FM organisational Model



Source: (Barrett, 2000)

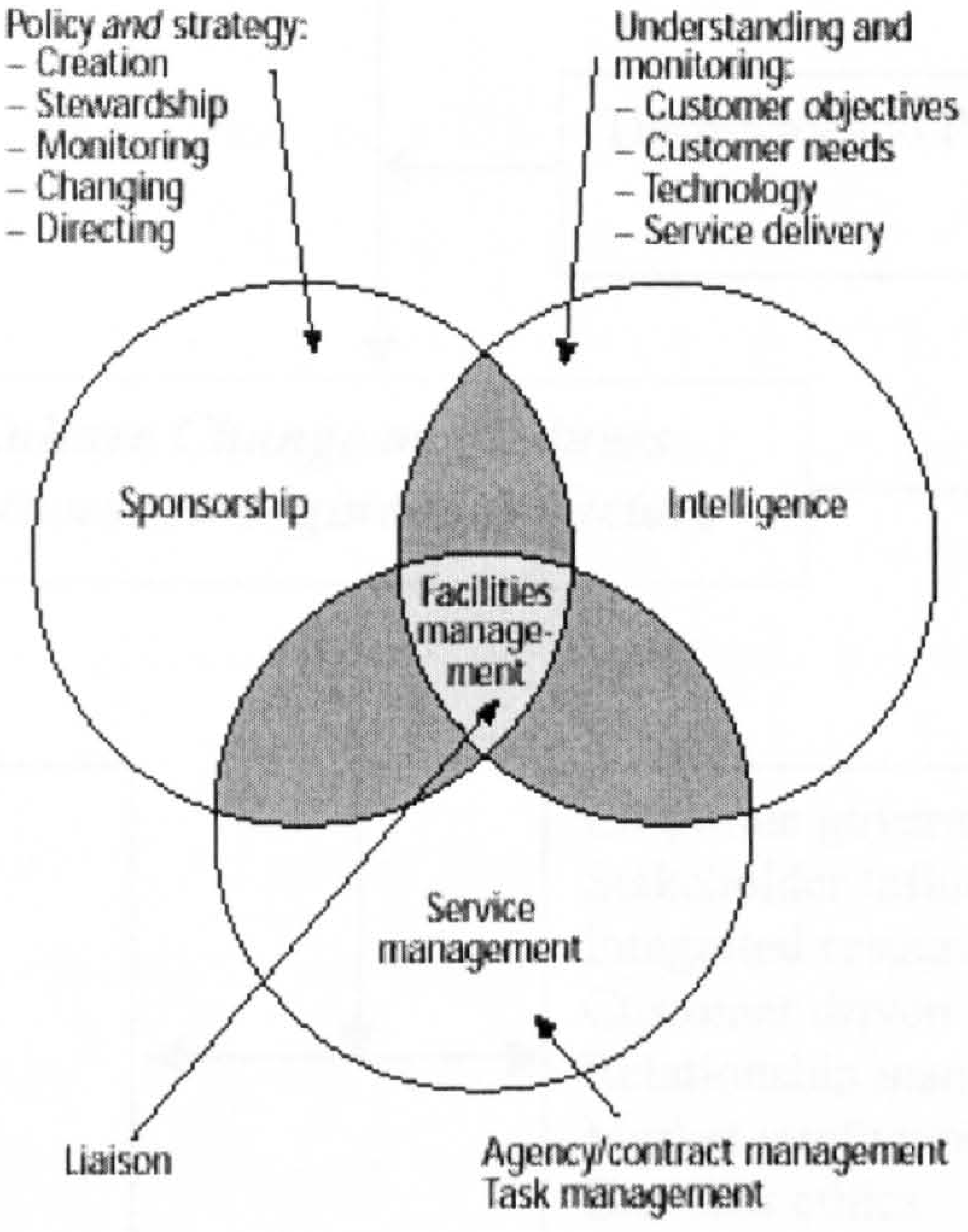
Taking the need for the facilities management organisation to respond to various time zones of the business environment and linking it to the notion of requisite variety leads naturally to the need for there to be aspects of the organisation that relate to each of these zones. In addition there is the level of facilities operations that is the activities that FM manages. This part of the structure could be termed *"functional units"*. Figure 2.10 shows the business environment primarily divided between the "current" and the "future" environment. The development of this part of the model took a lot of effort driven mainly by the case study information and resulted in a classification of parts, distinguished by time scale, but also by whether the focus is on FM or core business. In addition, each functional unit has its dynamic business environment. This creates a rather complicated looking model, but in fact enables the specific types of information linking parts of the FM organisation and these parts of the environment to be clarified. The distinction drawn between core business and FM highlights the fact that FM is a service that only makes sense if it supports the core business. So, the organisation's core business is a key part of the FM organisation's environment, albeit not the whole of it. Formulating the generic model in this way highlights six principal linkages, ie levels 1-3 at an operational level and 4 - 6 at a strategic level shown in Figure 2.10

2.16 Williams Model

Apart from most writers focusing on FM as service enhancement tool, Williams' (1996) model takes a value management approach. He argues that there are in fact three facets of facilities management in any service organisation (see Figure 2.11). After analysing a number of hospital service strategies in operation in the NHS, Williams was convinced that in many NHS hospitals one or more of these facets are either missing or depleted. For example, Williams saw that where the overall directive management is in-house – possibly managing a mixture of direct labour and "bundled" contracts – the "fire-fighting" function conventionally left little time for thinking, and little time for developing the "intelligent customer/client/purchaser" facet so essential in a constantly evolving business scenario amid ever-changing service technology and delivery regimes. The three facets found to be missing in most NHS organisations by Williams' model that define the scope of FM are: sponsorship (service funding), intelligence (knowledge of customer and market needs) and service management (contract and services management).

Therefore, Williams proposed that proper allocation of resources to each of these facets is absolutely critical to the achievement of cost-effective facilities, an axiom of true management concept of financial control in FM operations.

Figure 2.11: Scope of three facets of facilities management

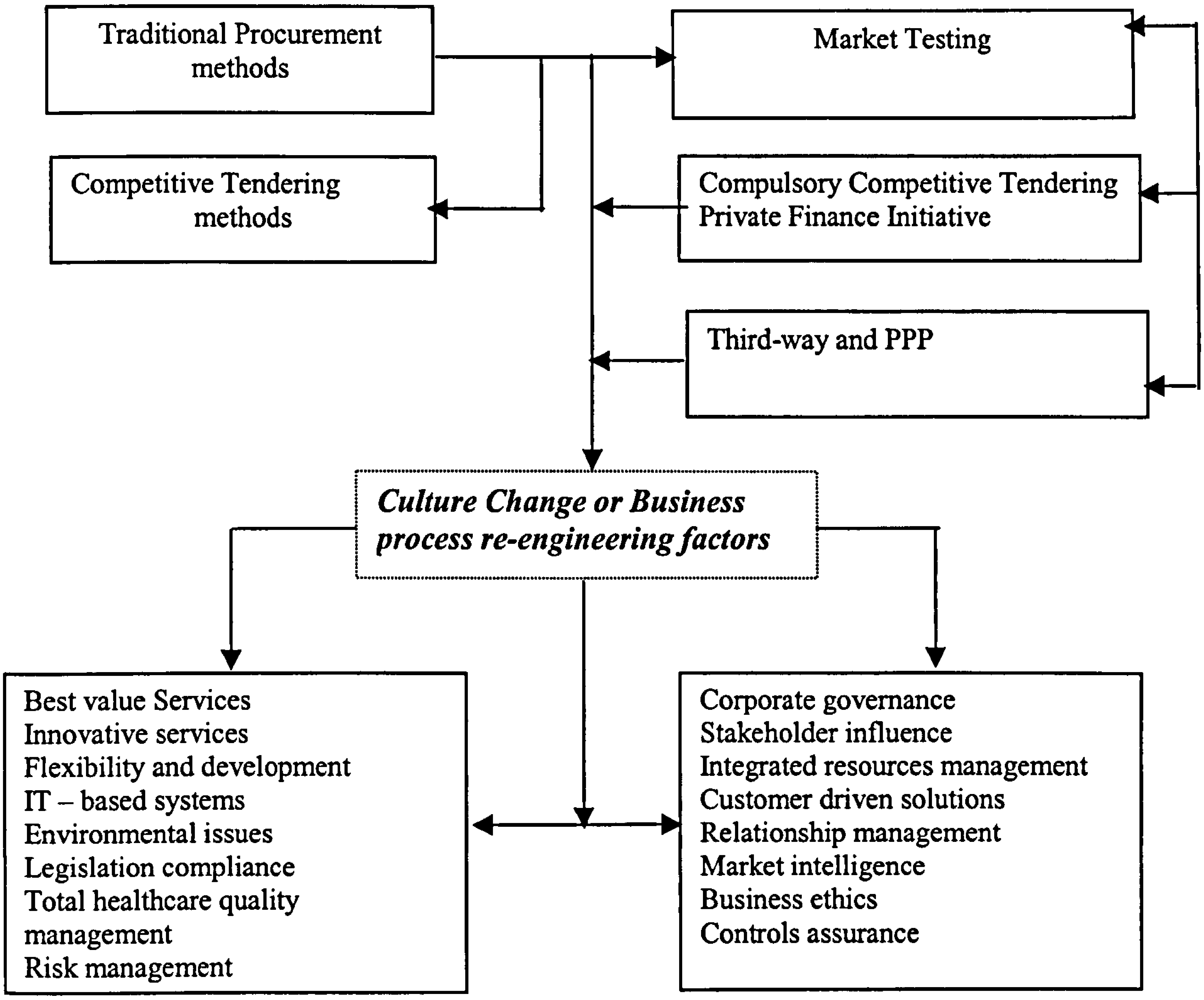


Source: (Williams, 1996)

2.17 FM service procurement strategies in NHS Trusts

FM services are delivered under contractual obligations between the provider (service contractor) and the service purchasers (Trust, users, customers and consumers) as grouped and observed by Tranfied and Akhlaghi (1995). Since FM is a service that requires a multi-disciplinary approach (turnkey service or package deal), the service provider has to be an expert in both project/contract management and operation/production skills. This has often not been the case in the NHS. In this case, the service provider might be asked to either to provide *"hard"* FM services (building construction works, facilities and equipment maintenance) or *"soft"* FM services (cleaning, domestic, laundry and security etc) to healthcare facilities. In some cases a combination of both *"hard"* and *"soft"* might be demanded of the contractor. The other more sophisticated service provision requirement might be that of requiring the contractor to provide a TFM role.

Figure 2.12: Procurement strategies used in the NHS non-clinical services



Source: Okoroh *et al.*, (2001)

In healthcare Trusts, FM service provision can be a one-off (*out-tasking*) or a plural task requirement (*out-sourcing*). The other modern and innovative service requirement is under the auspices of privatisation i.e. PFI. PFI is a total package for delivering FM services portfolio functions using commercial providers. It demands from the commercial contractor to provide a complete revolution of FM "bundled" services now being considered by most Trust hospitals under the banner of progressive outsourcing (Pearson, 1998). It should be pointed out however that, there is a knowledge dearth or gap which exists regarding the full benefits of using the PFI arrangements in the UK, as most NHS projects have not evolved through the whole cycle of asset management - facility design, finance, build and operate (Akitonye and Macleod, 1998). A few projects that are underway are in their infancy stages.

This research is quite optimistic from literature reviewed that not in the distant future more innovative practices will be used by Trusts, to minimise and share risks associated with healthcare support services management fairly amongst providers and purchasers. The latest option in such systems has been the PPP arrangement that was adopted from the Conservative government and later modernised by the current Labour government, in a bid to providing best value for money in healthcare service delivery

The above-mentioned three service procurement strategies shown in Figure 2.12 have been implemented in NHS Trusts in conformity with the reigning government in power at that time in the UK. These policies are a result of EU policies and other directives in line with free market participation (Single Europe) with the rest of other European core public service operators. So much debate and controversy surrounding these policies have haunted the provision of an economic and effective healthcare service in the UK.

For example Szymanski (1994), Kerr and Radford (1995), Milne (1994) and Adnett *et al.,* (1995) have all written extensively presenting the merits and demerits of market testing. Compulsory and competition for service provision (CCT) as it might be called was introduced in NHS Trusts in a bid to improve the competitiveness of the public sector reflecting the business environment and competitive forces of the 80s (Efficiency Unit, 1993). Due to these developments that retarded progress in the NHS sector, market testing for ancillary services was introduced in mid 1980s. This was in line with global developments taking place in public hospitals (i.e. in the US and Canada where privatisation and outsourcing of healthcare services had reached an advanced stage and were improving business performance in hospitals). Furthermore, this process created fair competition among European providers while drifting towards the creation of a single European market. These factors have helped in the emergence of a new ill-defined discipline within the healthcare sector that is concerned with the management of healthcare facilities and business services associated with this process: FM. The introducing of CCT was preceded by the market-testing reform of most ancillary healthcare services. Market testing was solemnly introduced in the public domain to improve business "efficiency, economics and effectiveness according to Akhlaghi's 3'Es' (1996) and reduce public expenditure (for more detail see DHSS, 1983).

This motive was mainly directed to lure private service providers to participate in the provision of ancillary services. They (private sector) had began enjoying the benefits of business integration in the form of SBUs, business alliances and mergers, outsourcing, BRP and issues surrounding core capabilities and sidelining anything that did not account to profitability. This move up until May 1997, has been in enforcement, until the new Labour Government came into power with their own concept of "best value for money service". Much to the delight of the Labour government, commentators such as Kelliher (1997), Sheaff (1984) and Charlesworth *et al.,* (1996) had earlier predicted that the benefits of market testing were mixed due to the level of cost savings achieved and other industrial relations, such as those to do with gender, managerialism, women managers, Labour payment rates and TUPE.

2.18 Strategic importance of integrated healthcare FM in the NHS

Although healthcare service provision in Trust hospitals is fronted by clinicians i.e. doctors and nurses, it relies heavily on the efficient management of many non-clinical departments that are all interdependent (see Figure 2.13). All these non-clinical departments/services are potentially subject to risk, and disruption of any service in one department, will inevitably have a knock-on effect on the function of other departments. Thus, healthcare facilities and support services represent a substantial investment (i.e. 40-60%) for Trust hospitals in the UK, and have to accommodate and support a range of clinical services, often taking into account competing customer and business service needs (Scott-Thomas, 1998). These business needs if designed and delivered effectively will obviously bring comfort and safety to customers whom clinical services are designed for. For example since the inception of the NHS in 1948, customers (patients, staff and visitors) have always considered trust hospitals to be "customer-arrogant" (Cook and Macaulay, 1997). This perception has been continuously changing due to the fact that NHS trusts have now become more sensitive to customers' (patients, staff and visitors) needs. Within those activities is the core function of the business of the trust hospital, that is, the creation of an environment to support customers' healthcare and treatment, teaching and training in facilities which may not have been designed for the purposes for which they are now used for. Yet, no matter how well focused a hospital might be on its core clinical business, it can not lose sight of the facility services adding value to the overall healthcare services received by NHS customers.

Trust hospitals may have already considered the distinction between their clinical (core) and non-clinical (non-core) services (such as cleaning and security) as part of the drive to deliver customer satisfaction and achieve better VFM (Akhlaghi, 1996). Since running a hospital facility, excluding clinical staff costs, accounts forms a significant part of the remaining annual expenditure, there is bound to be pressure to look for savings in non-clinical business functions. Cutting operating budgets may be a financial expedient, but this may not foster the long-term development of clinical and hospital services. Since the effective management of a trust hospital involves complex and co-ordinated processes, the response has to be one of taking an integrated view. A "piece approach" is unlikely to produce those cost savings and impair the trust's ability to deliver high quality clinical services.

In the past, it my have been possible for trust hospitals to operate their service facilities without giving them much strategic management attention. Cleaning, catering, hotel, estates and site, security, portering, maintenance, repairs and general housekeeping duties were typical of the "soft" FM services that formed part of the day-to- day (operational) running of a hospital trusts.

Costs were met from various budgets, with concerns about them usually passed directly to the local health service authority to act as it saw fit. Some hospitals did however, have delegated powers with respect to non-clinical services though this was with no general rule. The whole approach was largely one of reacting to uncertain business events. Incorporation and new legislation have changed all of that. The past decade has witnessed a fundamental shift in management strategy from one of business reaction to effective planning and action. Facilities management in NHS trust hospitals can therefore be summarised as the creation of an environment that is conducive to a healing environment, teaching and promoting health issues and training, taking an integrated view of the services' infrastructure to enhance the core healthcare business. This definition has been developed further to describe facilities management in accordance with the framework earlier shown in Table 2.1.

2.19 FM in secondary vertical markets

FM has grown more rapidly in the primary sector that consists of production industries and commercial enterprises, and where the need to maximise operating profits and increase shareholder value has been the critical success factor of such businesses. It has slowly found its way into the healthcare sector, where customer satisfaction issues have become of paramount importance. The utility of an integrated FM approach in the healthcare sector especially in trust hospitals as a business and risk management tool was very limited until the mid 80s, when it started to show positive signs of growth (Rees, 1998). Roseburg and Macaulay (1993) consider the healthcare sector as a "secondary vertical" or "non-traditional" market where business systems integration concepts were viewed with scepticism. Primary horizontal or traditional markets are those commercial organisations with the sole aim of producing "pure goods" which are tangible rather than "pure services" (Palmer, 1994).

These organisations have also a function of maximising shareholders' earning or profits and customer services and participation. The NHS is mainly focused on providing a "pure service" to healthcare customers and in this context cannot be considered as a traditional market. Research in service marketing has advocated that it is impossible to eliminate the elements of product or service provision and remain with a pure distinct "service" or "good" in any of the two markets. These types of organisations would not want to engage in any business activity and become unprofitable, tend to look outside their management organisations (i.e. commercial providers), for external FM providers to deliver their non-core services (Prahalad and Hamel, 1990).

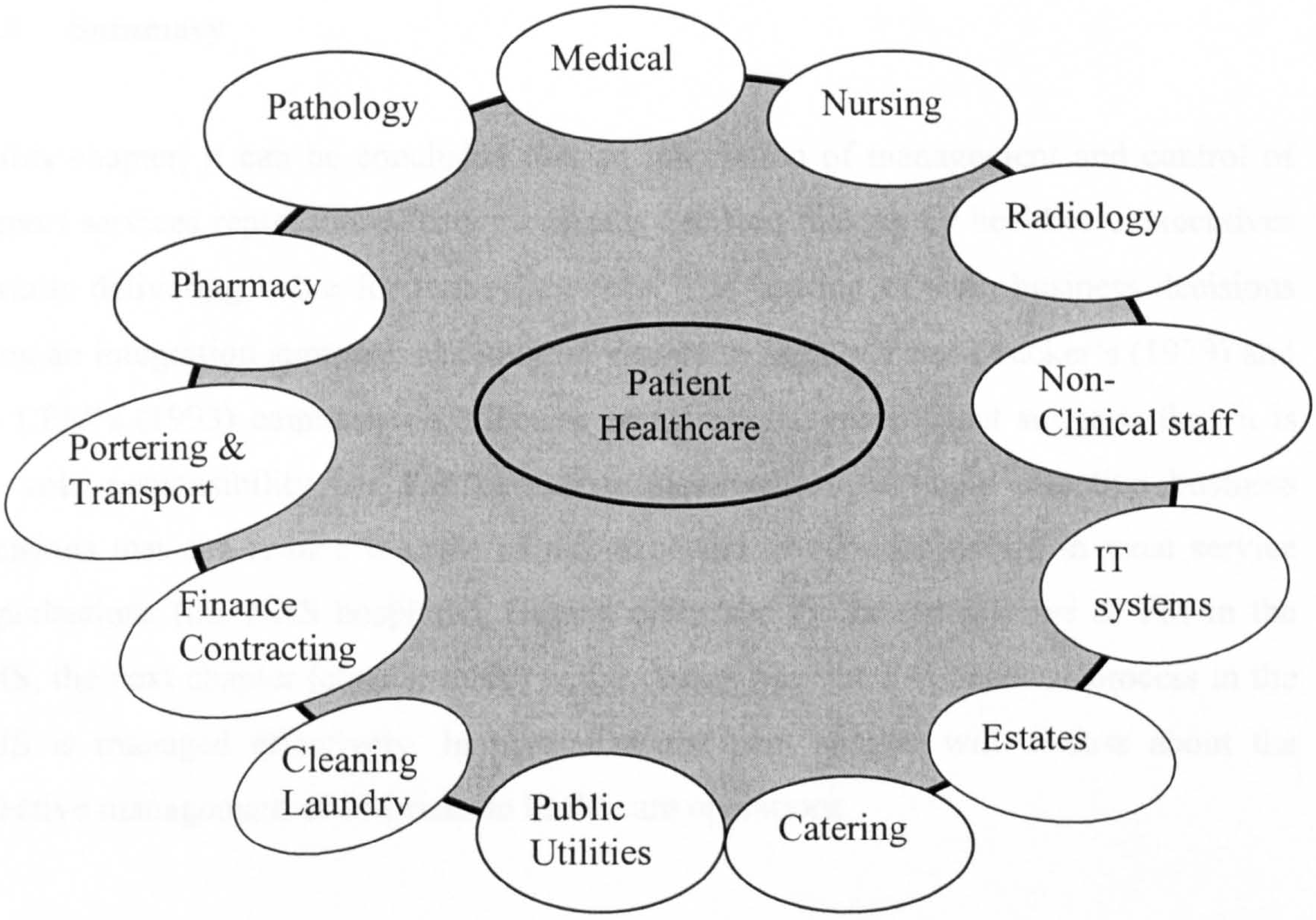
The other main factor that is considered in using external FM providers would be to place service performance accountability, and transfer delivery risks to a third party organisation. The external provider will then be responsible for service failure or implementing recovery strategies. It can also be said that the healthcare sector has been on "free ride" regarding service competition and niche marketing until 1990. This is due to the fact that hospitals have not been publicly accountable for service losses or profits generated from the caring for customers.

With the new reform of introducing "managed markets" preceded by the best value concept in managing support services; NHS trust hospitals have had to compete amongst themselves, private hospitals and with GPs for service provision. This scenario has resulted in hospital trusts improving their business performance and planning for effective risk management. As for those trust hospitals that have been found not performing by the government, they have been shut down or outsourced to commercial service providers. This strategy has been further modernised by the New Labour government. The Labour government has established hospital performance reporting system to mainly measure service performances in NHS trusts. The main focus now for NHS trusts in the UK, is the gradual change towards developing a non-statutory sector, improving value for money, and giving customers greater choice (McCartney and Brown, 1999).

Thus, McCartney and Brown (1999) have remarked that, "public accountability is the watchword and, with this, comes closer scrutiny of funding in relation to needs and outcomes". This concept has been pursued in other core public sector domains (i.e. prison services and education) where civil servants have been remunerated using the concept of performance-related services or prime contracting pay. Some commentaries and FM managers as a success story have heralded the continued shift from public accountability to private sector participation. This success emanates from the effective management healthcare facilities and the fair distribution of service risks among providers and purchasers, as we approach the next millennium in running healthcare facilities. As in most cases FM has been associated with outsourcing of support services Pearson (1998). The White Paper Working for Patients provided the scope for NHS trusts to re-model their clinical service operations along commercial lines for them to be competitive in the next millennium. Furthermore, the introduction of the free/quasi-markets in the NHS resulted in rivalry in terms of competition between NHS trusts and GPs for service customers. With such a scenario in place healthcare trusts had to compete for customers. This shift has seen trust hospitals implementing commercial business approaches, a policy shift from the traditional approach of being viewed as "customer-arrogant" to "customer-passionate" (Drucker, 1979). Hospitals as learning organisations have evolved through complex phases of service failures and continuous service improvement to meet the business need of a varied continuum of healthcare customers.

Much literature is well documented regarding the lack business care to customers and organisational effectiveness in trust hospitals in the NHS (Jarrett, 1998; Baggott, 1997).

Figure 2.13: General hospital services and their inter-dependencies



Source: Howell *et al.,* (1999)

Most writers and commentators have argued that the historic approach used in the healthcare sector of managing *"numbers than outcomes"* has operated inefficiently. Newman *et al.,* (1998) and Appleby *et al.,* (1995) suggest that one of the major causes of such a service crisis has been the core focus on clinical effectiveness and governance by clinicians without giving due consideration to customer satisfaction, complaints and claims, improving patients' access/choice and other measurable healthcare service factors (such as healthcare facilities and support services) of the service design and delivery process. Furthermore, clinical effectiveness and governance as argued by Newman *et al.* (1998) has narrow business focus with little or no appreciable relevance to customers and non-clinical services inclusive, in a sector where rationing of resources determines the quality of healthcare to be delivered to any patient.

This argument is much appreciated in the commercial sector where according to Peters and Watermann (1998) the most successful organisations today base their competitive strategy by putting customer issues first before any other organisational objectives (i.e. the customer is the king).

2.20 Summary

In this chapter, it can be concluded that an integration of management and control of support services represents effective business decision-making by healthcare executives towards delivering value for money services. The making of such business decisions using an integration approach can only be viewed in light of Peter Drucker's (1979) and the CFM's (1993) emphasis on effective organisational control that suggests that, it is the sole responsibility for FM executives/management to make effective business decisions that can reduce the rate of risk exposure or services failure in most service organisations (i.e. NHS hospitals). Having discussed the business scope of FM in the NHS, the next chapter (chapter three) will focus on how the FM business process in the NHS is managed effectively. In particular, the next chapter will discuss about the effective management of FM risks in healthcare operations.

CHAPTER THREE

RISK MANAGEMENT AND DECISION MAKING IN HEALTHCARE FM

3.1 Introduction

This chapter discusses the concept of risk management and its potential application to effective decision-making in healthcare FM in the NHS. In particular, it reviews the philosophical tenet debate regarding the distinction between risk and uncertainty. This chapter also focuses on describing better business practices of managing risks associated with the management healthcare facilities and support services. It identifies the major sources of risk in healthcare facilities management. In conclusion, this chapter describes the main risk management process and techniques that are applicable to the healthcare FM sector.

3.2 Value of managing risk and uncertainty in NHS FM operations

According to Davies and Walters (1998), risk and uncertainty are the dynamic business factors that most FM organisations have to contend with in their everyday operating environment. Furthermore, the NHS Executive regards the management of risk in the NHS as one of the key roles of every healthcare manager in NHS hospitals (DoH, 2001). According to Clark and Hinxman (1999) a facilities manager is a business executive of an organisation responsible for the strategic management of non-core services and decisions. So, it is therefore clear that healthcare facilities managers have a duty to identify, analyse and economically control those business hazards associated with threatening healthcare assets or the loss of earning capacity in the NHS. Thus, Davies and Walters (1998) have categorically stated the importance of the FM manager in managing risk and uncertainty in corporations. According to Davies and Walters (1998 pp.5);

"Risk and uncertainty are part of the everyday operating environment for all organisations. Occasionally the risks may be sufficient to generate a crisis which if left unattended can become a business disaster. The key person in an organisation who is often charged with the responsibility of recovering the supporting services (non-core service) that will enable the business to start functioning again is the facility manager."

Taking into account the objectives of this research explained in chapter one, it can be inferred that, the need to identify the business factors that affect or enhance FM services provision in the Trusts forms the fundamental argument of this research. Since the risk management process in healthcare FM service operations is considered as business decision-making process (Alexander, 1993), every healthcare decision made by hospital executives (i.e. FM managers) involves a range of risks that can be transmitted to;

i. FM staff ;
ii. work processes;
iii. the service environment (servicescape);
iv. to the facilities and real estate and ;
v. Finally to the organisation's financial performance.

As explained above by Alexander, it is the NHS facilities manager's (in-house/external) main responsibilities as part of the hospital executive team to manage and control the level of risk exposure in healthcare facilities and business support services to allow for clinical business continuity. From literature reviewed so far on risk management, it can be deduced that the major rewards or objectives for managing risk and uncertainty in the NHS are to;

i. Reduce business disasters or crisis and allow continuity;
ii. Protect and manage effectively the organisation's assets, resources and business systems;
iii. To offer value decisions which improve the performance of support services (healing environment) in underpinning responsive healthcare delivery to customers (i.e. offers customers healthcare through effective FM); and
iv. Improve and manage the organisation's changing environment with regards to the total workplace (premises, people, technology and the processes) in order for it to be competitive in delivering the core (clinical) business (Becker. 1990; and Akhlaghi, 1996).

3.3 Definition of risk and uncertainty

There is no industry-specific definition that can be used to adequately embrace all the various objectives FM decision-makers might aim to achieve in managing healthcare business risks. Furthermore in relation to industry specifics, O'Donovan (1997) reiterated that the concept of risk and its business management are a "recent advent" in the NHS. Its meaning can however be discerned to a common understanding that the business environment surrounding a decision is not always perfectly known to the decision-maker. As a result of this, it would be important to evaluate the choices available and the way they are valued - risk behaviour (Pablo, 1997). Most often than usual, NHS facilities managers as decision-makers are pressured to make healthcare business decisions or solve service delivery problems within limited and dynamic environments that leave them with only three choices under which decisions can be made. The three conditions under which healthcare FM decisions can be made are;

(a) Certainty;
(b) Risk and;
(c) Uncertainty.

3.4 Certainty

Certainty exists when the final outcome of the alternative choices can perfectly be predicted or forecasted. In this stage (certainty) the decision process involves pursuing a strategy that maximises the outcome or a combination of variable factors (multivariate analysis). For example, customer satisfaction, profit or shareholder value could be the main variables to be maximised in a business or economic context. This situation is typical to external FM service providers who are commercially driven by financial performance for them to survive in business. In the case of NHS purchasers, the strategy to pursue might be totally different, that of maximising clinical service outcomes and continuous improvement of healthcare services provision in order to reduce the rate of service crisis.

3.5 Risk

A business risk is according to Managing Business Risk, Economist Intelligence Unit, 1995, pp.2 is:

"the threat that an event or action will adversely affect an organisation's ability to achieve its business objectives and execute its strategies successfully."

The traditional view of risk management has been narrow in the NHS, with non-clinical service managers assessing exposures and securing insurance policies against the inevitable. However, nowadays where healthcare services are provided everyday, a broader business performance view is being established, which focuses on the healthcare services quality control, customer satisfaction and reduction of potential business losses, as well as the use of contingency and clinical service recovery strategies. In support of the above views, risk in FM has been also viewed as the "*probality that an adverse event occurs during a stated period*" (Royal society, 1991; Alexander, 1996; Edwards and Bowen, 1998). Furthermore, according to Jabes (1985) risk involves a state in which the outcomes of the alternative decisions can be determined and a probability attached to the likelihood threshold of repetition of each. In order to understand how healthcare FM decisions are made under conditions of risk, it important to understand;

(a) how the individual facilities manager values or judges the probability (techniques used) of occurrence of each outcome and;

(b) personal values which are anticipated to be maximised – hence personal PCT can be used to measure people's risk propensity;

These two conditions tell us more about what type of FM decisions are made in a particular environment (i.e. healthcare), where risk is eminent. Furthermore, Pablo (1997) identifies this situation of making decisions or choices under risk situations as *risk behaviour*. Risk behaviour is viewed as individuals' decision-making behaviour in risky contexts, and may be defined by the degree of risk associated with the decisions made (Sitkin and Pablo, 1992).

According to Pablo (1997) FM decisions can be riskier to the extent that:

1) there is more uncertainty associated with the potential business outcomes (i.e. none of the outcomes has a high probability of happening);
2) there is a high degree of variability in possible outcomes (i.e. the range of potential outcome values is wide); and
3) there is the potential for extreme, high consequence results (i.e. high absolute or relative magnitude of loss or profit).

It is quite clear from FM and business literature reviewed that the treatment of risk is generic in most business sectors (Finch, 1992; Alexander, 1992; Dyton, 1996; and Boon, 1998). What remains unique in various service organisations are the source, type, state, contractual transfer, culture, risk financing and organisational management approaches (Alexander, 1992; Edwards and Bowen, 1998). Hence, Wynne (1999: pp.1) has clearly pointed out that;

"all companies face a number of risks in achieving their objectives (business). These risks vary depending on the particular market in which the company is operating; its internal structure and it external environment."

According to Boon (1998) the concept of risk has become more "formal" in management and business disciplines such as healthcare FM. As such in any business organisational risks should be identified, evaluated and management decisions should be adopted as to how they are or to be treated. Chicken and Posner (1998) regard risk as essentially a mathematical construct, not an emotional one, which can be regarded as the mean chance that harm will occur. Since risk can be perceived as a mathematical construct, Chicken and Posner (1998) equate risk with the following formula;

$$\textbf{RISK} = \textbf{HAZARD} \times \textbf{EXPOSURE}$$

According to Chicken and Posner (1998) hazard is the way (probability) in which an event or situation can cause harm, while exposure is the extent of the hazard.

Their definition is derived from Popper's (1972) work that regards risk situations as those associated with "objective knowledge" of the perceiver. They (Chicken and Posner) also ascertain that if both hazard and exposure are happening simultaneously then there can be no risk incurred. While risk and uncertainty are prone to misinterpretation, there is a need in this research to explain the difference between the two, and how they relate to each other in terms of FM business planning.

3.6 Uncertainty

Uncertainty is generally defined in terms of the variability of outcomes, lack of knowledge of the outcomes, and the uncontrollability of outcomes (March, 1988).

3.7 Synonimity of risk and uncertainty in FM

Both in literature and business today, there are adversarial views on whether risk and uncertainty are synonymous. A clear separation of the two is difficult to find in primary and secondary sources of praxeology. Representing the synonymous school of thought are researchers such as Friedlob and Schleifer (1999) and Cooley (1977:pp.23). These writers maintain that;

"Risk is associated with uncertainty about future events, and more risk implies more uncertainty"

In agreement with this view, Nicosia (1969: pp.162) reaffirmed that in business the;

"handling of risk means handling of uncertainty"

In view of the above statement, Nicosia implied that dealing with business information implied handling of risk. This is so because business information is never fully reliable and is bound to have technical biases, human errors and purpose of use. In support of Nicosia, Friedlob and Schleifer (1999) in their analysis of the different types of uncertainty in financial auditing using fuzzy set theory as a business management tool concluded that, risk arises due to deficiency in information which in turn leads to uncertainty. Friedlob and Schleifer also argued that unlike risk, certainty grows from information reliability.

They also maintain that information can be insufficient in a number of ways resulting in auditors dealing with a variety of uncertainties. In support to the above views Vein Hertz (1968) and Herzt and Thomas (1984) put it across that;

"the exact course of future events is unknown when investment choices are made, and uncertainty creates risk."

Opponents of the Synonimity theorem such Van Horne (1977: pp.10) put forward his argument by categorically stating that;

" the distinction between risk and uncertainty is that risk involves situations in which the probabilities of a particular event are known; whereas with uncertainty, these probabilities are unknown."

Mitchell (1999) takes a view that although the two are interrelated they are not clearly the same. He argues that to have balance between perceived risk and uncertainty is to say that in today's world of customer service management, customers are able to procure any product or service they like without the fear of unacceptability (i.e. service brand or product class). This situation is not a true market reflection of service-generated risks as some service brands can be totally unacceptable to the customers due to past purchasing experience and information available about the product or service. In an attempt to separate the two schools further apart, Knight's (1948) definition separates the concepts of risk and uncertainty with some degree of clarity. His definition summarised risk as having a known probability of outcome while uncertainty existed when exact knowledge probability lacked. Although the separation proposed by Knight has been made in terms of distribution outcomes in business, healthcare managers have always used the two terms synonymously. This is probably because most healthcare managers feel that customers do not posses the appropriate knowledge to know the exact probability of outcome of any service transaction before total consumption (i.e. customer satisfaction) (Mitchell, 1999). In Knight's opinion perceived uncertainty should be used in order to unify the two. In contrast, Knight's suggestions are not directly applicable to healthcare FM operations, as NHS customers will often place a subjective probability on a healthcare services transaction or provision. The event may have no relationship whatsoever to the objective probability, but it will still have a "known" probability.

Cunningham (1967) further added more knowledge to this argument by suggesting that uncertainty or its consequences might involve either a known or an unknown probability. Again, Duncan (1972:pp.2) also supports the school of thought that concedes to risk and uncertainty being different. Duncan affirms this view but is quick to point out that;

"there is less predictability with respect to outcomes of events that are under conditions of risk."

Given this sort of divergence in opinion regarding risk and uncertainty cited from a large body of extant literature reviewed above, this chapter set to establish whether risk and uncertainty were different in Healthcare FM operations. In order to establish the working definition of risk in healthcare FM operations in the NHS, the next section provides an overview of reviewed literature regarding this subject.

3.8 Definition of risk in this study

While it is vital in literature to differentiate risk and uncertainty, it is of no practical importance in the 24-hour healthcare business and customer-shopping environment that has emerged today in the NHS. As a result of such a society and its dynamic environment Gill and Hillson (1998:pp.27) summarised their understanding of risk in business with the statement below;

"In a business environment, decisions are usually made under conditions of uncertainty rather than risk because it is difficult to anticipate future market and environmental development and to relate these to events in the past in objective way."

However, in the NHS many decision environments are unique. This is due to limitations involved in decision-making such as relying on past clinical service information (medical records) and limited resources available in a trust hospital, to enable healthcare managers (i.e. facilities managers) to facilitate to make effective service decisions that improve the probability of a successful outcome. As a consequence of such a situation in praxeology, facilities managers tend to assign subjective probability estimates to strategic support services delivery decisions in the NHS (Wagstaff, 1997).

Thus, after probabilities have been labelled, the decision making process remains the same despite the method of assignment to probabilities (subjective or objective analysis). Hence, healthcare business risk and uncertainty are synonymous as have been treated as such in this study. Therefore the definition of risk suggested by Herzt and Thomas (1984), Hertz (1984) and Alexander (1992) regarding risk analysis and its application seem to be the most suitable for this study. In particular, Hertz's (1968:pp.96) covers a broad view of the aspects of risk and uncertainty in the NHS. This definition states that;

"Risk means both uncertainty and the results of uncertainty. Risk includes both the lack of predictability about outcomes, and all the elements of the problem structure."

The adaptation of Hertz's definition means that risk hereafter will be used in this study to relate to the above definition.

3.9 Objective and subjective risk

There is a great difference in opinion regarding the acceptance and authentication of the concept of objective risk amongst NHS facilities and business managers, scholars and philosophers since Bauer (1960) first brought to the attention of the world the concept of perceived risk (Mitchell, 1999). When Bauer (1960) first published his famous services management article regarding the concept of risk, he emphasised the fact that he came from the school of thought that valued the concept of subjective (perceived) risk and not the "real world" (objective) risk. According to Bauer only perceived risk mainly intrigued him. Mitchell (1999) also echoes Bauer's (1960) thoughts by suggesting that, service customers i.e. NHS Trusts and their customers do posses "limited information" regarding new service encounters (clinical service demands). Furthermore, they posses a "semi-reliable memory" compared to actuaries and financial experts in implementing effective risk strategies that minimise service quality failures. Mitchell seems to suggest that risk and management experts in actuaries, insurance, meteorology, demography and finance do posses a large archive of database regarding records information, and hence are able to estimate the probability of adversity (risk) of an event or situation.

In most cases due to the changing healthcare business environment, FM directorates in trust hospitals are always faced with new and complex service procurement encounters from providers (in-house/SBU or external) and customers. In some cases these encounter might need to depend on past service experiences (good or bad) or a completely new and one-off situation that Peters (1992) regards as "moments of truth". In this era, the service expected or exchanged with might be completely different from the one they might have perceived before.

This is normally due to changing customer service needs in the NHS and as a result of this the decision-making process of procuring support services from in-house or external service providers becomes extremely difficult to arrive at. The only guarantee or promise purchasers will rely on would be the service guarantee or Service level agreement (SLA). In most cases purchasers will insist on professional indemnities covering the level of resource expertise to be delivered by the service provider on an FM contract. This level of skill required of the provider can be effectively monitored and policed using best project and contract management practices that can be implemented via an experienced facilitator working with the in-house or partnership team, or an informed client's agent (external facilities manager). Mitchell (1999) argues that although service purchasers might have put in place correct risk strategies or measures to manage uncertainty using their business intelligence in the service delivery process, it is not the objective risk that motivates the consumption behaviour but the consumer perceived knowledge of the service. Mitchell further accentuates that any further analysis of risks associated with service consumption should be pre-set with "subjective impressions" in thought.

In contrast, Stone and Winter (1985) are strong believers of the non-existence of objective risk in service management except for physical risk (Mitchell, 1999). Stone and Winter are of the opinion that it is extremely difficult to identify in practice objectively social, psychological, time, financial and performance risks. Their argument conveys mixed feelings to healthcare executives and presents some inconsistencies when they appreciate and consent to the fact some service experts/providers such as clinicians can be deemed to be "risk assessors" for physical risk, while strongly disagreeing with the fact that financial service providers could give a precise assessment on financial matters or risk.

Business decision making and risk management concepts in healthcare FM trusts have become more sophisticated and are attracting more attention from both researchers and practitioners. As a result of risky business situations in today's competitive business environment, trusts are in constant change to meet service needs and expectations of NHS customers. The strategic function and theory of risk in managerial decision making in trust hospital has a diverse range of interpretations by FM stakeholders (Sjoberg, 1980). Pablo (1997) and Pablo (1999) acknowledge that business managers (i.e. healthcare facilities managers) generally hold " widely divergent views on what risk actually is?".

Pablo also accepts that risk differs from one business environment to another (industry-specific), and there are no generic strategies that can be applied simultaneously to management decisions in each and every business servicescape. This situation is therefore no different in healthcare FM where a mixture of clinical (core) and non-clinical (no-core) business risk factors have a strategic and competitive influence in the efficient delivery of clinical services to NHS customers. NHS customers want service satisfaction and are rarely bothered with the way service risks are managed unless the risk aspects are transferred or directly affect their service consumption behaviour (Palmer, 1994). Risk can therefore be seen as a "benefit" or "loss" factor in determining whether a business is worth participation in or not (Ritchie and Mitchell, 1993; Pablo, 1997; and Pablo, 1999). On the other extreme, Cassels (1998) values risk in FM transactions as being a positive business opportunity to commercial "risk-averse" providers in improving service quality and business agility. Thus, the introduction of the commercial service providers to manage effectively non-clinical services in NHS hospitals has cast a different perceptive of risk in FM business. Even the traditional in-house departments that used to manage FM services in trust have had to change their managerial and decision making strategies to commercially compete in the delivery of best values service with the highly resourced external service providers. While the practice of risk management is new in the NHS, it does follow that risk management as a performance tool for measuring integrated FM operations is also a new practice in trusts (Alexander, 1993). Risk management practices therefore tend to vary from one trust hospital to another depending on the type of service procurement and delivery strategy in use.

That is to say for example, an acute or integrated trust with an insourced (in-house) FM services provision will be exposed to different types of risk factors that affects its business success. The same might also apply to a mental health trust that outsources or does a mixture of the two. In practice these risks in most FM directorates can be measured objectively using non clinical managers' experience. This is due to the "intangibles" involved in FM service provision. As noted by Parlmer (1994) service organisations are the highest risk bearers due to service consumption being done simultaneously with purchasing between the provider and the purchaser. The limitation of time to calculate the service effects are restricted while the service guarantees might not suffice or eliminate service failures. It is therefore a pre-requisite not only for trust hospitals to provide best value healthcare services to customers, but also avoid service failures, in order to win the hearts of many would be customers or the already existing clientele. The best information and interpretations on risk deeply depends on the type of business arrangement or practice in place and the level of experience and expertise of the FM stakeholders involved in healthcare business planning. It can be assumed that critical risk factors in healthcare FM if managed effectively will result in them being the critical success factors of a given business venture or case. In Facilities Risk Management, Alexander (1992:pp.2) states that the management of risk should effectively be concerned with:

"...a course of action planned to reduce the impact of an event occurring and/or to minimise or contain the consequential effects should that event occur."

Alexander's thoughts illustrate how the theory of risk and its anatomy have become vital in managing the success environment of any service organisation such as a trust hospital providing support service solutions to NHS customers.

3.10 Risk management in NHS FM operations

Since January 1990 NHS trust hospitals became corporate organisations legally accountable for business negligence and clinical service failures. In reality, the attainment of Trust status meant that NHS trust hospitals no longer enjoyed Crown immunity or business exemption regarding corporate governance, performance and strategic competitiveness.

All NHS trusts have a clinical and business duty of care to their customers and stakeholders. This duty of care involves the making of intelligent business decisions focused on improving service quality care, and on avoiding clinical failures that would render the core public services subject to risk and uncertain. Risk and uncertainty in the social business of healthcare delivery means inefficiency on the part of both the service purchasers (trusts) and providers (in-house/external contractors). Service inefficiency that includes support services delivery may portend a reduction in quality of life resulting, in high death rates that cannot be tolerated by the public or by the law in general. Reduction in the quality of life or service failure due to negligence would render the NHS, and the healthcare service provided, non-responsive and unsafe for the whole continuum of care customers in the UK. Past experience and literature reviewed have all reflected that service delivery failure or non-performance in the NHS is a key political barometer for measuring the performance and success of any governance system in the UK (Spurgeon, 1993). As a result of this most governments have been judged on the basis of service performance improvements made in the NHS. In some cases lack of public health focus has provoked public anger and in some cases some UK governments (i.e. Conservatives) are believed to have been voted out of office due to failure of providing better quality of healthcare (Spurgeon, 1993). The provision of such a service is not complete if it is not backed up or underpinned with the right support resources (FM services). The history of NHS since 1948 has always been that support service resources are always limited as they are provided by the State.

However, there is more research being undertaken by FM researchers in the area of public asset privatisation (PFI and PPP) and management.). It seems from literature review relating to healthcare, FM in Trusts is on the increase due to PFI or PPP (Jones, 2000). As a new area of business, this model is set to manifest more risks to NHS trusts. It should be pointed out that there is a knowledge dearth regarding the full benefits of using the PFI or PPP arrangements in the UK, as most projects have not evolved through the whole cycle of asset management and transferring back to the State. A few healthcare projects that are underway are in their infancy stages. Thus, this study had to focus on investigating the current healthcare FM services procured by various types of Trusts.

Risk management in various FM service transactions in the NHS rests on a clear understanding of business intelligence and continuous learning of the following (Wagstaff, 1997);

i. Exposure- working within healthcare servicescapes - external/internal
ii. Experience – service exchange transactions good or bad - moments of truth
iii. Resources – manpower expertise, technology and
iv. Strategies – mission, values and the future direction.

Like risk identification, stakeholders' recognition of "risky" business transactions will minimise uncertainty by delineating the relatively risky and potential risky, from the less risky business ventures.

3.11 Sources of risk in healthcare and FM operations

The last decade has seen FM business opportunities and operations in UK Trusts progressively increasingly but on steady pace. As a result of this expansion, Ritchie and Marshall (1993) advocated that most successful business facilities managers are those who discover and learn about an organisation's present and future business needs/risks. But however, trying to analyse the future in healthcare operations always does offer more "business risks" than answers to corporate success. The current state of FM in the healthcare sector seems to suggest that, more learning resources are being put (finance, expertise and information technology) to manage clinical and support services, while there is a continued increase in business knowledge dissemination regarding the management of FM risk in the healthcare sector (Payne and Rees, 1999; HFN 17, 1998; and Wagstaff, 1997). In addition, the NHS Estates has published a generic guideline for dealing with the management of healthcare FM and support services risks within a Trust framework - see Figure 3.5 (HFN 16, 1997). Current literature review on risk management in healthcare FM operations shows that many researchers have different views with respect to the categorisation and treatment of FM risks. To start with, Pablo (1998) in his survey on various service sectors concluded that the strategic method of risk management is universal but what differed were the business specific risks faced by these sectors.

It would be worthwhile therefore to give an outline of various risk classifications and sources identified by researchers to be in existence in healthcare and FM operations.

Davies and Walter (1997)

Davies and Walter undertook research survey work regarding the likely risks that can affect business and FM operations in disaster recovery situations in Hong Kong. They discovered that there were two main sources of risks within business settings that are;

1. external sources and
2. internal sources of danger

These classes were further split into a number of broad risk categories namely;

(a) economic
(b) technical
(c) hostile activities
(d) business confidence
(e) human resources and finally
(f) acts of God.

Dun and Bradstreet Corporation (1996)

In their survey regarding the causes of business failure between (1977-96) Dun and Bradstreet Corporation found several causes that are interrelated. They found out that the main risk factors responsible for business failure in terms of their percentages in most service organisations were:

i. economic factors – 59.7%
ii. asset and capital – 1.2%
iii. experience – 18.2%
iv. fraud and neglect – 1.9%
v. sales and services – 11.2%
vi. disaster – 0.3%
vii. expenses – 6.2% and
viii. customer care – 1.3%

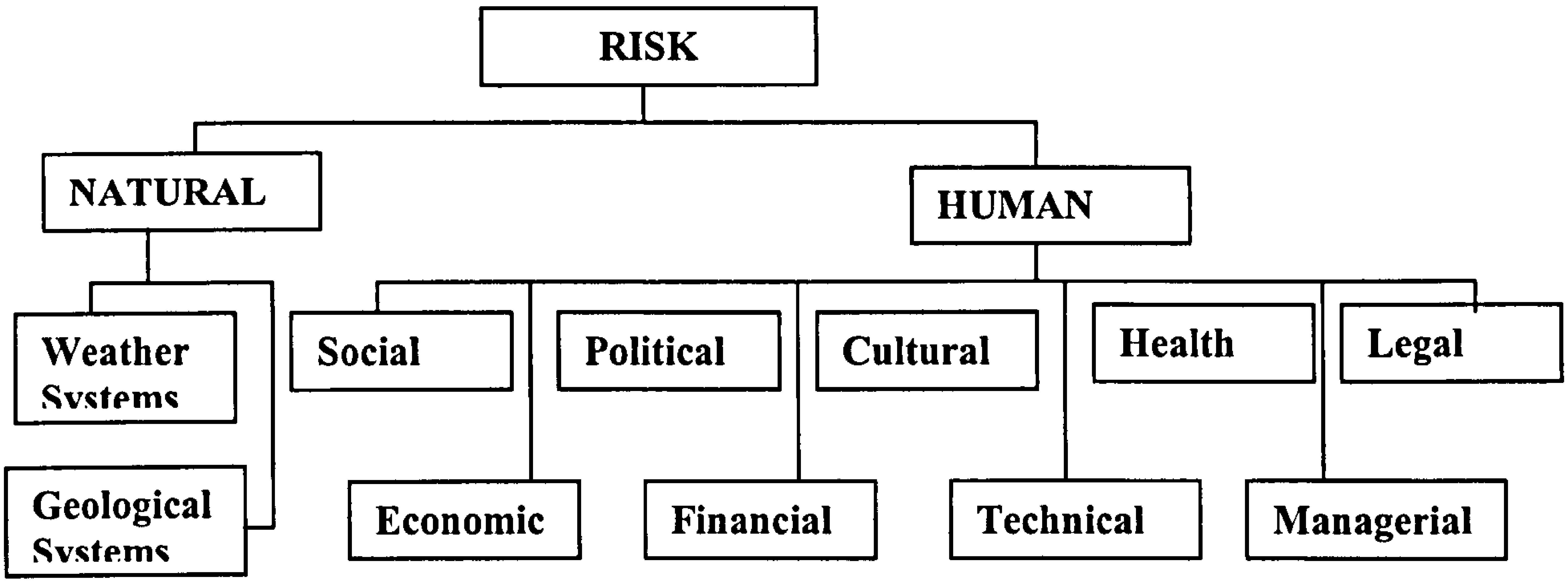
To date, perhaps the most comprehensive study on risk management in healthcare FM operations was performed by Okoroh *et al.,* (1998). After a careful analysis of literature and a case study of an on-going FM contract, the authors found nine main classes of risks in healthcare FM operations. These are listed below not in order;

i. corporate – organisation and strategic business objectives;
ii. legal – service contract design and procurement;
iii. commercial – provider/purchaser service chain management;
iv. financial and Economics – best value management of FM services;
v. business transfer- TUPE and employment related;
vi. customer healthcare – customer service management and repeat business;
vii. facility transmitted – hospital acquired infections;
viii. operational - transactional costs and servicescape intelligence and;
ix. Third way i.e. political and physcho-social considerations.

Edwards and Bowen (1999)

In reviewing of a large body of extant work on risk management from 1960 to 1998, Edwards and Bowen appeal to risk management writers, scholars and practitioners that, their work only provided a platform for further research work to be executed as a matter of urgency. In their review they also discovered that, there is a great dearth of information regarding the comprehensive identification and treatment of project risks in order to develop a "more informed understanding" regarding risk sources, nature and occurrences. Edwards and Bowen identified new research avenues that needed further investigation in order to judge the "difference in perception" among various project participants (i.e. providers and purchasers). The work of Edwards and Bowen has gone a step further to identifying some of major facilities operational risks using a source-based approach. Their approach is based on two major known causative/variation systems that are (see Figure 3.1);

Figure 3.1: Risk source categories



Source: Edwards and Bowen (1998)

(1) ***Human related systems*** – associated with management operations and activities in business. These are further subdivided into: social, political, economical, financial, legal, legal, health, managerial, technical, or cultural sources of risks and;

(2) ***Natural***– originating natural uncontrollable geographic conditions such weather and geological systems and

Davies *et al.*, (1998)

In their research to establish business recovery planning in FM operations, Davies *et al.,*(1998) discovered that most service companies involved in facility management as a part of their business suffered from a wide range of hazards in their bid to be competitive and survive. The major sources hazards/risks identified by the writers were classified into external and internal sources. Furthermore, these two groups could be further subdivided in the following classes: technological, hostile activities, business confidence, human resources and acts of God.

Hilary Davies and Megan Walters (1998)

Davies and Megan (1998) attribute the major sources of risk in most service providing organisations as being a result of business interruptions and poor contingency planning. The writers note that there are primarily two types of business risks that are applicable to FM organisations. These two are;

i. Brief business interruptions – these cause reduced revenues and profits, customer defect or loss of repeat business and reduced market share, and;
ii. Major business interruptions – these threaten the company's service strategy and survival.

Waterman (1995)

Waterman (1995) investigated the future development of health and safety needs in the healthcare sector in compliance with the Health and Safety Act 1974, Section 2. In his conclusion, Waterman recommended that healthcare service managers in the NHS had a duty to monitor and manage the following operational risks in healthcare facilities;

i. Hazardous waste such as glutaralde-hyde, cytotoxins, methyl methacrylate, anaesthetic gases and other substance harmful to customers;
ii. Manual waste handling risks – (accounted to 50% of documented accidents for clinicians);
iii. Security, violence and aggression on hospital sites;
iv. Fire safety management
v. Food poisoning and hygiene; and
vi. Hospital infection risks from clinical procedures and waste disposal.

Elaine Linnane (1996)

In her article "The importance of good clinical waste management" in NHS Trusts, Linnane the editor of the British Journal of Midwifery highlighted the major sources of risk in clinical waste management.

She found out that the removal of the Crown Immunity from NHS Trusts had brought with it a new set of operating liabilities as any other commercial organisations. According to Linnane the main sources of risks stemmed out from;

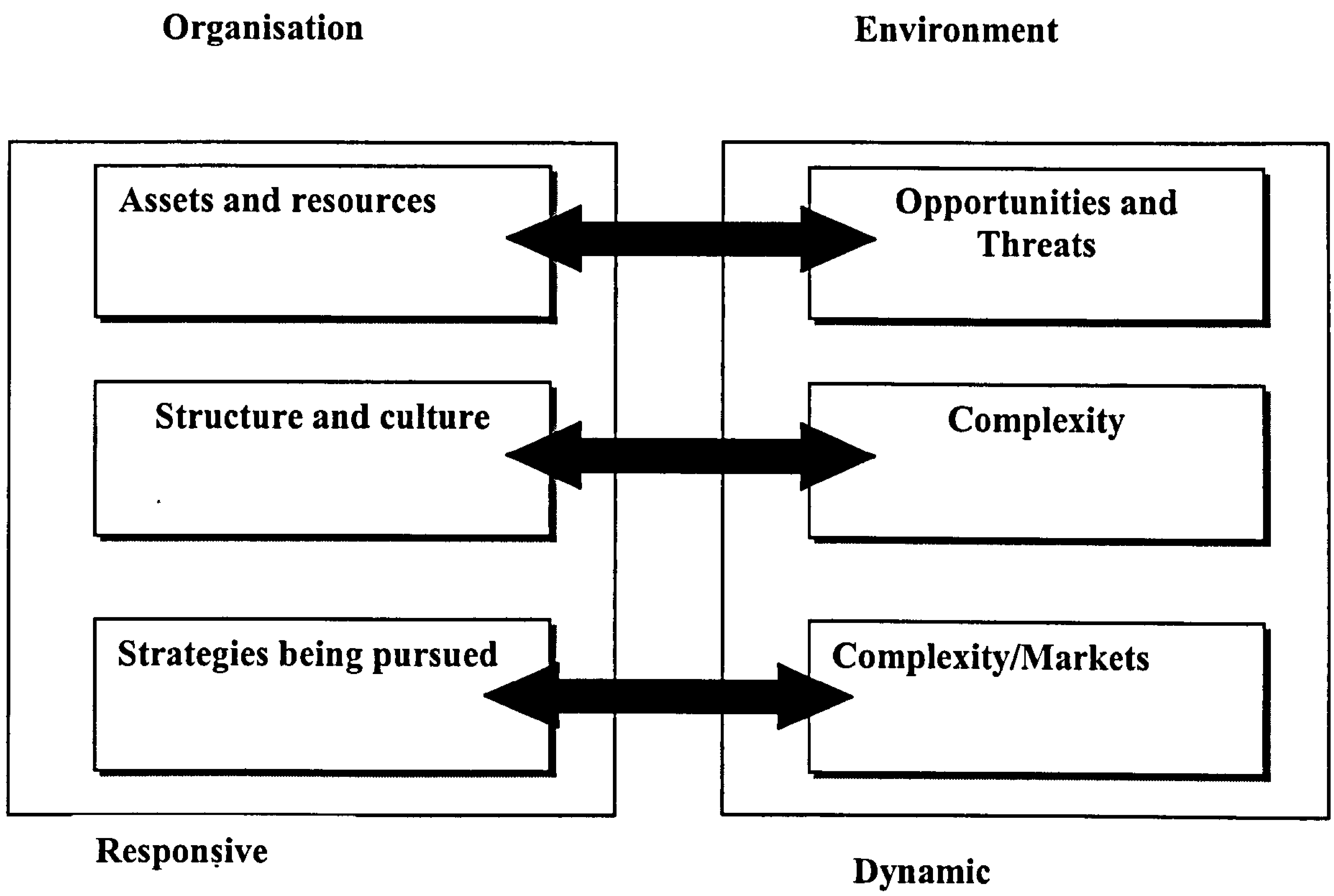
i. Complex legislation - i.e. the introduction of the NHS Community Healthcare Act (1990) followed by the removal of Crown Immunity of NHS Trusts.
ii. Adverse publicity and lack of environmental knowledge about waste disposal

Dyton (1996)

In using Ritchie and Marshall's (1995) model on the business-operating environment, Dyton identified the major sources of risks in any business providing services to customers. The major assumption in Ritchie and Marshall's model is that the servicescape in which modern business is conducted is chaotic and uncertain due to various internal and external risks working against it. This model has much relevance to both FM service providers and purchaser in the NHS who operate in a very fragile environment. The sources are broadly split into two main classes that are *endogenous* and *exogenous* risks - see Figure 3.2. This model is similar to the SWOT analysis commonly used in business planning and management in the NHS. This technique is important in the sense that it allows healthcare service providers to strategically analyse the business environment in which healthcare services will be competitively and commercially provided to NHS customers. In using the SWOT analysis, internal strengths and weaknesses are considered along with external opportunities and threats of FM service operators from Figure 3.4 above the source of risk may be;

i. **Endogenous** – having its origin within the internal envelope of the corporate organisation structure or;
ii. **Exogenous** – originating from the external environment of the corporate organisation

Figure 3.2: Classification of sources of risk



Source: Ritchie and Marshall (1995)

Furthermore, according to Ritchie and Marshall the two sources shown in Figure 3.2 are not mutually exclusive sources of risk. Significant interactions of service and business processes do take place between the two. As a result of this, each of the two sources or areas were further broken down into three classes of risks in an organisation and the environment. These sources can be a direct result of "responsive" or "dynamic" actions of the organisation. In a related study of the service operating environment as a key source of business risks in business organisations, Specht (1993) distinguished five main external environment risk factors affecting organisational continuity in business as:

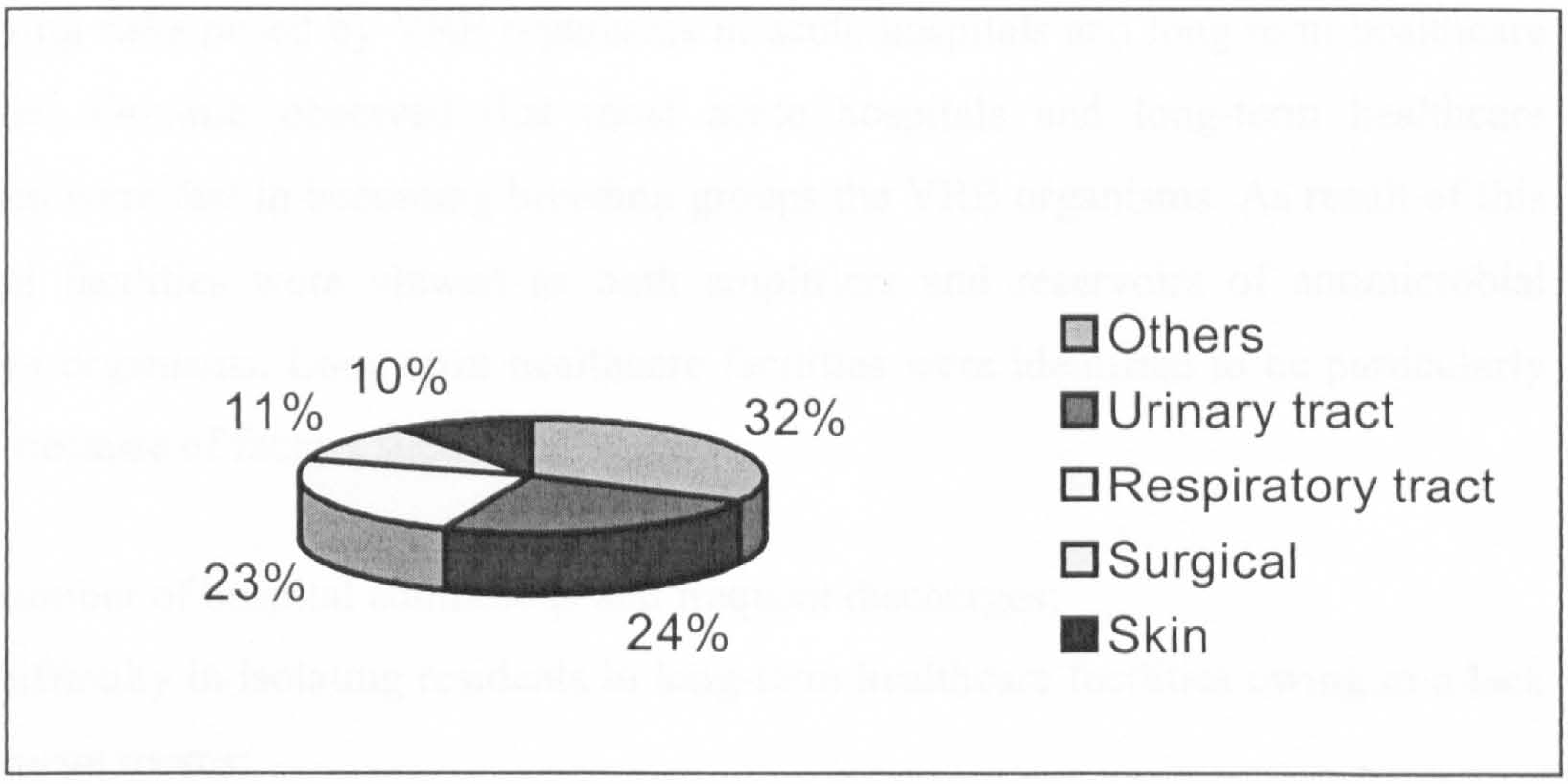
i. social;
ii. economic;
iii. political;
iv. infrastructure development; and
v. market emergence factors.

Within the social environment, the impact of networks and the support of socio-political issues along with cultural acceptance are of particular importance. The economic environment factors focus on capital availability, aggregate economic indicators economic recessions and unemployment. The political environment concerns mainly the support of public or semi-public agencies. Non core business services development encompasses numerous variables such as the learning system, the nature of the local labour market, incubator organisations, information accessibility and availability of premises. Finally, market emergence theory integrates both concepts of customer service intelligence, niche emergence and technological innovation.

Plowman *et al.* (1998)

In their investigation regarding healthcare facilities usage and prolonged period of stay and working in hospitals, Plowman *et al.*, discovered that customers were at high risk to acquiring new diseases (see Figure 3.3).

Figure 3.3: Hospital acquired infection risks percentage



Source: Plowman *et al* (1998)

Plowman *et al.,* also noticed that there was a dramatic increase of infection cases related to prolonged stay in a healthcare facility.

Plowman *et al.*, stated that these facility-related infections were caused by, prolonged hospital stay, additional investigation medication, treatment and healthcare and extra outpatient consultations. Key points to note were:

i. At any given time, an estimated 9% of hospital inpatients suffer from or had acquired HAI
ii. Additional cost increase were being incurred by the secondary and primary healthcare sectors including those caring for them
iii. At least 33% of HAI diseases could be prevented through effective infection control programmes currently introduced by NHS Trusts
iv. Purchaser/provider contracts and SLAs must incorporate issues relating to HAIs as key performance indicators (KPIs).
v. Further reduction of infections would improve patient outcomes and the release of facilities for other uses.

Kathleen Granitto (1998)

A registered practice nurse in Canada warned healthcare managers about the increasing risks posed by VRE organisms in acute hospitals and long-term healthcare facilities. Granitto observed that most acute hospitals and long-term healthcare facilities were fast in becoming breeding groups the VRE organisms. As result of this hospital facilities were viewed as both amplifiers and reservoirs of antimicrobial resistant organisms. Long-term healthcare facilities were identified to be particularly at risk because of factors such as:

i) the number of hospital admissions and frequent discharges;
ii) the difficulty in isolating residents in long-term healthcare facilities owing to a lack of private rooms;
iii) the frail condition of residents with complications such as catheters and open skin wounds;
iv) Abuse of antibiotics in hospital facilities.

Howell *et al.* (1999)

Howell *et al.,* discussed about the possible risks which could be faced by Trusts that did not implement information systems technology to control the risks of the "millennium bug". In their study, they discovered that virtually all hospital Trusts operated a wide variety of systems that if not protected from computer failure would cause extensive disruption to hospital activities. The risks they saw as eminent were;

i. Operations failure risks
ii. Non-clinical functions being made redundant
iii. Death or life threatening failure to customers
iv. Huge costs of systems maintenance
v. Disruption of supplies
vi. Information corruption risks
vii. Equipment non-compliance risks – health and safety

Smith (1995)

In support of the CFM (1993) survey done in the NHS on FM, Smith sides with the CFM report that highlighted that facilities management in the UK health care sector has a long way to go to become a fully integrated function with encompasses both hotel and estate services. Smith also discovered that some FM directorates have made significant headway, while others still operated hotel and estate services as distinct areas of responsibility. The common major risks that affected the fast integration of non-clinical services were identified as *personalities, politics and culture.*

Edward Finch (1997)

Edward Finch examined the nature of the "year 2000 date-change problem" with a view of considering its implications in the operation of facilities. He observed that the problem of information systems management posed by the Y2K conformity hazard was going to be wide spread and FM organisations devising effective risk management solutions for it.

Finch observed that the Y2K conformity problem was not only limited to office buildings and space, but also poised heavy business and service disruptions to healthcare facilities, prison buildings, factories and wider range of intelligent buildings and support services. In conclusion, Finch proposed for the REACT model as risk management system for which can be used by FM operators (providers and purchasers) to prevent and manage this risk. The key elements of the **REACT** model identified were;

i. Recognise – involves the gathering of information on date-dependent systems;
ii. Evaluate – considers the extent and importance of specific risks, resulting in a prioritisation;
iii. Adjust – addresses the opportunities for modifying or distributing the risk;
iv. Choose – involves an understanding of a company's propensity to risk and the criticality of the facilities management function;
v. Track – considers the ongoing procedures which need to be put in place to ensure year 2000 compliance.

NAO (1997)

In their report on "Health and safety in NHS Acute Hospital Trusts" the NAO found out that standards of health and safety management were variable, with many Trusts failing to meet their statutory obligations. In support of the NAO findings some reports from the HSE has also noticed this problem. In their investigations the NAO report listed some of the common risks related to health and safety, which are prevalent in NHS Acute hospitals. These include;

i. Manual handling
ii. Disposal of waste
iii. Needlesticks/sharps
iv. Substance hazardous to health
v. Violence to staff
vi. Slips, trips and falls
vii. Stress at work

In their conclusion regarding the management of such risks the NAO concluded that to succeed in attaining the high standards expected, hospital trusts should aim to develop a more proactive, rather than a reactive, approach. This involves developing hospital-wide strategies to minimise the level of accidents. These strategies need to be supported by effective reporting arrangements to assess trends, and informed by comparisons of best practice in health and safety management from both within and outside the NHS. To achieve good progress, action should be led from the top by trust boards and Chief Executive, so that the health and safety of patients, visitors and employees is routinely accorded a high priority within and across all trusts.

Perry and Hayes (1985)

In their work describing about risk-related decisions or actions in the management of infrastructure projects, Perry and Hayes established the main pertinent sources of risk, which are synonymous to FM and construction projects. The list traces the primary sources of risk in projects as physical, environmental, design, logistics, financial, legal, construction and facilities operational services. All these risk are further explained in Perry and Hayes (1985).

Gracia (1998)

In his paper entitled "Contractual Pitfalls" Gracia looked at the possible FM risks associated to FM operations. Gracia warns service purchasers and providers to consider the following risks before embarking on a new FM service contracts;

i. Staff transfer and liability – outsourcing risk
ii. FM service insurers' ability to take "high or low" FM operation risks
iii. Service outsourcing - collateral warranty risks
iv. Contract privity and negligence risks
v. Non performance risks- on the part of the provider

Downey (1995)

Jane Marie Downey discussed at length the problems associated with outsourcing manpower services in his article that she published in Facilities in 1995. She advanced the idea that many FM service organisations are transferring employment risks by way of employing hired staff on a contractual basis, as a result were creating and facing new risks arising in terms of facility management. The risks that emerged through outsourcing as highlighted by Downey are;

i. Elimination of employee terminal benefits and exclusive remedy and immunity;
ii. Service provision expertise conflict of interest between the in-house and hired staff;
iii. Heavy dependency on external service providers for the organisation's core business;
iv. Cost increases in strategic partnerships
v. Employee motivation, loyalty and service very difficult to maintain, as a result poor customer service deliveries – more absenteeism;
vi. Vicarious liability for actions of a contract staff;
vii. Occupational, healthy and safety risks in relations to employee administration and liability management;
viii. Loss of physical and organisational innovative secrecy and confidentiality;
ix. Lack of continuous learning in such organisation;
x. Insufficient training and employee development to improve service quality
xi. Loss of quality control, timing, scheduling and management mechanisms due to the temporary contracts of employees;
xii. Business loss due to continued use of external providers aimed at making huge profits at the expense of service quality;
xiii. Lack of insurance and other protection guarantees for service delivery through the continued use of staff leasing firms.

According to Downey, all these risks have to be taken into account of making outsourcing decisions in any organisations.

Downey proposed a sound risk management system to counter balance these risks which might arise if not taken into consideration when outsourcing staff.

Alexander (1992)

In his article on risk management Alexander (1992) traces the source of business risks in a FM organisation. Alexander noted that business risks are associated with the following four levels of risk shown in the Table 3.1 below.

Table 3.1: The scope of FM risks

Source	**FM risks**
Property	Investment/operational
Environmental	Spatial/physical/visual/impact
Services	Customer/end-user/corporate
Information	Business information/facilities information

Source: Alexander (1992)

Alexander also identified a "range of business risks" falling under the following classes (see Table 3.2 below):

Table 3.2: The range of facilities management risks

Source	**FM risks**
Organisational	risk of loss of business
Human use	risk to human life and limb (e.g. health and safety)
Environmental	risk to environmental failure (pollution)
Physical	risk to property, risk of physical failure
Financial	risk of financial loss and viability

Source: Alexander (1992)

Gaffney and Pollock (1999)

Gaffney and Pollock (1999) investigated the transaction cost of PFI schemes in the NHS. Their results showed that the cost of PFI schemes has produced a new set of risks. The cost of funding hospital facilities was being transferred to the cost of medical treatment resulting in Trusts having to off-set these costs by making saving in the core clinical budgets or capital charging. They discovered that PFI had a "knock-on" effect producing the following risks;

(a) Acute bed capacity reduction risk
(b) Clinical service reduction risk
(c) Increased investment cost risk
(d) Block capital allocation and equipment risk
(e) Affordability risks
(f) Land transfer risks
(g) Reduced business risk

Private Finance Panel (1995)

In their publication, the PFI Panel regarding Private Opportunity, Public Benefit, six prominent risks were identified as relevant to PFI operations in the UK. These risks were also reiterated by Akitonye *et al.*, (1998) as;

i. Design and construction risk (to cost and time)
ii. Commission and operating risk (inclusive of maintenance)
iii. Demand for volume/utilisation risk
iv. Residual value risk
v. Technology/obsolescence risk
vi. Regulation and legislation risk

These risks were further elaborated and evaluated in the PFI's publication (1996a), *Risk and Reward in PFI Contracts*.

MacDowall (1999)

In her work, Evelyn McDowall investigated the risks affecting PFI arrangements in the healthcare sector. MacDowall identified the major risk classes in using the PFI as a procurement route. These risks are shown in Table 3.3.

Table 3.3: PFI risks

Risk	**Example**
Design and construction	Cost increments in design of the facility Buildability – affecting cost and time scale healthcare facility services delivery Longevity of healthcare facility components
Operations	Facilities unavailability for clinical use Service quality below par Space capacity below trust's expectations
Demand	Service provider absorb the risk for patronage of service to generate income
Technology/Obsolescence	Service proper to be responsible for total value management and asset management Meeting of technological and clinical excellency standards (statutory requirements)
Financial	Risk in perfect markets, inflation and economic changes

Valla (1982)

Valla observed that whenever a service purchase in an organisation was made, the purchaser had to content with five types of inherent risks before consumption.

These are;

1. Technical risks
2. Financial risks
3. Delivery risk
4. Service risk and
5. Risk related to provider/purchaser long-term relationships

Akitonye *et al.*, (1998)

The operation of PFI schemes in the UK has in itself expose inherent and handled risks to both service purchasers and providers. Inherent risks are latent risks a service or product class holds for either the consumer or purchaser, while handled risks are the amount of conflict the service or product class is prone to produce during service encounter phases between the purchaser and the consumer (Mitchell, 1999). The two types of risks were also observed by Mitchell and can be applied in PFI outsourcing transactions between a purchaser (Trust) and an external FM service provider. The provider might have been engaged to carry out integrated or outttasked FM operations. Akitonye *et al.*, emphasise that these two types of risks form part of the fundamental mechanics that must be satisfied before a PFI scheme can be considered viable. Both purchasers and providers should be aware of these two types of risks inherent in most FM service contracts. Akitonye *et al.*, also pointed out the fact that for a PFI scheme to be implemented the following risks must effectively managed;

(a) the purchaser/client must be guaranteed value for money in the provision of FM service by the external contractor from the private sector.

(b) There must be a suitable instrument used to transfer Total FM operations risks to the private service contractors.

These two sources of risks if not effectively managed would render a PFI scheme not being viable.

Within the same article, in determining the perception of clients (service purchasers), contractors (service providers) and financial institutions (lenders) regarding risk management in PFI projects, Akitonye *et al.,* (1998) discovered that all FM stakeholders in a PFI scheme were exposed to certain levels of project risks. Furthermore, their business exposure could be measured using the relative important index technique adopted from Kometa *et al.,* 's (1995) work. Akitonye *et al.,*'s work was based on empirical data gathered from a questionnaire survey. The questionnaire survey was designed to identify most of the major risk factors faced by FM stakeholders when managing PFI schemes. The novelty of their work was based on the fact that it was the only study that managed to identify and classify critical PFI operational risks using all service stakeholders – Table 3.4 below.

Table 3.4: PFI risks in the UK

Risks	All respondents	Lenders	Contractors	Clients
Design risk	1	10	1	5
Construction cost risk	2	6	2	6
Performance risk	3	8	4	2
Risk of delay	4	7	7	3
Risk of cost overrun	5	2	3	9
Commissioning risk	6	5	17	1
Volume risk	7	3	8	10
Risk of operating/maintenance cost	8	13	9	4
Payment risk	9	1	10	14
Tendering cost risk	10	9	6	17
Contractual risk	11	15	5	11
Legal risk	12	12	11	19
Market risk	13	11	14	16
Residual value risk	14	14	16	12
Planning risk	15	19	13	18
Environmental risk	16	23	15	8
Safety risk	17	20	21	7
Financial risk	18	18	12	22
Credit risk	19	4	25	24
Possible change in government	20	16	20	20
Project life risk	21	22	24	15
Changes in European legislation	22	26	19	13
Development risk	23	24	18	21
Bankers risk	24	17	23	26
Debt risk	25	21	22	25
Land purchase risk	26	25	26	23

Source: Akitonye *et al.,* (1998)

Chu (1999)

In his journal paper in Facilities, Chu's article clearly sets out the major risks of the BOOT approach of procuring and managing public facilities.

Chu also discussed about the relative merits between BOOT and other strategies that can be used to procure public infrastructure. Furthermore, he also discussed about the possible risks poised by BOOT stakeholders and the life cycle of BOOT. The pros and cons of BOOT were also outlined. To justify his arguments case studies on energy infrastructure BOOT schemes were used by Chu to illustrate different terms, scope and benefits of such projects.

Table 3.5: Comparison of potential benefits from major procurement options

	Potential benefits			
Procurement options	**Efficiency gains in construction/operation**	**Additional finance**	**Risk transfer**	**Control by the principal**
BOOT contract	High	High	High	Medium
Franchising	Low/medium	Low	Medium	Medium
Contracting-out	Low	None	Low	High
Leasing	Low/none	Medium	Low	High
Purchase	Low/none	None	None	High

Source: Adapted from Flynn, 1996

Source Chu (1999)

Grimshaw and Nutt (2000)

The introduction of flexible working in the NHS although advantageous has raised fundamental problems.

Table 3.6: Opportunities and risks associated with flexible working in the NHS

Focus	Potential benefits and opportunities	Potential risks and constrains
Business	Business flexibility, lower costs (space) and closeness to customer	Organisation culture, corporate vision and business security
Employer	Flexible employment, workforce choice and increased productivity	Isolation and disaffection, self-esteem, Bio-psychosocial pressures and employment security,
Management	Healthcare business performance driven (balanced scorecard approach), service/work out based and improved	Collaborative working dispersed management, accountability and long-term risks.

Source: Grimshaw and Nutt (2000)

These problems relate to how FM services are delivered to front the delivery of healthcare in future, and how staff will react and operate within the flexible working and business environment. In their paper about flexible working as modern business practice bringing benefits to FM operators, Grimshaw and Nutt (2000) identified possible business opportunities and risks associated with this practice in service organisations such as the NHS. These factors were grouped into business, employee, employer and management risks. These merits and demerits if construed in the light of healthcare are applicable and are shown in Table 3.6

Steane and Walker (2000)

Public sector service organisations are reforming their operations to enhance effectiveness and efficiency. Competition and contracts are presented as mechanisms facilitating such reform in areas such as costs, productivity and quality. In their article Steane and Walker argue that short-term contractual arrangements such as compulsory tendering can expose FM operators to various management related risks. In pursuing "best value" procurement policies, the writers argue that the public sector should consider the delivery of public services as a facilities management issue as it is based on delivering flexible FM solutions that are customer focused. Furthermore, effective business management suggests that success is linked to the ability to be flexible in environments noted for change more than constancy. The writers state that, the preference given to competitive tendering and contracting and more specifically to best value by central government also pauses risks or limits the business growth of networks at community level. Therefore, in conclusion, Steane and Walker make recommendations that good procurement of facility (i.e. healthcare) services must be based on effective strategic linkages that reduce business service delivery risks.

Wagstaff (1997)

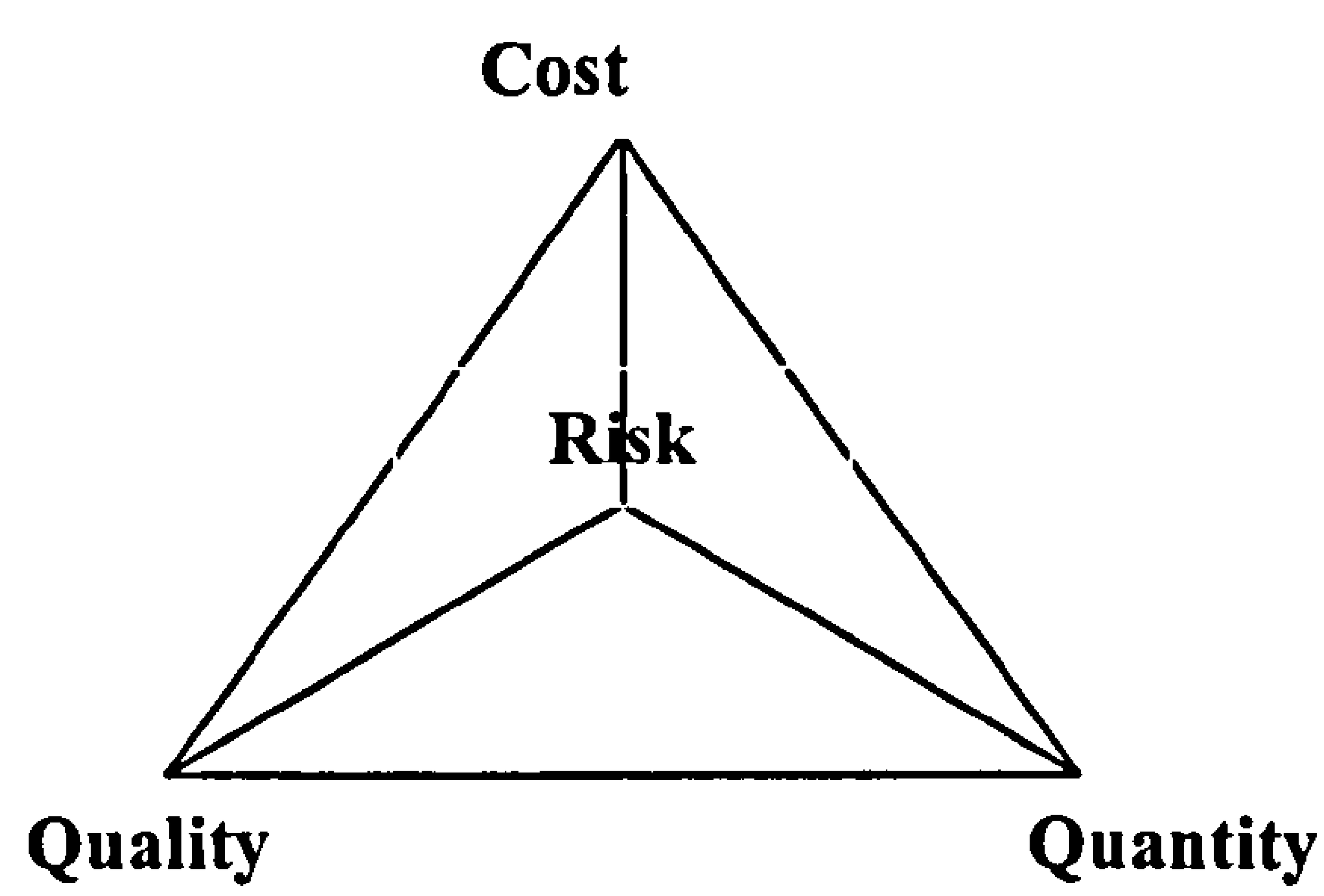
Wagstaff, a practising hospital non-clinical services manager claims that in business planning terms, cost, quality, risk and quantity, given that there is a market for the service, are closely interwoven (see Figure 3.4).

Terry Wagstaff (1997) in his work concerning the " productive use of IT in support of FM solutions" in the healthcare affirms that, quantity is a direct consequence of competition and market demand. Facilities managers have traditionally concentrated on cost rather than value for money. Recently, an added dimension to their management tasks has been the management and reduction of risks that may be;

i) commercial
ii) clinical
iii) political
iv) physical and
v) financial

Wagstaff also noted that there is a fine balance between acceptable risk and perceived service quality. Professional judgement and decision-making, based on sound information, is an essential element in interpreting the data in an infrastructure for effective healthcare delivery. Wagstaff concludes by saying that trusts should be aiming at achieving a high quality service at a cost the market can afford.

Figure 3.4: The link between risk, cost, quality and quantity



Source: Wagstaff (1997)

NHS Estates (2001)

In a report based on improving the standard of cleanliness in NHS hospital settings, the NHS Estates published results of a nation-wide survey they conducted in the UK. The report also identified major sources of risk in providing "clean hospitals".

The risks paused by poor hospital facility standards include:

i) the risk of infection for patients;
ii) the risk of a poor public image for the hospital and NHS trust;
iii) an occupational health and safety risk for hospital staff and the public;
iv) the risk of a service providing poor value for money.
v) the risk of use to customers, staff, equipment and materials.

Furthermore, the "Clean Hospitals" initiative report also observed that some hospital functional areas paused the greater risks to customers than others. Thus were grouped into five levels of cleaning intensity, based on the risks associated with inadequate cleaning in that functional area. The level of risk exposure in these functional areas was classified as:

1. Very high risk
2. High risk
3. Moderate risk
4. Low risk
5. Minimal risk

For example, 'very high risk' functional areas include operating theatres and the Intensive Care Unit (ICU) while also showing the level of cleaning required.

Hiles and Carman (2001)

In their business article " Survive and Succeed" in the Facilities Business magazine, Hiles and Carman described the source of facilities risk in most service providing organisations as being related to:

1) Property; and
2) Operational/processes.

Hiles and Carman also further ranked these risks as:

1) High impact, high probability;

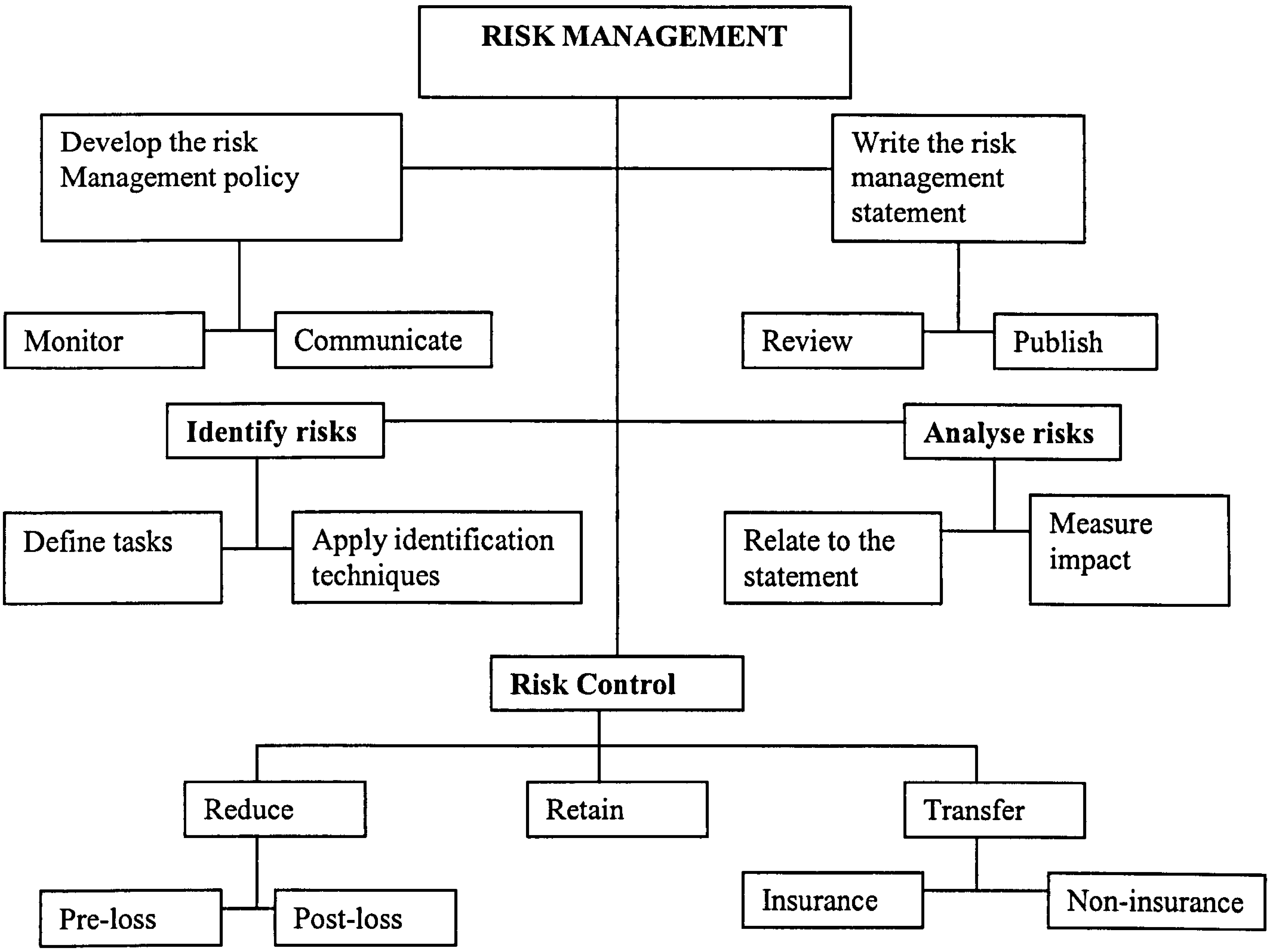
2) High impact, Low probability;
3) Low impact, High probability; and
4) Low impact, Low probability.

To have inside view of how FM risks affect the provision of responsive healthcare, the section above has explored various risk factors extracted from main literature sources. In overall, the main literature sources that were found to be more important in this study were from Kometa, (1995), Edwards and Bowen (1999), Alexander (1992) Wagstaff, (1997), Okoroh *et al.*, (1998) and HFN 17, 1998). If properly managed, these multivariate risks factors become the critical success factors of delivering best value non-clinical service in NHS trusts. Having established the main hypothesis of this investigation, it is of paramount importance to evaluate the various risk management strategies and to discuss further how these strategies that are implemented in the NHS. The section below and further chapters in this thesis will extensively explore various risk management process issues with a view of how testing the above hypothesis. Furthermore, if the hypothesis is proved to correct, the identified multivariate risk factors will be used to develop a risk management system that can be used by service operators to manage their non clinical businesses in the NHS. From literature reviewed so far, it was concluded by the researcher that the risk management process in any business sector is generic but what is novel are the specific inherent risks that are exposed by healthcare FM operations. These risks are unique to the NHS sector due to various business factors and strategies implemented in the NHS. Some of the business factors have already been discussed in chapter two, while some will be elaborated through the whole of this thesis.

3.12 Risk management process in healthcare FM

Healthcare facilities managers can help trusts to achieve uninterrupted provision of support services though benchmarking best practice management approaches in hospital organisations. In effect most non-clinical managers at all levels must subscribe to this approach, own the process take action, both proactively and retrospectively, and tackle any business risk issues affecting the effective delivery of FM services.

Figure 3.5: The risk management process in NHS trust hospitals



Source: Health Facilities Notes 17 (1998)

In order to achieve this task effectively, healthcare facilities managers will need to develop or implement sound risk management systems and action plans. These plans should allow for the identification analysis and control of risks that affect the delivery of non-clinical services in trust hospitals. This therefore calls for healthcare facilities managers to assume major responsibilities in the risk management process as shown in Figure 3.5 (HFN 17, 1998; NAO, 1999).

Their role, therefore, should range from evaluating the possibility and sources of risks with a view of preventing them at the source. In addition, they should assess risk exposure as a way of measuring service performance (i.e. customer satisfaction).

This is with a view of determining areas where healthcare service facilities are vulnerable and developing risk awareness strategies that are based on developing effective risk management systems, where appropriate, to improve the overall clinical service delivery process in the NHS. This approach thus adds service value to both the non-clinical and clinical business process leading to unrivalled customer satisfaction levels. Given the guidelines in Figure 3.5, the risk management approach adopted for this investigation is an integration of Alexander (1992), Boon (1998), McFadzean's (1996), NAO (1999) and the current risk management and quality assurance systems used in the NHS to manage business risks. This model is fully illustrated in HFN 16 (1998). This risk management process is similar to the one used by other clinical directorates in a trust, so it is universal and compatible with the holistic trust service and quality assurance management practised in the NHS and is illustrated in Figure 3.5.

3.13 Risk Policy

It is the responsibility of the facilities manager to determine non-clinical service implications for the NHS organisation from the decisions he or she makes. Healthcare facilities managers should therefore ensure that their adopted risk policy is consistent with the organisation's objectives and risk management policy from the facilities management operation, which gives a useful framework for the prioritising of FM-related risks to the business as well as assisting managers to make decisions regarding risk exposures. The objective of the FM organisation is to prevent injury (service failure) to all customers and stakeholders with whom the organisation comes into contact, whether they may be employees, customers or members of the community. The responsibility of facilities management is to take all necessary steps to avoid losses, injuries or damage to all healthcare facilities and real estate from any cause or other factors that could have adverse effects on the trust's operations and reputation. The overall objective of the risk management policy is to reduce the organisation's losses to a minimum, thereby substantially reducing the money spent on insurance premiums and the hidden cost of loss. The policy stage of the risk management process (see risk management process shown in Figure 3.5 is not normally considered in isolation.

The written policy on risk management should reflect a long-term commitment to the day-to-day (operational) dealing with risk management issues as well as producing a mechanism by which risks can be controlled by the organisation. In addition to Figure 3.5, Alexander (1992) has suggested a simple and systematic approach to risk management in FM operations that is very applicable to NHS operations. This approach focuses on the risk management process in which four distinct stages are identified namely:

(1) identification,
(2) analysis,
(3) control and
(4) financing of risk.

The first stage involves the identification of major sources of business risks in FM decision problems. In the second stage, the effects of these risks are quantified and evaluated against the business objectives. Thereafter sustainable risk policies and responses are developed to minimise FM operations and risks encountered. The fourth stage looks at mitigating circumstances for risk loss and setting up of contingency plans to finance any business loss incurred. This can either be through insurance, organisational funding or by either creating a captive insurance company or financing it through private finance initiatives in case of a core pubic institution.

From the work of Alexander (1992) and Boon (1998), it is practically impossible to eliminate business risks in any service organisation no matter how effective the organisational decisions made can be. This assumption would reinforce the fact that risk management is a trade-off between business opportunities and the probability of business failure (Casells, 1998). In this case, risk management will function to provide a logical framework for business performance improvement and reduction strategy to decision makers in order to pursue an organisation's business objectives effectively. Having looked at the risk management policy and action plan, the section below discusses the risk management process in healthcare FM.

3.14 Risk identification

In healthcare facilities management, risk identification forms the initial most integral stage of FM operations and business continuity. This phase involves a comprehensive evaluation of possible business risks, both present and future situations identified within the operating business environment. An evaluation of this magnitude will involve a close scrutiny of organisational and managerial risks likely to be encountered. The identification of risks will result in the formulation of both quantitative and qualitative approaches of manning business risks in healthcare FM operations. This process extends into the capitulation of knowledge regarding legal, commercial and human factors and communication systems in healthcare FM operations. Other human "uncertain" factor considerations such as criminal action, security and trade union action regarding employment and the transfer of business to a third party must also be considered. Very often, service providers and purchasers frequently rely upon their experience and intuition (perception) toward identifying and assessing FM risks. However this approach can be very complex and laborious when dealing with a core public service provider such as the NHS, which is highly political-sensitive to any service decisions made by hospital Trusts. The major sources of risk in healthcare FM operations have been identified and discussed earlier. The objective of the identification stage is to:

1. Identify source (s) and classification of risks.
2. Establish who is affected by them (i.e. service provider or purchaser).
3. Determine who is responsible for them (i.e. service provider or purchaser).
4. Detect where these risks fit into healthcare facilities management business process.

The identification of those FM service operators who are affected by the risk and those operators who are responsible for it - throughout the FM business process - means that the scope of the facilities management operations in the NHS must be extended beyond its traditional clinical boundaries. Consequently, the identification of risks at both the operational and managerial/strategic levels by healthcare facilities management service operators will typically include a detailed analysis of all present and future risks across the business process operations, property management and support/non clinical services.

The FM team must develop an understanding and knowledge of managerial risk factors such as: human resources, information management, communications, commercial and legal issues. This activity must be undertaken in conjunction with a more traditional understanding of, corporate, commercial, operational and technical risk factors.

3.15 Identification Procedures

The following procedures provide a useful basis of evaluating service performance of healthcare facilities, procedures and documents to identify all the relevant risks within and around the FM business process in the NHS.

3.16 Checklists

The checklist method will normally begin with a brainstorming session to identify key areas of concern within the operation of the FM business. Checklists can prove to be invaluable to the facilities manager in seeking to establish the location of problem areas in the business and are particularly useful in ensuring that basic evaluation criteria are not overlooked. However, a checklist does not reflect the constant changes that affect facilities managers. By the time a checklist is completed, it is inevitably out-of-date. It is often most effective to use a number of FM staff who are familiar with the day-to-day running of the activity under investigation.

3.17 Inspections

Inspection involves carrying out FM service and performance audits of the healthcare facilities, identifying anything that might pose a risk to the organisation and staff. This will often necessitate the use of brainstorming sessions, coupled with checklists to highlight key areas for examination.

3.18 Organisational Flowcharts

Organisational flowcharts can provide useful information to identify key business processes within the organisation that have an impact on NHS FM operations.

It is particularly important to consider how core (clinical) activities undertaken by the organisation along the whole FM stakeholder supply chain (in-house and external providers, purchasers and customers) can contribute to the risk profile.

3.19 Review of Documentation

Whilst the checklists, physical inventory and organisational flowcharts are being examined, records and documentation should also be considered in the NHS. Wagstaff (1997) identified this process starting with the review of the following;

1. Contracts for FM and maintenance agreements.
2. Service level agreements.
3. Service management and maintenance records.
4. Records of fixed assets.

Once all the identification procedures have begun the facilities manager should collect all the business process information that has been collected into a single database that will typically include details of the types of risk, the location of these risks, and customer responsibilities. In addition, a decision making process must be put into place that enables the database to be updated and maintained on a regular basis.

3.20 Risk register

This is more like a checklist of risks that affect healthcare FM operations. The difference with a checklist is that, the risk register contains a full cost plan of risks and various strategies to be adopted for healthcare FM operations by the facilities executive. It is important that the costs covering risks must be revised to reflect any service delivery level changes. This information can be kept in database.

3.21 Risk analysis

Risk analysis includes estimating the occurrence likelihood of each identified service delivery failures or hazards with potential to cause serious FM business consequences and assessing the magnitude of possible consequences. In other words, a risk analysis is a cause-consequence analysis.

Once major risk factors have been established through rigorous "check" systems of an organisation, various measures must be taken to quantify them so that it is possible to determine their effects on decision-making and judge the possible outcome. Various decision criteria (i.e. profit maximisation and customer-focus and responsive services) must be implemented so as to facilitate the selection of alternative decision-making options in healthcare FM operations. Various quantitative risk analysis techniques such as decision tree, probability and simulation, sensitivity, scenario analysis and utility theory may be used to analyse the possible outcomes and impact of these risk factors identified in the initial stage. In most cases these techniques often apportion a "weighting factor" value, which is ascribed certain decision parameters, that can evaluate the degree of risk event repeatability and the impact it might have on the decision outcome in terms of financial and utility values. Sometimes, a subjective judgement decision is required to measure such risk factors identified in the FM business process. This situation is often typified in the NHS, whereby the majority of Trusts and service providers are not able to obtain reliable business information to determine the probability of these FM risk factor outcomes in most service delivery projects (NHS Estates, 1997). Hence, risk diagnosis suffers severe limitations (as providers and purchasers are sceptical of its reliability and accuracy) especially when subjective judgements are required.

3.22 Risk response

Risk can be managed in a number of ways of which all will have an output objective of minimising business failure and improving service delivery success. From literature review so far, four common methods of managing FM risks that are used by decision-makers have been established. These methods are;

i. Risk avoidance –management tools
ii. Risk reduction- minimise impact
iii. Risk transfer – delegate and contract, insure, guarantor and funding and,
iv. Risk retention

3.23 Risk management tools and techniques

Various risk management techniques (qualitative or quantitative) can be used to treat risk and uncertainty in FM service operations, but the main common quantitative methods used are (Okoroh *et al,* 2000):

i) probabilistic approaches
ii) certainty factors
iii) influence diagrams
iv) fuzzy logic
v) decision trees
vi) clustering
vii) rule induction; and
viii) genetic algorithms

A detailed description of all of the above risk management techniques will be discussed in great detail in chapter four. This chapter will review the application of DSSs in support services management in the NHS.

3.24 Definition of decision making in healthcare FM operations

The provision of healthcare in the NHS entirely depends upon the process of effective decision making on limited healthcare resources. According to Ormrod (1993: pp.3),

" A decision is process or a sequence of activities undertaken by an individual or group(s) with a view to establish and implement a solution to an existing or potential problem"

From Ormrod's definition, it can be noted that a decision in FM, is the point at which a choice is made between alternative- and usually competing options. As such it may be seen as a stepping off point i.e. the point at which a commitment is made to one course of action to the exclusion of others. In FM terms, it is the commitment made by facilities managers to a course of action that imbues a decision with significance.

Thus according to Drummond (1996), this process calls for effective decision making which is to resolve upon a specific choice or course of action. Furthermore, Drummond makes a clear distinction between a decision per se, and the decision making process. The decision she suggests is the final outcome of the process, but the decision making process involves "events leading up to the moment of choice and beyond". This separation seems a wealthier, given the fact that so many cognitive processes take place in the mind of a facilities manager as part of the human system. It is therefore difficult to put a fine line between the causes from the effects in such circumstances.

3.25 FM decision and risk types

Within healthcare organisations, only executives i.e. facilities managers make healthcare delivery decisions which are sometimes compatible with their personal objectives but occasionally are not (Peter Drucker, 1979). As such incompatibility between personal and organisational goals can lead to further commotion regarding a decision. Most decisions made by healthcare organisations are of routine and market-driven nature, and as a result have to be made to improve the service performance of the organisation, and in so doing satisfying the organisation's business objectives. Examples of routine decisions can be for example, when a facilities manager orders first-line supervisors to manage facility services quality and performance to a certain service level on a daily basis in all the hospital floor wards, or check equipment failures relating to security cameras on a daily basis. Some facility and business decisions are more strategic than others. In most cases they involve risk and will also involve uncertainty. In today's changing business environment decisions can be classified in accordance with the nature of business as well as the level of decision-making involved. As result of the chaotic society and operating environment, many practitioners and researchers have proposed various methodologies of classifying FM decisions. We will start by examining the most common type of classification. Generally, according to Simon (1960) and Ritchie and Marshall (1995) two types of decisions prevail in business namely: programmed and non-programmed. In addition to the above, the implementation of these business decisions at an operational level will largely be based on the knowledge presented by the business and risk management process.

However, a certain proportion of the decision process will often depend on the facilities service operator's own propensity to risk, as shown below that they are three types of risk decisions that facilities managers can use in managing the FM business process in healthcare operations. According to Finch (1992) these are:

i. *Risk taking* - willing to accept a risk, though probability of loss is not favourable.
ii. *Risk neutral* - willing to accept risk, if probability of success is favourable.
iii. *Risk averse* - avoids risk, despite favourable probability of success.

3.26 Decision-making

In order to have an insider view of decision-making and praxeology, a narration of the characteristics of a decision situation must first be evaluated. Skyttner (1999) defines this situation with the following aspects;

i. A problem exists
ii. At least two alternative for solution exists
iii. Knowledge exists of the objective and its relationship to the problem;
iv. The consequences of the decision can be estimated and sometimes quantified

Although facilities managers as decision-makers use instrumental methods, they exercise free will and are thus responsible for their decision that often includes ethical and normative components. Generally in the NHS, a universal set of uncertain elements such as economic, environmental, and political fitness creates the anatomy of a decision. In this setting the facilities managers initially pursues existing alternatives and then make a choice between a set of them (usually micro). In turn, every option has consequences, connected to the aspects via the alternatives. Given these sets of aspects and consequences, the decision-maker has to choose the best value option. According to Skyttner (1999) all decision situations belong to three situational parameters.

This thinking can be applied to the case of healthcare facilities managers who may have to evaluate decisions belonging to any of the following three classes:

1. Decisions under strict uncertainty. Here the facilities manager is unable to know anything about the business situation. Quantification of the uncertainty is not possible.
2. Decisions under certainty. In this case the facilities manager has full knowledge of the situation, and the consequences of the decision can be predicted. The alternative, which has a value not less than the value of any other alternative, is chosen.

3. Decision with risk. In this situation the facilities manager is able to quantify the uncertainty by assigning probabilities, generally known in advance, to each alternative. It should not be taken for granted that the level of risk increases exponentially as more information is omitted.

By implementing effective decision-making processes, facilities managers are able to solve, resolve, or dissolve facility-related service delivery problems. Thus, allowing room for improving service delivery strategies. According to Simon (1976) the process of rational decision-making is an act of choosing among alternatives that have been assigned different valuations. It involves the following process:

(1) Listing all of the alternative strategies.
(2) Determining all the consequences that follow upon each of these strategies.
(3) Comparatively evaluating these sets of consequences.

3.27 Decision making models

There is a large body of knowledge written about decision-making processes in FM (O'Loughlin and McFadzean, 1999; Ritchie and Marshall, 1995; Barrett, 1995). But perhaps one of the most distinguished and respected writers is Herbert A. Simon (1976). According to Simon, the most important issue of any decision-making process is that of rationale behaviour.

As demonstrated by Simon, a decision making process basically consists of three distinct stages which are as follows:

1. **Intelligence stage** – This involves the evaluation of the economic, technical, political, legal, physco-social environment in order to scan for conditions or circumstances calling for new actions. It involves basically scouting for opportunities that exist for making a decision.

2. **Design stage** – in this phase, the decision-maker invents, develop and analyse possible courses of action. Thus, this stage involves the seeking of all possible courses of action to a decision problem.

3. **Choice stage** – This stage involves choosing one of the alternative courses of action. This stage is mostly involves FM executives making strategic decisions about managing FM services cost effectively.

3.28 FM decision-making model

Many attempts have been made by facilities managers and researchers to develop decision-making models that facilitate effective healthcare estate, site and hotel services management. Most of these models attempt to provide a "systematic framework" for structuring FM decisions qualitatively or quantitatively and effectively. Furthermore, by using this procedure, it allows for effective model analysis and enables senior healthcare managers to select the best practice action under various business circumstances. In healthcare FM, three levels of decision making structures exists in most trusts' facilities directorates which demand different types of healthcare information - information systems (HFN 17, 1998).
These levels are;

1. operational control;
2. management control and;
3. strategic planning.

A typical decision-making model in healthcare FM operations which shows various levels at which FM decisions are made proposed by HFN 17 (1998) is illustrated in Table 3.7.

Table 3.7: Levels of FM decision-making

Information	Operational control	Managerial control	Strategic planning
Source	internal	internal	external
Precision	high	medium	low
Timing	exceptional	periodic	irregular
Notice	sudden	anticipate	none
Nature	warning	results	predictive

Source: HFN, 17 (1998)

Although three levels do exist in most healthcare FM organisations, it is important to remember that as discussed above, FM models can be considered at four levels HFN 17 (1998). Facilities managers as decision-maker may utilise a variety of models in the NHS. These models although vary with the changes in business environments, the principles upon which the process is based is basically similar. Thus, for FM decisions to be effective in the NHS, they must be considered at the following organisational levels;

Corporate level – senior managers with an FM duty must add value to the service planning process (decision-making), formulate organisational policies and execute scenario planning. This level of decision-making requires an inside view of the corporate service culture and strategic intent.

Strategic level – facilities managers have responsibilities for effective business planning of the facilities service, management development and control and future development proposals for effective facilities management.

Tactical level – at this stage, facilities managers concentrate on delivering effective decisions that improves and ensures service quality is well managed, and in overall managing value and implementing effective risk management strategies.

Operational Level – in this stage the facilities manager is concerned with service performance management (auditing and monitoring performance). This stage involves an interface with the consumers in the physical servicescape. Customer satisfaction strategies and decisions will be mainly concerned with the delivery of innovative healthcare service to customer by service providers.

The main objective of most decision models in healthcare FM is to evaluate a sequence of activities aimed at providing guidance to management in order to perform the evaluation, analysis and control of healthcare business risks whilst increasing the quality of relevant service delivery information at their disposal. This process also involves the evaluation of good information systems, data input, sensible analysis and tracing the source of origin a decision problem. Thus, according to the CFM (1993) and HFN 16 (1996), the main purpose of any effective FM model is to set out the performance relationship between the following;

i. business;
ii. operations;
iii. facilities;
iv. infrastructure;
v. resources

Thus, the models described above provide an effective business risk management strategy that facilitates the decision making process of facilities managers.

3.29 Types of FM models and their uses

There are numerous FM models in commercial use by facilities managers to make business decisions. These models do vary in organisational use and are problem-dependant. Most of the models used in FM business modelling range from complex mathematical to simple decision-making triangle for managing service uncertainty.

The decision models healthcare FM managers can competitively use to provide effective business support services in the NHS can be classified in various domains proposed by Finch (1999), McFadzean (1998) and Skyttner (1999).
Having analysed the various models that are available for use by FM managers, it is equally important to illustrate what an FM model resemble in practice. To illustrate this situation, HFN 17 (1998) have provided archetypes of FM decision models that are shown in Table 3.7. It is also critical that while all these FM models can be used for the procurement of FM services, they should aid in problem solving of healthcare FM. The successful usage of such information systems to provide useful data is highly dependent on a multi-factor analysis.

3.30 Summary

This chapter has reviewed the concept of risk management in healthcare FM operations. It has also identified and evaluated the major sources of risks in FM that affect effective healthcare service delivery. In addition this chapter has also explored various techniques used as well as analysing the decision making process in the NHS. The risk management process reviewed highlighted strategic decisions that should be made by facilities managers who are attempting to balance the elements of risk and reward across the FM service organisation. Where appropriate, practical tools and techniques that analyse the level of exposure and control of risk were described in relation to the current best practice in healthcare and facilities management. In addition, examples were also used to provide support for the adoption of a FM risk management process as well as to understand the approaches used in managing FM business processes in the NHS. The next chapter (Chapter four) will discuss in detail the application and analysis of business decision support systems as part of effective risk management in healthcare FM operations.

CHAPTER FOUR

DECISION SUPPORT SYSTEMS IN HEALTHCARE FM OPERATIONS

DECISION SUPPORT SYSTEMS IN HEALTHCARE FM OPERATIONS

4.1 Introduction

This chapter describes the concept of DSSs in healthcare facilities management operations and decision-making. In particular, this chapter evaluates business decision-making models used by FM service operators in solving non-clinical service delivery problems in the UK NHS. Furthermore, the basic elements of a DSS are discussed including their potential application areas in healthcare FM. The final part of this chapter reviews literature on FM risk knowledge acquisition, implementation and development of business decision-making solutions in the NHS.

4.2 Definition of FM decision support systems

In healthcare FM operations, DSSs can be regarded as interactive computer-based information systems. These systems are designed to aid facilities managers in making best value decisions regarding the delivery of high quality non-clinical services. These best value solutions are normally based on analysing FM information and then developing business decision models to solve unstructured or structure healthcare service problems (Metawa, 1995; Then, 1995; and Grimshaw *et al.*, 1992). DSSs allow the scarce and expensive knowledge of FM experts to be explicitly stored into computer programs and made available to others who may be less experienced, to use in making strategic business decisions. They range in scale from simple rule-based systems with flat data to very large scale, integrated developments taking many person-years to develop. They typically have a set of "**IF……THEN**" rules which forms the knowledge base, and a dedicated inference engine, which provides the execution mechanism. This contrasts with conventional programs where domain knowledge and execution control are closely intertwined such that the knowledge is implicitly stored in the program. The explicit separation of knowledge from the control mechanism makes it easier to examine, incorporate and modify existing FM knowledge.

It is important and simpler to split the elements of a DSS into standard components that most facilities managers use in making responsive service enhancing decisions in the NHS. Sometimes these components are collectively referred to as an ES. Therefore, in today's very competitive business environment in the NHS, facilities managers can collect and analyse relevant site, hotel and estates services performance information and turn it into effective business management models. These business management models can then be turned into a basis for FM action and business solutions (Wagstaff, 1997). It is in hindsight of this that DSSs can be used in the NHS to assist facilities managers to make strategic and competitive FM business decisions that will improve the delivery of non-clinical services to NHS customers. In addition, DSSs also provide a more flexible problem-solving environment that allows healthcare facilities managers to asses their strategic decision making processes when managing non-clinical risks effectively. Thus, DSSs can be used to evaluate total FM business performance and risks affecting healthcare service delivery situations in the NHS. They are best suited to business problems where part of the analysis is computerised, but the decision maker's value judgment (personal experience) must be exercised in the interpretation of the data and the final decision-making. DSSs may be used in wide range of healthcare FM operations. For example in strategic planning and modelling, business optimisation, risk management, analysing alternatives and decision-making (Dowie *et al,* 1998; Finlay, 1989).

4.3 General properties of DSSs

In his famous publication on DSSs used in effective business management, Finlay (1989) distinguished two main types of DSSs. These are;

(i) data-oriented; and
(ii) management-oriented approaches.

Data-oriented systems include data retrieval and analysis systems involving accessing and analysing data held on files and small databases.

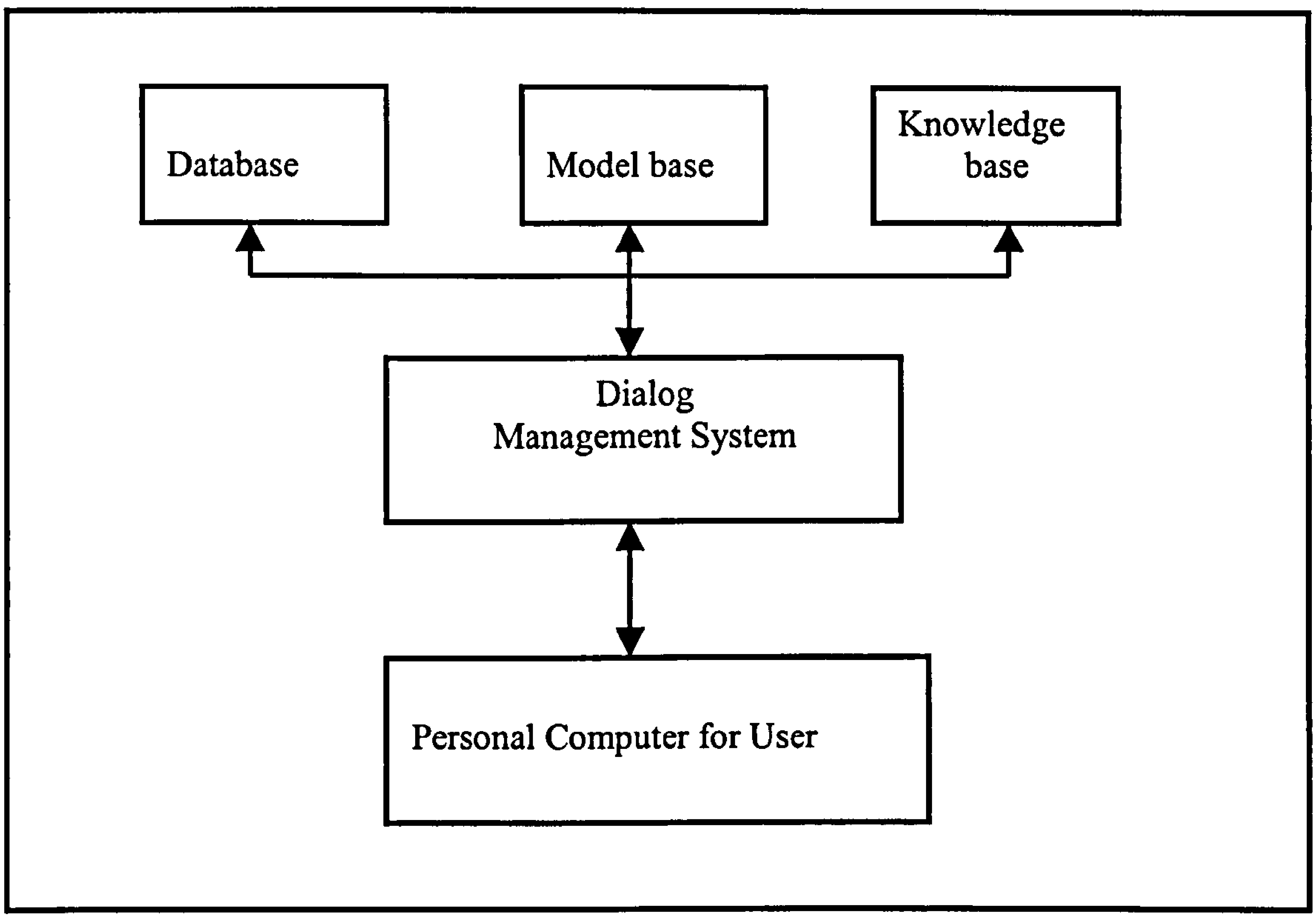
Management-oriented systems are simulation models that permit the consequences of a range of business actions to be explored and suggestions, or option models that offer the user a solution to a specific problem within clearly defined constraints. Increasingly today in healthcare FM operations, DSSs are now being used to develop strategic business or best practice models for effective decision-making. These models enable non-clinical service managers to explore a range of alternative decision-making options. Generally, DSSs have been less commercially used to successfully support the strategic management of healthcare operations in the NHS (Dowie *et al.,* 1998). Although there have been significant business and medical advances in the NHS, many of the current FM systems in most FM directorates are still in their rudimentary stages of development (O'Brien *et al.*, 1995). Furthermore, a major limitation of conventional DSSs in FM is that, they rely on limited quantitative models and cannot handle "fuzzy" situations, i.e. where complete information is uncertain or not adequately available (Amaravadi *et al.*, 1995). However, the most essential aspect of DSSs is their applicability to business situations where facilities managers normally make decisions based largely on their own personal beliefs/values, working experience and knowledge (expertise) rather than using complete information.

4.4 General structure of a DSS

A conventional DSS consists of a database, model base and dialog system. For this research, the DSS is designed as an intelligent DSS or expert system. In such a system, the knowledge base is an integral part in the development of an effective DSS. It has models and databases and a dialogue facility. In addition, it will have a knowledge base containing FM knowledge and an inference engine. In relation to this, Figure 4.1 adapted from Nagarur and Kaewplang (1999), illustrates the components of a typical FM DSS. The important components are the database, decision-making model, and knowledge base. The user interface for the dialogue management unit consists of a workstation usually with a set of programs that manage the display screen. It obtains input (business information) from and sends output to the user and translates the user's business requests into commands/actions for the other two units.

The model management unit contains models of the business information. Examples can be spreadsheets, financial models, and business process simulation models. This unit also creates, modifies, and invokes the models. The data-management unit maintains the internal database and interfaces other sources of data from external databases such as domain FM experts/consultants and NHS facilities managers interviewed. In principle, a DSS can deliver its own solutions at decision time and perform the whole task itself, although a responsible decision-maker is unlikely to give up his/her right to decide.

Figure 4.1: Decision support system components



Adapted from Nagarur and Kaewplang (1999)

4.5 Knowledge base

The knowledge base contains the specific FM knowledge or information elicited from experienced facilities managers who can be regarded as domain facilities management experts.

Human expertise is incorporated into a DSS in the form of knowledge about a domain. The knowledge may comprise of rules, facts, reasons, procedures, rules of thumb, intuition or inference nets which need to be observed. This knowledge is also used to develop decision solution information to the DSS. The knowledge base also contains an expert's knowledge about a particular domain. The expert's knowledge is normally entered into the knowledge base by a system developer or the user. For FM knowledge or decision information to be handled by the computer software, it must be represented in a "systematic" or coded format. Coding is achieved by using the system editor to normalise the data using a recognised pattern of classification (i.e. numerical or symbols). This aspect of data classification will be elaborated further in Chapter nine of this thesis that deals with model development using ANN systems.

4.6 User interface

This provides communication with the system developer and the eventual user of the system. It also controls the dialogue with the user in a form consistent with the user's understanding of the task being dealt with. This may be an explanation module or model base that provides the user with the information about main questions asked, and decisions made, by the inference engine.

4.7 Database

This contains facts about the problem domain to be solved. In this case these will be FM risk factors that affect healthcare operations in the NHS. These FM facts (risk factors) include the components that are required for the design of a model system. These FM facts can be initially known facts about a domain or facts that are used as input in order to begin the inference process or facts that are stored temporarily during the inference process.

4.8 Model base

The model base normally consists of decision-making models. In this study, these models belong to a class of mathematical models. These mathematical models are classified into three types. They are the relative index models, statistical models, and artificial AI models (i.e. ANNs). For the proposed DSS in this research only ANNs with high predictive capabilities were incorporated. Other AI models need detailed modeling of data collected and hence were not developed at this stage (Lu *et al.*, 1996; Okoroh, 1992) However, any other additions can be easily incorporated because of the flexibility of the object-oriented environment. All these models can interact with other modules like the knowledge base and database.

4.9 Business decision support models

Several types of business decision models have been developed to assist FM managers as decision-makers in solving simple and complex service delivery failures in the NHS. Decision-making in healthcare FM operations can either be qualitative or quantitative depending on the preference of the management and operation team, as to which approach can be followed to get the best performance results. Quantitative models in FM operations are decision support systems that foster contract success by identifying tasks and their impact within a budget, time, quality against the resource level line. The most popularly used are Hypothesis testing, Statistics analysis, Decision analysis, Sensitivity analysis, Monte Carlo, Factor analysis, Stochastic dominance, Algorithms, Caspar and intuition, Simulation, Bayesian theory, Decision trees, Mean-end analysis, Subjective probability, Probability impact tables and grids, influence diagrams, MERA, Systems dynamics, PERT, and other techniques described further in the Association of Project Managers' PRAM Guide (1998). All these decision-making techniques are reasonably well known to most FM, project managers and researchers (Akintola and Macloud, 1997; Gill and Hillson 1998). Quantitative techniques have recently been seen to add value to the delivery of non-clinical services and contract strategies for project managers managing business risks in the NHS (Gill and Hillson, 1998).

According to Gill and Hillson (1998), the best projects that can benefit from the use of such techniques in decision-making are innovative large, complex, critical, sensitive, time-constrained and highly fixed budgets adversarial contracts. Healthcare FM operations best fit the classification above due to their complexity in service design and delivery output requirements. QTs can also be used to enhance FM services provision and risk management strategies, bringing a better vision of understanding of the business process in healthcare FM service operations.

4.10 Quantified Risk Assessment

The above is decision making tool that attempts to quantify the level of business risks in healthcare FM operations in an objective way by using a numerical measure/score. The initial assessment of this technique is clearly based on deciding which parts of the FM business process would have most impact on a risk occurring such as a health and safety, unhelpful staff and facilities service failure due to poor quality delivery decisions in a hospital. Once the unit, or units, have been identified, a measurement of the intensity of the risk should be taken. The next step is then identifying other hazards, such as a reaction to the risk, along the process. Once all these factors are calculated, they may be multiplied together to produce a risk index (ie high/low) that measures the FM business process/performance. Points can then be deducted for the use of risk reduction methods (e.g. fire detectors and sprinklers or having a risk register for cleaning ward floors). Using such an index, the facilities manager may make comparisons and monitor changes on a regular intervals of the service operations.

4.11 Statistics

Statistics is an indispensable component in FM data selection, sampling, analysis, and knowledge evaluation. It can be used to identify and analyse the results of a risk analysis using particular management data collected from the business process or FM surveys conducted by facilities managers. This normally involves using a computer software ie SPSS, to analyse and separate the best from the worst results (Olubodan, 2000).

In data analysis, statistics offer the means to detect "outliers", to smooth (arrange) data when necessary, and to estimate normality in distribution. Statistics can also deal with missing data to predict trends using estimation techniques. Techniques in clustering and designing of experiments come into play for exploratory data analysis. Work in statistics, however, has emphasised generally on theoretical aspects of techniques and models. As a result, the concept of search that is crucial in risk data analysis, has received little attention in literature. In addition, interface to database, techniques that deal with massive data sets, and techniques for efficient data management are very important issues in facilities management. These issues, however, have only begun to receive attention in statistics (Kettenring and Pregibon, 1996; and Olubodan, 2000).

4.12 Artificial intelligence (AI) techniques

AI techniques are widely used in risk modelling and analysis of both business and clinical processes in the NHS. Techniques such as pattern recognition, fuzzy logic, and neural networks have received much attention (Bussabaine, 1996). Other techniques in AI such as knowledge acquisition, knowledge representation, and search, are relevant to the various process steps in risk analysis. Classification is one of the major risk analysis problems. Classification is the process of dividing FM data sets into mutually exclusive groups such that the members of each group are as "close" as possible to one another, and the members of different groups are as "far" as possible from one another. For example, a typical classification problem is to divide a database of NHS FM customers into groups that are as homogeneous as possible with respect to a variable such as support service needs, creditworthiness, intelligence and customer satisfaction levels. One solution to the classification problem is to use ANNs. According to Lu *et al.*, 1996, a neural network-based data mining approach consists of three major phases. *Network construction and training*: in this phase, a layered neural network based on the number of attributes, number of classes, and chosen input coding method are trained and constructed. *Network pruning*: in this phase, redundant links and units are removed without increasing the classification error rate of the network. *Rule extraction*: classification rules are extracted in this phase.

For a detailed review on ANNs, Akinsola (1997) provides an objective appraisal on this topic. Other AI techniques that can be used for data analysis include case-based reasoning and intelligent agents. Case-based reasoning uses historical cases to recognise patterns and the intelligent agent approach employs a computer program (i.e. an agent) to sift through data.

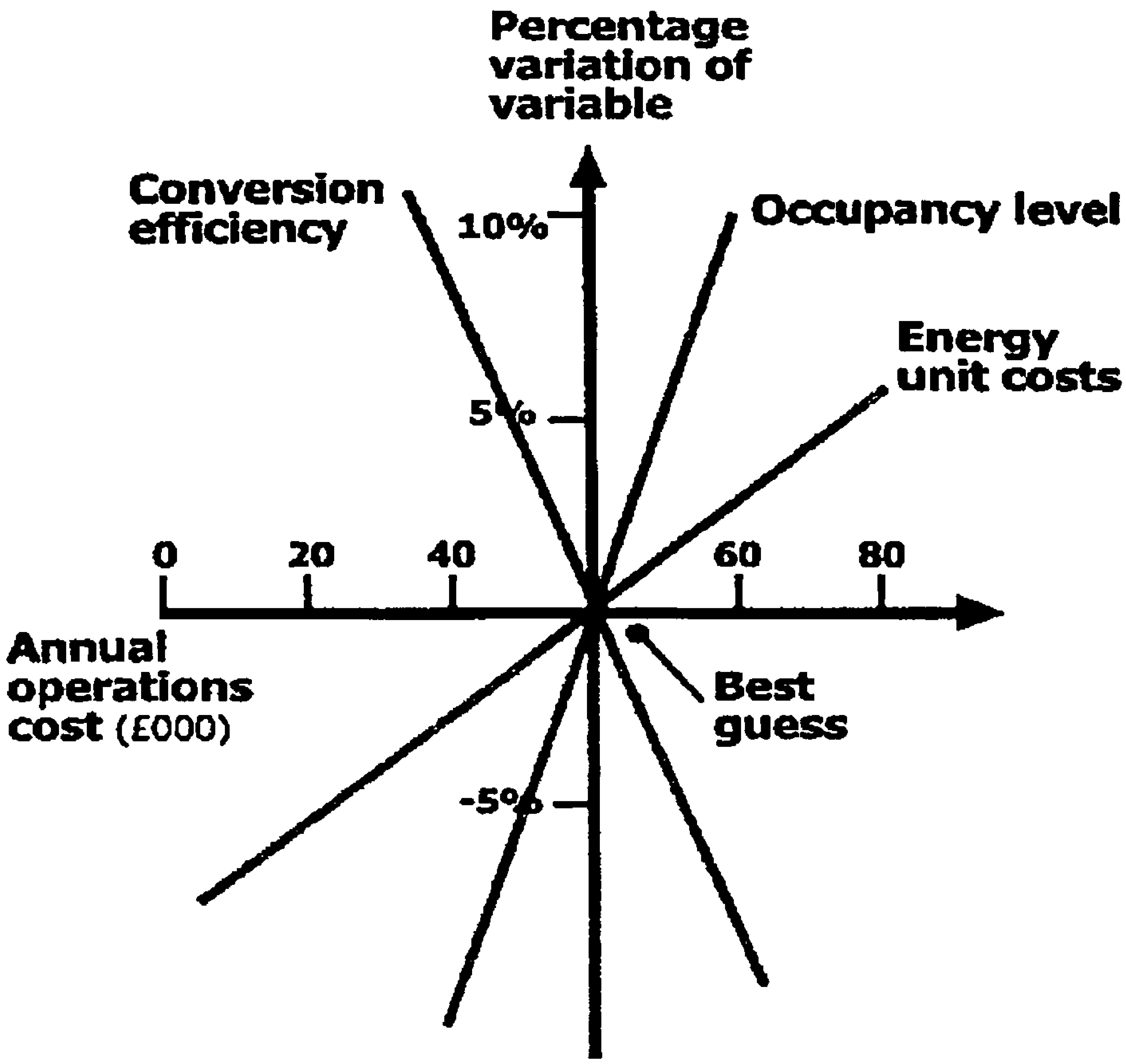
4.13 Genetic algorithm

Genetic algorithm is a relatively new software paradigm inspired by Darwin's theory of evolution. A population of rules, each representing a possible solution to a problem, is initially created at random. Then pairs of rules (usually the strongest) are combined to produce offspring for the next generation. A mutation process is used to randomly modify the genetic structures of some members of each new generation. The system runs for dozens or hundreds of generations. The process is terminated when an optimum solution is found. GAs are appropriate for problems that require optimisation with respect to some computable criterion. This paradigm can be applied to data analysis problems. The quantity to be minimised is often the number of classification errors on a training set. Complex FM problems require a fast computer in order to obtain appropriate solutions in a reasonable amount of time. Analysing large FM data sets by genetic algorithms has become practical only recently due to the availability of affordable high-speed computers. For a detailed literature review on GAs Ceranic's (1999) work gives a good background of this concept and its potential application in the built environment.

4.14 Sensitivity analysis

This method is normally used to evaluate the influence of changes in an individual risky element or uncertain parameters on the outcome of a FM decision dilemma. This decision model is normally used to predict uncertain factors related to perfect service markets. It is normally used in the analysis of financial and investment uncertain decision problems, which can be faced by FM service providers and purchasers in delivering capital and FM projects at best value.

Figure 4.2: Spider diagram for sensitivity analysis



Source: Finch (1992)

The likely impact of the uncertain element on the final decision is then evaluated by changing the value of the uncertain variable of the final output results. These results can be interpolated into a simple table to enable the FM manager to judge alternative decision options at his/her disposal. In cases where the variable options are more than one, the results of the analysis can be shown using a spider diagram such as the one shown in Figure 4.2. The spider diagram provides a clear representation of evaluating the critical FM variables. The main merit of such a technique is that, it allows the FM manager as the decision maker to identify major pertinent risk factors so as to make proper remedial decision action plan that will adversely reduce the risk exposure of the organisation.

Although this technique is a useful decision making tool for FM managers in risk modelling, it has its shortcomings such as;

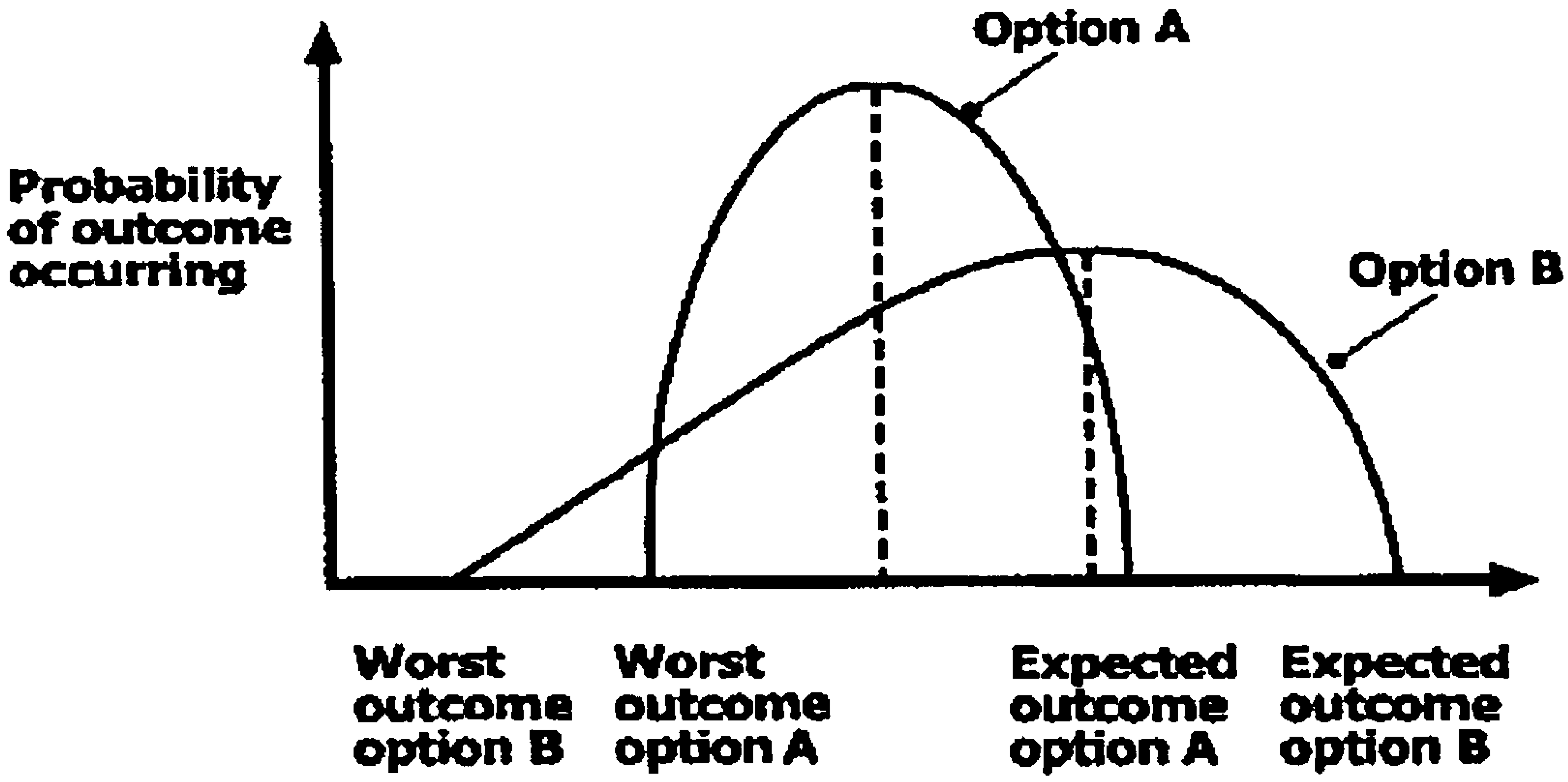
i. the variable factors are treated individually and this can often lead to severe limitations in the extent to which combinations of variables can be evaluated directly from a given data FM set.
ii. it provides no indication of the anticipated probability of occurrence for any FM operation event.
iii. it indicates only the size of any loss, and not the probability.
iv. it does not give an indication of the combined effect that two or more variables will have on the potential size of any loss.

Figure 4.2 taken from Finch's (1992) work on risk management clearly illustrates how this technique can be applied to FM operations. In Figure 4.2, by adjusting the cost of utilities between 5% and 10% may indicate the impact that this will have on the annual FM operations cost for a proposed new facility. Each adjustment may then be plotted on a chart known as a spider diagram.

4.15 Probability analysis

Probability analysis is a means of scoring and comparing FM risks on the basis of the certainty, or uncertainty, that a particular event will occur. Any loss to the service organisation can be calculated by determining the severity of the risk with the consequences that the event will not happen. Figure 4.3 taken from Barrett's (1995) work on decision making details the probability that two options will occur, using a distribution diagram. The use of probability theory in healthcare FM provides a powerful and complex form of risk analysis tool. Probability analysis overcomes the limitation of sensitivity analysis by specifying a probability distribution for each uncertain variable and provides the mechanism that allows all factors to change their values at the same time. However, in FM business practice it is often complex to quantify all management-related risk factors, especially in the NHS where FM business processes are unique and complex in nature, and their operating environment is highly dynamic.

Figure 4.3: Probability of outcome chart



Source: Barrett (ed) (1995)

Furthermore, the adequate collection of healthcare FM data avoids the quantitative derivation of the probability distribution of many uncertain elements. As a result, subjective judgement decisions are often required to estimate the probability of outcome of uncertain FM events. Quite often, this problem of specifying probability distribution is overcome by utilising a sampling approach such as Monte Carlo simulation technique (Gill and Hillson, 1998). This will result in probability risk analysis providing a more robust and quantitative approach towards risk treatment, which is seldom used by FM service operators. This can account for the sophisticated and risk-aversion nature which FM service operators possess regarding the use of subjective judgement decisions to estimate the probability of various uncertain business elements.

4.16 Decision tree analysis

Decision trees are tree-shaped structures that represent a set of business decisions made by healthcare facilities managers. The decision tree approach can generate rules for the classification of a data set in an FM business process highlighting the probabilities of success or failure. Specific decision tree methods include CART and CHAID.

CART and CHAID are decision tree techniques used for classification of a data set. They provide a set of rules that can be applied to a new (unclassified) data set to predict which records will have a given outcome. CART typically requires less data preparation than CHAID. A decision tree offers FM managers a visual presentation of the structure of a decision situation (Skyttner, 1999). Skyttner state that the analysis comprises of an anatomy of the decision being displayed diagrammatically using a decision tree. The decision tree explicitly illustrates the possible remedial actions together with the outcomes and associated probabilities of various outcome states. The branches of the tree represent either decision alternatives or chance events nodes (represented by circles). The decision tree from the left to the right will display various decision points and chances of the decision problem over a specific time period (planning phase). A transition occurs between openness to closure, something that presupposes a moment in time when all necessary information is collected. If risk or uncertainty is associated with each step in the decision tree or process, then a certain degree of inherent qualities are accumulated. The structuring of a decision problem in this situation improves the decision making process for FM managers. This technique has a unique advantage in that it facilitates non-clinical managers as decision makers to quantify the FM operations in terms of probabilistic outcomes, resulting in the evaluation of service delivery decision options cost effectively.

4.17 Decision matrix

It is a very popular decision aid used by facilities and healthcare managers in the NHS. A decision matrix is commonly used for improving the choice of the best decision option when various alternative decisions have been critically appraised and identified. According to Skyttner (1999) the value of a decision matrix increases proportionally to the number of increasing alternative options available. The design and use of the decision matrix can be explained using four steps shown below (Skyttner, 1999). These steps shown in Figure 4.4 can also be also used to manage business risks in healthcare FM.

Step one: - Involves the identification of all the alternatives (factors) which are appropriate and relevant to allocate them to the decision matrix.

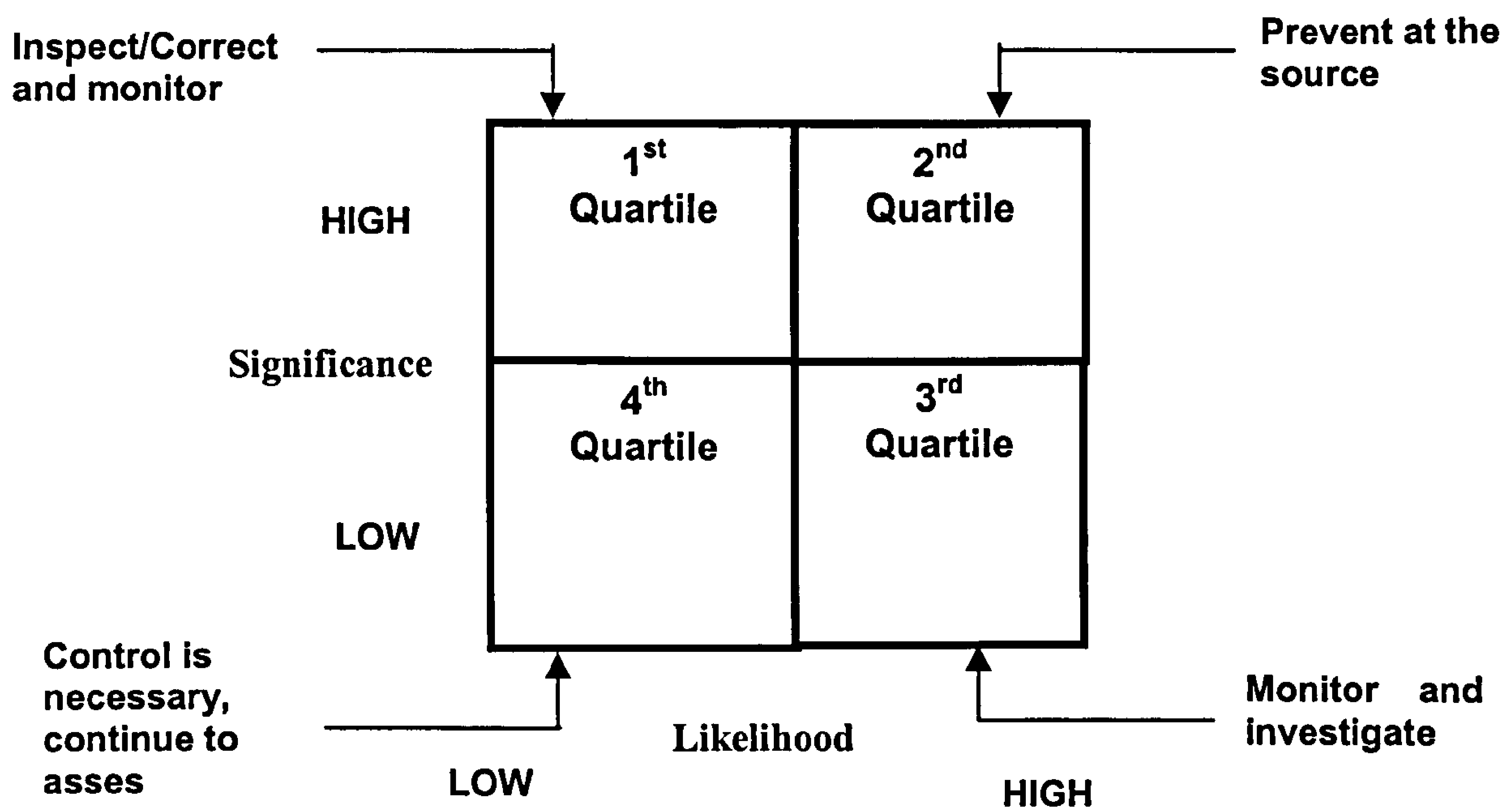
Step two: - In the second stage, a criterion is established to formulate the basis for a decision exercise for each individual against the others. The total numbers are summed up, and weighting factors also attached by dividing this total into each item's single number. A specimen of with the four-quartile criteria is then developed.

Step three: - This involves assigning a rating factor value to all the decision alternative options under consideration. The four quartiles are used to show the various decision solutions. The assignment of these values can be best done on an individual basis at a given opportune of time, while each alternative is considered using the same particular criterion.

Step four: - This represents the final stage in the completion of a decision matrix. The stage involves the multiplication of each ranked factor against the corresponding weighting factor, then recording the product sum in the proper quartile. Finally, all products are totalled as shown in a completed matrix in Figure 4.4 below.

By using mathematical assumptions, the highest sum of weighting factor can be ten, since all factors must range between one and ten being the highest-ranking value. In Figure 4.4 the second quartile has the highest value and a result may be chosen. The main merit of using this type of decision matrix is that all decision steps are well defined and tabulated. This gives a clear explanation as to why a certain decision was by a facilities manager chosen over the others.

Figure 4.4: Decision matrix



Source: NHS Estates (2001)

4.18 Utility theory

The source of utility theory was founded by Neuman and Morgenstern (1953). It is a psychological concept that denotes a measure of the total worth of an outcome reflecting a decision maker's behaviour towards considerations such as profit, loss and risk. FM service operators are always aware that as long as the monetary value of payoffs stays within a range that is considered reasonable in FM operations, selecting an alternative decision with the best expected monetary value usually leads to selection of the most preferred FM decision. However, when the payoffs become extreme, most decisions makers are not satisfied with the decision that simply provides the best-expected monetary value. It also provides a common platform for modelling the value system of an individual decision-maker. In the past, most work on risk analysis has focused on the use of the MEV criteria (usually expressed in monetary measures) as a basis to assist decision-makers evaluate and judge among alternative decisions. This approach in recent years has been criticised for falling to account for the non-linearity of the value of system of individuals.

As with most management techniques used in business decision-making, quantitative techniques have many strengths and weakness that need to be elaborated. The main advantages and disadvantages of using quantitative technique in healthcare FM operations have been fully elaborated by Gill and Hillson (1998). Therefore, in order for quantitative techniques to provide the best results in healthcare FM operations, they will need to fit a particular NHS trust culture and facilitate management understanding of the purpose and use of such techniques. The Health Facilities Notes 17 (1998) provides an overall framework for consideration of a risk management policy that both include clinical and non-clinical services. This has been discussed in chapter three, section 3.12. Input data provided must be accurate and fit for purpose. The project cost dimensions must also suffice the need for a risk remedy using QTs. On the overall outlook there must be partnering among project team members to support the whole system and strategy of risk analysis. If all these aspects are properly executed and computed with the aid of an effective DSS (i.e. ANNs), best results of predictability should be the ultimate goal for supporting management decisions. It should always be remembered that quantitative techniques are not a perfect match for all business decision-making problems. In some cases qualitative techniques NLP and projective techniques can also be used in conjunction with quantitative techniques to provide the best risk analysis results.

4.19 Application of DSSs in healthcare FM

Decision makers in healthcare FM operations are always faced with many business challenges, opportunities, threats, strengths and weaknesses as a result of the complex and uncertain environment in which they operate. Moreover, many FM operators tend to focus on internal organisational operations and overlook attractive external business opportunities and threats (market) because of various attitudinal informational. The application of DSSs in various areas of healthcare FM would help to reduce this complexity and to overcome these barriers significantly as learning or training tools.

Through interacting with such systems and accessing their knowledge base, users (i.e. facilities managers) can obtain a comprehensive view of the decision areas and criteria to use, thereby enhancing their decision-making process. Furthermore, such systems can be customised to suit the facilities manager's needs as the user, and offer a very practical, concise and efficient improvement tool for non-clinical service managers. DSSs can also facilitate effective decision-making in hospital support services provision and thereby contributing to the enhancement of the competitiveness of the clinical business enterprise. For example, they can also help the user to capture the domain healthcare problem they are addressing. In some cases DSSs can point to the relevant, critical dimensions and risk factors to be managed effectively and provide a systematic approach to problem solving. No matter what its domain of application is, DSSs will have an impact on an organisation's ability to achieve its customer service objectives, as well as on overall business performance (Ozsomer *et al.,* 1992). Some of the areas of possible healthcare FM applications include;

Facilities maintenance and prioritisation – DSSs can be used in the management of hospital facility services and carrying out various building maintenance operations such as planned, routine and emergency. Expert systems can also be used in value management. Quah (1999), Ali and Torrence (1999) have identified facilities maintenance management as an area where DSSs can readily be applied. Furthermore, Bejrum and Haugen (1990) developed life cycle costing DSS for FM service operations.

Financial management – DSSs can also be used for tendering, value management, risk management and for cashflow purposes of FM projects. In light of this, Then (1995) developed a FM DSS which combines IT and economic evaluation techniques to assist facilities managers in the decision making process about financial and budgeting for the life cycle costing and good upkeep of buildings.

Project management – DSS can be used for evaluating project tasks, resources, milestones and targets set for facilities management projects. Expert systems can also be used for project management such as the PERT and CPA.

Grimshaw *et al.,* (1992) developed a DSS for manpower planning based on data collected form a direct labour organisation employing 30 operatives managing sixteen building facilities.

Intelligent building systems – DSS can be used in building information management systems (BIMS), building services information technology and security systems, air quality control, energy efficiency and environmental systems. Finch (1998) examined the prospect and benefits of remote building control and found out that, the convergence of Internet technology and building management systems has transformed facilities management. Information ranging from individual light sensor outputs to strategic occupancy data has become accessible to secure users on the Internet. Garbett and Baldwin (1999) also developed an expert system for management information in local authority real estate facilities.

Design – The production of specifications for the manufacture and assembly of building components and facilities to meet defined user requirements (Cerenic, 1999). DSSs can provide assistance with many of the problems encountered in building facilities and services design, in particular they can;

i) help facilities managers to evaluate the risks associated with design decisions and allow possibilities to be explored tentatively;
ii) evaluate design brief and actual drawings against codes of best practices, facilities management regulations and other statutory requirement such as health and safety, construction design and management and environmental quality management systems.
iii) select building components or items and service that meet service users' requirements

Intelligent organisations (purchaser/provider) – used in developing knowledge for FM purchasers and providers who are able to procure i.e. design a facilities brief that encompasses their project needs. In light of this, Lansley (1984) discussed extensively knowledge-based systems that can be used to manage operations risks and decision-making in FM design and build projects for clients/purchasers and contractors/providers.

Modelling – used in developing business models or complex systems for decision-making and risk management of business support services. Boussabaine *et al.*, (1999) developed six cost models using a DSS for managing effectively sport facilities by predicting total energy costs. Ramachandran (1999) also discussed at length the possible application of expert models in fire safety management and risk assessment in facilities management. In their Engineering and Physical Sciences Research Council funded research project Aouad *et al.,* (2000) developed a DSS that can be used to develop commercial supply chain models that can help the construction and facilities managers to develop feasible technological IT solutions. Cho and Fellows (2000) in their paper on intelligent building management systems discussed how office environments in Hong Kong could be managed by using of artificial intelligence systems.

4.20 DSS development

The process of developing a FM DSS or an ES is called knowledge engineering. This process often involves a collaborative process between the systems developer (knowledge engineer) and one or more experts in some problem (i.e. healthcare FM) domain.

4.21 Multiple FM experts

Traditionally, expert system development is based on the production systems approach (also referred to as rule-based systems) that emphasises building a single monolithic knowledge base. However, such rule-based expert systems become unwieldy when the knowledge base increases in size, and when changes are required to a knowledge base that are more subtle than simple updates. This makes the production systems approach unsuitable for large-scale expert systems. However, in today's business environment, NHS trusts through their FM directorates have dynamically expanded to cope with ever increasing customer facilities solutions needed when providing care services. The utilisation of expert systems in many decision-making and problem-solving processes has created a need to develop expert systems for large and complex problem domains.

This opportunity, thus presents a very strong case for eliciting knowledge from several (multiple) experts in healthcare FM. Thus, in most cases removing the biases that are inherent in humans and the knowledge they supply or represent. As a result these problems, there is a dire need for strength of authority and breath of expertise, since different FM experts have bespoke strategies they use to solve knowledge problems. The development of a KBS can be considered to be in four interwoven stages, which are:

(a) Selecting the problem
(b) Knowledge.acquisition
(c) System implementation
(d) Testing and using the system

4.22 Selecting the problem

The FM problem selected should be suitable for analysis by a KBS. There are many application areas in FM operations where KBSs would be of potential benefit. These have already been outlined above in section 4.19. Healthcare facilities managers (purchasers and providers) frequently have to make expedient and best value decisions on the basis of insufficient, imprecise and fuzzy information during the pre- and post FM contract management processes. KBSs do not provide a means of utilising the facilities manager's inexperience but competency in managing or optimising uncertain and imprecise non-clinical service information for modeling FM problems. Therefore, KBSs establish a way of making the expertise and knowledge resource more available. Other external factors such as, flexibility of use within the clinical services delivery process, FM resources available, the method of FM procurement and control should also be considered when determining the appropriate KBS to be used in the management FM risks.

4.23 Knowledge acquisition

The knowledge acquisition stage refers to the process of collecting appropriate FM knowledge/data to enable effective system development. This process represents one of the main problems in system development. It is therefore discussed in detail below.

4.24 Knowledge elicitation

In order to design a FM DSS, the ES developer must first extract appropriate FM knowledge from domain FM experts. This is knowledge is then transformed (coded) into a form that the computer can process. The most fundamental problem is the difficulty in "downloading" an expert's knowledge, and coding it into a set of rules that can be put into the ES software (Dubelaar *et al.,* 1991). Through years of experience, FM experts have built up a body of knowledge that they use to make informed and wise decisions. Some of their knowledge has come about through personal experience (professional expertise) and cannot be found in literature. Then (1995) states that, until more is learned about what goes on inside the mind of an FM strategist/executive, we won't know how experts personally develop strategic FM plans. Then (1995) further argues that if we lack knowledge about how these business strategies are made, it would be very difficult to develop effective ways that aid facilities managers to learn more about how to manage integrated support services effectively in their organisations. In addition, Then thinks this situation will not enhance the use of computers to assist facilities managers in business planning and decision making. Since human beings are not very good at expressing their knowledge and find it difficult to explain how they reach certain decisions, knowledge acquisition, (i.e. how we get the knowledge out of an expert in order to put it into the computer) is crucial in determining the success of an expert system. This is often cited as the bottleneck in the design of an expert system. The main reasons for this is that experts find it extremely complex to articulate and make explicit the knowledge they posses and use. An important part of a knowledge engineer's role is to help the FM expert to structure the domain FM knowledge and to identify and formalise FM concepts.

Many knowledge acquisition techniques have been developed, although three types of knowledge elicitation techniques are commonly recognised. These routes are described below:

(a) **route one** – consist of psychological techniques for behavior analysis; Today in FM business, the most commonly used technique is interviewing domain experts (Delphi approach). In overall this route involves one form of interaction between the KE and the DE (i.e. it involves analysing the decision maker's personal intuition and cognitive style.

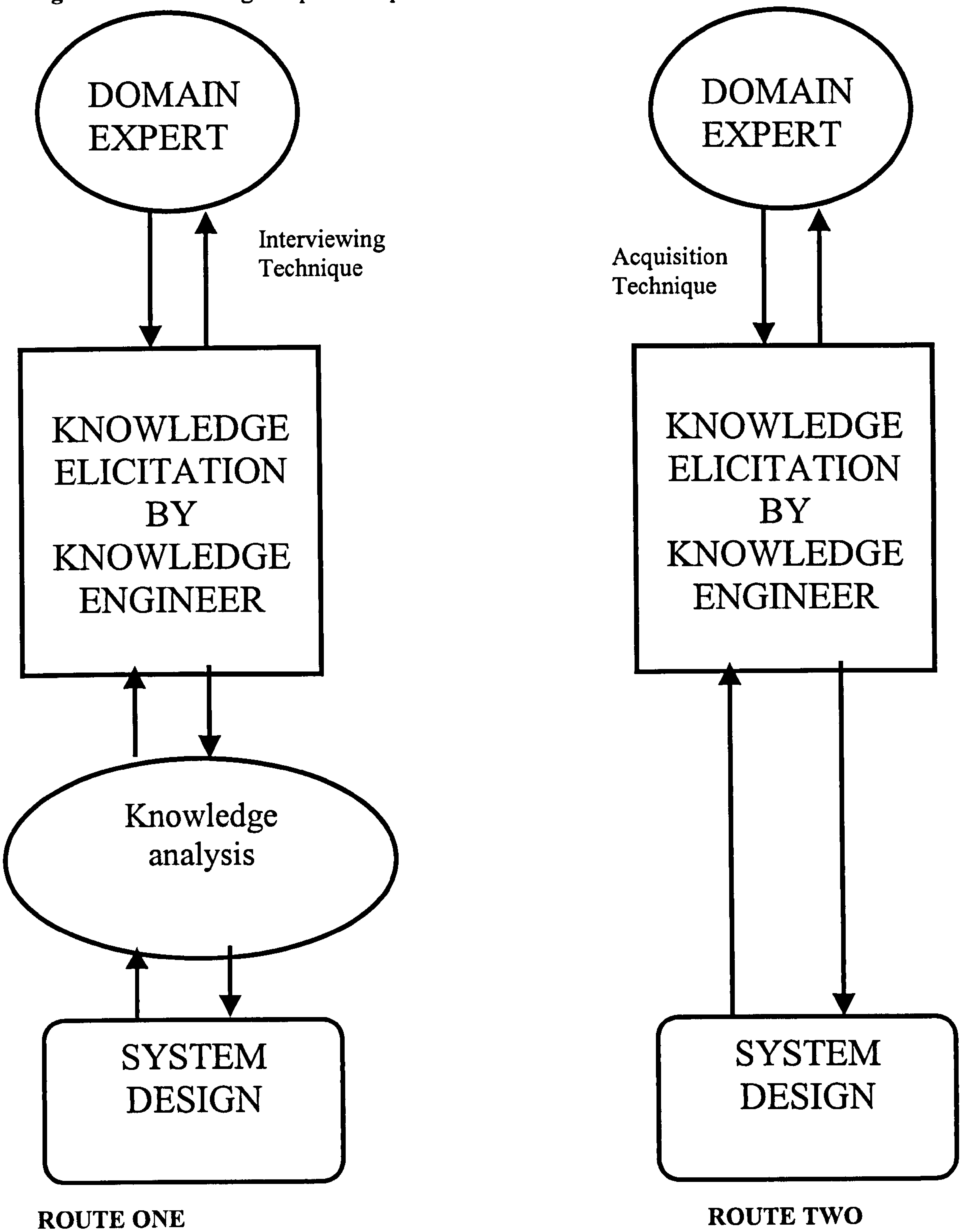
(b) **route two** – is machine induction, in which the computer induces rules from objects as examples automatically.

(c) **route three** – is where the domain engineer plays a role of the DE. Hart (1987) has cited two main reasons as to why an expert such as a facilities manager should not assume the role of a knowledge engineer. Firstly, the expert will be normally have incompetent knowledge about programming and the KBS techniques. Secondly, the expert will find it difficult to describe their knowledge fully.

As these two reasons show some knowledge gaps that may work against the expert being a knowledge engineer, the researcher decided not to use this approach in this research. As a result, this approach was not utilised. For a diagrammatic process illustration of route one and two, see Figure 4.5 adapted from Okoroh and Torrance (1999). After careful evaluation of the machine induction approach, the researcher saw that, for a domain like healthcare FM operations machine induction is inadequate. Bloomfield (1992:pp.712) developed a set of criteria for choosing domains suitable for the elicitation of knowledge by machine induction. One such criterion according to Bloomfield is that:

"Any chosen domain must contain sufficient examples that make it is possible to construct a training set which constitute a comprehensive encapsulation of expertise in that domain."

Figure 4.5: Knowledge acquisation process



Adapted from Okoroh and Torrance (1999)

Healthcare FM operations are best examples for this approach as various service functions are managed under an integrated approach are bespoke. As a result psychological techniques were considered for this particular study. Since structured interviews is the popular technique most familiar to KE's and DE's. It is always logical and advantageous to use a knowledge elicitation method that the DE is more experienced in using. This will obviously enhance the performance of the DE in providing knowledge to the system being developed. The problems of knowledge management that might be encountered during elicitation have been discussed at great length by Shaw and Gaines (1989). They suggested that:

"most of the problems are caused by the fact that the process of knowledge elicitation requires many hours of expert's time who is already busy and has many demands on his time".

Some of the common knowledge elicitation techniques used in healthcare FM operations that were identified by the researcher as useful are:

i) Concept sorting
ii) Protocol analysis;
iii) Rapid prototype
iv) Interviews; and
v) Repertory Grid.

4.25 Concept sorting

Concept sorting is a well-known technique, where the DE is given "cards" corresponding to concepts and instances, and sorts them into piles (values) according to different criteria (attributes). Cognitive psychology studies have shown that this is a very efficient elicitation technique and facilitates the acquisition of new concepts, attributes, and relations.

Apart from the specialist knowledge that experts bring to bear specialised areas, they are likely also to have a more global perspective approach of the domain area and such heuristic knowledge will prove useful when there is a lot of information to be organised. Furthermore, Ngai and Li (1998) observed that, concept sorting is a helpful technique for getting most organisational knowledge. The basic procedure is to obtain a set of concepts that broadly cover the domain. They can be delivered from a glossary or literature, or can be gleaned from an introductory tutorial talk given by the DE. The next step is to ask the DE to transfer each concept to a card and to sort cards into a number of groups, describing what each group has in common. The groups can then be alternatively combined to form a hierarchy. In this approach the PCPACK Card Sort tool is a useful to identify additional attributes and values, especially at the end of domain analysis (Geiwitz *et al.*, 1990).

4.26 Weaknesses

According to Geiwitz *et al.*, concept sorting is only appropriate and effective where there is a large population of concepts, ranging across the whole domain which require suitable structuring to become manageable.

4.27 Protocol analysis

A protocol is a set of rules and conventions that define the communication framework between two or more parties. The parties are said to be communicating *(principals)* and can be end-users, processes or computing systems. Therefore a protocol analysis becomes an observation of the DE during knowledge elicitation, and the analysis of a protocol recorded by the DE explaining what he/she is doing. It can be taken at the same time (e.g. a video recording with a running commentary), or afterwards. Protocol analysis is the best way to acquire procedural knowledge, as observation allows the knowledge engineer to study the way and solves problems, rather than how they say and do it, i.e. including the problem-solving sequence.

The protocol gives the reasoning behind this: the expert's strategy. Protocol analysis that leads directly to the development of a model for solving facilities management has been extensively discussed by Mutewa (1995), Aouad *et al.*, (1999), Grimshaw (1992) and Then (1995). In this method the behaviour of the DE is recorded (either by video or audio) as the expert works through a problem or task. This protocol is transcribed and analysed by ultimately converting it into a set of productions that transform one solution state to the next. In this way, the KE is given not only the answer to the problem but also information about the problem solving process itself. Generally, there are three different ways of generating protocol;

(a) Think aloud protocol; - here, the DE thinks aloud during the solving of the problem.
(b) Retrospective verbalisation protocol; - in which the DE completely solves a problem by reporting how it was solved.
(c) Discussion protocols; - a small number of DEs discuss with one another as they attempt to solve a problem.

Their merits are that they go beyond what experts can explicitly tell you in a problem solving situation to permit inference of what knowledge they must be using but either cannot verbalise or are unaware of. By constructing the solution using inferred production system rules, the expert's knowledge can be modelled. Such a method is particularly useful for eliciting procedures that experts use in problem solving, which they may not be able articulate fully. Protocols can also be taken concurrently with experimental as well as real world tasks. These incidental protocols may provide useful heuristic or facts that the KE can use, either directly as domain knowledge or indirectly as heuristic knowledge.

4.28 Weakness

One of the major problems with thinking aloud is that reporting may interfere with the DE's task performance. Related to this is any need to conform to real time constrains.

For example, solving a mathematical problem allows the mathematician to stop and rethink about the problem and possible solution. However, a FM service operator dealing with hazard or risk may require immediate responses. Also serious limitations occur when they are subsequently used to try to refine early versions of an expert system, in an attempt to elicit the essential expertise. One aspect of this problem is trying to capture, in the form of rules, knowledge that is not suitable for such representation. This is not merely a problem of representation but also has implications for elicitation. Although the expert clearly has the knowledge, this may be directly communicated to the prototype situation and must be inferred using other techniques. For this technique to be effective a representative set of problems has to be chosen, otherwise there could be serious errors of omission.

4.29 Prototyping

Prototyping is mainly used in testing a trial executable version of the prospective KBS. It can be used in both conventional DSSs and KBSs. This technique is the most common approach to KBS development and is advantageous when finding out what technology and knowledge can be used to develop the system model. The creation of a single KBS prototype is a low-risk way of assessing the feasibility and planning resources for further projects. Such feasibility will depend on technical and operational considerations as well an economic analysis comparing benefits and costs. The costs include the expertise required to build the application, the technology that will have to be purchased as well as the expenses associated with implementing and maintaining the system. Significantly, the latter should account for periodic updates of the knowledge base. Grimshaw *et al.*, (1992) considers these costing issues while Daigle *et al.*, (1994) provide guidance for measuring the effectiveness of implementing these information management systems. This technique is also important as it facilitates knowledge acquisition. Generally, there are three types of prototyping namely;

a) Rapid prototyping

b) Incremental prototyping

c) Throw-away prototyping

For further detail on these methods, Gains and Shaw (1992) have written extensively about their use and limitations.

4.30 Interviews

Interviewing is the primary means of acquiring human expertise especially in terms of interface design. Successful interviewing involves planning, preparation, recording and documenting the required knowledge to solve a problem. If the expert has not been adequately briefed, or prepared, then the expert may for example, misunderstand the context in which a question is being asked and consequently give an incorrect response. There are two types of interviews commonly used for knowledge acquisition: the unstructured interview, in which there is lack of organisation. The advantages and disadvantages of this technique are listed below;

Advantages

(a) does not threaten the domain expert

(b) does not prejudice the response and;

(c) KE needs little background knowledge.

Disadvantages

(a) Domain expert is always in control

(b) involves long transcripts

(c) Domain expert may show off

(d) Domain expert may dry up

When constructing questions for an interview it is more effective if a combination of question types is the result.

The two specific types of questions mostly used in interviews are open, and closed. Open questions provide a basis for the interviewee to respond freely to questions without fear. There are no restrictions placed upon them. It allows the interviewer to receive a response of high standard, and get to entice the interviewee to provide more information. However, an excessive amount of open questions can lead to the interviewee starting to waffle, and conversing in a manner that is meaningless to the interviewer. Closed questions provide a limited form of response, and usually provide alternatives. The advantages and disadvantages of this technique are listed below;

Structured interviews advantages

- KE keeps control
- Transcripts structured
- Structure prevents interview dry up

Disadvantages

- Harder to do than unstructured interview
- May not get at the domain expert's actual strategies

4.31 Repertory Grid methodology

The use of the Repertory Grid technique was originally pioneered by a Clinical psychologist George Kelly (1955) to support his model on human cognitive process refereed to as personal construct theory. Briefly, Kelly claims that the way people, as individuals, make sense of their everyday world they live in is by "construing" what they see and experience in terms of the words and ideas they would naturally use. This is based on experience to make sense of an individual's own *personal constructs*. This idea can be used in a variety of contexts. Developed from its use in clinical and counselling psychology, it has also been used as a tool in management development and business information/expert systems (Stewart and Sterwart, 1981; Jancowicz, 1981; Boose, 1985; and Easterby-Smith, 1996). The Repertory Grid technique in this research was used for knowledge elicitation on risk factors in healthcare FM operations.

Repertory Grids involve participants in systematically contrasting people/objects/events (elements) to generate the "dimensions" along which they are, in effect, considering/contrasting them (constructs). This approach has been used in managerial decision-making and FM perception studies by many different business and service managers (Easterby-Smith *et al.,* 1996; Dutton *et al.,* 1989; and Sparrow, 1999). A Repertory Grid contains elements, constructs and linking mechanisms. Full details of the Repertory Grid methodology are provided in chapter five (research methodology) of this thesis. In addition, it is important that the collected grid knowledge is properly formatted and represented to develop an effective DSS/KBS.

4.32 Knowledge Representation

The following characteristics of knowledge representation have been identified by Yeoman *et al.*, (2000):

(a) A knowledge base should be flexible, so that its extension by way of revision will not necessitate major problems;

(b) The knowledge represented should be kept conceptually simple and concise as possible as a result of which flexibility can be more easily achieved and inference engines more effectively developed;

(c) The knowledge represented should be represented explicitly in order not only that the system exhibits transparency, but also that the experts who are assisting in the design of the system may examine the knowledge that it is being incrementally constructed. If these guideline were not observed, then domain experts would be unable to determine contents of the knowledge base and might, therefore, omit crucial knowledge or input data more often;

(d) A representation should facilitate knowledge acquisition. It should be designed so as to minimise those problems associated with extracting expert heuristic from experienced healthcare facilities managers; and

(e) A representation should be computable by some existing procedure, that is, it should be designed in such a way that it can be included as a collection of the data bases within the computer system and so that reasoning mechanism can operate within this integrated environment.

Basically, there are two main types of strategies to knowledge representation (Anderson, 1983). These are:

(i) Procedural representation;

(ii) Declarative representation;

Procedural knowledge follows Ryle's (1959) philosophical division of knowledge divided into "knowing that" and the "know how". This strategy allows experts in a domain to have knowledge of the facts of their domain, and also know how to utilise this knowledge to solve domain related problems. FM professional expertise in solving these problems successfully and repeatedly requires a substantial knowledge base of facts and procedures. Facts about the empirical world (theoretically explicit or tacit) may elucidate or furnish the heuristic search, but in and of themselves cannot solve problems and therefore cannot offer a model for a rational problem solving science (Popper, 1972).

4.33 Procedural representation

Procedural or practical knowledge consists in detailed experientially moderated problem-solving procedures. Expertise is acquired as practitioners proceduralise and refine their declarative factual knowledge through direct interaction with domain relevant problems. It is normally used in conventional algorithmic programming. In this type of knowledge representation, knowledge is context dependent and embedded in the code. This results in an opaque knowledge, making it unintelligible and difficult to use.

4.34 Declarative representation

Declarative, sometimes known as propositional knowledge, consists of factual knowledge of the domain and may be expressed as a series of declarative statements. This type of representation is more understandable and easier to modify, as knowledge in this case is encoded as data. Declarative representation is also context independent. The semantic network is a collection of nodes that are connected by links to relate objects. The links correspond to slots in the frame-based scheme. These characteristics are essential in decision support systems that are knowledge based. Given this disadvantage, the researcher preferred declarative approach due to the disadvantages mentioned above in procedural representation, since healthcare FM strategies are characterised by relationships and interdependencies more than anything else. Some of the commonly used declarative knowledge representation in business DSSs are (Bench-Capon, 1990),:

a) production rules;
b) semantic network; and
c) frames

For a detailed description and knowledge about production rules, semantic networks and frames regarding expert system, Buchanan and Fiegenbaum, (1978) provide a detailed literature review on this subject matter. Immediately after knowledge acquisition follows system implementation and testing. These two final stages in KBS development are fully described and applied further in chapters nine (model development) and ten (validation and performance) of this thesis.

4.35 Dealing with uncertainty in DSSs

Uncertainty is always inherent in any reasoning process, and a result it can be managed using three approaches or values: deterministic, probabilistic, or possibilistic. These include such examples as accuracy of the information, ambiguity and vagueness within the representative language, incompleteness of the information, and imprecision in aggregation of the information from multiple sources.

Because most knowledge in expert systems is obtained from people and because of much human knowledge is imprecise and noisy, it is usually correct that the expression of facts and rules contain various degrees of uncertainty. It is because of this point that we can make assumptions that the reasoning process used by experts (i.e. in FM) in certain situation is highly approximated.

4.36 Summary

This chapter has reviewed the purpose and function of DSSs in healthcare FM operations. It has also described in detail the basic features of a DSS and its possible application in healthcare FM operations to manage risk and uncertainty in the NHS. In this chapter, it has also been seen that the inference mechanism can process risk factors (facts) in the database using rules in the knowledge base in order to infer conclusions or decisions. Rules can be inferred by following a forward or backward chaining strategy. Most of the potential advantages of using DSSs in healthcare FM operations have been discussed and can be summarised as follows:

i) They are aids to experienced/inexperienced facilities managers in the NHS when executing effective FM decisions that underpin the delivery of responsive care services provided by NHS trusts on a daily basis.

ii) They can also provide healthcare facilities managers with analytic techniques (programs), business mathematical models, multi-criteria decision-making approaches or a means to process to data to integrate this information into a simple and effective DSS meaningful in decision-making.

iii) They are a very effective of way of collecting a dossier of business intelligence and mimicking human expertise in FM, which is important and often quite expensive and scarce.

CHAPTER FIVE

CONCEPTUAL FRAMEWORK AND RESEARCH METHODOLOGY

5.1 Introduction

This chapter discusses the main research methodology for this study, as well as the nature of research information used and its systematic organisation. First, it explores in general the factors used when selecting the most suitable and effective research methodology to develop a best practice model for managing effectively non-clinical risks in the NHS. This is followed by an explanation of the main reasons for choosing the selected research strategy adopted for this study. Finally, this chapter details the framework for knowledge acquisition and analysis relating to the identification and analysis of pertinent risk factors and their subsequent modelling to develop the proposed risk management system: (NHSFREPS).

5.2 Selection of the research methodology

The research investigation started in September 1997 with an extensive literature review of best practice experiences in FM and healthcare business operations in the NHS. Results of the literature review revealed that limited research has been conducted using commercial business models to develop various risk management systems in healthcare FM (HFN 17, 1998; Barrett, 1995; Dowie *et al.*, 1998; Finch, 1992; Featherstone, 1999; and Payne and Rees, 1999). The few models that are available have not been developed fully to aid FM service operators in managing business process risks involved in non-clinical operations effectively. It seems from a series of discussions held by the researcher with various FM researchers and practitioners currently working in the healthcare sector, there are four main types of research methods that can be used to develop problem decision-making models as described by Chinyo (1997). These methods can either be;

i) Opinion Research
ii) Empirical Research
iii) Archival Research
iv) Analytical Research

5.3 Opinion Research

By using such a method, the researcher will seek to gather or sample information relating to the views, opinion, behaviour, perception and judgements of people with regards to the research problem under investigation. This method is normally used in general elections or opinion polls associated with political and local government elections. The main data soliciting tools for this method can include a wide range of instruments such as postal questionnaire surveys, personal and telephone interviews, focus groups, interactive surveys, the Delphi method technique and brainstorming (Hinks and McNay, 1999). In relation to the use of the opinion research methodology, Hinks and McNay (1999) have used this approach in their investigation on the strategic "management-by-variance" approach in FM operations for a major financial service provider. The advantages of using this type of research methodology are manifold, and can be summarised as follows (Chinyo, 1997);

a) It is an effective and consistent method of soliciting information on perceptions, attitudes, beliefs, values, motives and experience of the selected FM service providers and purchasers.

b) This method allows the researcher to identify general trends in risk perception, attitudes and strategies used in healthcare decision-making by FM providers and purchasers.

c) It is one of the simplest and most direct ways to collect qualitative information from a large number of individuals over a large geographical area.

d) A lot of data can be gathered expediently through structured questionnaires within a specific time.

e) It is a relatively cheap method to use over other research techniques.

f) It takes up minimum of busy participants' time to respond to the questionnaire.

g) The information gathered is standardised and consistent due to the structuring of the survey questions.

h) It allows participants sufficient time to respond to the questionnaire thereby increasing the reliability and accuracy of the responses.

i) It also allows the data to be captured directly into a machine sensible form.

j) The research study can be repeated, in cases where comparative studies need to be made.

Although opinion research is one of the most favoured data soliciting tools, it has however its limitations which can be narrated as (Teo, 1991);

i) It may suffer from methodological deficiencies such as, (a) biases inherent in the design of the survey apparatus, for example prior to the selection of questions and response sets, (b) systematic biases in the way the respondents answer the questions, for instance biases between liked or disliked, popular or unpopular questions, (c) systematic biases in the administration of the survey apparatus such as sampling and population errors, the responsibility of the researcher who in most cases is the interviewer and the attitude of the participants.

ii) Opinions and perceptions of people are subject to various interpretations and do tend to shift with the lapse of time. This may result in the lack of consistency or standard model theory in the data gathered rendering the survey unfit for purpose. In most cases, a correlation of two events regarding data collecting needs to be executed to test if there is any change of opinion over time with regards to the sample surveyed. This helps in some way to correct or standardise this error.

iii) In most cases it is extremely difficult to analyse the perceptions of a sample population target and at the same time analyse the shift in the consensual processes.

5.4 Empirical Research

In any research process, empirical refers to that which is based on observation or experience rather than on theory (Bowers and Akhlaghi, 1999; and Quah and Damen, 1998). This approach requires the researcher to carry out personal research experiments or investigation where he/she gathers data solemnly for his/her own use rather than relying on the information provided by others.

This method demands maximum and physical participation of the researcher as an eyewitness or experiment controller in the experiment process. Empirical research methods are customarily used in case studies, field studies and laboratory work. This method has its main advantages that are (Teo, 1991);

i) It is a useful tool for analysing actual perception and behavioural shifts in people, through fact-finding or seeking to know the truth.

ii) In relation to case studies and fieldwork surveys it provides the best practice environment in which research work can be conducted. In cases where laboratory experiments are involved, the approach allows certain controls and parameters to be put in place during the experiment.

iii) Complex and expensive research instruments are normally used to produce accurate and reliable data results for analysis.

iv) Allows the researcher to make effective statistical inferences from observations.

This method however has a number of limitations that can range from those listed below (Teo, 1991);

i) The analysis is restricted to current events and makes it more complicated to make retrospect and post analysis studies.

ii) It is a long and laborious exercise that in some cases can be complicated and ends up causing some incomplete investigations.

iii) In detailed case study analysis this method often provides complications in determining the variable factors affecting the research problem. As opposed to laboratory research work, most of the required variables or control factors may not be put in place to monitor the overall experiment process, in order to produce an undisturbed experiment.

iv) The experiment may furthermore suffer from design and control procedure biases that are cumulative in the experiment design and control.

v) Naturally in most cases participants of the research may be influenced by overt or covert hostility towards the researcher or the experiment, thus resulting in unreliable or inaccurate results

5.5 Archival Research

This approach is principally concerned with the analysis of past recorded data or knowledge that is normally stored in databases, hard files and other data mining facilities. According to Chinyo (1997), three main types of data source domains that are embraced in this approach are;

i) Primary;
ii) Secondary and;
i) Physical.

The main difference between primary and secondary data sources was well separated by Hurst *et al.,* (2000). Hurst *et al.,* define a primary archive as one that contains the original unprocessed data or official records in store. Secondary sources would include authoritative and literature sources published by researchers, scholars, practitioners and other multi-media sources. The physical domains primarily consist of ad-hoc physical evidence that is often investigated in problem decision-making scenarios. The main advantages of using archival research are;

i) It is able to utilise and analyse vast quantities of raw data that can also be manipulated to provide analysis of data in research documents and problems. This data could be stored in official files, records, data banks and also information that might be stored in the public domain environment.

ii) It is very good in historical and trends analysis of future predictions and patterns.

iii) Large databases can be set-up or accessed for use in statistical and empirical analysis by a large number of users provided they are authorised to use this confidential data.

Furthermore, accurate results, overviews and models can be formulated to suit various research problems under investigation using large quantity of information stored and readily available. The main limitations of this approach are;

i) **Selective depositing** – This happens when the information collected and analysed exhibits systematic bias toward certain matters such as events of historical and architectural significance, political, economic, social, technological systems and military developments

ii) **Selective suicidal**- This refers to data distortion situations emanating purely as a result of the lack of information accessibility and completeness due to those participants who might have failed to communicate the information. For example, unpublished manuscripts or out of print books and literature may contribute to such biases in information retrieval.

iii) **Selective retrieval** – In such a scenario, the data collected will suffer from systematic bias and population sampling errors. For example, an experienced Facilities Director may place great personal value on managing certain key service performance indicators (KPIs) that reduce the rate of risk exposure in non-clinical services in the NHS. In this case, the FM executive will persuade the NHS Trust as the service purchaser to outsource most of the strategic support services to an external provider, whom they will specify high standards of service levels to be delivered to NHS customers.

iv) **"Filling in the gap"** – This situation happens when the researcher infers or adds his own knowledge regarding the investigated case to formulate a final comprehensive opinion.

v) **Biases inherent in the researcher** – This refers to the personal prejudices and in-built beliefs (conscious or unconsciously) of the researcher.

The effects of communication and rapport building exercises are more acute with this approach compared to the other methods such as opinion and empirical research.

5.6 Analytical Research

This method involves solving facilities management problems analytically by analysing the problem into its finite constituent parts or elements. This is done to facilitate knowledge soliciting and brainstorming of the basic decision problem, in order to evaluate the general relationship between the variable factors involved if any conclusion is to be made. This method is highly dependant on the knowledge and power of the researcher, to use logical inferences in obtaining answers and solutions without any reference to explicit primary and secondary data sources. Analytical research demands a high level skill of problem analysis and precision in making well thought out and argued statements that do not affect the reputation of the researcher, intellectually and universally. This lack of "analytic" may be equated to lack of substantial evidence or authority relating to the prevailing body of knowledge in the domain field of the researcher. This in most cases results in the analysis being challenged by other experts, authorities and scholars in the same discipline (i.e. FM industry), thus this method requires rational thinking and continuous knowledge management to determine the exact cause and effect of a research problem. The main advantages of using this method are as follows;

i) It is best advantageous to use in cerebral activities and provides the "best fit" scope for rational decision-making and creativity.

ii) It provides research theories that are extremely valuable beyond impressions or the truth and in most cases might not require justification of additional information. In the majority of the cases, the final solution to a given research problem lies within the researcher's ability to interpret analytically the events.

iii) It is handy and plausible when using clear logic, philosophy and operations research tools such as mathematical modelling, flowcharting, network analysis, decision strategies, algorithms and heuristic methods.

Although highly respected and rated by researchers, the analytical method has its own in-built weakness. These are;

i) It is always vulnerable to misapplication and may be employed by unscrupulous researchers to defect from the truth of the original body of knowledge available. Such dangers are cause of concern to new researchers and converts of knowledge who would tend to be deceived by such a method, leaving knowledge gaps in their minds.

ii) In most cases, researchers and scholars using this approach are reluctant to adopt scientific and technical techniques to solving the research problems they may be confronted with. This method thus leads to inconclusive research problem solving which leaves so much to be desired.

iii) It also suffers from common research downfalls like precision errors, problems of semantics, failure to satisfy epistemological beliefs and theories in research philosophy and finally, it can cause deviations in meeting common methodological considerations that might be metaphysical in nature.

5.7 Choice of research methodology procedure

As this study involved the development of best business practices in healthcare FM operations, it was necessary to use research methods that measured the influence of the uncertain NHS servicescape under which non-clinical service decisions are made. Initially, the researcher had several brainstorming sessions with healthcare FM experts, personal interviews with healthcare managers and other researchers in the NHS. These sessions were held specifically to explore the strategic context of the research problem. This was done using various business environmental scanning techniques such as the SWOT, the PEST analysis, Porter's value chain, Boston matrix, Cause and Effect analysis, and other competitive techniques applicable in the NHS (Gilligan and Lowe, 1995; Wagstaff, 1997). These approaches helped the researcher to establish the strategic context of the research problem and underlying business and risk management issues in the NHS.

As time is always the essence of any research study, the researcher had to use research methods that allowed for the expedient identification, collection and analysis of risk factor changes in decision-making processes of healthcare facilities managers over the duration of the study. The time value of decisions made by healthcare facilities managers has always been seen in business research as a major factor impacting the development of effective business models in behavioural research (Wagstaff, 1997). After further consultation with his supervisors and fellow academics, the researcher decided to use a combination of Opinion, Empirical, Analytical approaches while incorporating some aspects of the Archival research. As this research involved the investigation and identification of pertinent risk factors and their sub-attributes that affected FM business operations in the NHS, it was important for the researcher to validate the identified risk factors (data) with risk registers or domain knowledge already possessed by the surveyed NHS FM providers and purchasers in the UK.

Thus, the Archival approach was also used as a comparable method to facilitate reliable results in the development of the final risk management system. More importantly, as this study was the first of its kind to be undertaken in the NHS, it was necessary to develop and collect extensive business and risk management information from experienced healthcare facilities managers in the NHS. This information would be collected using postal questionnaires (dry run tests, pilot and major surveys) and structured interviews (telephone and face-to-face). In addition to the above, the researcher also performed a number of pilot investigations to determine the suitability and feasibility of the whole project in the NHS. Consultation also continued throughout the research with other fellow researchers in the department, and research supervisors in order to formulate the best practice methodology for this study. During this period, the methodological work of Quah (1988), Teo (1991) and Okoroh (1992) regarding the development of risk management and decision support systems in the built environment gave huge impetus to this study. These studies gave leads to various research strategies (most of which have been reviewed above) that are useful in developing a risk management system in healthcare FM operations.

5.8 Research strategy adopted

In order to facilitate efficient data collection and ensure that accurate healthcare risk management knowledge was elicited, the following stages formed a solid foundation of the study. These stages are divided into the following sectional parts;

i) Preliminary meetings and interviews with leading healthcare facilities service operators, customers and researchers working within the FM and NHS sectors.

ii) Preliminary analysis of an ongoing FM operational contract at the Derby Royal Infirmary (DRI) NHS Trust, now part of the Southern Derbyshire Acute NHS Trust. This contract will be refereed to as the "DRI Experience" in this study for future references;

iii) Presentation of the research proposal to the DRI FM directorate, to allow for further collaboration and discussions. This was done with a view of opening-up clear lines of participation and rapport between the DRI management and the researcher;

iv) Collective discussions and FM operational analysis of the DRI partnership resulting in the publication of a conference paper presented at the CIB W70 International Symposium, November 1998 in Singapore by the researcher;

v) Dry-run tests to various healthcare FM experts for a fair view on the acceptability and success rate of the pilot questionnaire survey before its final despatch. This was immediately followed by the expedient posting of the preliminary survey carried out on 365 NHS healthcare executives;

vi) Presentation of the pilot study findings to a joint meeting organised for the staff members and fellow researchers in the School of Engineering and Division of Construction. This allowed staff members and fellow researchers to participate and offer professional and academic input on the future direction of research;

vii) Dry-run testing followed by the main questionnaire survey to 120 healthcare facilities managers (30 external and 30 in-house providers, and 60 purchasers) managing healthcare operations in the NHS;

viii) Interviewing of selected 60 NHS FM service operators; - 20 in-house and 20 external providers and 20 purchasers and 20 customer focus groups using the Repertory Grid technique and;

ix) Feedback of findings from FM purchasers and providers.

In overall, the research methodology and framework adopted for this study was divided into five main stages that are described below;

(i) pilot survey
(ii) Dry-run tests
(iii) major survey and;
(iv) Repertory Grid interviews; and
(v) Artificial neural networks modelling

As described above, the strategy adopted in this research consisted of five main stages. This methodology does to a greater extent illustrate the dynamism of the research process that continues to be "iterative" through out the whole project as noted by Aouad *et al.*, (1999). It is important to note that, since FM in the NHS is still in its developmental stages, the research process adopted used various sources of FM knowledge from multidisciplinary fields of research domains, which include;

i) Healthcare service management and Social sciences;
ii) Business and information technology management; and
iii) Built environment.

This interdisciplinary approach in FM research in not a new paradigm, as other FM scholars such as Featherstone and Baldry (2000) and Auouad *et al.*, (1999) have used it before. As explained in chapter two, FM is currently classified as multi-disciplinary that is still developing its own peculiar service identity, and hence thrives mostly on borrowed ideas from various business disciplines (Grimshaw, 1999; Nutt, 1999; Green and Price, 2000).

5.9 Preliminary research strategy

The conceptualisation and realisation of this investigation also focused on a mapping strategy that was used to review current FM research in various professional, academic institutions and centres of excellence.

Furthermore, the main research-active centres in UK have been highlighted by Nuttt and Grimshaw (1999). Another useful FM resources locator that was used by the researcher was the University of Derby's learning resources such as the Babour Index, CD-ROMs and the intranet via the WWW searching engine to various renowned FM websites in the UK, Asia, Europe and North America. The utilisation of the Internet as a literature search engine for collecting FM knowledge has been highly recommended in a wide range of business research studies (Todd, 1999). Furthermore, Todd (1999) also highlighted the main advantages of using such an innovative tool in modern-day built environment research. In addition to an extensive FM literature review, the researcher personally contacted the main built environment institutions (i.e. professional and academic centres of excellence) listed below, for any information regarding the research problem;

i) British Institute of Facilities management (BIFM),
ii) Royal Institute of Chartered Surveyors (RICS),
iii) Chartered Institute of Building (CIOB),
iv) Royal Institute of British Architects (RIBA)
v) Centre for Facilities Management (CFM),
vi) British Property Federation (BPF)
vii) Association of Consulting Engineers (ACE)
viii) Centre for the Built and Human Environment at Salford University,
ix) Facility Management Exchange University College London (FM-X) and ;
x) FMGC at Sheffield Hallam University; and many more centres of FM excellence disseminating FM and business knowledge awareness internationally.
xi) CABER in Scotland.

A list of information sources and links to other FM related research projects were provided to the researcher by these research centres. Furthermore, the researcher also navigated these centres' websites to view details of FM research projects completed and those in progress. In the context of this research, web-site navigation gave the following advantages;

i) Expedient search for more FM information sources, projects and publications either in the public domain or unpublished. The most useful sites on line are the RICS, CIB W70 conferences as well as other sources such as MCB journals on line;

ii) Bookmark favourite sites and downloading them as literature review material; and

iii) Establish constructive links for future collaboration and sharing of FM knowledge with other researchers in these establishments.

The researcher also utilised other information resources online such as the CNBR and FM intranet mailbases. The CNBR and FM mailbases are the largest single worldwide database networks used by professionals and researchers wishing to exchange any FM research information. Using these two online services, the researcher made an initial inquiry or appeal to be provided with any information available on healthcare FM risk management. An overwhelming response was received from various FM researchers internationally that provided useful leads to pursue towards the inception of this research project. After collecting adequate background information about the FM research problem. The researcher developed the conceptual framework and methodology. This was based on detailed interviews held with a numbers of domain FM experts (scholars, consultants and non-clinical services managers in NHS Trusts) in both the healthcare and business sectors.

5.10 Delphi approach using FM industry professionals

A Delphi (structured interviews) approach was used to solicit more FM knowledge from leading experts in healthcare FM. This approach is not new, as it has been used in the past by FM researchers (Green and Price, 2000; Bandyopadhyay *et al.*, 1999; and Hinks and McNay, 1999). The main NHS FM experts contacted by the researcher in the exploratory stages of the research to provide background information were;

i) Dr. Stacey of Southern Derbyshire Primary Care Research Centre based at Kingsmill Centre, Micklover Derby,

ii) Steve Lees, Healthcare Director for Carillion Services,

iii) Collin Hillard, General Manager of a chain of hotels and former HEFMA Secretary,

iv) Steve Tapham, a FM expert at the NHS Estates,

v) Gerry Scott-Thomas, Chairman of the HFC,

vi) Professor Keith Alexander, Director of CFM, Salford University and Editor of the International Journal of Facilities Management,

vii) David Rees a Research Fellow with Sheffield Hallam's FMGC. David Rees is Vice Chairman of the BIFM's Research Committee and Chairman of the North East Branch Committee.

In addition to meeting the above FM experts, the researcher also arranged four other meetings. These meetings were arranged to investigate a best practice case study FM contract at the DRI, part of the Southern Derbyshire Acute NHS Trust. At all these four meetings the researcher was accompanied by his main supervisor. The DRI FM partnership contract is currently in final phase of implementation. The DRI experience was chosen as best practice experience for this research due to following reasons:

i) The DRI was ranked as one of the best practice FM services operators in the NHS, according to the performance league table published in 1998, and as one of the top 20 performing NHS hospitals in the UK (DoH, 1998; and DoH, 2001).

ii) It was one of the earliest (started in 1995), if not the first FM partnering contract of its kind in the UK NHS to provide Total FM services. It is still currently on "live" and finishes in 2003 (Okoroh *et al.,* 2000).

iii) The DRI was easily accessible to the researcher and thus could be monitored for its FM performance easily.

5.11 FM meetings at the DRI

The first meeting was held at the DRI main site with Mr Steve Lees who was the GFM for Carillion Services. Mr Lees has over 20 years experience in managing healthcare FM operations in both, the NHS and commercial sector. Carillion Services is a public limited company that is also an FM services provider for number of PFI schemes in the NHS. At the DRI, Carillion Services is currently providing integrated non-clinical (hotel, site and estates) services in a partnering arrangement with the trust. The first meeting was a research marketing and collaboration exercise between the researcher and the DRI FM senior management staff. It was a brainstorming exercise where the researcher explained the rationale behind their investigation. At this meeting, the details of the research proposal were left with the Mr Lees, for him to critically evaluate the research objectives. This approach was used in order to allow Mr Lees to contribute fully practical suggestions gained from the DRI contract model that could improve the quality of the risk management model to be developed. The second meeting was held also at the same venue (DRI). This meeting took about 2 hours in total. This meeting was arranged by the researcher in order to get feedback on the research proposal. In overall, positive recommendations in relation to effective methodologies of identifying and analysing of FM risks were suggested. This resulted in a few adjustments to the original project proposal and plan of work.

At this meeting Mr Lees gave a short presentation about the business model and organisational structure being utilised at the DRI FM operations. At the end of the meeting, Mr Lees also gave the researcher large documentation concerning the DRI contract's inception, project management, performance successes and problems to date. This was taken back to the University of Derby by the researcher for further analysis. With regards to documentation, the following information was provided to the researcher for further study by the GFM: strategic planning report; annual report; Patients Charter; business plan; department reports; business and newspaper publications; Trust newsletters; communication strategy publicity material presentation material; organisational structure; quality assurance reports and records; customer satisfaction questionnaires; complain management systems; employee satisfaction and sickness reports; partnership record and achievements; and report compilation of all the aspects of the partnership.

The last two meetings were also held at the DRI with the new GFM, Mr Evison and Mr Brian Ebell, Deputy Chief Executive FM, for the DRI. Both FM executives have more than fifteen (15) years experience in NHS FM operations and as a result could be deemed as healthcare FM experts. In all these meetings, a set of designed investigative questions were asked by the researcher in order to gather as much information as possible regarding FM business process risks. The aim of these meetings was to learn from the large wealth of personal experience (knowledge) these FM executives had as decision-makers in healthcare FM operations. The researcher also wanted to evaluate transferable business intelligence from Carillon's experience and performance on other NHS FM contracts they were currently managing and benchmarking it with the DRI experience. This best practice experience if any could then be applied to the research. In overall, other objectives of these meetings were as follows:

i) to investigate the initiation and strategic operational issues regarding the "DRI experience" as a case study of an on going FM business concern;

ii) to evaluate various risk factors (negative, positive and neutral) that affect healthcare FM operations;

iii) to collect as much written documentation and information as possible regarding this FM business relationship and operations and;

iv) to investigate and supplement information gathered so as to publish the initial findings on FM risks.

This process resulted in a detailed analysis of the information from the DRI and FM literature review that culminated with an international publication on FM risks that was presented in Singapore (Okoroh *et al.*, 1998).

5.12 Pilot survey aim and objectives

As part of a comprehensive survey on risk management and business decision-making in healthcare FM, service procurement practices within Trusts had to be evaluated first. This evaluation formed part of the preliminary knowledge eliciting stage.

The rationale for carrying out the pilot survey was;

a) to form background information regarding those NHS hospitals Trusts with some facilities management outfits; and

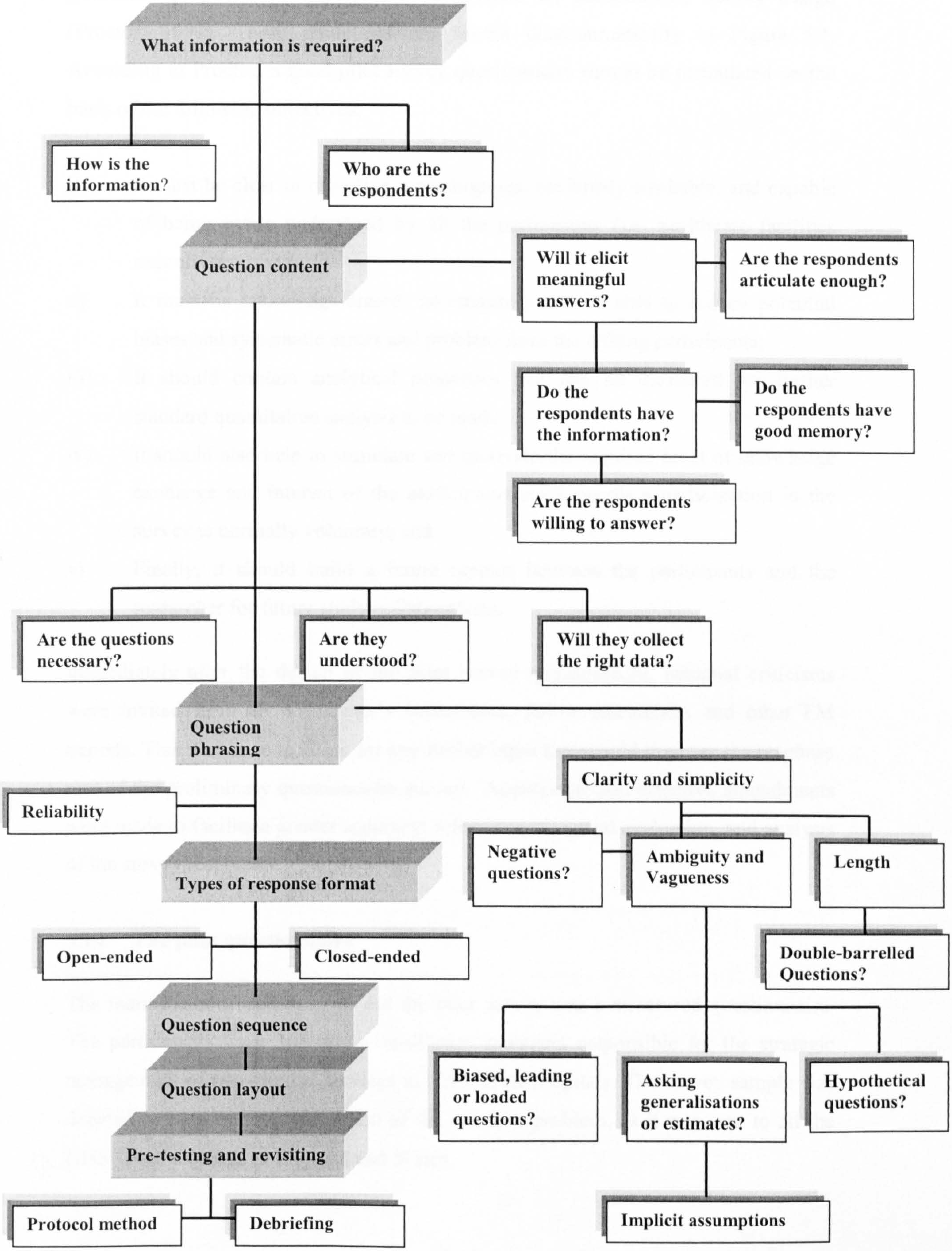
b) to observe the spread of NHS FM structures and service culture among hospital Trusts.

Given that the FM service models in NHS Trusts are still developing, a preliminary survey was necessary in order to identify the best practice (Grimshaw, 1999). In support of this approach, Jackson (1998) used a pilot survey to investigate factors that affected support services organisational effectiveness in NHS Trusts. Therefore, according to Kidder (1991) pilot surveys are an essential part of any FM research, as they can improve cross-pollination of support services management and research knowledge in a research study.

5.13 Pilot survey design

Initially before the pilot questionnaire was designed, the researcher consulted a statistician in the School of Mathematics and Computing, at the University of Derby. The statistician was contacted in order to ascertain the type and analysis of data collection that the researcher proposed to undertake for the pilot survey. After getting expert advice on statistical data analysis, the researcher proceeded to designing the pilot questionnaire. Ten investigative questions were asked in the pilot survey. All the questions were asked in a completely different way to allow for full communication skills and options for answering the questions. The questionnaire was also designed to allow participants (i.e. senior Trust and healthcare facilities managers) to respond to these open-ended and multiple-choice questions asked regarding the management of healthcare facilities in the NHS.

Figure 5.1: Research survey design - Source: Proctor (1997)



The design of the pilot questionnaire was based on incorporating a wide range of guidelines proposed by experienced researchers on questionnaire survey design (Proctor, 1997). These guidelines are shown diagrammatically in Figure 5.1. According to Proctor, a good pilot survey questionnaire should be formulated on the basis of the following objectives;

i) it must be clear in objective, unambiguous, uniformly workable, and capable of being easily understood by all the participants (i.e. healthcare facilities executives

ii) It must be knowledge-biased, investigative and be able to reduce potential biases and systematic errors and problem from the willing participants;

iii) It should contain analytical properties that can be measured for further standard quantitative analysis to be made;

iv) It should also help to stimulate and motivate the required level of knowledge exchange and interest of the participants since people's participation in the survey is normally voluntary; and

v) Finally, it should build a future rapport between the participants and the researcher for future study collaborations.

Immediately after the design of the pilot survey questionnaire, personal criticisms were invited from the researcher's supervisors, fellow researchers and other FM experts. This was done to allow for any further input that would improve the response rate of the preliminary questionnaire survey. Appropriate and effective amendments were made to facilitate greater accuracy; reliability, statistical evaluation, and analysis of the survey responses.

5.14 The pilot questionnaire

The main method used to carry out the pilot survey was a structured questionnaire. The participants were 365 senior healthcare managers responsible for the strategic management of non-clinical services in NHS Trust hospitals. The survey sample was deemed to be a true representation of the research problem, as it was sent to all the NHS Trust hospitals in England and Wales.

Although it excluded Scotland and Northern Ireland who are part of the UK, all hospitals selected for this survey were representative of all main types of NHS Trusts available in the UK (Rees, 1997; and Rees, 1998).

5.15 Implementation

Immediately after the amendments, the questionnaire was then posted to 365 NHS Trusts CEs nationwide. The selected NHS executives were targeted using the NHS Trusts Directory supplied by NHS Federation (DoH, 1998). All the questionnaires sent out were secretly coded or numbered on the right-hand corner of the second page. The secret mark was considered important as a check for any responses sent using other means of communication (i.e. fax, e-mail or telex). This method also helped to accelerate the cross-examination exercise of received responses, resulting in a follow up of delayed responses. Most responses were returned to the researcher by either post or by fax. The method of answering was based on either ticking a box provided or filling in the required information on the space provided as proposed by Moon *et al.*, (1999). The questions asked are shown in appendix A of this thesis.

5.16 Pilot survey results

Table 5.1 shows that out of a total of 365 questionnaires posted, 219 (60%) questionnaires were returned of which 19 (5%) were unusable. A further 146 (45%) were regarded as non-responsive. Therefore 200 fully completed questionnaires were received from the NHS Trusts surveyed.

Table 5.1: Pilot survey responses

Questionnaires	**Number of responses**	**Percentage %**
Returned complete	200	55
Returned incomplete	19	5
No response	146	45
Totals:	**365**	**100.0**

Taking into account the complexity, and the number of questions posed by the survey, the response rate achieved in the pilot survey was 55%. This response rate can be regarded as reasonable (Honville and Jowell, 1987). The results obtained from the pilot survey were mostly qualitative which were analysed empirically. Furthermore, a detailed analysis of the pilot survey results is done in chapter seven of this thesis.

5.17 Major questionnaire survey

After completing the pilot survey analysis, the researcher proceeded to design the major survey questionnaire. Just as in the pilot survey, the researcher again consulted a statistician in the School of Mathematics and Computing, at the University of Derby. The statistician was contacted in order to get expert opinion on the suitability of the type of data collection and analysis methods to be use for the major survey. Critical comments were also invited from the researcher's supervisors, fellow researchers and other FM experts regarding the major questionnaire design. The main objective here was to allow for external input regarding the design and format of the major questionnaires. Constructive criticisms were made resulting in cosmetic adjustments being done to the questionnaires to facilitate for accuracy, reliability, statistical evaluation and analysis in anticipation of the survey responses. After getting expert advice on questionnaire design and statistical data analysis, the researcher proceeded to designing the major postal questionnaires for FM purchasers and in-house and external providers. Immediately after completion of these dry run tests were performed on a number of selected research participants and FM experts currently working within the healthcare sector. The dry run tests showed in overall a positive feedback resulting in more fine-tuning of questionnaire format before sending it out. The three questionnaires for FM purchasers, in-house and external providers were designed in a similar format to allow for comparison and uniformity in questionnaire objectives and answering by participants.

5.18 Questionnaire objectives

Taking into account the research study objectives, the main questionnaire was well designed to elicit business risk factors faced by the three main FM service operators (purchasers, in-house and external providers) when delivering non-clinical services in the NHS. In overall, the main objective of the major survey was;

(i) to identify business process risk factors faced by FM service operators when benchmarking the best practice of delivering value adding non-clinical services in the NHS;

(ii) to sought information on the business and risk management strategies that these three FM groups used (if any) for managing healthcare FM operations; and

(iii) to explore how business on FM risks is gathered by purchasers, in-house and external providers and utilised when making strategic decisions that continuously improve the provision responsive support services that underpin clinical services delivery in trusts.

5.19 Questionnaire design and layout

In developing the major survey the researcher also took into account the various advantages and disadvantages of using the postal method (Proctor, 1997; Kometa, 1995). These have already been fully explained in section 5.3 of this chapter. After completion of the postal questionnaire design, the strategies listed below were incorporated in the questionnaire layout. These strategies were incorporated in order to reduce biases associated with such a method and achieve maximum responses:

1. A clear instruction was given at the start of each question on how to fill in the answers.

2. The questions were typed on the left-hand side of the page with enough space provided for answers at the end of each question.

3. Being somewhat a long and rigorous questionnaire, some reluctance to respond was thought to be possible on the part of potential respondents.

Thus, the questionnaire sequence was carefully considered, starting off with some easy, impersonal questions to develop enthusiasm, until major questions had been well answered.

4. In an attempt to achieve a high return and completion ratio, the average time it would take to complete the questionnaire was determined during the pre-testing and was assessed as 20-25 minutes on average. The questionnaire was done to eliminate any misleading and unwanted questions.

5. Much effort was made to keep the questions short and simple, giving clear and concise instructions.

6. Each question was worded in a manner that made it simple, clear and as brief as possible. The pre-testing helped in determining the effective wording of the questions.

7. Responses to questions were limited to either a tick, filling in the answer or by simply filling the response using an interval-scale data already provided in the questionnaire. In this study, the researcher used the Likert scale.

8. In order to separate various important information aspects of investigation in the questionnaire, it was split into five categories. These sections concentrated on investigating various aspects of healthcare FM risk management needed by the researcher. Sectioning in this study helped to break possible biases that could have been created by the questionnaire.

9. The problem of 'central tendency concept' i.e. the tendency for people to shift from firm views and opinion choosing to answer in a very neutral and mild way as described in Kaln and Cannell (1987) was overcomed by providing an even number of categories to force the respondents to take one side or the other.

10. Internal consistency checks were built into the questionnaire in that some questions had to be answered in similar way, while some either investigated directly or indirectly the same aspects using different techniques.

11. Question wording was chosen with care to ensure that it roughly conveyed similar meanings to what the respondents were used to.

12. An open page was left at the end of the questionnaire to allow respondents to give constructive criticism about the questionnaire and other issues of importance.

In addition, respondents were asked to put in if any, their e-mail address so that the questionnaire could be posted via the internet, thus facilitating expedite responses.

13. Consideration was given to the intended type of qualitative and statistical analysis that would be used in chapter seven.

Each question was designed in such a way that the results could be analysed in statistical package for social science (SPSS) 8. Some consideration was also given to the use of Microsoft Excel spreadsheets for the data analysis using dynamically linked graphs. This was done to allow for expedient data inputting in cases of late response arrivals.

5.20 FM Purchasers' questionnaire

The purchasers' questionnaire used in the research is presented in Appendix B.

5.21 FM Providers' questionnaire

The providers' questionnaire was designed to investigate mainly two types of FM providers (in-house and external) available in the NHS. The same procedure used to design the purchaser questionnaire was adapted for the providers' questionnaire. This questionnaire is also presented in Appendix B.

5.22 Improving the success rate

To improve the success rate for completion of these long and somewhat sensitive questionnaires, the following decision strategies were taken by the researcher;

1. The researcher made telephone interviews, personally contacting most of the selected respondents as a follow up operation. These conversations took at least 10 minutes, while the researcher explained the rationale of the study to the respondents.

2. Assurance was given on the cover note of the questionnaire that all the information provided by the respondents would be treated with the strictest confidence, and would not be used for any other purpose except for the research study.

3. All the potential respondents received a personal introductory letter specifying the main purpose of the research study, the researcher's contact details in case of any further clarification or queries regarding questionnaire completion.

4. All the participants were assured of being kept informed about the possible research outcome, in case they wanted to take any further part in the study.

5.23 Sample selection

After careful design, the final draft was passed on to the researcher's supervisor for his academic comments. Some further changes and modifications were recommended on the layout of the questionnaire, while minor wording and additional questions fine-tuned ready for despatch. Having completed all the necessary modifications, the three questionnaires were given a final seal of approval by the research supervisor. Prior to the despatching of the postal questionnaire survey, dry run tests were performed with ten selected healthcare facilities managers, to establish the willingness of healthcare facilities managers to participate in the major study. The tests showed that the majority of healthcare facilities managers contacted although very busy were willing to spare their precious time to respond to such a service value adding survey. After the dry run tests, three sets of one hundred and twenty five (125) questionnaires were sent to selected healthcare facilities managers. These were working for the three main FM service operators (i.e. purchasers, in-house and external providers) in NHS Trust hospitals. As this survey was a nationwide one, the selected facilities managers who took part in the purchasers' survey were working for the five main NHS Trust hospitals available in the UK. The main five types of NHS Trust hospitals identified in the pilot survey were Integrated, Acute; Community; Teaching; Mental and or community; Paramedical and elderly care; Learning disabilities and other minor care services.

As for the providers' survey, the participating facilities managers were;

i) in-house senior NHS support services managers working in the FM directorate of the surveyed NHS Trusts; and
ii) external providers experienced in managing FM services in NHS Trust hospitals.

Facilities executives in the NHS are responsible for the strategic management and co-ordination of non-clinical services. As a result were considered appropriate participants for this study due to their day-to-day (experience) involvement in FM. FM executives were also chosen, as they possessed the professional competency to make strategic decisions regarding management of business risks in non-clinical services in the NHS. Therefore to ensure a good response rate from respondents, the researcher designed the questionnaire into four sections:

i) General information about participants and their organisation;
ii) Risk management and decision making;
iii) Further comments.

5.24 General information

The first part of the questionnaire consisted of introductory questions for data classification purposes including the type of the respondents' business and the total amount of FM service operations. This section also consisted of information about the participants; organisation size, FM services they offered, experience of the organisation in FM provision. In addition this section sought to evaluate financial, human and technological resources they used annually to deliver FM services. This section also investigated the procurement systems currently used by these providers and purchasers in delivering support services in various NHS Trusts.

5.25 Risk management and decision-making

This part was designed as the main part of the questionnaire with a view to identify the key risk factors that influenced the effective management of healthcare operations.

It involved participants rating or measuring FM risk factors according to how important they were in healthcare FM operations. To aid participants, a five point Likert Scale was used as a continuous scale to discriminate the most important from the less important factors. To facilitate the easy completion of the questionnaire, the researcher also provided two simple tables for participants to fill in their answers. Respondents for each questionnaire were supplied with forty-eight (48) risk factors. The risk factors used in this section were obtained from extensive literature review, interviews held with healthcare FM experts and managers, and a detailed case study analysis of the DRI experience. The levels of importance of these risk factors were measured on a Likert scale that was designed to be a continuous rating scale as shown below. The parameters used on the Likert scale rating system used were: 0 = not applicable; 1 = unimportant; 2 = not very important; 3 = important; 4 = very important; and 5 = extremely important (Khosrowshahi, 1998). The main reasons for using the Likert scale were;

i) The scale is an important and popular tool for measuring a large number of risk factor variables that are very closely associated to each other, where in practice the measurement of risk perception can be very subtle.

ii) It can be used as an ordinal and comparative scale for measuring perceptions.

iii) The scale could be used as an interval scale to allow for data transformation.

iv) It allows finer discriminations to be done between the measured factors.

v) It takes minimum participant's time to answer

vi) Data can be transformed for statistical use in a computer program i.e. SPSS 8.

Although the Likert scale offered numerous advantages, the researcher was well aware of the limitations this type of scale caused in practice (Cho and Fellows, 2000). These limitations have been summarised by Rees (1994: pp.12), as follows;

"It is recognised that, while Likert scales have a limited application to statistics, they at least permit a numerical classification to be attached to an ordered set of variables. However, there is little scope to reflect any weighting between variables"

Although such criticism can be levelled against such a popular rating scale, the conclusion from literature sources suggests that, the advantages of using a Likert scale outweighed other available techniques (Cho and Fellows, 2000). Furthermore, this technique has also been used in most FM and healthcare studies measuring survey perceptions of healthcare managers by experienced researchers such as Smith (1999), Rees (1994), Bowers and Akhlaghi (1999) and Green and Price (2000).

5.26 Further comments

This section was mainly provided for respondents to elaborate on issues contained in the questionnaire that they felt needed correction or future attention in the research. In this section respondents were asked to express their own personal comments and interests in this research. In addition, this section contained the researcher's correspondence and e-mail addresses, and telephone numbers in case participants needed further information. At the bottom right hand corner of the page, respondents were asked to attach their business cards in order to identify their organisations they were working for.

5.27 FM operators survey responses

Out of a total of 125 questionnaires that were sent out to the FM purchasers surveyed , only 25 (20%) questionnaires were returned back fully completed by the participants. As for the providers survey, 125 questionnaires were sent also to out to external providers., and only 25 (20%) fully completed.

Finally, the last questionnaires sent were a total of 125 questionnaires sent out to in-house providers, and only 25 (20%) were returned back. In overall, the response rate of 20% achieved for the three FM surveys can be regarded as low according to Runnell and Ballane (1963). After a detailed analysis of the returned questionnaires, further discussions were held with the supervisor and the university statistician.

It was concluded that the response rates obtained from these three FM groups (purchasers, internal and external providers) were fairly lower than expected. Although the response rate obtained in these three questionnaire surveys was low, it was considered that their numerical strength was sufficient to allow for conclusions to be made from the analysis of this information. This is a very normal practice in operational research particularly given the nature of the information required and the lukewarm response to questionnaire surveys in the healthcare sector generally (Gray and Ghosh, 2000).

5.28 Repertory Grid Interviews

In view of the low results obtained in the major survey, and the need to further analyse and compare any shift in perception of the risk constructs elicited from senior non-clinical managers, the researcher decided that a Repertory Grid Technique (RGT) was needed. The RGT was therefore used to further elicit personal knowledge and allow for appropriate analysis of business risks faced by FM operators when effectively managing integrated non-clinical services in the NHS. This was done in order to control variations in time of collecting major survey and Repertory Grid data that could influence the analysis and model development resulting in an unreliable risk management system. Thus, Repertory Grids were used to facilitate both qualitative and quantitative analysis of key risk factors identified as affecting healthcare FM operations. The RGT was designed in such a way that it did not only use NHS facilities managers' responses to the interviews about risk perception. It also allowed participants to interrogate and supply (mind mapping) the required FM knowledge. Thus allowing them to construe personally the key FM risks that affected the delivery of best value FM solutions in the NHS. The RGT was then adopted to achieve the following objectives stated below;

i) To compare and contrast the risk constructs obtained in the major questionnaire survey and the Repertory Grid interviews in order to develop a reliable risk management model;

ii) To elicit the critical FM risks faced by NHS facilities managers when they are assessing and evaluating risk propensity in healthcare FM operations;

iii) To identify key common risk constructs used by healthcare facilities managers (purchasers, in-house and external providers) in discriminating between high and low risk management situations in healthcare FM operations;

iv) To provide feedback information to individual healthcare FM providers and purchasers (through their facilities managers) about their own risk perception;

v) To collect personal knowledge from non clinical managers on FM risks that could be analysed and then used as input to develop the ANN model for predicting risk exposure;

vi) to determine the relationships between the identified risks and their sub-attributes; and

vii) to determine whether most purchasers and providers (in-house and external) used any clearly definable business and risk management strategies when managing healthcare FM operations.

5.29 FM data elicitation process

After carefully evaluating the need to use the Repertory Grid technique for this research, the researcher then proceeded to collecting most of the FM knowledge on risks faced in the NHS by FM service operators. The participants for the interviews were FM Directors and senior facilities managers working within the identified 125 NHS Trusts in the UK. Previously, the researcher had made earlier contacts through telephone conversations with all the 80 selected (20) FM in-house and (20) external providers and (20) purchasers who had participated in the main questionnaire survey. The telephone conversations were made by the researcher in an attempt to clarify and explain the need for collection of more FM knowledge from willing participants. Out of the 80 FM service managers contacted, only 60 (20 in-house providers, 20 external providers and 20 purchasers) confirmed their willingness to participate in the interviews. As for the other 20 NHS facilities managers who did not agree to participate. They were too busy to commit their time to the second survey. Some did apologise for missing out in taking part in such an organisation value adding exercise.

For those 60 healthcare facilities managers who agreed to be interviewed, concrete interview dates and convenient venues were arranged for the knowledge elicitation process to take place. In overall, the Repertory Grid contained strategic decision making information on the criteria used by those interviewed FM managers when effectively managing business risk factors that disrupt the smooth delivery of support services in healthcare operations.

5.30 Repertory Grid data elicitation

In chapter four, the researcher discussed about the overall development of DSSs using knowledge elicited from domain healthcare facilities managers. The researcher specified that, the main knowledge elicitation method used in this research was the Repertory Grid technique proposed by Kelly (1963). As a consequence of this, the Repertory Grid data elicited was made to comply with requirements of the proposed modelling technique (i.e. ANNs) based on FM knowledge and management solutions that are used in solving the research problem. The knowledge elicitation process was carried in March 2000 for the following reasons;

(i) it was immediately after the presentation of the annual NHS Trust performance budgets, when FM staff were less busy with more time to participate in the interviews;

(ii) more FM projects had just started, thus it was far much easier for healthcare facilities managers to provide personal and appropriate knowledge for the research.

The interview sessions as part of the knowledge eliciting exercise were well received by healthcare facilities managers as they were well designed. In addition, the interviews were also considered as an effective brainstorming exercise by the researcher.

5.31 Advantages of using Repertory Grids

The use of Repertory Grids offered a number of great opportunities such as;

i) It allowed the selected healthcare facilities managers to sufficiently respond to the questions asked at their own pace of time thereby increasing the reliability and accuracy of their responses.

ii) The information received from participants was standardised and consistent due to the design structure of the Repertory Grid.

iii) It was a very straightforward yet rigorous way of gathering qualitative information from experienced healthcare facilities managers about how they view the management of NHS FM operations.

iv) It is a fairly cheap and low cost data acquisition method with less interviewer bias and a high degree of anonymity to a wider sample (as such is the case with UK NHS Trusts).

v) Additional important information was obtained through the use of the questionnaire.

5.32 Grid design

Kelly also used the RGT as a way of quantifying and making these cognitive map objectives. Since Kelly pioneered the Repertory Grid technique, a great deal of changes and modifications has taken place with regards to its pattern of use and application. Some of the changes that have been modernised in the use of Repertory Grids are as follows:

5.33 Linking mechanisms

These are various methods that illustrate how elements and constructs are linked. As a result of this, generally there are three main ways of linking constructs to elements.

5.34 Dichotomising

If the element is closest to the left pole of the construct, place a tick, or put a cross.

5.35 Ratings

Treating the poles of the construct as the extremes of a continuous scale (normally five or seven points are used). This offers a flexible approach of analysing qualitative grid data and transforming it into quantitative statistics such as regression analysis. In this research a 5-point continuous scale was used by healthcare facilities managers to rate each element against each construct along each row of the grid. This method allowed participants to have greater freedom when sorting the constructs and did not force them to make discriminations which do not exist (lopsidedness), which has been one of the problems found with Kelly's original format of dichotomising (Beail, 1985). This procedure also highlights the functional meaning of the elements and constructs and offers a greater understanding of how they are used by the participants. It must be remembered, however, that the rating figures carry no inherent meaning in themselves, but simply provide a way in which participants can position the elements in relative terms on each of their construct dimensions thus providing the researcher with a richer picture of the overall structure of their construct system (Stewart and Stewart, 1981).

5.36 Ranking

All of the elements must be placed in a horizontal order alongside each construct. Before the RGT and its methodology are discussed extensively in this thesis, it is important to explain the stages or methodological decisions that were taken into account by the researcher. Having explored the main components of a Repertory Grid, it is important to note that a modern Repertory Grid investigation usually goes generally through five stages. In designing the Repertory Grid, the researcher adopted a more flexible, yet systematic, research process that combines both qualitative and quantitative methods of analysis based on Marsden and Littler (2000) and Okoroh and Torrance's (1999) main principles.

These principles are described as follows:

i) Main objective of the Repertory Grid;
ii) Selection of elements;
iii) Elicitation of constructs;
iv) Preparing the grid;
v) Grading each element on each construct; and
vi) Analysing the results by computer-based software.

5.37 Elements selection

Representing the focus of inquiry of this FM study, the first stage in using the RGT was to choose a set of elements which were consistent with the objectives of the research and the targeted (sub)system of constructs (e.g. FM services) to be elicited from participants (Stewart and Stewart, 1981). In this FM research, for example, the elements used were taken from the pilot study. These were of various "hard" or "soft" support services (i.e. hotel and catering, relocation, portering, cleaning, space management, building maintenance etc.) that were used to front the core business service delivery in organisations. For a detailed explanation and illustration of how FM services were successfully used as elements in a grid, the work of Jones and Okoroh (2000) can be used as best practice. Therefore, elements are objects of thought that are normally of other people within our physical servicescape (i.e. the FM sector). Elements represent those events or services in the business environment that are dealt with by a facilities manager's sub-system of bipolar constructs that are the focus of any investigation. They can be sometimes events, pictures, situations, facilities, places, people, ideas or inanimate goods and services. Always when eliciting for elements the researcher should first decide on the subject area (domain), he wishes to map, then he must elicit a sample of objects his "client" thinks about within that subject area. In this research the domain is healthcare FM.

As a general rule, elements should be chosen by the participants in the study and not pre-selected by the researcher unless only when the research problem is too complex and the researcher is fully aware of the objectives (Marsden and Dale Littler, 2000).

The eliciting of elements is the foremost crucial stage of a Repertory Grid as it forms the basis of everything else that follows. They could be provided by the researcher or elicited personally from respondents. The choice between elicited and provided elements depends on the researcher and also the purpose of the investigation. However, it is important that adequate preparatory work is done to ensure that the selected elements are representative of the nature of the problem to be investigated. Normally, this would entail discussions or conversations with the potential participants so that a common understanding can be comprised between the researcher and the participants. Due to the complex nature of the research, the researcher supplied seventeen (17) common FM elements associated with an integrated approach identified in the major survey. Thus, in order to determine the risk perception of NHS FM service providers and purchasers in healthcare FM operations, it was quintessential to elicit various representative FM operational situations, which reflected the experience, knowledge and risk attitude of both providers and purchasers. As a result of this, elements could be generated in the following four ways listed below:

5.38 Supplying them

In this case a list of named individual people or situations would be provided; for example several particular incidents on a videotape are pinpointed i.e. six objects are displayed and participants are differentiated and associated in pairs or more.

5.39 Provide role titles of situation or descriptions

Similarly as above, a number of different types of persons or situations are specified. The researcher completing the grid must supply/attach specific names to the people or incidents chosen. The researcher does not need to know these names. However, when constructs are generated the researcher must be encouraged to think of these specific people or situations rather than of ideal types (unless ideal types are being compared). For example, if you want to understand what a purchaser views as a good facilities manager, it is useful to get the person to think of a bad healthcare facilities manager whom they know, rather than good healthcare managers in general.

5.40 Define a "pool"

A person is asked to write down "the names of five good FM managers", "three portering managers", or "two hotel services managers" that he/she can compare and contrast. It is important that the person is asked to assign names to the different elements.

5.41 Elicit through discussion

Both parties discuss a topic of interest and as a result of this discussion a list of specific elements is drawn up. According to Easterby-Smith *et al.* (1996) it is important that the final list of elements is;

i) **Homogeneous**:- are drawn from the same category, in order to avoid mixing situations and people unless you are seeking to compare them.

ii) **Representative**:- They should provide adequate coverage of most aspects of whatever is being examined.

iii) **Unambiguous**:- all elements should be specific, simple and readily understood by the participant.

iv) **As short as possible**:- eight to ten elements are quite adequate for most managerial applications although more can be used.

5.42 Elicit from triads

This method of "triading" is one of the most commonly used techniques for eliciting elements from participants. However, there are a number of different ways in which triads can be used (Marsden, and Littler, 2000). The participant is presented with three elements and asked to consider ways in which two are alike but different or opposite in the third. This process can be quite difficult. The investigator should not be surprised or feel uncomfortable by long periods of silence.

The cards are normally drawn randomly from the pack and triads are presented until time runs out or the person "dries up" (minimum context card form). All elements are spread out in front of the participant, who is asked to think of ways in which groups of the elements are alike. When two cards have been selected, the person is asked to describe how they are similar. More cards are added and the person is asked if each card in turn is in the same category. If the card is not added to the group the person is asked why (full context form).

5.43 Elicitation of constructs

The second stage of using the RGT is to conduct personal interviews with participants in order to elicit the content and hierarchical structure of the subjective meanings, in the form of bipolar constructs that they attach to the set of elements (Jones and Okoroh, 2000). Constructs can be regarded special "qualities" which are used by people to describe and differentiate between elements. Constructs can be viewed as bipolar as they normally posses both a positive and negative (bipolar) ends. For example, 'good customer' and 'bad customer' are examples of the extreme ends that can be applied to a construct. As constructs are frequently expressions of intuition "gut feelings" and perceptions, which are peculiar to individual people's informed judgement as a guide to action without necessarily having verbalised them explicitly prior to the interview. Extra care should be taken when using any method by the researcher to generate relevant constructs that reflect the magnitude of the problem to be investigated. Normally, the elicitation of constructs is carried out by presenting a random set of three elements at a time to the respondent and inviting him or her to think of similarities and differences between the elements. The standard question normally asked by the researcher is:

" In what ways are the two of these alike and different from the third in terms of .... (Purpose of study)? "

As described by Kelly (1955), there are six principal and distinct approaches to the elicitation of constructs that are described below.

5.44 Supplying them

This is probably the quickest way to generate constructs whereby the researcher provides predetermined constructs for respondents to assign the necessary ratings. The uncertainty that is attached to respondents' construing of supplied constructs places the supply of constructs upon distinctively uncertain foundations (Grover, 1983). There is always a danger with this method in that the grid becomes inflexible like an attitude questionnaire, with the researcher's world being imposed on the participant.

5.45 Triadic construct elicitation

In this method the respondent is represented with three constructs at a time from a list of representative constructs and asked to distinguish in what ways the two constructs are alike or different from the third. The respondent is then requested to name the emergent people and the implicit or contrast pole that discriminate the constructs. The two contrasting poles of the constructs are then recorded. Whilst triadic elicitation is commonly used (Fransella and Bannister, 1977; Jancowicz, 1996; and Eden and Jones, 1984), it does not always facilitate the production of constructs. Since, according to Kevill *et al.,* (1982), some respondents appear to find the cognitive demands of the procedure alien to the way they think, or will prefer to respond. Depending on the size of the grid this can be rather time-consuming and may create frustration with the interviewee (sequential form).

5.46 Dyadic construct elicitation

Although triads are the most common method used, the researcher found out that thinking in this way could be sometimes difficult. For some people it may be easier to use dyads (pairs of constructs) rather than triads. Therefore, in this method two constructs are presented to the respondent each time and, he/she is requested to discriminate the difference or likeness between them.

5.47 Free response construct elicitation

Through conversation, FM experts or respondents provide their constructs instinctively or using their own knowledge, expertise and perception. Probing can then be used to cluster the most meaningful constructs. Once a set of constructs relevant to a particular person's circumstances is generated, it can be used at regular intervals to measure that person's values over time. A particular set of constructs, though, may have a limited life. As the purpose and mind processes of a person changes, the constructs relevant may need to change with new sets of constructs identified, using the same technique as before.

5.48 Laddering

Laddering is a way of exploring a person's understanding in more depth and relates to the notion of constructs having a hierarchical relationship. Laddering helps the researcher gain a better understanding of a person's construct system. Laddering *down* (also called pyramiding) is where you explore the person's understanding of a particular construct. The technique is normally used in conjunction with one of the above methods after some constructs have been elicited. It involves asking the respondent a series of "why" or "how questions so as to solicit more specific constructs which are relevant to the field of knowledge under investigation. Laddering can also be used to move between construct levels. Given a construct, one can either ladder "upwards" towards the central construct by asking which pole of the construct is more important to the individual and why? For example, construct "*keep customers highly satisfied / always dissatisfy customers* is elicited. It is possible to obtain further constructs (for instance, constructs such as "*shows dedication/ no dedication*" may be elicited by laddering from the "*aims to maximising profits/ aims to enhance service quality*" by asking the "why" question. This process may be repeated until the central construct of the respondent is revealed. Similarly as stated above, constructs can be laddered downwards the "how" and "why" question to obtain more specific constructs.

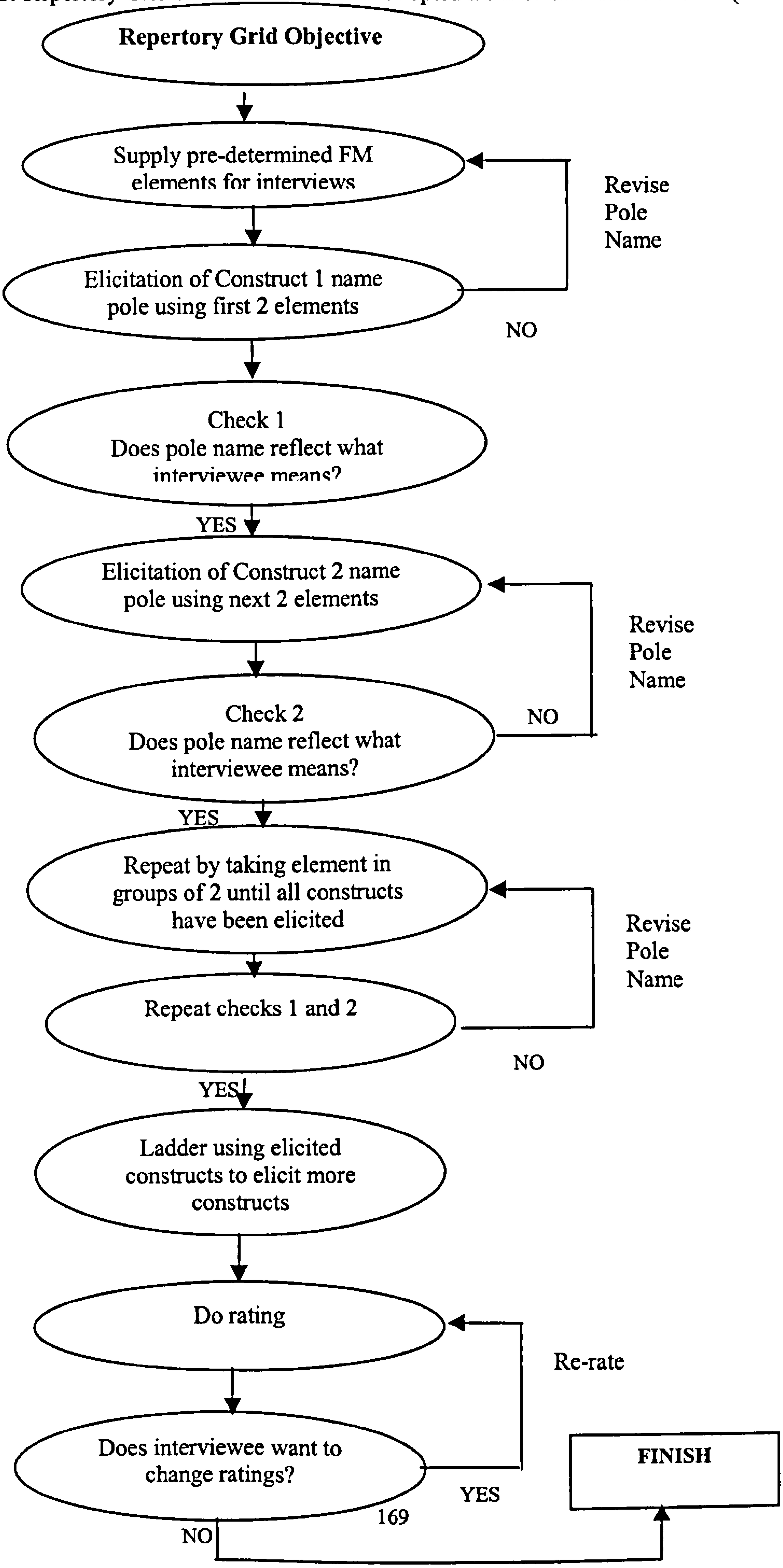
5.49 Combination of the above methods

This method is self-explanatory. As the statement above suggests, constructs are elicited using all of the methods described above for the respondents to assign a rating. Another important aspect that needs to be emphasised is that the researcher should ensure that the elicited constructs are appropriate for the purpose of the investigation.

5.50 Dry run knowledge elicitation test

Before the researcher performed the main FM knowledge collection exercise, the researcher performed several trail tests or dry run interviews with fellow researchers, lecturers and other experienced healthcare facilities managers working in the NHS. The main objective of these "dummy" tests was to investigate any problems and modification in grid completion that could be made before the main interviews. These trial tests also offered the researcher an opportunity of getting acquainted with various aspects of this otherwise novel technique of knowledge eliciting as suggested by Ruíz (2000). The dummy tests proved to be a very useful learning exercise to an otherwise new approach to the researcher. As a result of the experimental knowledge elicitation exercises some vital adjustments were made to the whole structure of the Repertory Grids used. Also during the dummy tests, the researcher observed that some FM elements chosen for this exercise tended to load heavily on the research problem overshadowing the constructs that were being used. In such a situation the researcher noted that there was a high possibility of the designed Grid becoming a postal questionnaire, as a result distorting the overall objective of using a Repertory Grid technique. The researcher also observed that some of the participants who took part in the trials faced difficulties in innovating new sets of constructs that represented the research problem. Due to these problems, the researcher took a decision that he should use the 'dyads' elicitation technique. The researcher used this method in accordance with the description guidelines mentioned in section 5.48 of this chapter. In brief, this method allows the choosing and comparing of two elements at a time and participants asked to state whether they are alike or different, and what it is that makes them similar or different from each other?

Figure 5.2: Repertory Grid elicitation framework adopted from Okoroh and Torrance (1999)



This technique played a major role in providing an interview friendly environment for participants and eased the elicitation process of the constructs.

5.51 Interview framework

The procedure in which the interviews for the Repertory Grid data elicitation were performed is clearly shown in Figure 5.2. The framework shown in Figure 5.2 was adopted from Okoroh and Torrance's (1999) work on subcontractor selection in refurbishment projects. The initial step in eliciting the necessary FM knowledge from the selected participants started with the researcher clearly stating the main objective of the research problem and the purpose of the Repertory Grid data elicitation exercise. Before the interviews commenced the researcher assured the participating healthcare facilities managers that all completed Grid data would be kept in confidence. In addition, participants' names were not included in any analysis. As they were no names used a special coding system was used for further identification purposes. After the conformation of information confidentiality, the researcher provided the participating healthcare facilities managers with a list of risk constructs they considered affected their rate of business success when delivering non-clinical services in NHS Trusts. During the elicitation of constructs, a set of randomly selected pair of FM elements/services were displayed and the domain expert asked how they considered the management of these two services different in terms of risk exposure.

The FM experts were also asked to show with reference to constructs that they would use to describe the difference in management strategies between the two. Furthermore, healthcare facilities managers working for purchasers, in-house and external providers were also asked the criteria they used to evaluate the FM services they managed using the elicited constructs in terms of the following ratings: unimportant, not very important, important, very important and extremely important. Thus, differences in terms of relative importance amongst the constructs showed how critical these FM services were managed as well as the strength of construct parameters used to define the FM business process by the interviewed FM operators.

As a result of this process, the researcher was able to select the most popular critical constructs that carefully discriminated between the 'unimportant' and 'very important' risk constructs used by NHS facilities managers to manage effectively their FM business processes in order to support the delivery of care services in NHS Trusts. This process also helped in the investigation of those constructs that were highly rated by FM purchasers and providers when providing high quality non-clinical services in the NHS. By asking both differences and similarities of two services, FM operators as the domain healthcare FM experts would get out both implicit and explicit poles of the FM business process resulting in the data becoming much more meaningful, crisper and easier to learn the relationships. As a result of this, high and low risk FM situations were also investigated from participants in order to determine a better way of rating such situation in the grid.

5.52 Recorded knowledge elicitation

In this research all the FM knowledge elicitation was performed at various NHS Trust hospitals where the selected experienced healthcare facilities managers worked. Furthermore, all the knowledge elicitation interviews were tape-recorded. Tape recording is a procedure that has been recommended and used in most knowledge elicitation interviews (Okoroh and Torrance, 1999; and Ruíz, 2000). A typical knowledge elicitation exercise lasted for about 3 hours. During the interviews most healthcare facilities managers agreed to being recorded only if the researcher would use the recorded tapes for the purposes of this research. The researcher gave them his full assurance about information confidentiality and as a result all the participants eventually agreed. In addition, all the responses supplied by the participants were also written down during the interview sessions. The interviews were in form of brainstorming sessions that allowed a two-way approach of information, but in most cases the interviewed facilities managers led the process. This approach allowed the participants to supply the required information in a more business-friendly environment. The researcher also took a lay-back approach that allowed the participants to supply information freely, as a result this approach worked well in eliciting more information that respondents regarded as highly confidential and could lead to the exposure of their competitive strategies.

As this research was highly sensitive, the researcher also had to employ some of the techniques that allowed him to elicit FM knowledge from the participants by asking indirectly some very important questions which could have not been answered directly by the participants.

5.53 Preparing the grid

The grids were prepared with supplied elements and free response constructs arranged as shown in Tables 8.1, 8.3 and 8.4 respectively and in chapter eight of this thesis. Full details of the Repertory Grid results used in this research are shown in Appendix C. During knowledge solicitation 17 non-clinical/FM services were used as pre-determined elements. These FM services had earlier on been identified in literature review; the pilot and the major survey as being managed under an integrated FM approach in the surveyed NHS Trust hospitals. Therefore, in this research, the researcher supplied elements for the Repertory Grids to all healthcare facilities managers who were interviewed. The advantages of supplying elements in this research were:

i) This approach allowed the researcher to select the most common FM elements/services that are represented by an integrated FM approach used by healthcare FM operators to manage effectively FM businesses these in the NHS.

ii) Elements determine the focus of the grid and must be representative of research problem to be solved (Jones and Okoroh, 2000).

iii) This approach allowed for flexibility and ease in use by participating healthcare managers, as it did not require them to recall past FM service delivery situations that they had provided in the past.

iv) Finally, it acted as a catalyst to healthcare facilities managers as it allowed them to focus on providing the researcher with personal experience and knowledge of the most critical risk factors that they faced when managing healthcare operation in the NHS.

During the designing of the grids, it was important to incorporate identification numbers and aids to facilitate data preparation. As a result of this, the provided FM elements were centralised at the top of the Repertory Grid as recommended in Senior's (1997) work. The method used in the elicitation of the most meaningful risk constructs for research was the 'free response' technique. Due to the complex nature of the research and for comparison purposes, the researcher supplied the forty eight (48) common risk constructs identified in the major survey they affected the smooth delivery of FM services in the NHS. This involved conducting personal interviews with experienced senior healthcare facilities mangers as participants in order to elicit the bipolar constructs that these managers highly rated as being the critical factors towards the effective management of a chosen set of FM elements they delivered in the NHS. The use of this technique was advantageous in the sense that it allowed these non-clinical managers to compare and contrast, then expediently select the most and less meaningful risk constructs using their own business experience. This method was also designed to elicit in more detail of the defining characteristics of a participant's subordinate constructs and involves asking them: "what" defines or constitutes the other negative pole of the supplied construct? While the questions "what" and "how" tend to produce very concrete, or tangible, constructs, the question "why" generates constructs of far greater generality and intangibility. This thus allowed healthcare facilities managers to value those risk constructs that have an everlasting effect on their FM business process.

5.54 Repertory Grid data analysis

The FM participants interviewed represent the three main FM operators working in NHS Trust hospitals to deliver facilities service solutions to customers. In order to develop the proposed FM risk management and DSS, all the data collected was stored in the researcher's desktop computer. The RGs were analysed using Richard Bell's (1999) Beta Release Freeware program for DOS: GRIDSCAL. GRIDSCAL is a simple DOS style menu driven program that specifically analyses single and multiple grids. Considering the qualitative nature of the grid data obtained, the researcher had to transform this data using several quantitative techniques to format (coding) it.

GRIDSCAL was preferred due to the following reasons:

i. Most commercially available programs such as Slater's Grid Analysis Package (which includes INGRID), FLEXIGRID ignore the variation between grids when they are combined into a single set of data;
ii. GRIDSCAL is principally used to produce a consensus grid from a multiple of grids and allows for the focusing of the consensus grid.
iii. It is also a freeware that can be easily downloaded on the internet (i.e. on the world wide web)

For a detailed overview on various Repertory Grid programs available, Chris Evans, a clinical psychologist has produced a website for the evaluation and downloading Repertory Grid software available commercially. A good idiot's guide is provided online - visit http://www.psyctc.org/grids/default.htm.The techniques used by the researcher to analyse the Repertory Grid data were:

i) Visual focusing
ii) Construct variability and analysis
iii) Principal component analysis; and
iv) Correlation analysis

Each of these techniques mentioned above is fully explained and applied in the relevant part of the thesis.

5.55 Model development

Initially, before the conceptual model was developed, the researcher developed a theoretical risk management model that was sent to various FM experts and the participated healthcare facilities managers to solicit their expert advice on the feasibility and practicality of such a model. The overall responses received were positive and constructive resulting in some minor cosmetic refinements to the proposed model. The principal modelling technique used to develop the NHS facilities risk exposure prediction system (NHSFREPS) model and testing it is the artificial neural network technique.

Artificial neural networks (ANNs) are new mathematical based computer modelling paradigms that simulate the human behaviour and can learn various factor relationships.

In this research 48 FM risk factors were identified using the RGT as qualitative information that was transformed and normalised into quantitative input values that can be processed by ANNs of the proposed model. In this research ANN modeling was used as decision-making system that aid healthcare facilities managers to model and predict their business performances. ANNs have the ability to learn and identify pertinent risk factor patterns and to associate them with the development of the proposed risk management information system. ANNs can recognise and recall information in spite of incomplete or defective input information. They can also generalise learned information to other related information. These abilities form the basis for supporting learning of relationships between business risk factors in healthcare FM operations. The Repertory Grid data supplied by 60 selected and experienced healthcare facilities managers working in NHS Trusts was used as the input to the ANN model. This data was first normalised to allow for the transformation of the otherwise qualitative data into quantitative data accepted by the ANN model. In developing the model, attention was paid to the most critical risk factors (i.e. 48 factors used) for optimising and simplifying the model. To measure the model performance, the commonly used traditional technique of multiple regression analysis was used to develop the secondary model.

The secondary model was developed in order to measure and compare the performance results of the principal model in solving the domain research problem. The main objective of the primary model was to measure and predict the total risk exposure of integrated FM services against set targets or FM business key performance indicators (KPIs) set by service operators in healthcare operations. This procedure allowed service operators to monitor and improve their business performance levels and response times in the delivery of high quality non-clinical services to customers.

5.56 Model validation

A simple and straightforward procedure was adopted to test the performance of the developed healthcare FM NHSFREPS model. This procedure focused on evaluating the accuracy prediction range of the NHSFREPS model and statistical consistency with its intended application to healthcare FM risk management. The model was then supplied with new independent sets of (training) data and its output checked against the actual results, to calculate the prediction accuracy range. Three (purchasers, in-house and external providers) sets of unseen average grids data produced by GRIDSCAL during the Repertory Grid data analysis that was first integrated into a single file, normalised and then processed into ANNs, was used for validation of the NHSFREPS model.

These sets of FM risk data collected, each containing 17 FM services by 48 risk factors were first transposed into Windows 97 Excel (using IBM PC) and later normalised in order for the ANN model to read and process the data properly in a standard format. The forty eight (48) FM risk variables were then classified into a second-order factor analysis to produce seven main risk factors that formed the FM and risk knowledge to be used for modelling the proposed risk management system. This approach is commonly used in the analysis of multivariate factors of such nature (Tamimi, 1998). This process resulted in a consensus grid with the 7 main FM risk classes by 17 (FM services) cases as the input data to be processed by ANNs (see Figure 9.2). Each set of data was then used to test the accuracy prediction of the NHSFREPS model. The full details of the NHSFREPS development and decision-making process including results on validation of the model using domain healthcare FM experts are presented in chapter nine of this thesis.

5.57 Summary

The main objective of this research was to identify and analyse healthcare FM risk factors that are faced by service operators when delivering best value support services in the NHS. The main research technique adopted to investigate this problem involved Repertory Grid Technique. The Repertory Grid Technique was used in order to collect the 'best fit' data for modelling the research problem.

This was then followed by the development of the research model and the framework for the research. In view of the qualitative nature of the research and the type of information required, the ANN modelling technique was used in the transformation of the qualitative data obtained in personal interviews to a quantitative one. As a result of this the NHSFREPS that uses artificial business solutions (ANNs) was developed using FM knowledge collected from service operators already outlined in sections 5.55 and 5.56 respectively of this chapter.

Validation of the developed NHSFRES as best practice model was first validated using the traditional comparative technique, regression analysis. Regression analysis was used to compare the performance of NHSFRES in order for the researcher to gauge its reliability and accuracy. Furthermore, the developed NHSFRES was validated using FM experts and healthcare facilities managers who took part in the interviews. The results produced by the use of these two methods showed that, both methods provided stronger results that are reliable. The overall results from the validation showed that NHSFRES was novel and reliable risk management system that can be used to evaluate FM services performance in the NHS.

6.0 Introduction

This chapter presents and discusses the results of a nationwide pilot questionnaire survey conducted on 365 NHS trust hospitals in the UK to investigate the existence of integrated FM structures. The postal questionnaires were sent to 365 senior healthcare managers responsible for the strategic management of non-clinical/FM services. Due to the exploratory nature of this survey, some general comments and conclusions are made on the results obtained. The results of this pilot survey are also presented in tables. Furthermore, the pilot questionnaire format used for this survey is shown in Appendix A.

6.1 Pilot survey objectives

The main objectives of the pilot survey were;

a) to identify those NHS trust hospitals utilising a business approach of managing integrated non-clinical/FM services in the NHS.

b) to further investigate the surveyed NHS hospitals and their FM management approaches that could be used for further evaluation in the major survey on risk management.

6.2 Data collection technique

A total of 365 questionnaires were mailed to 365 non-clinical services managers working in the five main NHS trust hospitals found in the UK. The questions used for soliciting information from participants covered ten main areas of healthcare facilities management in the NHS. The questions asked were carefully designed to investigate certain business aspects of managing non-clinical services using an integrated approach in the NHS. As a result, Table 6.1 shows a summary of the survey response rate. Table 6.1 shows that out of the 219 (60%) questionnaires returned back, only which 19 (5%) were not satisfactorily completed rendering them unusable for the analysis. Therefore, only 200 questionnaires were fully completed, and represented 55% of the original questionnaires sent out.

Table 6.1: Pilot survey responses

Questionnaires	Number of responses	Percentage (%)
Returned complete	200	55
Returned incomplete	19	5
No response	146	45
Totals:	**365**	**100**

Table 6.1 also shows that 146 questionnaires were not returned back and can be regarded as non-responsive. For the 146 questionnaires that were not completed or returned back. One of the following reasons could have caused the participants not to respond to the questionnaires;

i) NHS Trusts' policy on information confidentiality- i.e. some trusts wrote back to say that it was their organisation's policy not to answer public questionnaires;
ii) exposure of the corporate strategy to other trust hospitals or commercial competitors;
iii) lack of time to respond to the questionnaire due to pressure of work;
iv) delay in passing questionnaire to the responsible manager for completion;
v) absenteeism of the right respondent (i.e. on-leave) to give information; and
vi) reluctance and lack of interest to respond to otherwise a voluntary questionnaire.

This situation again is common with self-administered questionnaires, as most respondents will not answer questionnaires that they do not understand, or which are too laborious for them to answer. This aspect was also observed in some of the questionnaires that were returned uncompleted or partially completed. No attempt was made to do a follow up survey. This is for a number of reasons. First, with such a large response rate, the randomised sample of responding trusts is representative of the population of NHS trusts. Second, it ensures homogeneity of timing of responses to questions: this is important in the context of the rapidly changing institutional environment within the NHS (DoH, 1997).

The survey response obtained in this study compares favourably well with response rates for self-administered postal surveys in the field of healthcare management, and moreover, is higher than many surveys organised internally by the NHS themselves - typically having a 15-20% response rate (Gray and Ghosh, 2000). Taking into account the complexity, and the number of questions posed by this survey, the response rate achieved in the pilot survey of 55% can be regarded as reasonable (Honville and Jowell, 1987).

6.3 Characteristics of NHS hospitals executives surveyed

The composition of healthcare service managers surveyed in NHS trust hospitals is shown in Table 6.2. Table 6.2 shows the seniority and percentage of those healthcare managers who participated in the survey. Table 6.2 also shows that senior healthcare managers who participated in the pilot survey were multi-disciplinary (i.e. ranging from the most senior: Chief Executives (CE) to senior operational and middle management), representing all aspects of non-clinical services directorates of a hospital.

Table 6.2: Composition of participants

Type of NHS Trust Executive	Number of respondents	Percentage of respondents (%)
Chief Executives	64	31.2
Trust Secretaries	2	1.0
Operations	16	8.0
Finance and Allied services	19	9.0
Risk Management	4	2.0
Corporate Affairs	6	3.0
Business Development	5	3.0
Clinical Support	1	1.0
Strategy and Planning	3	2.0
Hospital Services	1	1.0
Resources	8	4.0
FM and Support services	60	30.0
Total	**200**	**100**

This multi-disciplinary nature of healthcare managers who participated is a clear indication that integrated non-clinical/FM services were managed by a variety of healthcare managers. In addition to the above, NHS facilities management now emulates commercial business approaches as can be seen in Table 6.2 that most executives' job titles reflected a general business flair. Since this study set to investigate management structures relating to integrated non-clinical/FM services provision in the NHS, healthcare executives were of interest to this study due to their decision-making role in the delivery of non clinical services (Drucker, 1979). To demonstrate how healthcare executives are responsible for decision-making in any public healthcare business, Drucker (1979:pp.93) a management guru clearly states that;

"Executives do many things in addition to making decisions. But only executives make business decisions. The first management skill, is therefore, the making of effective business decisions."

Table 6.2 also shows that 64 (31.2%) of the total responses received were answered by the most senior executives; CEs signifying how strategic FM decisions have become important in the day-to-day delivery of responsive healthcare services to NHS customers. The second highest responses came from those healthcare managers mainly responsible for FM service functions. They accounted for 60 (30%) of the total responses. Results shown in Table 6.2 indicate a difference of 16% compared to a similar survey carried out by CFM in 1995. In 1995 the CFM carried out a similar survey and found out that those NHS managers with an integrated FM function were only 14% of the total healthcare managers who participated. An increase in FM roles observed in this survey could also be inferred to mean that there has been a gradual "prescription for change" culture-wise in NHS businesses to that of commercial enterprising recommended by the *Working for Patients* White Paper (DoH, 1989) and other FM writers such as Payne and Rees (1999) and Webb *et al.*, (1997). In addition, Table 6.2 also shows that 76 (37.8%) of the remaining responses were received from other NHS executives showing that there was diversity in FM responsibility in NHS hospital systems of service delivery.

6.4 Integrated FM practice in the NHS

It is clear from business literature and in recent FM surveys that the practice of integrating FM services is still in its "embryonic" stages of development (Rees, 1997). As a result of this, Trusts as self-governing corporations have often used various business models of managing and co-ordinating hotel, site and estates services under a single FM directorate (Featherstone and Baldry, 2000). This question therefore sought to evaluate those hospitals with some FM outfits/directorates. Hence, the establishment of those hospitals with some FM outfits was the principal objective of the pilot survey. As a result, correct identification of those hospital Trusts practising an integrated approach would allow for further investigation in the major survey. On the other hand, FM is not the "industry standard" for managing healthcare support and ancillary services in the NHS, some traditional archetypes of managing non-clinical and support services have long been in practice alongside with the continuous development of FM as a business tool for managing change processes in Trusts (Houston and McFadzean, 1996; Rees, 1998; Gallagher, 1998; Williams, 1996; and Payne and Rees, 1999)

Table 6.3: Defining non-clinical/FM service directorates

Type of NHS Trust directorate	Number of Trusts	Percentage of respondents
Facilities Management	121	60
Support Services Management	84	46
Non-Core Services Management	6	3.0
Services Management	6	3.0
Estate Management	95	47.5
Others	13	6.5

Results in Table 6.3 clearly show that FM directorates in Trusts are widely regarded by healthcare managers as being responsible for the procuring, co-ordinating and managing non-clinical services in the NHS. Table 6.3 shows that 121 (60 %) healthcare executives who were surveyed confirmed this.

Furthermore, these results typify writers from the management school of thought that equates FM to the outsourcing or procurement of business support services (Arnold, 1995; and Hinks and Hanson, 1998). Table 6.3 also shows that the traditional system of managing healthcare facilities and support services under an estate directorate is the second popular route. Results justifying the practice of managing healthcare facilities through the estates department illustrated in Table 6.3 were responded by 95 (47,5 %) executives. These findings do agree with Alexander's (1992) work regarding the emergence of healthcare FM. Alexander attributes the continued growth of FM in Trusts to the high abundance estate and premises management expertise in the NHS. Alexander also argues that, due to experienced in-house estates management resources in Trusts, healthcare FM has capitalised on this added resource value to develop and market its service delivery brand.

As a result of the above, FM has also received much support in the form of research and development from the NHS Executive through the NHS Estates (HFN 17, 1998). The NHS Estates functions as central co-ordinating and regulatory department for NHS Trusts regarding healthcare facilities and management issues. Another added advantage that has fostered the development of FM directorates in the NHS, has been that traditionally in the past, the "works" and "estates" departments have handled the majority of the aspect of healthcare FM and capital projects such as hotel, estates and site services through their specialised in-house staff. Alexander (1992), Webb *et al.*, (1997) and Smith (1997) have also noted that, politics and bureaucracy have always played a central role in culturally changing the management of support services under Trust estates divisions. As a result of this most NHS FM writers and practitioners classify estate management as a major FM competency (Payne and Rees, 1999; and Okoroh *et al.*, 1998). Taking into account this argument, if we are to combine the mean response rates received for FM and estates management, they would account for 54% of the population sampled, resulting in FM being used by more than 100 (50 %) of the Trusts surveyed. From Table 6.3, it can be seen that 84 (46 %) of the Trusts surveyed used their support service directorates to manage non-clinical services in their hospitals. These results are not surprising given that there has been a shift in business planning in Trusts recently towards utilising commercial and business approaches of managing the delivery of healthcare (DoH, 1989; HFN 16, 1997; and HFN 17, 1998).

According to Porter (1985) support services of an organisation refers to those services or products that support the core business objectives. In the NHS non-clinical services procured from either in-house or external FM providers are regarded as support services, as they front and add value to the healthcare services being delivered by Trusts. References to support services as non-core services is more akin to the commercial sector, where an activity that an organisation (i.e. NHS trust) is not competent in or outsources from a third party, is regarded as support services (Prahalad and Hamel, 1990). Prahalad and Hamel (1990) regard any business function an organisation performs that is not central to its core business objectives as support services.

Another observation from literature so far reviewed is that no scholar, expert, practitioner or researcher can define FM without incorporating directly or indirectly the procurement or management of some ancillary services that enhance businesses as "support services". Non-core services are regarded as support services fronting the core business objectives in most business and FM operations (Barrett, 1995; Alexander, 1992; Rees, 1998; and CFM, 1995). Results obtained in Table 6.3 show that NHS hospitals still have to come to terms with the use of the term "non-core" services management to denote their weak competencies in the caring business. This is because commercial approaches introduced in the NHS are a recent advent (HFN 17, 1998). Non-core services management as a term has not been frequently used and applied to meaning the integrated management of support services in the NHS, as can be seen by 6 (3 %) respondents. This can be inferred to mean that the use of commercial approaches although welcome in the NHS is still in the infancy stages of implementation (HFN 17, 1998). It is possible that clinicians are still sceptical of embracing commercial concepts in caring for their customers. This could be because healthcare managers especially clinicians have not yet considered commercialisation as important business model for delivering clinical services in the NHS. As a result of this some healthcare managers are not sure of treating patients as customers. Other terms used in the NHS included either a mixture of the described terms or a variance of service provision mechanisms in Trusts such as, business contracts services, hotel services, non-clinical services, operational and property services. Those were reflected by 13 (6.5%) participants.

It is rather surprising, that this survey did not discover a high usage of the term "hotel services" to denote non-clinical services, yet much FM literature has often used this term with regards to NHS support services (Randall and Senior, 1994). The response rate of 6.5% shown in Table 6.3 may well indicate a gradual change in practices by healthcare managers towards the use of business process re-engineering (BPR) of support services delivery within Trusts. As earlier stated above, it has been noted that no single commentator has used any one of the terms described above consistently throughout any of their research work or publication so far, but uses them interchangeably. Even the author of this report cannot avoid this dilemma. The conclusion therefore would be that, FM is fast growing into a directorate in Trusts with a responsibility of co-ordinating non-clinical services into FM (Rees, 1998; Okoroh *etal.*, 1998).

6.5 FM Service procurement options in Trusts

As observed above, there has been an increase in FM uptake in Trusts. Hence, proper identification of non-clinical services managed using this integrated approach by NHS hospitals per given time is difficult without detailed investigations. This question sort to evaluate non-clinical services provided by the Trust hospitals surveyed. Furthermore, it also sought to establish those non-clinical services bespoke to healthcare provision and managed under a single FM directorate in the NHS (Rees, 1998). Table 6.4 shows the main FM services investigated in Trusts, which are characterised by progressive outsourcing, out-tasking or insourcing. The list also includes those 'hard' and 'soft' FM services surveyed by the CFM (1995) and Rees (1998). Furthermore, the list also includes the six common FM elements identified by the BIFM report as central to an integrated FM approach which are cleaning, catering, security, gardening and landscaping, mechanical and electrical and building services (Ridout, 1997). Table 6.4 shows that out of the 200 hospitals surveyed only 158 (79%) of the NHS Trusts were practising an integrated FM approach of outsourcing and insourcing FM services. On average they outsourced 6 (23%) elements while 17 (56%) elements were insourced. These Trusts also outtasked 5 (20%) elements of the 24 non-clinical services identified. The above-mentioned Trusts can be classified as practising an integrated FM approach due to them having at least 95% of the 22 FM services listed by the BIFM.

The BIFM listed about 22 FM elements that are classified as part of a comprehensive list of an integrated FM approach (Ridout, 1997). It can also be said that on average from the survey, at least 11 (48%) of the bundled FM services were outsourced from external providers, from which 6 (23%) of the FM functions were out-tasked to the same providers by the Trusts surveyed.

Table 6.4: NHS Trusts non-clinical services surveyed

FM Function	N0.of Trusts	Percentage (%) Outsourced	Percentage (%) Outtasked	Percentage (%) In-sourced
Gardens and Grounds	105	53	7	40
Estate Management	15	8	33	51
Hotel & catering	70	35	13	52
Mechanical & Elect	15	8	3	89
Domestic	87	43	21	36
Risk Management	5	3	2	95
Building Services	40	20	20	60
Waste management	200	120	20	60
Total FM	5	3	7	90
Energy management	60	30	7	63
Car parking	80	40	45	15
Healthy and Safety	45	23	73	4
Reprographic	5	3	45	52
IT & Telcomms	20	10	73	17
Cleaning	90	45	10	45
Portering & security	25	13	10	77
Pathology & X-ray services	19	9	20	71
EBME & medical equipment	115	56	20	14
Courier and lock smith	61	30	10	60
Low dependency patient healthcare	13	6	15	79
Patient transport	30	15	10	75
Specialist support	11	4	5	91
Police force	41	20	5	85

On the other hand at least 13 (52%) of the Trusts managed their FM services in-house. Other FM services unique to Trusts such pathology, patient services and transport, medical equipment and sterile suppliers and low dependency patient care accounted on average to 14 (60%) of FM services were insourced from in-house providers.

Following on from their own independent survey, the Building Services Research and Information Association (BSRA) identified the level of outsourcing in the commercial sector of these six main FM functions as 60%. In comparison, this survey found out that this level was 30%. The two surveys indicate a difference of 30% that could possibly account for the concerns some FM commentators have levelled against NHS Trusts for not outsourcing much of their non-clinical services (Bell, 1999). According to Blumberg (1998) outsourcing can be a "good management tool" in organisations (i.e. Trusts) that operate labour intensive businesses and often experience reforms changing rapidly due to "cyclical factors". This scenario is typical of healthcare Trusts where continued medical technology, business and political reforms are always changing. Outsourcing of FM services has been seen by some FM researchers such as Bell (1999) and HFN 17 (1998) to expedite improvement changes in staffing levels, working practices, management controls and costs, service levels and quality of healthcare. Furthermore, a summary of the advantages for outsourcing are summed up by Blumberg (1998) as follows;

i. Offers best value for money services across a wide spectrum of low margin, non-differential services such as FM and support services as well gaining some income opportunities from "non critical functions". This will allow the cash stripped Trusts to increase their financial resources;
ii. Eliminates possible investments in fixed infrastructure;
iii. Allows for greater healthcare quality and efficiency that has been lacking in Trusts to improve their services;
iv. Permits multi-disciplinary experience in clinical and non-clinical directorates to support clinical service objectives;
v. Outsourcing of FM and support service in healthcare allows for competitive service advantages and allows the Trust to offer support services that would otherwise have required considerable costs and commitment of in-house staff; and
vi. Outsourcing in healthcare can allow for the use of an external service provider to market test the demand for a service in the most cost effective (less risky) way than providing the service internally.

From results analysed in Table 6.4, it can be inferred that 106 (53%) NHS Trusts managed and co-ordinated FM services in-house to support the core (clinical) business of Trusts. It can also be said that, since the NHS is a bespoke sector that cannot afford "trial and error" approaches or service failures on patients, most Trust executives were not keen in taking on the risk of outsourcing FM services. Outsourcing can be risky in the sense that it often requires great changes in management mind set if not a new innovative method of communicating amongst Trust staff employees and external providers. It has also produced insecurity to most healthcare staff and trade unions especially in issues relating to the transfer of business to the external service provider -TUPE Regulations 1981, as amended. Furthermore, the management and monitoring of outsourcing is often very complex.

It is also important to note that outsourcing is a long-term objective rather short term one. This idea can often mislead Trusts to think that this measure is an immediate cost cutting exercise. In some cases long term FM contracts that have a feature of short-term savings can prove to be very expensive at a latter stage. However, it can be said that, with such mixed feelings similar to those raised by Bridge (1998) about outsourcing, Trusts are not sure of any study which has been carried out in the NHS which has evaluated the cost benefits of outsourcing in financial and quality service terms explicitly. Bridges recommended that better methods of procuring support services must be based on an organisation's ability to manage cost profiles across all facility services, and the internal against the external capacity to deliver the services. Results in Table 6.4 shows that, NHS Trusts look comfortable with using their in-house resources, due to their expertise and understanding of the healthcare business. In overall, at least 13 (60%) of the 24 FM services considered by the survey in Table 6.4 were managed in-house by 73 (36 percent) of the Trusts who participated.

6.6 FM decision making in the NHS

Due to FM not being properly understood and defined in Trusts, FM decision making has often been seen to be executed by various non-clinical managers in Trusts (Gallagher, 1998).

While it is self-evident from past surveys carried out that caring in NHS Trusts is heavily dependent on "facilities and supporting services" (Rees, 1997; Rees, 1998; Kitchen, 1997; and CFM, 1995), the biggest point of commercial contention has been about which healthcare executive was responsible for the strategic management of these facilities and supporting services. Rees (1998) suggests that the idea of co-ordinating a "single" facilities management service directorate borrowed from commercial organisations has been the key influence in development of FM and its management structures in NHS Trusts. According to Rees, this approach has resulted in the appointment of senior healthcare managers with a sole responsibility for the provision of a whole range of non-clinical services.

As a result, this question was drafted into the questionnaire in order to properly identify those executives or healthcare managers responsible for the planning, co-ordinating and directing of non-clinical services in the Trusts surveyed. Furthermore, the questionnaire sought to elicit knowledge about the level of FM acceptance and accountability in the overall management structure of the Trusts, which differs in individual Trusts due to various business and strategic planning reasons. Table 6.5 shows the number of healthcare managers in form of percentages that were responsible for the management of healthcare support services in NHS Trusts. Those executives involved mainly in managing only non-clinical services were 81 (40.5 %), and those with a key responsibility of facilities and support services were 26 (13 %). These results include support services and estates and facilities. Those executives with a main duty of managing estates services were 20 (10 %). Most FM directorates in the NHS comprise of estate and support services as part of the main services they delivered to the trust hospitals (Alexander, 1993). If estates and support service were included as part of FM, the total number of executives practising an integrated FM approach would rise to 126 (63 %). These results further explain that more than two thirds (133) of the NHS Trusts surveyed employed facilities managers responsible for the management of non-clinical services. According to the results in Table 6.5, FM can also be regarded as part of the strategic decision making process in the majority of the Trusts, as it was represented by various senior healthcare directors.

Table 6.5: Trust directors responsible of FM decision-making

Type of NHS Trust Executive	**Number of respondents**	**Percentage (%) of respondents**
Assistant Chief Executives (ACEs)	7	3.5
FM	81	40.5
Operations	21	10.5
Support services	11	5.5
Estates management	20	10.5
Estates and Facilities	15	7.5
Business/Corporate Development	5	2.5
Finance	13	6.5
Procurement/Supplies	11	5.5
Others	16	8.0
Total	**200**	**100.0**

These results also support claims made by most leading healthcare FM writers such as Barrett (1995) and Alexander (1992) that the rate at which FM was being integrated in to the strategic planning process in the NHS was quite high and continuously developing in order to cope with the ever-changing business and clinical needs of service users.

The healthcare executives identified above who were responsible for strategic planning of FM services in the NHS included 21 (10.5 %) Operations directors, 7 (3.5 %) ACEs, 13 (7.5 %) Finance directors, 16 (8.0 %) Procurement/Supplies and 5 (2%) Business/Corporate directors. The involvement of various healthcare directors denotes that FM in the NHS has responsibilities that cover a whole range of business and support service delivery functions. Thus, FM was being used as a business re-engineering process for promoting commercialisation in the NHS (DoH, 1989). Furthermore, these results in Table 6.5 also reflect the congruency healthcare FM has with other corporate and non-clinical (financial, operational, occupancy and user) service aspects in managing patient defined outcomes in the NHS. These were also shown earlier on in Table 6.2 and contributed to approximately 76 (37.8%) of the healthcare directors surveyed.

Table 6.5 also shows that 16 (6%) healthcare directors had roles that included FM functions as part of their executive duties signifying that FM encompassed various strategic issues regarding the caring for patients. It was interesting to note that 7 (3.5 %) hospital directors, assistant Chief Executives, in some cases 4 (1.5%) Trust Secretaries in Trusts were holding FM roles. This shift shows how NHS Trusts executives realise the strategic worthiness of FM in managing their healthcare business, as opposed to the past when FM was treated as a "backroom" service needing no strategic considerations.

6.7 Summary

The pilot study has revealed that an integrated approach of managing non-clinical services under a single directorate by NHS hospitals is now widespread in the UK. In fact, out of the 200 NHS hospitals investigated, 160 (80%) were actually practising an integrated approach of managing 24 non-clinical services established in this survey. Furthermore, the 24 non-clinical/FM services identified in this study were managed using various procurement routes namely: outsourcing, insourcing and out-tasking. In fact, out of the 24 FM services established, 6 (23%) elements were outsourced from commercial providers while the majority 17(56%) were managed by in-house providers. The pilot study results have also shown that healthcare FM and decision-making is now a strategic function that was carried by a multi-disciplinary team of senior healthcare managers (i.e. ACEs, Estates and FM Directors) working across all NHS hospital service departments. In conclusion, the pilot set out to identify those NHS hospitals with some FM outfits that could be used for further evaluation in the major survey on risk management. This objective has been achieved successfully. Therefore, the major survey (i.e. chapter seven) will now focus on evaluating risk management strategies that affect the clinical service delivery process in those 160 NHS hospitals identified as having FM structures.

CHAPTER SEVEN

ANALYSIS OF MAJOR SURVEY RESULTS

7.0 Introduction

This chapter presents results of the major survey carried out on the three main FM service operators (purchasers, external and in-house providers) working in the NHS. The results are presented in three sections. The majority of results obtained in this survey were analysed using SPSS 8.0, and in most cases some tables and figures are used to present the results. In addition, the questionnaires used for this survey are shown in Appendix B.

7.1 Characteristics of FM purchasers surveyed

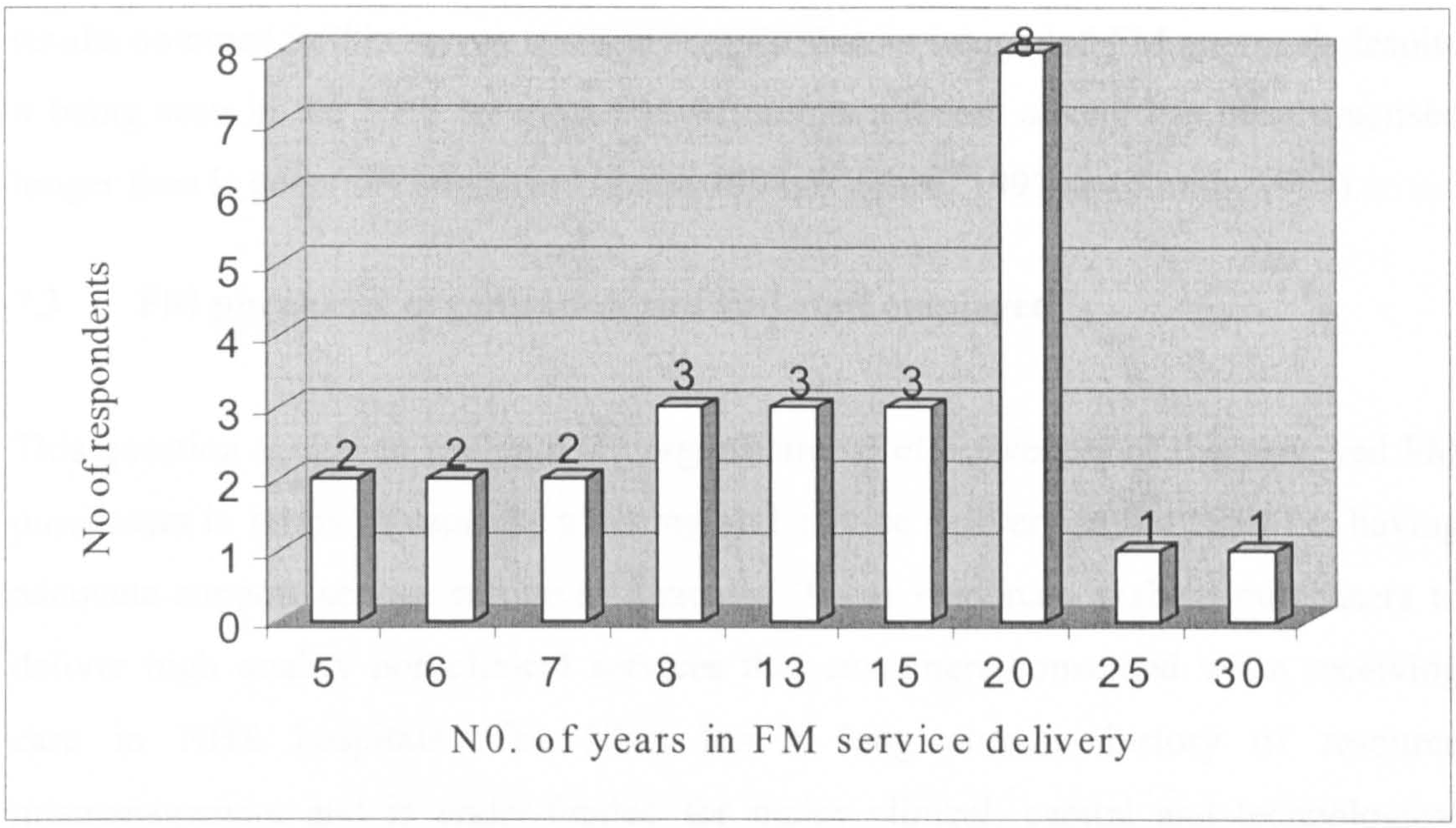
Table 7.1 shows the composition of the main types of FM purchasers surveyed together with the main clinical services they provided in the NHS. The main clinical services provided to NHS customers by FM purchasers surveyed were acute, acute and community, teaching, community/mental and integrated care services.

Table 7.1: Composition sample of FM purchasers surveyed

Type of FM purchaser	N0. of participants Surveyed	Percentage (%) Surveyed
Acute hospitals	5	20
Acute and Community hospitals	4	16
Teaching hospitals	5	20
Community/Mental hospitals	4	16
Integrated Acute hospitals	7	28
Total	25	100

In terms of years of experience in using an integrated FM service approach, Figure 7.1 shows that the frequency range of distribution of those purchasers who were managing non-clinical services under an FM directorate in the NHS was 21 years (i.e. ranged from 5 to 26). A distribution range of 25 years obtained in this survey is not surprising given that FM directorates are a new management style (post-modern) of patronising the entire range of non-clinical services in the NHS. These non-clinical services are normally managed under a single directorate or hospital department in the NHS.

Figure 7.1: Experience in FM service delivery



Furthermore, given that facilities management both in the UK and NHS is still in its developmental stages. It can be inferred that the practice of managing non-clinical services using FM directorates by purchasers surveyed is still developing. As a result of the above, Figure 7.1 also shows that 16 (62%) out of the 25 purchasers surveyed had at least 13 years experience of using this business management model. An average of 13 years obtained in this survey indicates a relatively low rate of FM development in the NHS compared to other traditional departments that have existed in the NHS such as hotel, estates, asset management, valuations, construction and property management. The level of experience possessed by FM purchasers in this survey although higher compared to other NHS FM surveys conducted seems slightly exaggerated (Kitchen, 1997; Rees, 1997). This could be due to reasons earlier established in the pilot study, about the lack of standard FM competencies and the use of various management models. The pilot study also identified that some non-clinical services (e.g. estates, hotel, site and catering services) were more developed in terms of management and control than others in the NHS. Furthermore, it can be suggested that 16 (62%) purchasers surveyed had been managing estates, hotel and site (non clinical) services separately for many years using the traditional system. As for the other 9 (28%) purchasers surveyed, they had less than 10 years of FM service delivery experience.

The results obtained above although low, can be regarded as a fair reflection of the numbers of years FM has developed in NHS Trusts (Alexander, 1992). In overall, results obtained in this survey seem to suggest that an integrated FM approach despite it being seen in the NHS by most FM writers as a recent advent has been practised longer than is generally suggested (Rees, 1998; Kitchen, 1997 and Smith, 1997).

7.3 FM purchaser organisation size and staff employed

This question sought to evaluate the organisational effectiveness of the surveyed FM purchasers in terms of capacity planning and service delivery in the NHS i.e. having adequate support service resources annually. These resources enabled purchasers to deliver high quality non-clinical services that customers consumed when receiving care in NHS hospitals. The NHS has a long chronic history of resource mismanagement and is under-funded for major clinical, capital and technological projects (Webber, 1994). As a result any improvements in healthcare services capacity has always hinged on having adequate operating/support resources.

Table 7.2: Number of FM staff employed

Type of NHS Trust	No. of respondents	Mean	Median
Integrated	7	1020	1020
Acute	5	398	300
Acute and Community	4	523	475
Teaching	5	280.0	250.0
Community/Mental	4	137.5	140.0

Operating resources are required in the NHS for example to finance capital projects, to remunerate NHS staff and procuring drugs. In addition, they are also required to operate and modernise healthcare facilities services, as well as to buy more hospital beds (acute/or non acute). Thus, the provision of adequate operating resources allows purchasers to develop competitive service strategies that help to meet and reduce patient waiting/access targets proposed by the NHS Plan. Hence, in order for FM purchasers to provide high quality healthcare services in the NHS, they must have sufficient and knowledgeable support staff, to manage effectively healthcare facilities and support services that sustain the delivery of the core (clinical) services.

Table 7.2 shows descriptive statistics relating to the number of FM staff employed by purchasers, while Table 7.3 also shows the annual turnover (budget) used by the surveyed purchasers in managing non-clinical services in the NHS. Furthermore, Table 7.2 shows that 7 (28%) purchasers provided integrated clinical services and also employed on average 1020 FM staff. The results above suggest that these purchasers were large FM directorates responsible for delivering a complex portfolio of (hard and soft) non-clinical services in the NHS.

Table 7.3: Annual turnover

Type of NHS Trust	No. of respondents	Mean (£m)	Median (£m)
Integrated	7	211	211
Acute	5	61.9	58.0
Acute and Community	4	99.5	111.0
Teaching	5	71.2	60.0
Community/Mental	4	45.4	51.7

The results also show that such purchasers were complex healthcare organisations in terms of the amount of resources (staff and complex facilities) employed and the healthcare needs (i.e. non clinical services) they effectively delivered to customers in the health economy. These results are not surprising given that FM purchasers providing integrated clinical services in the NHS provide a range of acute, community, teaching and mental healthcare services as a 'one stop shop' to patients, staff and visitors. Furthermore, since the provision of healthcare has become a '24-hour shopping service', most purchasers providing integrated care services are now expected to have large FM directorates that underpins or adds value to the delivery of clinical services in the NHS. Table 7.3 also indicates that 4 (16%) purchasers providing acute and community services were the second largest, in terms of the number of non-clinical staff employed and the annual capital budget operated. As a result of this, these FM purchasers employed on average 523 FM staff, and had an annual capital budget of £99.5 million. These results are not surprising given that, nowadays purchasers providing acute and community services are usually considered as medium to large organisations, and have less complex healthcare facilities compared to integrated FM purchasers. Table 7.3 also shows that 17 (68%) purchasers surveyed provided non-clinical services with a budget below £65M.

These were considered to be small to medium size FM purchasers (hospitals). In actual fact, these purchasers were providing non-clinical services to front the delivery of acute (£61.9M) and community/mental (£45.4M) services. From this survey, these purchasers were mostly providing community, and teaching clinical services that did not involve much usage of healthcare facilities, and also provided customers with less facility occupancy services such as paramedical, community and primary care services. Hence, working capital (income budget) provided to these purchasers by central government was mainly to fund for "lighter" clinical services rather than providing acute clinical services. It seems these healthcare facilities were mainly used for service production as opposed to the large "one-stop shop" hospitals for treating and operating or surgical activities to NHS customers. In hindsight, it can also be suggested that those purchasers providing integrated clinical services had enormous support resources in form of FM staff and services to deliver to a large population of NHS customers. As a result they needed to use strategic procurement options for designing and managing these FM and support services effectively. It can also be said that those purchasers who were considered to be small to medium size had limitations in their financial and human resources. Given such a situation, effective resources management of these support services and staff would be vital in order for purchasers to be able to compete for service delivery with other healthcare providers and GPs. Most purchasers nowadays in the NHS tend to look for resources not only from central government but also elsewhere (outsourcing) in the private sector to revitalise their service delivery strategies (Jones, 2000).

7.4 FM procurement systems used in the NHS

This question sort to evaluate procurement systems used by the surveyed purchasers when managing business risks in healthcare FM operations. Table 7.4 shows that FM purchasers in the NHS used many service procurement arrangements for managing their non-clinical delivery processes. In fact, Table 7.4 shows that the most used procurement system by 10 (40%) purchasers surveyed was the traditional system. This was followed by partnering that was used by 8 (32%) purchasers surveyed. The third and fourth popular routes were the SLAs and PFI schemes, and were used by 5 (20%) and 2 (8%) purchasers surveyed respectively.

Table 7.4: Procurement systems used by FM purchasers

Procurement system	Number of respondents	Percentage of respondents (%)
Traditional (Firm price)	10	40
Partnering	8	32
SLA output based	5	20
PFI	2	8

The traditional systems might have been a popular method of managing support services due to a number of reasons that have been highlighted by most healthcare FM writers (Alexander 1992; Webber, 1994; and Smith, 1997). Although the traditional system has many advantages over other systems, some FM purchasers and writers in practice have reservations about the business ethics and culture that allows one or more contractors to deliver support services using the firm price approach (Smith, 1997). To overcome this situation, Smith proposes that purchasers must design flexible FM contracts that are based on customer service demands of providing high-quality support services in the NHS. Table 7.4 also shows that the second most popular procurement system was partnering. These results show how important it has become in the NHS for purchasers as clients to partner with commercial FM providers in the provision of non-clinical services in accordance with the Latham and Egan Reports, and as part of the central government's policy of modernising the NHS. Purchasers might have preferred partnering possibly because it;

(a) allows purchasers to source for targeted funding from the commercial sector;
(b) has the least cost overheads in FM contracts management, making it more advantageous to manage and transfer service expertise among service purchasers and providers on most capital FM projects;
(c) also allows for a free flow of FM information while service risks are shared between purchasers and their providers fairly and squarely;
(d) allows purchasers to learn from commercial providers who are highly effective in using their marketing and commercial strengths to model business processes that best add value to the purchaser's FM business in the NHS;
(e) purchasers can gain from the competitive advantage brought by external service providers in form of extra resources that are very limited in the NHS; and

(f) the present Labour government in the UK is pushing forward a policy that promotes PPP (Okoroh *et al.*, 1998).

Table 7.4 also shows that the third most popular procurement system was the use of SLAs. Out of the 25 purchasers surveyed, only 4 (20%) stated that they used SLAs frequently. Although service level agreements have recently become the most favoured procurement system of managing FM services and business risks in the NHS (Akhlaghi, 1996). The results obtained here signify a huge shift in opinion over the use of SLAs in the NHS as advocated by most FM writers (Payne and Rees, 1999; Akhlaghi, 1996). Such a difference could well be a result of the following;

(a) there are no clear benefits in managing healthcare FM services using output-driven approaches (SLAs) in the NHS;
(b) possibly because non-clinical services are dynamically driven by customer needs (output);
(c) FM outsourcing is still developing as safe way of specifying customer-driven facility solutions in the NHS; and
(d) as a result of this, not many purchasers currently specify the management of their FM service processes using SLAs.

Finally, Table 7.4 shows that the least used procurement route was the PFI system, and was used by 2 (8%) purchasers surveyed. The low rate of usage in the PFI approach can be attributed the fact that;

(a) it is a modern and innovative way of providing a wide range of support services in the NHS and;
(b) it is most probably that most purchasers were beginning to use this approach as part of the central government policy to manage capital projects in the NHS.
(c) It has a long lead of commissioning and involves complex negotiations that are laborious

7.5 Service quality management in non clinical services

In the NHS quality systems are also used to continuously manage and mitigate integrated non-clinical service risks that may affect purchasers from meeting their clinical objectives. This section was designed to evaluate quality systems the surveyed purchasers were using to manage their non-clinical business processes. Table 7.5 shows that 20 (80%) purchasers surveyed used ISO 9000. The use of ISO 9000 by most purchasers may well indicate that ISO 9000 contains a more simple and broad-based set of quality system standards, that are recognised in most global business environments. The use of ISO 9000 also allows for a standard of quality certification that is designed to meet both the host organisation and customers' needs. Table 7.5 also shows that 5 (20%) purchasers surveyed were not using ISO 9000. This is most probably because they might have been using other more advanced and specific quality management systems such as ISO 1400 and other business excellence models. Probably, the main reason for using ISO 14000 is that, it is a more specific quality management system that is used by those purchasers whose business is highly affected by the environment more. Since the provision of facility services is based on managing the physical hospital environment, most purchasers probably found ISO 14000 more useful in managing their FM businesses.

Table 7.5: FM quality systems used by purchasers

No. of purchasers using ISO 9000	No. of purchasers not using ISO 900
20	5

Another reason could well be that FM purchasers in the NHS today are required to be "social corporate" responsible when delivering safe non-clinical services to customers in the public domain. Hence, the use of quality management systems that continuously improved the provision of value adding non-clinical services was much welcomed in the NHS. The other explanation could that some of the purchasers might having been using other quality management systems such as the EFQM business excellence models, Malcolm Baldrige Quality system or ISO 14000 in managing service value and risk in support services.

The main objective of this question was to evaluate methods used by purchasers to design and manage FM service performance that enhanced the quality of healthcare services they fronted in the NHS.

Table 7.6: Service performance management systems

Service quality management tools	**No of respondents**	**Percentage of respondents (%)**
SLA (service output specification)	21	84
Service Quality Plan	5	20
SERVIQUAL Scale	5	20
Patient and Service quality Charter	3	12
Method statements	2	8

Table 7.6 shows that all (i.e. 25) the surveyed purchasers were using a variety of performance management systems to monitor the quality of the support services they were currently providing to NHS customers. Table 7.6 also shows that 21 (84%) purchasers used SLAs for monitoring and managing FM services they delivered to NHS customers. The use of SLAs in the design and delivery of non-clinical services indicates that, purchasers frequently used SLAs to develop specifications or user brief for delivering FM services to NHS customers (internal and external). Furthermore, SLAs have also been used to measure performance in FM operations, and can also be used as an integral part for a FM outsourcing contract to specify the client's service needs and performance. FM performance in this case may be the quality of how support services are organised and delivered (responsive) to customers, as well how well the purchaser intends to provide dynamic FM solutions in various market demand driven situations. Also, the use of SLAs could have been preferred by most purchasers due to its flexibility in use, and also as a mean for managing and controlling any service variations and monitoring the quality of support service deliverables. After the SLA, the second most popular method used by purchasers for managing service quality in healthcare FM operations were service quality plans. Table 7.6 shows that 5 (20%) purchasers used quality plans for managing the level of FM services delivery in the NHS. It is not surprising that these purchasers used quality plans as they are normally incorporated in most SLAs of in healthcare FM contracts. Hence, most purchasers may have used quality plans as part of developing an effective SLA for managing FM contracts.

Another reason that explains the low usage of service quality plans may well be that quality plans in some cases are mere method statements (road map), that show how service quality will be achieved (designed and adhered to as opposed to being control mechanisms) by the purchaser. However, in some cases the purchaser will carry huge service management risks that are related to service variations and legislation control. Apart from the use of SLAs and quality plans, 5 (20%) purchasers used the SERVIQUAL Scale, possibly because of its flexibility in determining the relative importance of the five most important dimensions that influence NHS customers' overall quality perceptions of support services in the NHS. The five SERVQUAL dimensions of quality in FM identified by Parasuraman *et al.,* (1985) are:

(1) Tangibles - physical facilities, medical equipment/beds and appearance of staff;
(2) Reliability - ability to perform the promised service dependably and accurately;
(3) Responsiveness - willingness to help customers and provide prompt service;
(4) Assurance - knowledge and courtesy of staff and their ability to convey trust and confidence; and
(5) Empathy - caring, individualised customer attention the organisation provides to its customers.

The five dimensions used in the SERVIQUAL were probably the ones that might have attracted purchasers to use this method. Moreover, there is an added advantage of using this technique, as its application and use is generally widespread in the NHS. Other quality management techniques used by purchasers were the Patient Service Charter (PSC). The PSC was used by 3 (12%) purchasers probably because of its simplicity in use and development regarding the control and management of non-clinical services. Its main advantage over others is that, it provides specification of the FM services customer will expect to receive from purchasers. As a result, the use of this technique might have been restricted to a few informed FM purchasers. Finally, the least used FM service management system by purchasers surveyed was the method statement. Table 7.6 shows that only 2 (8%) purchasers used this technique, possibly due to it being a generic technique for managing FM services. Method statements are normally used by purchasers for setting out the service brief and business plans before delivery. Hence, it is impossible to see how purchasers could have used this method alone effectively to manage the FM process.

For this reason, this is probably why 23 (92%) FM purchasers surveyed did not favour the use of method statements.

7.8 FM risk identification techniques

This question sort to evaluate modern techniques that were used by purchasers to identify FM risks in the NHS. Table 7.7 shows that FM purchasers used a variety of techniques to identify non-clinical risks faced in healthcare service operations. Interestingly, Table 7.7 shows that 22 (88%) purchasers surveyed used the customer complaint system as the most popular tool for identifying service failures in FM operations in the NHS. In this case, customer complaints would be regarded as the "*moments of truth*" experienced by customers when receiving non-clinical services.

Table 7.7: FM purchasers risk identification techniques

Risk identification methods	Frequency	Percentage (%) of responses
Analysis of customer complaints and care strategies	22	88
Brainstorming	20	80
Case studies, best practice and benchmarking forums (e.g. public sector)	15	60
Checklists	15	60
Financial and investment appraisals	20	76
Flow charts, frequency impact analysis, fault/event tree	14	56
FM performance team review and audits (including use of focus groups)	15	66
Legislation compliance (e.g. health and safety and NHS Acts) audits	15	60
Strategic partnering	8	32
SWOT analysis	15	56
Surveys, seminars, conferences, interviews and questionnaires	12	66
Seven quality tools use	18	48
Internet and multi-media information	10	40

This method may have been popular possibly because it allows customers to record their personal experiences (bad or good) of using non-clinical services when receiving care in the NHS. It is through the critical analysis of customer complaints that allowed purchasers to improve the level of support services delivery.

It is well researched in the NHS that every dissatisfied customer can influence more non-clinical service users (i.e. generally 16 more customers) normally in a bad or good way, not use or use FM services any more. Apart from using customer complaint systems purchasers also used other useful risk identification techniques such as brainstorming, investment appraisals, peer group discussion, SWOT analysis, flow charts, fault/event tree analysis, group discussions, research surveys, seven quality tools, use of internet and multi-media information.

Interestingly, 20 (80%) purchasers surveyed also used the brainstorming technique for identifying key FM risks in the NHS. The use of brainstorming is important as it allows risk knowledge to be communicated among purchasers and stakeholders in order to manage effectively the FM service delivery process. Table 7.7 also shows that brainstorming was followed closely by the use investment appraisals that had with a 76% response rate. The high usage of investment appraisals may well indicate that more capital projects in the form corporate PFI and PPP were coming on stream, and hence more resources such as healthcare facilities, finance and IT are now being invested in the NHS. This situation has resulted in the need to identify risks associated with investment returns (yield) on all FM and capital projects that affect purchasers' business objectives. Other techniques that were also used by purchasers to identify FM risks were FM performance audits with a 60% response rate, checklists with a 60% response rate, flow charts and fault/event tree analysis with a 56% response rate. The results above seem to indicate that these techniques were used frequently used to identify FM risks in more complex service delivery scenarios. Apart from using the above techniques, Table 7.7 also shows that 15 (60%) purchasers identified FM risks using their own professional expertise acquired from the NHS and other public sector organisations (benchmarking best practices). These results seem to suggest that FM risks in healthcare projects can be identified and benchmarked using other public sources. Table 7.7 also shows that other techniques such as environmental impact assessments and healthcare legislation compliance audits were also used by purchasers to identify FM risks. These techniques were possibly used to manage issues related to clinical governance and health and safety of customers using modern and hospital facilities.

7.9 Techniques and methods of FM risk analysis

This question sort to evaluate the main techniques used by purchasers to analyse and manage FM risks in the NHS. Table 7.8 shows that most purchasers surveyed used a variety of qualitative and quantitative techniques to analyse FM risks. The most commonly used technique by all (100%) the purchasers surveyed was the risk-based matrix; followed by the discounted cashflow with a 80% response rate; followed by probability theory with a 60% response rate; followed by the qualitative technique with a 40% response rate, followed by the decision tree with a 32% response rate; followed by sensitivity analysis with a 28% response rate. Finally, the least used technique was the Monte Carlo simulation with a 20% response rate. It is not surprising that purchasers used a variety of techniques to manage FM risks given that it is now a requirement for purchasers of FM services to assess and manage business risks in the NHS as part of clinical governance and quality assurance (DoH, 1999).

Table 7.8: Risk analysis techniques used by purchasers

Type of risk tool	Frequency	Percentage of responses %
Risk exposure matrix	25	100
Discounted cashflows	20	80
Probability theory	15	60
Qualitative techniques	15	40
Decision trees	8	32
Sensitivity analysis	7	28
Monte Carlo simulation	5	20

Table 7.8 also shows that the probability theory, mean-end analysis and decision tree were commonly used techniques of managing risks, most probably in line with risk tools used by healthcare executives and other clinical departments in the NHS (NAO, 1997). It is also surprising in this survey that most purchasers did not use frequently qualitative techniques to manage FM risks. This is probably because the concept of using FM business models in managing FM risks is a recent advent. As a result, was beginning to be used by purchasers in business decision-making in the NHS. The other possibility that may have attributed to the low usage of qualitative techniques is that, they are very smart and subjective techniques that can sometimes not provide clear solutions to managing FM businesses. Hence, their use has been fairly restricted to FM experts in solving healthcare FM problems.

7.10 Purchasers' analysis of the risk exposure in healthcare operation

This section was designed to establish a relative weighting index or perception value of all the key risk constructs that affected purchasers' business management process in healthcare FM operations. The relative importance index allowed for the appropriate discrimination of risk constructs based on respondents' value judgements. The use of such a technique although novel might be debated at this stage, due to lack of similar FM surveys that currently exists for comparative purposes. In this section, a three-stage data analysis protocol was developed. The first step was a simple procedure to determine the relative importance of the identified constructs using the well-developed RII technique. The relative importance index was designed in the survey to mirror the participating facilities managers' (i.e. for the FM service purchaser) perceived importance of each risk construct established by the survey. This was measured by numerical scores established from a Likert scale from 1 to 5 where: 1 = not important; 2 = neutral; 3 = important; 4 = very important; 5 = extremely important. These numerical scores provided respondents with a measure of strength or importance of the risk constructs identified by purchasers. These risk construct scores were then transformed into relative importance indices using the relative importance index technique calculated using the following formula (Akitonye *et al.*,1998);

Relative Importance Index = Where: $\dfrac{\Sigma W}{A * N}$

W = weighting given to each factor by the respondents and ranges from 1 to 5 where '1' is the least important and '5' the most important;

A = is the highest weight or score (i.e. 5 in this survey);

N = total number of sample.

In addition to using the numerical scores, the levels of importance were hypothetically divided in three parts as shown in Figure 7.3. Figure 7.3 shows that the risk interval scale used was divided into, those respondents scoring 2 or less, 3 (the central and neutral point), and 4 or more to calculate the level importance of each risk construct.

The scale was also used to rank the risk constructs where their relative importance indices are equal. The interval scale in Figure 7.3 was transformed into a nominal scale showing that:

i) if a risk construct was ranked extremely important by most purchasers, it would achieve a score of 4 or more (5 being maximum effect with relative index of 1); and

ii) with decline in perceived importance being mirrored by a decrease in relative importance, down to between 1 and 2 (being the minimum effect with relative importance down to 0).

Figure 7.3 Risk construct Nominal scale

1 2	3		4 5
Score of 2 or less indicates less critical factors or a negative effect of FM	Neutral moderate effect	or	Score of 4 or more indicates very critical success factor or a positive effect of FM

In order to demonstrate the calculation of the relative importance index technique, Table 7.10 was produced using this procedure. The fist stage of the analysis evaluated the risk construct with the highest possible score; *customer satisfaction* (see Table 7.10). Each of the 25 respondents rated this risk construct with a numerical score of between 1 and 5 depending on its influence on the purchaser's decision to manage the FM business process effectively. Therefore, the RII for

***customer satisfaction* = 100/5*25 = 0.8**

In this instance, the relative importance index of *customer satisfaction* is 0.8, and was ranked as the most important risk construct that purchasers faced when managing effectively NHS FM businesses. On visual examination of the indices in Table 7.10, it can be seen that 53 risk constructs had indices higher than 0.50, signifying how important purchasers rated these constructs towards the provision of seamless support services to customers in the NHS. The only risk construct that had a score of less than 0.5 was *corporate business taxation*.

In fact, *corporate business taxation* had a scored of 0.496. This can be explained by the fact although purchasers are highly capitalised corporate entities, they are managed as social businesses which provide quality life enhancing services for the public. As a result they are exempt from corporate business taxation as they have a charitable status.

Secondly, the significance correlation between these constructs was established by correlation analysis. A clear development and analysis of these two basic concepts aided the process of having an in-depth understanding and discussion of the relative importance and correlation between constructs. The third step was used to analyse the interaction between the established groups of risk constructs by using the PFA technique. This procedure allowed the survey to expose construct groupings underpinning strategic decisions made by purchasers to manage FM business risks, and thus improve performance in healthcare operations.

7.11 Multivariate risk construct analysis

As this survey will be drawing special inferences from the numerical scores provided by the respondents using the Likert scale, the data collected needed to satisfy the normality of distribution and reliability analysis statistical tests, before any further exploration took place. These tests were performed for the following reasons:

i. the sample size analysed was considered statistically small ($n < 30$) for analysis, as a result they was a need to determine which types of tests (i.e. parametric or nonparametric) could be used to analyse the data.

ii. because of the tendency of small-sample **s** to underestimate σ, the use of a **t** score at the cut-offs (and not a **z** score), which essentially compensates for this tendency and allows for the maintenance of the validity level (α risk) of the test.

iii. most statistical packages tend to have a common bias of assuming that the histogram of a sample of scores collected was drawn from a normal population (or one which nearly so).

In order to overcome the problem of sample distribution, the **Kolmogorov-Smirnov test** was used for testing the distribution of normality or goodness-of-fit. This test compares the centiles of the observed distribution of the data with corresponding centiles of the normal distribution, and can also be regarded as the largest discrepancy between observed and theoretical centiles. Furthermore, Kinnear and Gray (1999) have developed a table for selecting the most appropriate one-sample test in various situations. Results of the normality test shown in Table 7.9 indicate that the scores for each construct is normally distributed at least at 93% level of significance. According to normality test results obtained in Table 7.9, it is possible to proceed with the analysis of the data using normal distribution statistics

7.12 Reliability analysis

This section assessed the instrument (Likert scale) development procedure (i.e. reliability and assignment of constructs to measure the fifty four (54) risk constructs, assess validity, and establish the instrument). The main assessment techniques that can be used were proposed by McGrath (1982). According to McGrath (1982), in order to test the relation between two constructs, an operational definition for each of the constructs must be developed; then find some setting in which the empirical relation between the operational definitions can be tested, so that an inference about the relation of the two constructs can be drawn. The reliability analysis in the survey determined the consistency in repeat measurements of the purchasers' perception of the risk constructs they considered influenced their FM operations in the NHS. Four methods could be used to assess reliability of the data in this survey, and these are:

a) test-retest method;
b) parallel-form or alternative-form method;
c) split-half method; and
d) inter-item or internal consistency method.

In FM surveys, the first three methods have major limitations such as requiring two independent assessments of an identical instrument on the same group of people, or requiring two comparable sets of the measuring instrument.

Table 7.9: Test of distribution for normality on Purchasers' constructs

Risk construct	Statistic	Significance
Customer satisfaction	2.247	0.00
Service delivery certainty (time)	1.579	0.014
Customer involvement	1.518	0.014
Service quality reliability	1.768	0.004
Continuous service improvement	1.572	0.014
Customer healthcare	1.630	0.10
Health and Safety	1.491	0.023
Service value management (Best Value)	1.429	0.034
Staff participation and partnership	1.418	0.036
Health Legislation compliance	1.798	0.003
Service Cost certainty	1.885	0.002
Service speed	1.156	0.138
Benchmarking best FM practice	1.209	0.108
Staff motivation and knowledge	1.681	0.007
Service price competition	1.156	0.138
Continuous service improvement	1.257	0.085
TUPE	1.005	0.265
Service measurement	1.263	0.082
Service variations	1.382	0.044
Change management (cultural)	1.040	0.230
Partnerships	0.998	0.272
NHS Trust image	1.226	0.099
Service competition	1.528	0.019
Service level agreement	0.921	0.365
Service contract design	1.045	0.225
Financial transfer/stability	1.252	0.087
Information Strategy & confidentiality	1.140	0.149
Clinical strategic fitness	1.239	0.093
Provider's financial reputation	1.214	0.105
National minimum wage requirements	1.057	0.214
Innovation (service and core business)	0.966	0.309
Performance guarantees	1.111	0.169
Environmental impact/issues	0.819	0.513
Management accounting systems	1.035	0.235
Organisation cultural disparities	1.264	0.082
Management development	1.257	0.085
Market intelligence	1.310	0.065
Economy (International & national)	1.173	0.128
Social corporate responsibility (SCR)	1.073	0.200
Business transfer costs	1.696	0.006
Medical technology innovation	1.386	0.043
Sourcing risk	1.229	0.097
Business process re-engineering	1.158	0.137
Clinical-related	1.246	0.089
management transfer	1.484	0.024
Provider Reimbursement method	1.067	0.205
Third way (Political, Physcho-social)	0.815	0.082
Stakeholder resistance	1.257	0.085
Return on capital employed	0.949	0.329
Agency/ delegating decision-making	1.024	0.245
Primary healthcare impact	1.549	0.16
Insurance liability costs	1.170	0.129
Profit margin	0.882	0.418
Corporate business taxation	1.189	0.118

Churchill (1979) suggested that researchers should avoid test-retest reliability, as well as split-half reliability, because the former would have the respondent's problems associated with memory that would influence responses in the second test, whereas the latter would give different coefficients depending on how the items were split to form the two halves.

In contrast, the internal consistency method is popular in field studies (i.e. such as FM surveys) because it needs only one administrator for the measuring instrument. It is also the most basic form of reliability estimation. In this survey, reliability is operationalised as internal consistency, which is the degree of intercorrelation among FM constructs that measure the same concept. The recommended measure of the internal consistency of a set of constructs is provided by coefficient alpha. Cronbach's alpha can be considered a perfectly adequate measure of the internal consistency, and thus of reliability. Before assessing the internal consistency of the measures, an item intercorrelation matrix was constructed for each measure to examine the extent to which some common trait was present in the items. Low inter-construct correlations indicate that the associated constructs are likely to have been inappropriately selected. Constructs having a relatively low correlation (0.30) with the other constructs within a measure have to be deleted prior to reliability analysis in accordance with the recommendation of Flynn *et al.,* (1994). Table 7.9 shows that all the inter-constructs correlations for each measure of constructs were above 0.35. Next, an internal consistency analysis was performed separately for the construct dimensions. A satisfactory level of reliability depends on the purpose of the research (Nunnally, 1978).

Permissible alpha values can be somewhat lower for new measures, suggesting reliabilities of 0.70 or higher are sufficient. As the measurements used in the present survey questionnaire were developed by the researcher, therefore may be deemed new, a criterion alpha value of 0.70 was considered adequate for these new measures. The reliability coefficients ranged from 0.9 to 2.25 for all the risk constructs used, indicating a strong reliability. Table 7.9 shows the computation of relative importance indices and a ranking order for the main fifty-four (54) risk constructs used in the purchasers' survey. This was done mainly for comparing risk perceptions between purchasers, and also providers of FM services as part of the major survey analysis.

The risk constructs used in this survey were identified as the most important factors towards improving FM business success in managing NHS support services that underpin the provision of clinical services.

Table 7.10: Purchaser generated FM risk constructs

Healthcare FM related constructs	≤ 4	3	≥ 2	Total	Relative Importance Index	Rank
Customer satisfaction	25	0	0	25	0.8	1
Service delivery certainty (time)	24	1	0	25	0.792	2
Customer involvement	23	2	0	25	0.784	3
Service quality reliability	23	1	1	25	0.776	4
Continuous service improvement	22	2	1	25	0.768	5
Culture change	21	4	0	25	0.768	6
Health and Safety	21	4	0	25	0.768	7
Service value management (Best Value)	21	2	2	25	0.752	8
Staff participation and partnership	19	6	0	25	0.752	9
Health Legislation compliance	20	4	1	25	0.752	10
Service Cost certainty	21	1	3	25	0.744	11
Service speed	18	7	0	25	0.744	12
Benchmarking best FM practice	18	7	0	25	0.744	13
Staff motivation and knowledge	17	8	0	25	0.736	14
Price competition	16	9	0	25	0.728	15
Continuous service improvement	16	9	0	25	0.728	16
TUPE	16	8	1	25	0.72	17
Service measurement	15	10	0	25	0.72	18
Service variations	14	11	0	25	0.712	19
Customer care	15	8	2	25	0.704	20
Partnerships	14	8	3	25	0.688	21
NHS Trust image	17	4	3	25	0.688	22
Service competition	16	3	6	25	0.68	23
Service level agreement	13	9	3	25	0.68	24
Service contract design	13	9	3	25	0.68	25
Financial transfer/stability	12	11	2	25	0.68	26
Information Strategy & confidentiality	15	4	6	25	0.680	27
Clinical strategic fitness	14	5	6	25	0.664	28
Provider's financial reputation	11	11	3	25	0.664	29
National minimum wage requirements	12	8	5	25	0.656	30
Innovation (service and core business)	14	4	7	25	0.656	31
Performance guarantees	11	10	4	25	0.656	32
Environmental impact/issues	12	7	6	25	0.648	33
Management accounting systems	13	4	8	25	0.64	34
Organisation cultural disparities	9	11	5	25	0.632	35
Management development	9	11	5	25	0.632	36
Market intelligence	11	7	7	25	0.632	37
Economy (International & national)	10	9	6	25	0.632	38
Social corporate responsibility (SCR)	9	10	6	25	0.624	39
Business transfer costs	6	16	3	25	0.624	40
Medical technology innovation	12	4	9	25	0.624	41
Sourcing risk	8	12	5	25	0.624	42
Business process re-engineering	9	9	7	25	0.616	43
Clinical-related	11	4	10	25	0.608	44
Technology transfer/exchange	7	12	6	25	0.608	45
Provider Reimbursement method	8	9	8	25	0.6	46
Third way (Political, Physcho-social)	9	7	9	25	0.6	47
Stakeholder resistance	6	12	7	25	0.592	48
Return on capital employed	8	8	9	25	0.592	49
Agency/ delegating decision-making	6	10	9	25	0.576	50
Primary healthcare impact	6	10	9	25	0.576	51
Insurance liability costs	10	2	13	25	0.576	52
Working capital	5	11	9	25	0.568	53
Profit margin	6	5	14	25	0.536	54
Corporate business taxation	2	8	15	25	0.496	55

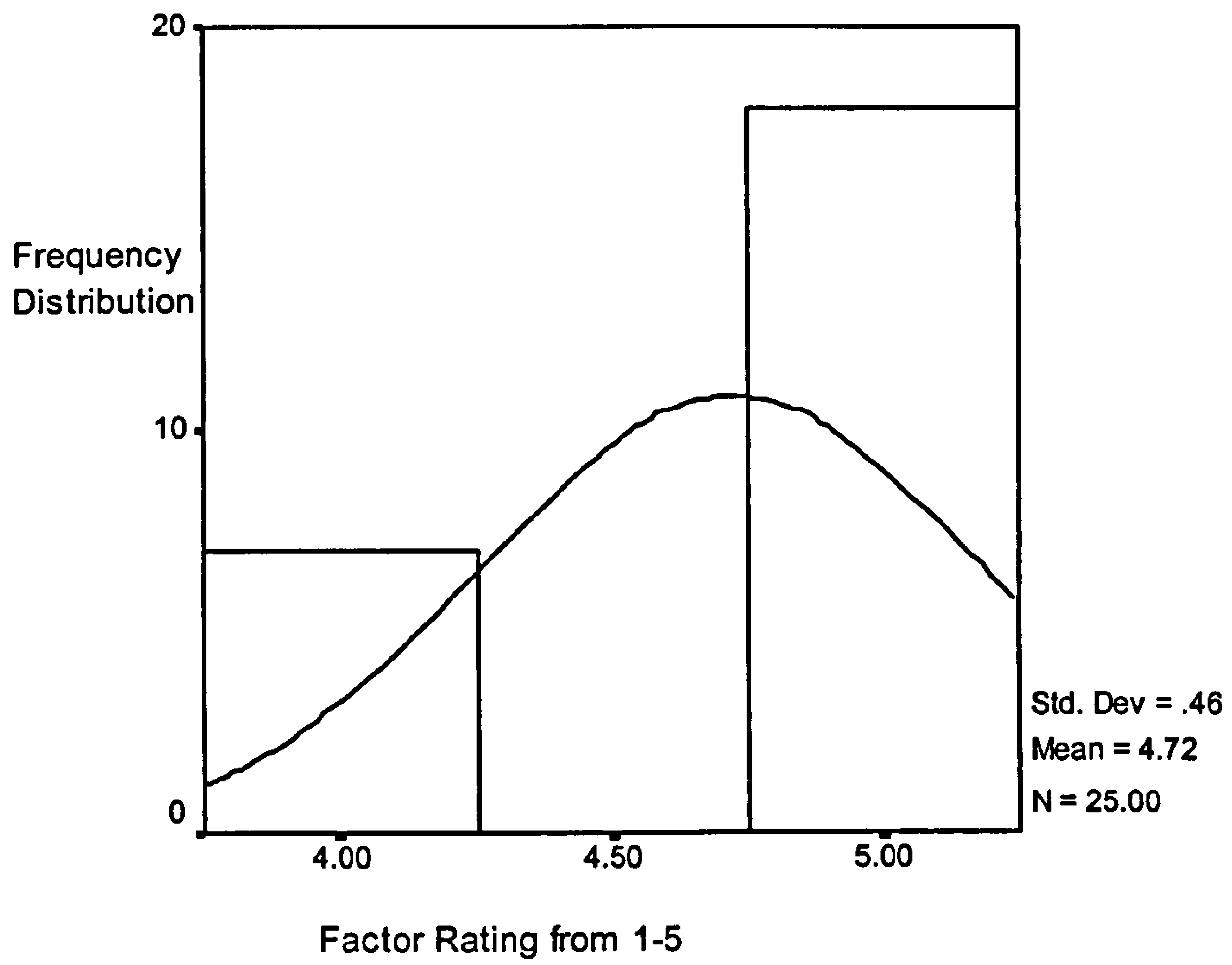
Furthermore, many business and facility-related risk constructs that might have a potential to adversely affect, or even negate attempts of the delivering best value clinical services are minimised. In practical terms, effective service management in NHS trusts through best practices in healthcare FM will lead to an uninterrupted delivery of hospital services and minimises risks associated with business disruption and the purchaser's image of delivering cost-effective healthcare. This is an immunity statute that was enacted by an Act of parliament: NHS and Community Act 1990. Thus, the need to pay corporate business tax was found not to be a major consideration in most purchasers. As would be expected, whilst some risk constructs have strong (close to 1) leverage on the purchasers' decision-making strategies of effectively managing FM performance and business risks, others do not. In this section, we shall first consider the most important ten risk constructs ranked by purchasers as the salient factors that affect FM operations in the NHS. The rationale being that once a systematic and proactive approach is adopted for the analysis of the top ten factors it can extend to the rest of the remaining constructs that were rated as important by purchasers. The knowledge used in this survey is that the provision of effective business and customer-focused non-clinical solutions in healthcare operations will continuously lead to improve high quality care provided by purchasers. As a result of this approach business objectives in the surveyed purchasers' organisations can be enhanced through FM performance. The top ten risk constructs shown in Table 7.10 and ranked in order of relative importance to the purchaser's best practice FM process are;

1) Customer satisfaction;
2) Service delivery certainty (time);
3) Customer involvement;
4) Service quality reliability;
5) Continuous service improvement;
6) Culture change;
7) Health and Safety;
8) Service value management (best value);
9) Staff participation and partnership and;
10) Health legislation compliance

7.13 Customer satisfaction

According to Table 7.10, FM purchasers ranked *customer satisfaction* as the most important risk construct they faced when developing business strategies in healthcare operations. Table 7.10 also shows that *customer satisfaction* had the highest relative index as an aggregate measure of importance, and as a result was ranked first.

Figure 7.4: Frequency distribution of Customer satisfaction



Using the relative importance index, *Customer satisfaction* was highly rated with an overall value of 0.8. All (i.e. 25) respondents had a repeated rating of 4 or more on the importance scale signifying how important it has become in NHS hospitals to meet customer needs and expectations when delivering clinical services. Furthermore, a histogram showing the frequency and normal distribution of scores for respondents is shown in Figure 7.4. Figure 7.4 shows that the mean score for customer satisfaction was 4.72 and its standard deviation was 0.46, meaning that this construct was highly rated as a key construct which needed to managed by most participants. The results obtained here are not surprising given that the need to deliver customer-focused support services is now the ultimate goal for every successful healthcare business that seeks to be competitive and increase capacity to deliver high quality clinical services (Jones, 1995).

It can also be said that *customer satisfaction* is extremely important in the NHS as costs associated with service failures in a sensitive sector such as healthcare are highly unacceptable and can put the public lives at risk resulting in health deterioration or death. Thus, in delivering customer-driven support services purchasers will be seeking to enhance clinical services which are core to their business process, and simultaneously allowing for more repeat business. As a consequence of purchasers meeting their customers' support service needs in hospitals, risks associated with the service provision of responsive healthcare are drastically reduced, resulting in an improved patient environment that underpins an integrated approach of managing care in the NHS. In Trusts, FM customers are the patients, visitors and staff that use support services as part of the healing environment or service value chain process of receiving healthcare. As for staff, FM allows them to plan and manage the practical delivery and capacity for a range of diverse, complex clinical services to direct (internal departments) and external customers in an environmentally friendly workplace. Customers are the main purpose for any business that seeks to succeed or survive in today's uncertain business environment. As a result, it follows that the importance of customers and meeting their needs is central to provision of high quality support services in the NHS. This can contribute to the efficiency, economy and effectiveness of any NHS organisation. Past work done on customer service management in the NHS revealed that those customers who were delighted with clinical services they received in hospitals are six times more likely to do repeat business or recommend others.

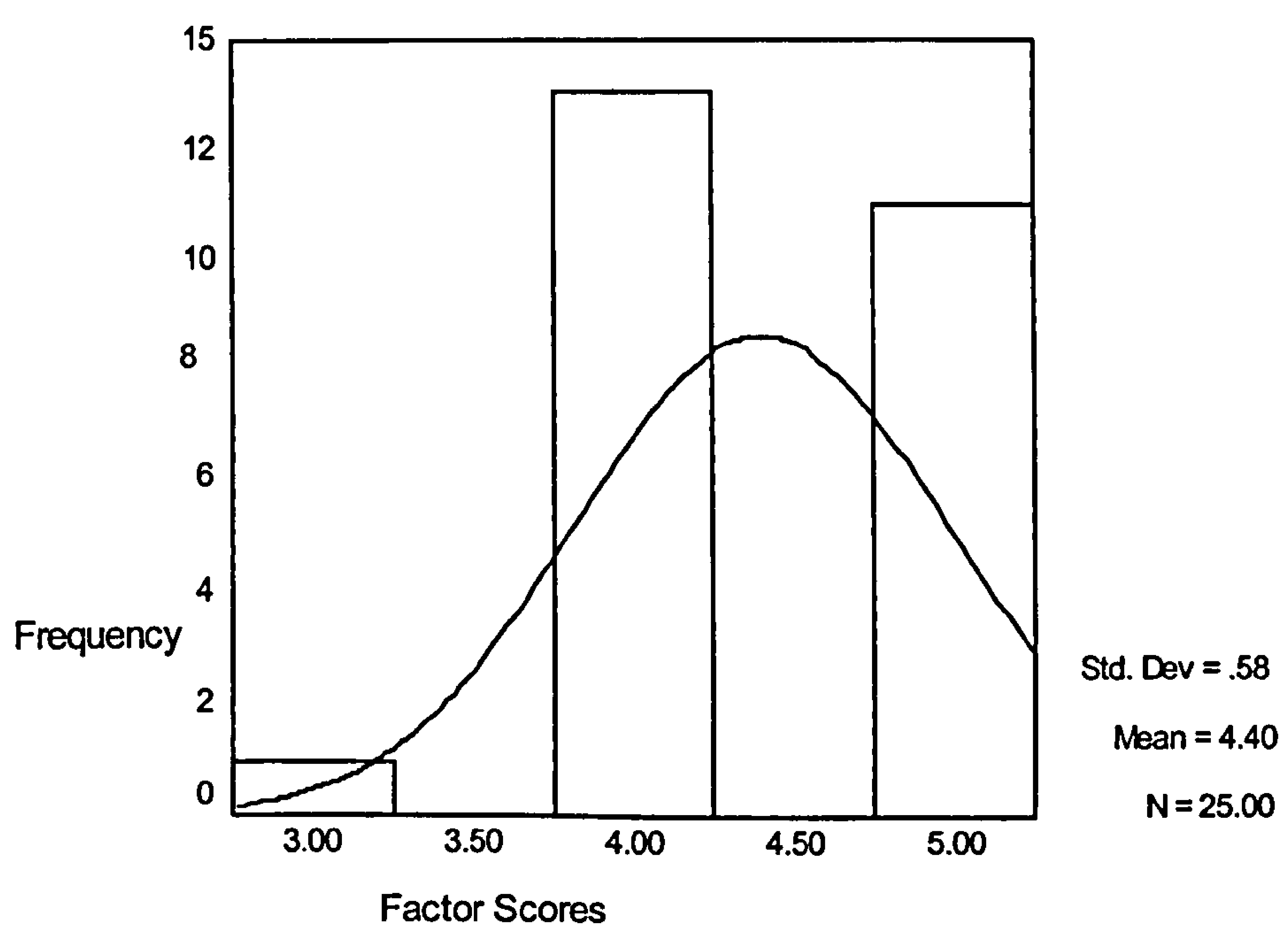
On the other hand, those customers who were not satisfied with the healthcare services they receive are more likely not to return back and will not recommend others to use the service. The implications of customer satisfaction are therefore that purchasers have to re-engineer their business processes to provide the best value facilities solutions that meet customers' expectations in order to avoid service failures or risk business disasters. *Customer satisfaction* becomes a measure of the overall organisation business perceived performance relative to customer expectations. This is often measured by various customer surveys using a repeatable process to track service needs or changes over time. Therefore, FM purchasers need to focus on managing effectively support services that front the patient focused healthcare system in order to meet the satisfaction levels of the customer that are affected by perception.

In overall, it seems from this survey that FM purchasers need to deliver high quality facilities services to customers within the context of a seamless healthcare service provision.

7.14 Service delivery certainty (Time)

Service delivery certainty was ranked as the second most important risk construct with the greatest business effect on the surveyed purchasers' healthcare FM operations after customer satisfaction. It had a relative importance index of 0.792. Furthermore, Figure 7.5 shows that 23 (96%) of the respondents ranked *service delivery certainty* with a score rating of 4 or more signifying how important support service response times have become in underpinning the treating and caring for those who are critically and terminally ill (inpatient), as well as day case patients. In this survey, it is also clear that FM purchasers were aware that the evaluation of service value by customers was not only based managing clinical outcomes but also the ease and safeness by which clinical and non clinical services are provided to those who patients who need them urgently. Hence, the need for purchasers to consistently reduce service variations and deliver output based demand levels, as part of the patient's environment was also an important service consideration. Efficient delivery times will ensure that waiting times for service consumption are reduced drastically through innovative practices.

Figure 7.5: Frequency distribution of Service delivery certainty



This will result in improving the rate of clinical service delivery thereby reducing the risk of greater service demands by customers who might have deteriorated in health. The importance of reducing delivery times and waiting lists can be clearly demonstrated in most acute trusts (large specialist hospitals) where clinical healthcare provision is heavily dependent on hi-tec facilities and support services (capacity) for a range of clinical and medical specialities. The NHS can not afford to have low delivery times as this can often lead to disastrous consequences to FM operators as customers' life are put at risk. Once customers' lives are put at great risk then the NHS business image will be heavily criticised by taxpayers who fund it, or damaged financially by huge claims of clinical negligence from dissatisfied customers, as has been the case recently. Therefore, it is imperative that support services are always (365 days) delivered at precise points of service delivery to enhance the clinical business and reduce waiting lists. FM purchasers normally define this response as a percentage over a measurement period for a specific measurement scope. For example "soft" FM services such as cleaning, security, portering and health and safety must be provided to all internal clinical directorates (i.e. accident and emergency, intensive healthcare unit, theatres and surgical wards) and patients 95% of the day. Generically in the NHS, FM patterns are that purchasers "sweat the assets" currently in hospitals and embrace and front the seven-day a week society in which healthcare is provided in. There has been greater need by FM purchasers to have complete flexibility and changes in "opening hours" of hospital facilities and for customers receiving healthcare and treatment. Furthermore, there have been proposals to shift the delivery of healthcare towards 12-hour out-patient clinics which will allow effective use of healthcare facilities in hospital freeing pressure on service availability times in Trusts.

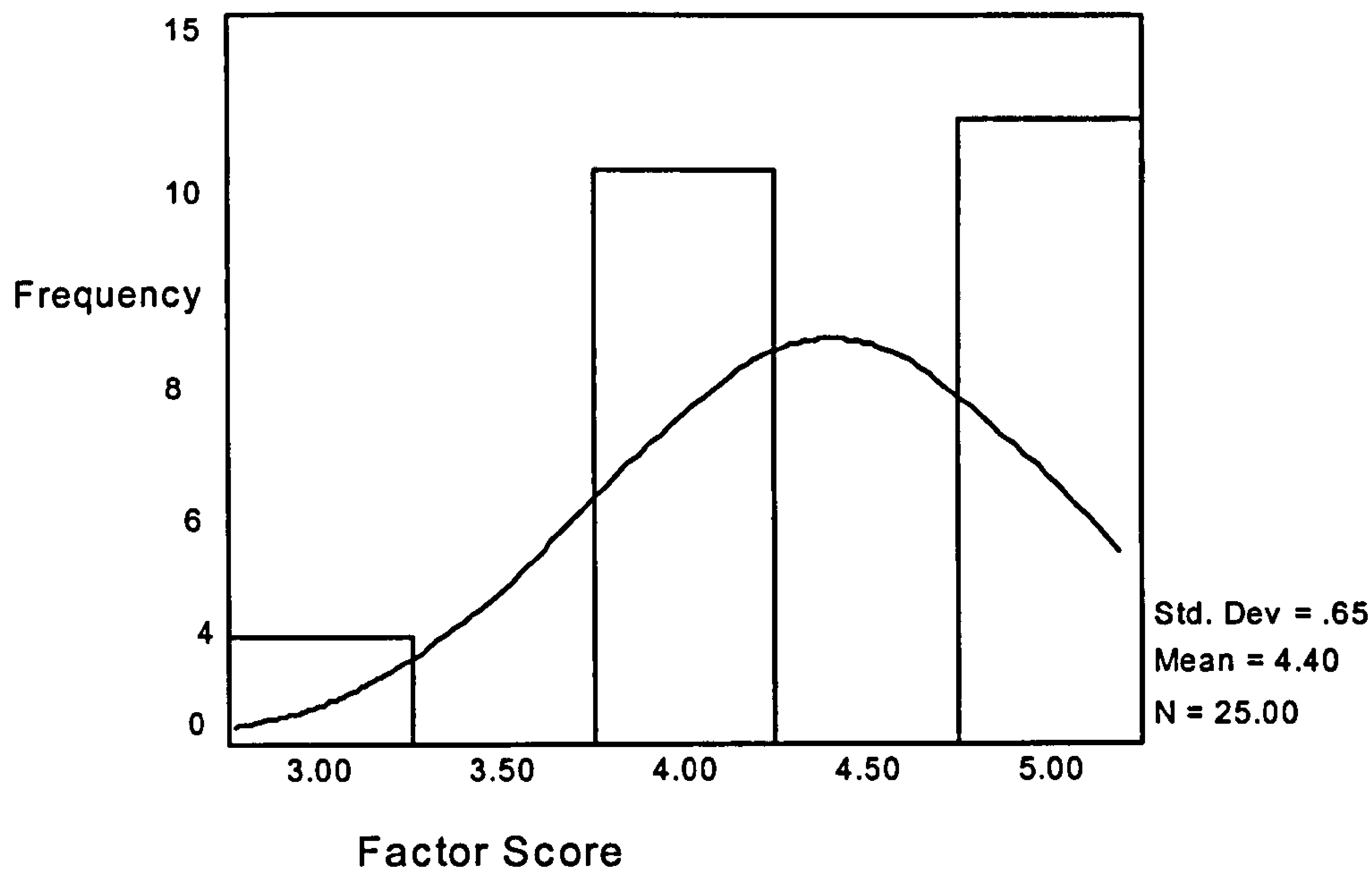
7.15 Customer involvement

Customer involvement in the design and delivery of various diverse non-clinical services was identified by purchasers as the third most important risk construct. Table 7.10 shows that respondents rated it with an overall relative index of 0.784. Figure 7.6 also shows a histogram together with the normal distribution curve for those purchasers who ranked customer involvement as one of the salient risk construct they faced in their bid to provide cost effective support services in the NHS.

Figure 7.6 shows that 23 (92%) of the respondents scored *customer involvement* with 4 or more on the importance scale. The results in this survey seem to support the view that the designing and delivery of responsive non-clinical services in the NHS is heavily centred around the needs and expectations of customers who use the services and quite often have varying clinical and non-clinical services needs. Therefore, in this survey it seems that purchasers were using modern business strategies that specify for the utilisation of the service users' knowledge and expectations in designing support services in the NHS. Furthermore, Cairns and Beech (1999) in their work on user-involvement in FM decision-making processes argue vehemently from both literature and evidence-based practice that customers' needs must first be gathered through FM surveys and then used as expert knowledge in designing the service delivery process. Cairns and Beech value the inclusion of service users as the first and foremost critical success factors for designing and managing seamless support services in most public healthcare organisations. In this survey, it can be said that purchasers were well aware of service failure risks that are associated the lack of incorporating valued customer views (consumerism) in the healthcare delivery process.

It looks like in order to achieve this, purchasers had to take into account when planning the views of service users on how responsive the non-clinical services they provided were in meeting the ever changing needs in the NHS. Hence, the use of service level agreements and quality plans for delivering responsive facility related services would not be complete without involving or consulting internal and external customers that use hospital facilities and support services when receiving care in the NHS. Therefore, it is essential that when purchasers are designing support service performance levels, they need to allow customers to specify their clinical needs and expectations through service level agreements, in order to identify what service deliverables they need, and when they can be delivered at the right POSD? In other words, the involvement of customers in the service design process will determine the clinical service mix required. This approach is normally considered using the popular service-marketing concept of the 5Ps (product/service, place, proximity, promotion and the people).

Figure 7.6: Frequency distribution of customer involvement



7.16 Service quality reliability

Service quality reliability was seen as one the most important risk constructs that needed to be managed effectively by purchasers in order to delivery high quality and responsive support services to patients, staff and visitors in trust hospitals. As a result of this, purchasers ranked this construct fourth with an importance index of 0.776. In rating this construct, FM purchasers may well have been aware that in order to achieve service quality reliability in healthcare FM operations as part of their business goal, they needed to deliver the promised FM services dependably and accurately to customers, as well as measuring them against their customers' service needs and expectations. The findings established here are not surprising given that past research in the NHS indicates that the service quality reliability dimension is the most important dimension in consumers' evaluations service quality (Bertrand, 1988; Parasuraman *et al.,* 1988). Therefore, in this survey it can be concluded that most purchasers surveyed were keen to deliver best value non-clinical services that were responsive to customers' varying clinical needs when receiving care in the NHS. As a result of this approach, service failures associated with FM operations would be drastically reduced allowing purchasers to continuously improve their FM business performance.

Purchasers may also have been aware that in order for them to survive and add value to the healthcare service chain, they needed to deliver FM services that customers would be satisfied with. Hence, the need to design and deliver high quality non-clinical services would be seen by FM customers and other stakeholders as the best way of reducing service failure in a sector that has a variety of consumers with varying healthcare needs.

7.17 Continuous service improvement

Table 7.10 shows that purchasers rated *continuous service improvement* as the fifth most important construct that affected FM business operations. As a result, it had a relative importance index of 0.768. Purchasers probably saw continuous process improvement as a performance management tool in their businesses, which allowed them to deliver of their non-clinical services effectively. In a constantly changing environment such as the NHS, it is vital that any purchaser has the capacity and ability to respond rapidly to those service (capacity) changes required to deliver best value for money services to FM customers. Thus, maybe purchasers may have seen continuous process improvement as a business-enabling factor for managing non-clinical service quality improvements. By so doing they would encourage and support their FM staff to continuously improve effectively all non-clinical service operations and activities that front the delivery of care in the NHS. It is not surprising that purchasers saw continuous improvement as a business performance tool that enhanced their FM businesses while in competition with other healthcare service providers. Although the surveyed purchasers considered continuous process improvement critical, it is important to note that its creation requires a supportive organisation that respects FM customers' values. To be effective, a continuous improvement process needs to be delivered through rapid resolution of FM service problems, which represent a concrete improvement activity, with problems alternatively being referred to as business improvement opportunities. Although there are many different problem-solving methods available, the best are simple models that can be applied at all levels from senior management to junior FM staff. These business models for the purchasers should always involve and enhance employees and customers in the design and delivery process of high quality FM services.

7.18 Culture change

Another risk construct that was highly valued by purchasers was *culture change.* Culture change as a construct was highly valued with a relative importance of 0.768. Out of the 25 purchasers who responded, 23 (92%) purchasers rated this construct with a score of 4 or more, while the remaining 2 (8%) purchasers who responded rated culture change with a score of 3, signifying how important culture change has become if NHS organisations are to survive business competition. The results obtained here are not surprising given that in the NHS, many commercial reforms have been introduced that advocate for changes in management and staff culture of delivering clinical services, to that of using commercial business models that promote continuous service innovation in today's ever changing business environment. In highlighting this construct, purchasers could have been probably aware that, although a cultural change which allowed in-house and external providers to work closely together was inevitable as part of modernising healthcare facilities in the NHS, there was a need to balance these commercial reforms with employment security under TUPE on the part their in-house FM staff.

As a result of this, purchasers might have seen that culture change was not an option if they wanted to re-engineer their non-clinical business processes to allow for effective resources management leading to service innovation. FM purchasers although willing to improve their service delivery strategies and become customer-focused, might have been particularly worried that commercial reforms such as PFI and PPP would call for major mindset changes in management culture and commitment to delivering and managing high quality non-clinical services that add value to the clinical services provided in the NHS. Hence, all this change externally or internally it might be, would need to be related to the structure of the healthcare marketplace, attitudes of FM staff and customers' perception of responsive non-clinical services.

7.19 Health and safety

Health and safety was highly valued by purchasers in the delivery of non-clinical services in a friendly working environment that is provided in the NHS.

As result, health and safety had an importance index of 0.768 signifying how important it has always been for purchasers to provide healthcare facilities that contribute to customers feeling comfortable and improve their experiences in hospitals. Probably, purchasers knew that if they did train their employees in the basics of health and safety, food hygiene, and promoting patient access to hospitals services, they would deliver high quality support services and reduce the high rate of accidents that currently exists in the NHS. The results here are very interesting given that, most purchasers in the NHS have recently had a lot of problems in delivering high quality physical environments that did not transmit further diseases to patient, staff and visitors in hospitals. Furthermore, purchasers have also encountered serious problems related to the use of healthcare facilities and contaminated equipment that has injured a lot of their staff, patients and visitors. It is probably these issues that prompted purchasers to regard health and safety as a critical construct and aimed to reduce the number of reportable accidents to very low levels. Another possible factor that might have contributed to purchasers valuing this construct was possibly that, recently they have be so many cases reported of absenteeism of FM staff suffering from occupation health problems in the NHS. As a result of this, maybe purchasers were aware that they needed to operate effective health and safety policies that reduced the rate of absenteeism in the NHS to acceptable levels.

7.20 Service value management (best value for money)

Service value management was ranked as the eight most important risk constructs with an increased business effect on purchasers FM business process strategies. Figure 7.9 shows that 21 (84%) purchasers surveyed rated this construct with a score 4 or more as being important. In this case, well defined support services and their associated service levels are fundamental components of any successful FM contract. The key to successful service value management encompasses defining services and service levels, that:

i. can be measured and managed in various demand driven situation in the NHS;
ii. can be audited;
iii. can be provided at a cost effective price to meet customers' service needs and expectations and

iv. is capable of delivering maximum value to the users of FM services.

In this survey purchasers were probably aware that in order to manage the clinical delivery process in the NHS effectively, they had to provide support services that added value to patients' environments when receiving care. It is important to note that service value management can be negative if it does not provide NHS customers with an improved patient's healing environment of delivering care or causes patients to deteriorate in the quality of healthcare they receive in hospitals. Therefore, it seems that purchasers were also aware that not all NHS customers perceive non-clinical service value, either because some cannot use the extra healthcare facilities and support services provided during their treatment period at hospital, or because the augmentation reduces an offering's value. Therefore, in terms of service value management, FM purchasers had to contribute significantly through designing and delivering high quality FM services that adapted to, the changing needs of hospital organisations, and contributes to productivity, service enhancement and high quality.

7.21 Staff participation and partnership

As a valuable construct, *staff participation and partnership* was rated as the 9th important key factor that purchasers had to manage in order to improve the level of customer service and deliver high quality non-clinical services in the NHS. Hence, this construct had a relative importance index of 0.752 signifying how important it has become for senior management of FM purchasers to work in partnership with their FM staff and reward them for their hard efforts. As has been seen in the past that happy staff will improve the service levels of satisfaction to customers and thereby allowing customers to become more loyal. The involvement of staff and their participation in the purchaser's programme of improving customer services and high quality they delivered was valued by purchasers as the key to improving business success in FM directorates. Partnering in this survey may have been seen by purchasers as way of empowering staff to make effective customer and business decisions during any service transaction that added value to the FM services delivered to customers in the NHS.

Hence, a culture of openness and sharing business intelligence among all staff and senior management of purchasers while working in partnership to improve the quality of support services was probably seen by purchasers as a best practice of managing non-clinical services in the NHS. It is not surprising that these purchasers valued this construct as critical success factor in the continuous management of FM services. If FM staff were working in partnership and were involved in all the purchaser's customer service improvement programmes, they would no doubt add value to the total healthcare service delivery which is highly based on managing customers' clinical outcomes in the NHS.

7.22 Health legislation compliance

It is interesting to observe that FM purchasers ranked *legislation compliance policy* as the tenth most important factor, influencing the effective management of healthcare facilities, and the need for clinical enforcement before customers receive responsive care services. Table 7.10 shows that legislation compliance had a relative importance index of 0.752. These results are not surprising given that nowadays in the NHS there is a dire need for trusts to comply with current strict codes of clinical excellence and governance. It has become the number priority in the NHS that FM service purchasers through their multidisciplinary medical teams deliver seamless and responsive FM services that are safe and do not put the quality of patients' healthcare at risk. The failure to observe and comply with legislation and clinical governance standards that control the delivery of care and support services goes on well to explain why most purchasers in the NHS have failed strategically to cope up with service delivery demands, and also given that there has been a sudden rise in clinical service negligence cases in the NHS. In year 2000 alone, a report published by the NHS HAIs showed that at least 100 000 patients are affected by HAIs while 5000 die every year as a result of clinical negligence. The NAO (1999) also revealed that during 1996/7, negligence cases cost health authorities and trusts £200 million. This figure is expected to rise by 25% annually over the next five years. As a result of this, NHS trusts set aside each year £80 million for negligence cases already going through but identified that these could cost up to a further £1.6 billion. Cases of medical negligence where a claim has not yet been made could cost another £1 billion.

On one hand, customers expect high clinical service needs when receiving care to be matched. While on the other hand customers do not only expect to received high quality care services, they also impose indirectly a duty of care to purchasers to deliver FM services in compliance with the current legislation in order not to endanger public health and safety. For most FM purchasers in the NHS, the new millennium has also started to present a challenge with respect to the Y2K and beyond compliance of business systems and corporate security data protection, equipment and processes – with much focus being directed on developing compliance testing regimes and contingency planning and business law. More so, legislation compliance especially health and safety at work, healthcare facilities use regulations, healthcare reforms, Acts and clinical governance and other legal requirements that are needed to be followed. The non-compliance or non-delivery of responsive support services that eventually underpin the delivery of care cannot be tolerated by NHS customers, as it will cause reductions in quality of customers' lives or deterioration of those who are ill.

7.23 Factor grouping using principal component factor analysis

To have an inside view of how risk constructs work together influencing the purchasers' decision to manage healthcare FM and business risks and to further explore the structure of the data collected, the Principal Component Factor Analysis (PFCA) technique was employed. This meant that to ensure suitability of the data for this analysis, certain statistical tests had to be performed. The determination of the correlation matrix shown on Table 7.11 is 0.002377 that is greater than the required 0.00001, indicates that the data matrix used was not suffering from multicollinearity or singularity (Kinear and Gray, 1999). In addition, the Kaiser-Meyer-Oklin measure of sampling adequacy was found to be 0.6, that is greater than 0.5 confirming that the sampling adequacy is acceptable. First, a summary of the scores for each of the top ten risk constructs which were critical in the management of purchasers healthcare FM operations as identified by the questionnaire survey is presented in Table 7.11. These results suggest that risk management decisions of FM purchasers in healthcare operations have to date, been modest with all the average success scores clustered around the midpoint of 4 on the Likert scales.

Table 7.11: Descriptive Statistics for Purchasers' FM risk constructs

Risk Construct	**Average construct score**
Customer satisfaction	4.7200
Service delivery certainty	4.4000
Customer involvement	4.4000
Service quality reliability	4.5200
Continuous service improvement	4.0400
Culture change	4.2000
Health and safety	4.3200
Service value management	4.1200
Staff partnership and motivation	3.9600
Health legislation compliance	4.3600
Factor correlation matrix	0.002377
Kaiser-Meyer-Oklin	0.6

However, it is interesting to note the *priori* that, whilst the overall impact of support services operations "as backroom services" on direct patient healthcare is generally perceived to be limited by less knowledgeable healthcare executives, its positive contribution through risk management to clinical efficiency and managerial decision making is readily acknowledged. In order to explore the ten pertinent FM risk constructs identified as being critical in the management of the FM business process in the NHS, it was necessary to generate an overall score for each risk construct deemed important by purchasers in the survey. Averaging the ten individual risk constructs derived this overall score. The relationship between each risk construct and the overall success measure was explored by generating a series of correlation coefficients, utilising one-tailed tests; the results are presented in Table 7.11. These results indicate that the top ten most important risk constructs identified in the purchaser survey have a relationship with a score that is statistically significant at the 0.01 and 0.005 level. The highest of the coefficients was for *customer satisfaction*. Thus the importance of offering customer-driven facilities solutions is recognised as a best practice factor in maintaining customer loyalty and offer seamless clinical and support service in NHS trusts, and therefore its significant score in this analysis simply supports existing theory.

Other pertinent risk constructs that were also found to have significant correlations in the purchasers' risk management and decision making process, at the 0.01 and 0.05 % level, are *health and safety* which ensures that customer are safe to use FM services in user-friendly facilities, ensuring adequate user involvement and maintaining support for the service provision from top management.

Furthermore Table 7.12 shows all the top ten factors with their eignevalues, percentage of variance and cumulative percentage of variance. Four component factors and their loadings were extracted from the analysis based on their eigenvalue being greater than 1 (Table 7.12). Loadings are standardised correlations between components (in this case, FM risk constructs). High loading values suggest a high correlation between the represented purchasers' construct or component. Table 7.12 shows a summary of communalities of the variance in the factors that is accounted for by the four factors extracted. For example, about 60% of the variance in customer satisfaction is accounted for. A close examination of the communalties revealed that the four components account for over 60% of the variance in all the variables suggesting that the factor analysis has been very effective.

Table7.12: Factor-Loading before varimax rotation – Purchasers risk constructs

Variables	**Factors**				**Achieved Communalities**
	1	**2**	**3**	**4**	
Customer satisfaction	-.319	.357	.426	.435	0.600
Service delivery certainty	.464	-.152	.753	.202	0.847
Customer involvement	.873	-.355	-.105	0.016	0.899
Continuous service improvement	.595	.357	-.103	.428	0.675
Continuous service improvement	.720	.493	-.226	-.305	0.907
Change management (culture)	.943	-.212	0.01186	.125	0.951
Health and safety	.233	.499	-.117	.551	0.621
Service value management	.352	-.527	-.463	.462	0.830
Staff partnership and motivation	.684	-.151	.516	-.219	0.805
Health legislation compliance	.643	.466	0.07753	-.366	0.771
Eigenvalues:	3.902	1.459	1.322	1.222	
Percentage of variance	39.020	14.592	13.217	12.215	
Cumulative % of variance:	39.020	53.611	66.828	79.043	

Table 7.12 also shows the associated percentage of variance of the four factors; factor 1-39.02%, factor 2-14.59%, factor 3 -13.22% and factor 4 - 79.04%, which are *customer satisfaction*, *service delivery certainty*, *customer involvement* and *service quality reliability* respectively. Like the percentage of variance in the Table, the eigenvalues indicate the relative importance of various factors in accounting for the total variance in the data set. It should also be noted that factors with eigenvalues that are less than 1 (i.e. continuous *service improvement, Culture change, Health and safety, service value management, staff partnership and motivation* and, *health legislation compliance*) were not selected. This is because an eigenvalue value is a measure of standard variance with a mean of zero (0) and standard deviation of one (1); and the variance that each standard variance contributes to the principal components extraction is 1. A component with an eigenvalue value of less than 1 is less important than an observed variable and can therefore be ignored. In order to achieve factor loadings that are easier to interpret than those shown in Table 7.12, a varimax rotation was carried out on the factors. This had the effect of minimising the number of risk constructs on which the variables have high loadings. The new factor-loadings shown in Table 7.13 is easier to interpret psychologically. The new factor loading are simply the correlation coefficient between an original variable and an extracted factors.

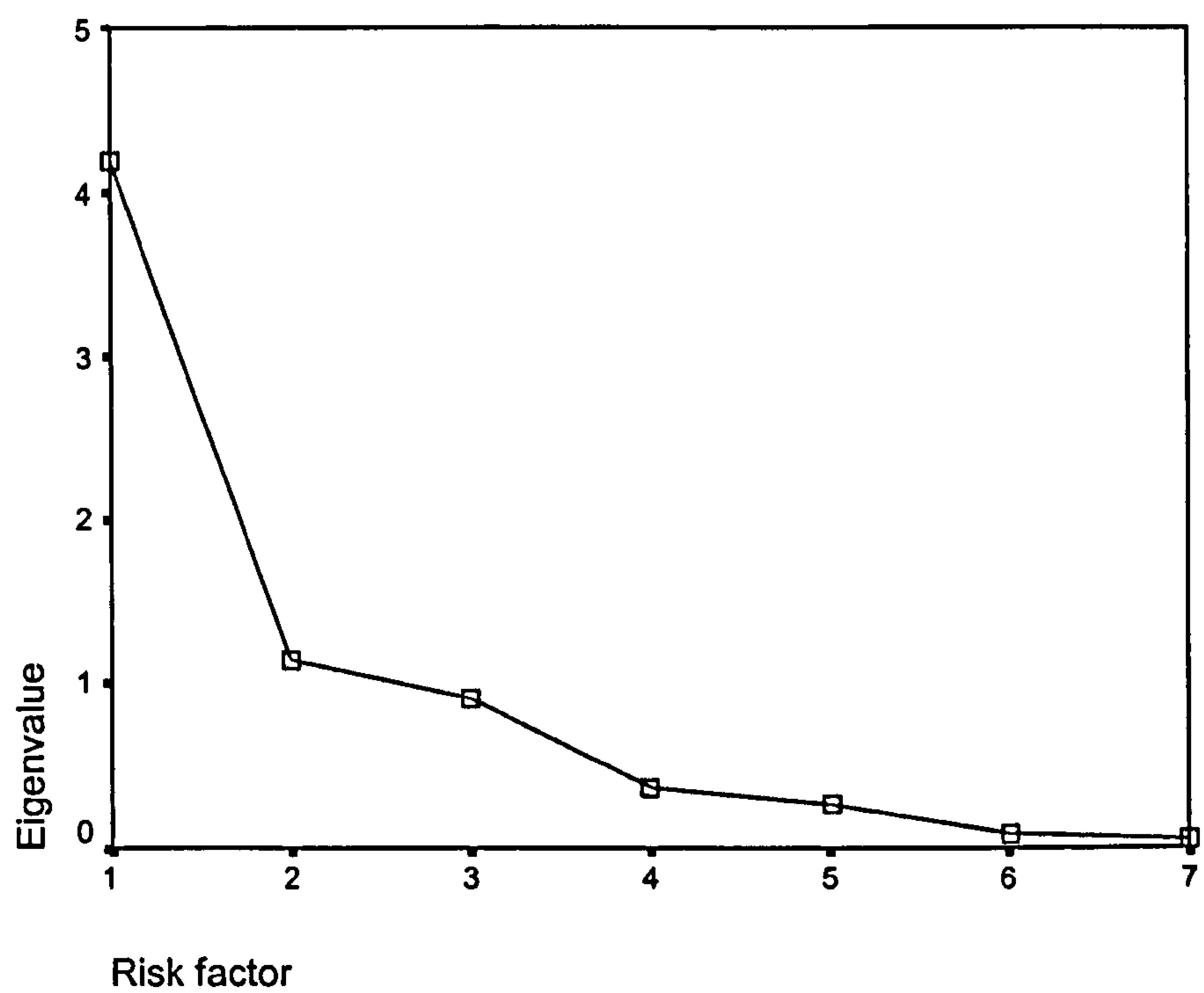
Table 7.13: Initial statistics of Principal Component Factor Analysis – Purchasers risk decision constructs

Component Factors	Initial Eigenvalues Total	Percentage(%) of Variance	Cumulative % of variance
1	3.902	39.020	39.020
2	1.459	14.592	53.611
3	1.322	13.217	66.828
4	1.222	12.215	79.043
5	.929	9.294	88.337
6	.618	6.179	94.516
7	.230	2.301	96.817
8	.198	1.978	98.795
9	.112	1.116	99.911
10	0.08865	0.08865	100.000

Thus the higher the absolute value of the loading the more the variable contributes to the factor.

After factor rotation it was evident that *customer involvement, continuous service improvement, health and safety, service quality reliability, health legislation compliance* and *service cost certainty* are loaded substantially on factor 1 in that order, and only *staff partnership motivation* was loaded only on factor 2, while and *service delivery certainty* and *health legislation compliance* are loaded on factor 3. Only *service value management* was loaded on factor 4.

Figure 7.7: Purchasers' Scree Plot



Moreover, a scree plot of factors shown in Figure 7.7 revealed that the data lies close to two dimensional subspace and would therefore represent the whole data and thereby reduce any concentration on the none principal factors of the data. Further analysis shown in Figure 7.7 classified risk factor loadings into seven groups. Taking the eigenvalue as a measure of importance it is self evident in Table 7.13 shows that factor 1 had the highest eigenvalue of 3.902 and the most important group of risk constructs that influence the purchaser's FM service delivery process. This was followed by factors 2, 3 and with eigenvalues of 1.459, 1.322 and 1.222 respectively.

7.24 Summary

The FM purchasers survey has explored various risk management strategies and identified risk constructs faced when managing non-clinical services in the NHS. In addition, the survey has also identified fifty-four constructs that are critical in the management of the FM business process in the NHS. The conclusion in this section is that purchasers face a multivariate of constructs when managing healthcare FM operations effectively. Most of the constructs that affected the purchasers were highly associated with purchasers achieving their core business strategy and FM service delivery process.

External FM service providers' risk management survey

7.25 Introduction

This section presents results of a postal questionnaire survey carried out on twenty-five (25) facilities executives working for external FM service providers managing healthcare operations in the UK NHS.

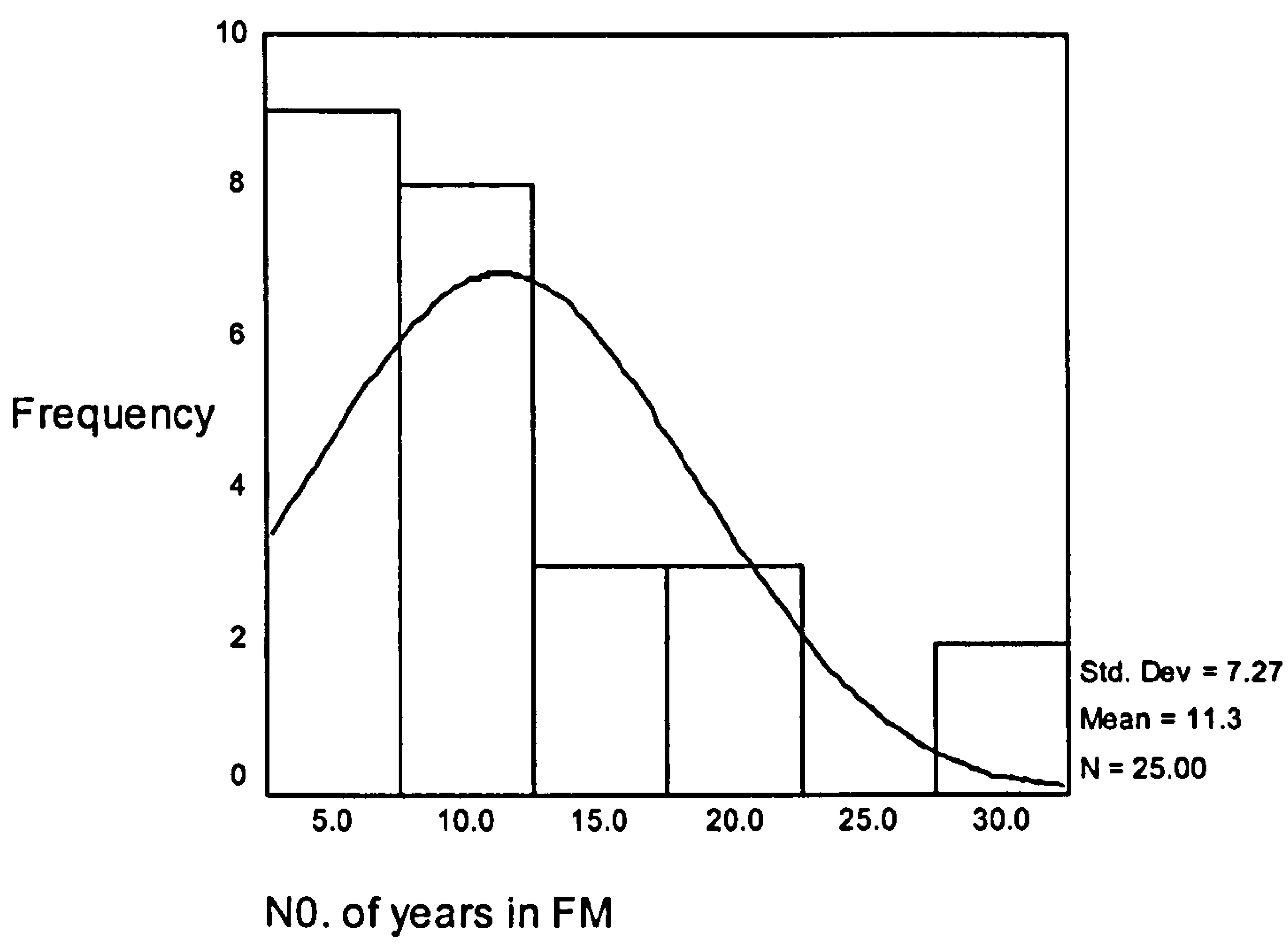
7.26 Characteristics of the commercial FM providers surveyed

In terms of experience in healthcare FM operations, Figure 7.8 shows that the range of the distribution of commercial FM providers surveyed was 25 (5 to 30) years in the NHS. In comparison to the purchasers' survey, this range was similar indicating that the two FM groups had more or less similar experience in managing FM operations in the NHS. A range of 25 years is quite acceptable given that the majority of these commercial providers were traditionally experienced in delivering a variety of integrated non-clinical services such as construction, estates, site and hotel services to the NHS well before privatisation was introduced in the NHS in the mid 80s. On the other hand, 17 (68%) commercial providers surveyed had between 5 to 10 years experience in delivering non-clinical services. The main reasons as to why some commercial FM providers had such experience could possibly be as a result of the introduction of market testing and new PFI projects that are barely 10 years old in the NHS (Akintoye *et al.,* 1998). The PFI concept has created more contract opportunities for commercial providers to deliver a wide range of "hard" and "soft" non-clinical services.

In addition, the pilot survey also revealed that most FM purchasers/clients used commercial providers who had experience in delivering integrated FM services such as construction, hotel, estates maintenance and medical equipment repair services. As a result of this, it was easier for providers to diversify and provide a full range of integrated and innovative non-clinical services that underpin the delivery of responsive healthcare in the NHS. Figure 7.8 also shows that 6 (24%) commercial FM providers surveyed had between 15-20 years of experience in providing support services in the NHS.

The level of experience stated here is not surprising given the fact that FM has been traditionally practised using different models of delivery, and is still developing its service brand in the NHS. Although the level of experience stated above sounds reasonable, one would have expected the surveyed commercial providers to posses more experience in using FM as a business management model. This is presumably because the FM approach is more advanced in the commercial sector as it has been practiced for past 30 years (Alexander, 1992). It would have been appropriate to expect the majority of the external providers in this category to have more than 20 years experience in delivering FM services in the NHS.

Figure 7.8: Experience in FM service delivery



The existence and domination of large in-house departments that have traditionally managed integrated facilities and support services in the NHS could be also one major factor used to explain this low rate of experience. Due to the less development of integrated FM services in the NHS, only 1 (4%) commercial FM service provider had 30 years of experience in delivering total FM services. These results are interesting given that an integrated FM approach in the NHS is a new business and risk management strategy that is hardly 30 years old. On average Figure 7.8 shows that the number of years in FM services delivery possessed by most commercial providers was 11 years.

These results also indicate a fair representation of experience possessed generally by most external providers given that FM as a business practice is still developing in the NHS and has only been dominant in the last decade (Alexander, 1992; Gallagher, 1998).

7.27 commercial FM provider organisation size and number staff employed

This question was designed to evaluate the organisational resources used by the commercial providers surveyed to improve support services customers received in the NHS. Table 7.14 shows the descriptive statistic regarding the organisational size and the number of FM staff employed by the surveyed commercial providers to manage their FM contracts effectively in the NHS. Table 7.14 also shows that the frequency range of distribution for the commercial providers' annual income was £137 (3 to 140) million while that of FM staff employed was 1117 (30 to 1200). The two ranges obtained in this survey although huge are not surprising given that the values used in this question are simply total of resources used by commercial providers used in multi-FM contracts. It can also be said that the average number of FM staff employed by commercial providers to manage efficiently healthcare FM operations was 390 staff. These results represent a high number of staff employed by individual commercial FM providers. Such a high number of staff is also indicative of the fact that the demand for FM services by purchasers/customers was generally high in the NHS. As a result commercial providers needed more staff to deliver them.

It is important to note that the smallest commercial provider in this survey employed a minimum of 30 staff, while the largest FM provider employed 1200 staff. Such a contrast in staff numbers also indicates that the demand for FM services generally varies with the type of FM purchaser (hospital trust) commercial providers were delivering non-clinical services to in the NHS. These results are interesting given that the purchasers' survey also identified similar trends (see section 7.2). It can also be inferred in Table 7.14 that those commercial providers who employed 30 staff were generally delivering "light" non-clinical services to purchasers providing mental and community services, while those who employed 1200 staff were delivering "heavy" non-clinical services to purchasers providing integrated and acute services.

Table 7.14: Descriptive statistics of staff employed and turnover

Statistic	N0. of FM staff employed	Annual turnover Million (£M)
Mean	390.3200	55.68
Std. Error of Mean	55.0875	7.69
Median	400.0000	65.00
Mode	450.00	20.00
Std. Deviation	275.4376	38.49
Variance	75865.8933	1481.60
Kurtosis	1.884	-.799
Std. Error of Kurtosis	.902	.902
Range	1170.00	137.00

Table 7.14 also shows that the mean annual turnover for the surveyed commercial providers was £55 million. An average of £55 million indicates that the management of non-clinical services under FM directorates in the NHS was generally capital-intensive and needed huge resources (capital and staff) in order to be operated efficiently 24 hours a day.

7.28 FM procurement systems used in the NHS

This question sort to evaluate procurement systems used by commercial providers when managing FM business process risks in the NHS. Table 7.15 shows that the commercial providers surveyed used a variety of procurement systems to manage non-clinical services in the NHS. The most popular used procurement system was the traditional system and was used by 21 (84%) commercial providers. The results obtained here are not surprising simply because of the reasons and benefits of this approach were all highlighted in the purchasers' survey (see section 7.4). Apart from the traditional system, Table 7.15 also shows that commercial providers also used performance contracting, SLA-based contracting, partnering and the PFI approach to manage FM services effectively. In fact, Table 7.15 also shows that 14 (56%) commercial providers surveyed were using the performance-related contracting to deliver a range of non-clinical services effectively in the NHS. This method might have been ideal possibly because it allows commercial providers to have flexibility in specifying the level of service delivery depending on customer service demands.

Table 7.15: Procurement systems used by commercial providers

Type of procurement system	**No. of respondents**	**Percentage (%) of respondents**
Traditional contracting	21	84
Performance contracting	14	64
SLA-based	7	28
Strategic partnerships	5	20
PFI	5	20

The other major advantage as to why commercial providers might have preferred this route is that, performance contracting is based on a system of rewarding the commercial provider's performance for future cost savings and quality improvements in FM services delivery. Hence, this approach might have been used to maximise commercial providers' business objectives, increase shareholder value and profitability.

Although service level agreements have recently been advocated to be the most suitable system of managing demand based services such as FM services in the NHS. Surprisingly, in this investigation 7 (28%) commercial providers surveyed used the SLAs-based system. This is possibly due to similar reasons identified in the purchasers' survey regarding the use of this approach in the NHS (see section 7.4). According to Table 7.15 the least used procurement route was the corporate PFI. This route was used by 2 (8%) external providers surveyed. The low usage rate of the PFI route could have been due to the fact that, it was a new procurement method, and possibly not many commercial providers were familiar with its use in the NHS. Although from this survey it seems that the PFI approach was not the most popular procurement, much literature suggests that this approach will be utilised more in future due the present government's initiative of modernising healthcare facilities in the NHS (Jones, 2000; Okoroh *etal.,* 1998).

7.29 Service quality management in non-clinical services

This question was designed to evaluate quality management systems used by commercial providers surveyed to manage the non-clinical business processes in the NHS effectively.

Table 7.16 shows that 17 (69%) commercial providers surveyed were using ISO 9000 as their major quality management system. The high usage of ISO 9000 here is not surprising. This is because most healthcare managers regard ISO 9000 as an effective quality management system that improves the provision of service quality in NHS support services. Table 7.16 shows that while the majority of the commercial providers used ISO 9000, interestingly only 8 (32%) providers surveyed used other approaches.

Table 7.16: Quality management systems used by commercial providers

Quality management tools used	No of respondents	Percentage (%) of respondents
ISO 9000	17	68
Others	8	32

The main reason possibly why they were not using ISO 9000 could well be that it is generic quality management system that was not particularly sensitive to these commercial providers' various business needs. In addition, some of these commercial providers might not have been using ISO 9000 due to lack of expertise required to implement this system effectively. The use of other quality management systems seem to suggest that these commercial providers were also aware of the problems of using ISO 9000, as a result were using other systems such as ISO 14000, TQM and business excellence models which are more environmentally friendly to their business needs, and were also compatible with other quality systems currently used in the NHS. In addition to the above, the following question was designed to performance management methods used by commercial providers in the design and management of FM services in the NHS. The results obtained here were very similar to those obtained in the purchasers' survey. As a result of this, Table 7.17 shows that the most used technique of monitoring and managing the FM service process was by using service level agreements (SLAs). In this survey 20 (80%) commercial providers compared to 21 (84%) in the purchasers' survey stated that they used SLAs. The use of SLAs in this case shows that SLAs have become a modern business tool for specifying what commercial providers (FM departments) will provide to their NHS customers (internal and external).

Furthermore, besides being used for setting quality standards, SLAs have been used to measure performance in FM operations regularly. They can also be used as an integral part for any FM outsourcing contract specifying the purchasers' (client) FM service requirements and performance. FM performance in this case may be the quality of how support services are organised and delivered to customers as well how well the commercial provider will provide dynamic FM solutions in various market demand driven situations.

Secondly, the use of SLAs may have been preferred by most commercial providers due it flexibility in use as mean of managing and controlling any service variations, and also for monitoring the quality of support service deliverables. After the SLA, the second most popular method of managing service quality in healthcare FM operations were quality plans. Table 7.16 shows that 5 (20%) external providers surveyed agreed that they used quality plans for managing the FM service delivery process in the NHS. It is not surprising that commercial providers used this method given that quality plans give a detailed approach as to how FM services are to be quality assured and managed from design to the point of service delivery to NHS customers. This approach does not only show the quality management process but also shows the best possible way of delivering non-clinical services safely to customers. Hence, it is not surprising that some commercial providers used quality plans as in-built in SLAs and in turn tended to design SLAs that are based on FM quality plans. On the other hand, the reason as to why service quality plans may have had a low response could well be that quality plans in some cases are very simplistic in nature and show how service quality and support service strategies are to be designed and adhered to as oppose to offering tight control mechanisms for non-performance compliance. Not withstanding this, the use service quality plans may have been preferred by some commercial providers for managing service outcomes as opposed service inputs. This approach is relevant to the management of performance related services where the purchaser only details their customers' service needs (turnkey). The rest is left for the commercial providers to establish their own innovative service delivery processes. This method also allows for the transfer of management and delivery responsibilities to the commercial provider who is normally experienced in providing support services competitively.

Table 7.17: Tools used for managing service quality in healthcare FM

Service quality and performance management systems	No. of respondents
SLA	20
Service Quality Plan	5
SERVIQUAL Scale	10
Patient service charter	5

However, this method can lead to disastrous consequences, for example in some cases the commercial provider may carry huge service management risks relating to service variations and clinical governance. Therefore, most commercial providers due to possibly this reason might have disliked this method. Apart from using SLAs and service quality plans, Table 7.17 shows that commercial providers also used other service quality measurement techniques. These were the SERVIQUAL Scale and the PSC. Table 7.17 shows that 10 (50%) commercial providers surveyed used the SERVIQUAL Scale possibly due to possibly its flexibility in determining the relative importance of the five most important dimensions earlier explained in the purchasers' survey that influence NHS customers' overall quality perceptions of support services (see section 7.5).

These five dimensions used in the SERVIQUAL are probably the ones that might have attracted commercial providers as well to use this method. Moreover, there is an added value of using this technique, as its application is generally widespread in most clinical directorates in the NHS. Other quality management techniques used by commercial providers were the PSC. The PSC was used by 5 (20%) commercial providers probably due to its lack of much detail regarding total healthcare quality control and the management of support services. It only provides the specification of the non-clinical services customers will expect to receive from the purchaser without highlighting how it will be achieved either from a purchaser or customer view.

7.30 FM risk identification techniques.

Table 7.18 shows the methods used by commercial providers to identify FM risks in healthcare operations. Interestingly, most commercial providers were monitoring most of their service risks through customer complaint systems.

According to Table 7.18 this method was commonly used by 23 (92%) commercial providers surveyed. The popularity of this method indicates that customer experiences (bad or good) when using support services in the NHS were the best indicators of how well commercial providers were delivering responsive FM services to their customers. It is through the analysis of customer complaints related to the consumption of FM services that business risks can be designed out and managed effectively.

Table 7.18: commercial FM service provider risk identification techniques

Risk identification methods	Frequency	Percentage (%) of responses
Analysis of customer complaints	23	92
Brainstorming	20	80
Case studies, best practice and benchmarking forums (e.g. public sector approaches)	12	48
Checklists	15	60
Financial and investment appraisals	19	76
Flow charts, frequency impact analysis, fault/event tree	15	60
FM performance team review and audits (including use of focus groups)	17	68
Legislation compliance (e.g. health and safety and NHS Acts)	12	48
Formation of strategic partnering arrangements	10	40
SWOT analysis	10	40
Research, surveys, seminars, conferences, interviews and questionnaires	8	32
Seven quality tools	8	32
Internet and multi-media information sources	5	20

This approach was popular as it also measures the real service problems faced by customers in using FM services. It is well researched that every dissatisfied customer can influence more FM services users (i.e. generally 16 more customers) normally in a bad or good way, not to use or use FM services in the NHS. Apart from using customer complaints commercial providers also frequently used other techniques such as brainstorming and investment appraisals. Table 7.18 shows that 20 (80%) commercial providers surveyed used the brainstorming technique. The use of brainstorming is not surprising as it allows the collection of useful business and FM information from all the service users for process mapping.

Furthermore, brainstorming also allows for the collection of good and bad business ideas from commercial providers and other FM stakeholders for further analysis to develop a structured solution to any service problem. The use of brainstorming was also considered important by commercial providers probably because it allowed risk knowledge to be shared and communicated among commercial providers effectively to improve FM service processes in the NHS.

Investment appraisals were used by 19 (76%) commercial providers surveyed. The use of investment appraisal techniques is not unusual given that FM contracts in the NHS are considered as capital projects, and have to be financially evaluated using cashflows to show that they were delivering best value for money to purchasers as part of their strategic/outline/full business cases. Furthermore, as more resources such as finance are put in the NHS, the need to identify and evaluate business risks associated with FM operations has become the critical success factors in improving the direct patient care to be provided. Apart from using brainstorming and investment appraisals, commercial providers also used a variety of quantitative and qualitative techniques to identify and evaluate FM risks. These techniques were checklists, the SWOT analysis, flow charts and fault/event tree analysis, group workshops, Delphi interviews, research surveys, seven tools of quality, internet and multi-media. The use of a variety of techniques by commercial providers in Table 7.18 shows that external providers continue to take precedence on risk identification by relying on the past and present experience (i.e. benchmarking best practices), and from various business management models in the NHS as well as other commercial sectors. This trend also suggests that FM operational risks are multivariate and can be analysed and managed effectively in a number of ways by commercial providers. Table 7.18 shows that all the techniques that were employed by external providers to manage FM operations possibly helped them to comply with clinical governance and environmental management issues that have become vital in the delivery of high class and safe FM services in the NHS.

7.31 Techniques and methods of FM risk analysis

This question sort to identify the methods used by commercial providers to analyse and manage FM risks.

Table 7.19 also shows that all (i.e. 25) commercial providers surveyed used both qualitative and quantitative tools. The most common risk management technique used by 25 (100%) commercial providers surveyed was the risk exposure matrix, possibly because it is the most widely used and recommended technique by the NHS Executive for FM service operators to use as part of quality control assurance and control of healthcare services in the NHS (DoH, 2000).

Table 7.19: Risk management technique used by commercial providers

Type of risk tool	Frequency	Percentage of responses %
Risk exposure matrix	25	100
Discounted cashflows	21	84
Probability theory	13	52
Decision trees	10	40
Sensitivity analysis	12	48
Monte Carlo simulation	5	32
Qualitative techniques	10	40

Furthermore, it also allows commercial providers to assess the degree of impact (severity) or likely on any hazard in managing healthcare FM risks. The matrix approach also allows for effective decision-making and management of the risks involved. The use of risk matrix was followed by discounted cashflows that were used by 21 (84%) respondents. The high usage of discounted cashflows by commercial providers again here is not surprising given that all FM services delivered commercially or outsourced in the NHS are regarded as capital projects. As a result, have to be evaluated for possible business risks using business cases under guidelines set out in the CIM provided by the NHS Estates. The use of discounted cashflows to appraise the financial viability of those outsourced FM services and showing how they offered best value for money to the purchaser could have been seen by commercial providers as the key to successful business management in the NHS. Furthermore, the advantage of using discounted cashflows is that they allow for various service delivery options to be compared equally (like for like) on a short or longer-term basis showing all the capital outlay and payback to be invested by any commercial provider.

- Although commercial providers favoured the used of cashflows as a technique for managing business risks in FM operations, they also used other techniques such as the probability analysis to complement their risk management processes in place. This technique was used by 13 (52%) commercial providers surveyed. The use of the probability analysis technique is important as this technique allows commercial providers to assess the likelihood of any service success or failure and its impact in the delivery of FM services.

Although, external providers used the above-mentioned techniques, they also used a variety of other risk management and decision-making techniques such as decision trees (72%), sensitivity analysis (45%), Monte Carlo simulation (32%) and other qualitative techniques (40%). In this survey, it seems that that qualitative risk management methods were less used by commercial providers to analyse FM risks. The results here are a clear indication as to why recently there has been many reforms in the NHS advocating for FM service operators to use commercial business management models that can add value to the clinical service delivery process. If compared to the purchasers' survey, the results here substantiate that both external providers and purchasers used similar strategies for managing risks associated with the effective delivery of non-clinical services in the NHS

7.32 Commercial providers' risk analysis in healthcare operations

The aim of the commercial FM providers' survey was to identify risk constructs that were highly valued by commercial providers in healthcare FM operations. Due to similarities in the aim and objectives of the two surveys (purchasers and external providers surveys), statistical techniques that measured multivariate data were used, to allow detailed comparisons to be made between the two FM operators. This measure also allowed for the appropriate discrimination of risk constructs based on value judgements made by commercial providers surveyed using the RII. Input to the final weighting index (W) was mainly composed of the relative importance index already discussed in the purchasers' survey (see section 7.13). Since this survey will be drawing special inferences from the numerical scores provided by external providers using a Likert scale. A similar analytical procedure used in the purchasers' survey was also be used in this survey in order to compare risk perceptions in the two surveys.

Furthermore, the data (categorical) collected needed to be tested for normality of distribution. A similar procedure to the one used in the purchasers' survey was also used here as way of looking for possible data comparison clues. In order to investigate for sample distribution and normality, the **Kolmogorov-Smirnov test** was used for testing the distribution of normality or goodness-of-fit. Table 7.20 shows that the results of the one-sample test executed on commercial providers data confirmed that the sample was normally distributed, thus allowing further tests to the data to proceed. Table 7.20 also shows that most of the values for Kolmogorov-Smirnov Z-test were more than one (>1), signifying that the data in use was normal and could be analysed using parametric tests.

7.33 Reliability analysis

The data was also subjected to rigorous tests to establish whether the scale used for measuring the data was consistent and reliable. The method of measurement used was the internal consistency method. This method was preferred due to reasons already mentioned in the purchasers' survey (see section 7.12). The reliability coefficients established from SPSS were based Cronbach's alpha values using the covariance matrix. The reliability coefficients for the top ten constructs using the alpha value was 0.7846 while the standardised alpha value was 0.7991. The two coefficients values obtained from this computation showed that the scale used to analyse commercial providers' data was consistent and therefore can be regarded as reliable. On visual examination of the indices in Table 7.20, it can be seen that all the commercial providers' risk constructs had a an overall relative importance index which was more than 0.5 (>0.50), signifying how important commercial providers rated all the these elicited constructs to be critical in healthcare FM business success. The commercial providers' results in Table 7.20 if compared with the purchasers' shows that commercial providers had generally higher rated values (i.e. lowest was 0.54). The reason may be simply that external providers as commercial organisations were risk seekers compared to purchasers in terms of managing healthcare resources (finance, human and assets), and regarded FM operations as a highly risk business transactions. As a result of this, commercial providers would want to improve their business performance and reduce business risks in order to enhance shareholder value and maximise profits (business opportunities).

Thus, commercial providers rated their risk constructs with slightly higher values in order to show how sensitive their business strategies were in managing and taking risk for future business rewards in the NHS. This might not have been the case with FM purchasers who naturally are risk averse and are not geared towards making profits but providing high quality life enhancing (clinical) services. As would be expected, whilst some risk constructs showed in Table 7.21 have strong (close to 1) leverage on the commercial providers' decision making strategies of effectively managing FM performance and business risks others do not. In this section onwards consideration shall be given to the top ten most important constructs ranked by commercial providers as critical in healthcare FM operations. This approach was used mainly for two reasons. Firstly, to adopt a systematic and proactive approach which will facilitate an extensive analysis of the top ten factors, and then extend the procedure to the rest of the remaining constructs in order to develop a risk management model. Then secondly, to allow for systematic comparisons to be made in terms of risk perception between purchasers and external providers in order to identify the most common risk constructs that would be used to develop the business decision model.

7.34 The relative importance index

The relative importance index was designed in the survey to mirror healthcare facilities managers' (i.e. for the commercial providers) perceived importance of each risk constructs established by the research survey. Numerical scores established from a Likert scale (between 1 to 5) were used to measure the relative importance or weight of each construct. Therefore, in healthcare FM operations it can be hypothetically postulated that if a risk construct was highly rated as extremely important by most commercial providers, it would achieve a relative importance score of 1 (being the maximum) with decline in perceived importance being mirrored by a decrease in relative importance, down to a minimum of 0 (being the minimum). The mechanics of this approach has been clearly illustrated in the purchasers' survey using the risk nominal scale in section 7.11. In order to demonstrate the calculation of the relative importance index technique, Table 7.21 was produced using this procedure. The first stage of the analysis was to consider the risk construct with the highest score: *customer satisfaction*.

Each of the 25 respondents rated this construct with any numerical score between 0 and 5 depending on its influence on the commercial FM service provider's decision to manage FM constructs effectively. Therefore, the: Relative Importance Index for *customer satisfaction:*

= 118/5*25 = 0.94

In this instance, the relative importance index of *customer satisfaction* is 0.94 and was ranked as the most important risk construct that commercial providers faced when managing effectively healthcare FM businesses.

7.35 Commercial providers' risk factors affecting healthcare FM performance

Table 7.21 shows the fifty-four (54) critical risk constructs established in this survey that were faced by external FM providers when managing healthcare FM contracts. The risk constructs used were identified as the critical management-related factors towards improving FM business success and reducing the risks involved in managing NHS support services that front the effective delivery clinical services. These risk constructs were regarded as critical as they can adversely affect commercial providers' ability to achieve business objectives and thereby execute service strategies successfully. As a result of this business scenario, if these constructs were unmanaged, they would expose the entire service provider organisation to serious FM business non-performance or disruptions in the NHS. In this survey only the top ten risk constructs shown in Table 7.21 were analysed and ranked according to their relative importance to the commercial FM service provider's best practice FM process. The researcher adopted this approach with a view that this approach could be extended further to analyse all the external providers' surveyed constructs. Given the detailed nature of this survey, it was not possible to analyse all constructs individually as it was time consuming. However, it was seen fit by the researcher to analyse the external providers' main FM risk constructs identified in this survey. The main constructs that were highly rated by external providers as affecting the effective management of non-clinical services in the NHS were:

1 Customer satisfaction (0.94);
2 Return on capital employed (0.936)
3 Provider Reimbursement method (0.928)

Table 7.20: Test of distribution for normality on commercial providers' constructs

Risk construct	Statistic	Significance
Clinical strategic fitness	1.239485	0.092588
Organisation cultural disparities	1.264315	0.081765
Management development	1.256757	0.084941
Service competition	1.527677	0.01879
Price competition	1.156378	0.137848
Market intelligence	1.310089	0.064599
Information strategy & confidentiality	1.140072	0.148557
Service value management (Best Value)	1.429228	0.033633
Social corporate responsibility (SCR)	1.073295	0.199533
Service Cost certainty	1.884823	0.001642
Service speed	1.156378	0.137848
Service delivery certainty (time)	1.578944	0.013664
National minimum wage requirements	1.056518	0.214264
Service quality reliability	1.768301	0.003846
Service level agreement	0.920765	0.364706
Service contract design	1.045316	0.224552
Innovation (service and core business)	0.965628	0.30868
Economy (International & national)	1.172999	0.127586
Service availability	1.571665	0.014305
Staff participation and partnership	1.418001	0.035854
Service variations	1.382033	0.043854
Customer satisfaction	2.247019	0.00823
Continuous service improvement	1.256757	0.084941
Staff motivation and knowledge	1.680541	0.007046
Financial transfer/stability	1.252486	0.08678
Business transfer costs	1.696298	0.006335
Stakeholder resistance	1.3	0.068092
Performance guarantees	1.11103	0.169274
TUPE	1.004956	0.264725
Customer care	1.630491	0.009815
Provider Reimbursement method	1.067086	0.204891
Partnerships	0.997802	0.272363
Purchaser's financial reputation	1.213822	0.105007
Third way (Political, Physcho-social)	0.815401	0.519301
Service measurement	1.262765	0.082408
Clinical-related	1.24638	0.089468
Medical technology innovation	1.386088	0.04288
Healthy and Safety	1.491213	0.023417
Customer involvement	1.518445	0.019877
Environmental impact/issues	0.819322	0.513051
Benchmarking best FM practice	1.208525	0.107736
Technology transfer/exchange	1.483685	0.02449
Agency/ delegating decision making	1.024293	0.244864
Change management (cultural)	1.040026	0.22954
Business process re-engineering	1.15813	0.136736
Health Legislation compliance	1.798487	0.003101
NHS Trust image	1.226478	0.09872
Corporate business taxation	1.189322	0.118123
Primary care impact	1.54934	0.016445
Insurance liability costs	1.16982	0.129499
Management accounting systems	1.034609	0.234732
Profit margin	0.881868	0.418247
Return on capital employed	0.94857	0.329244
Working capital	1.229228	0.097396

Table 7.21: Commercial providers' group ranking of FM risks

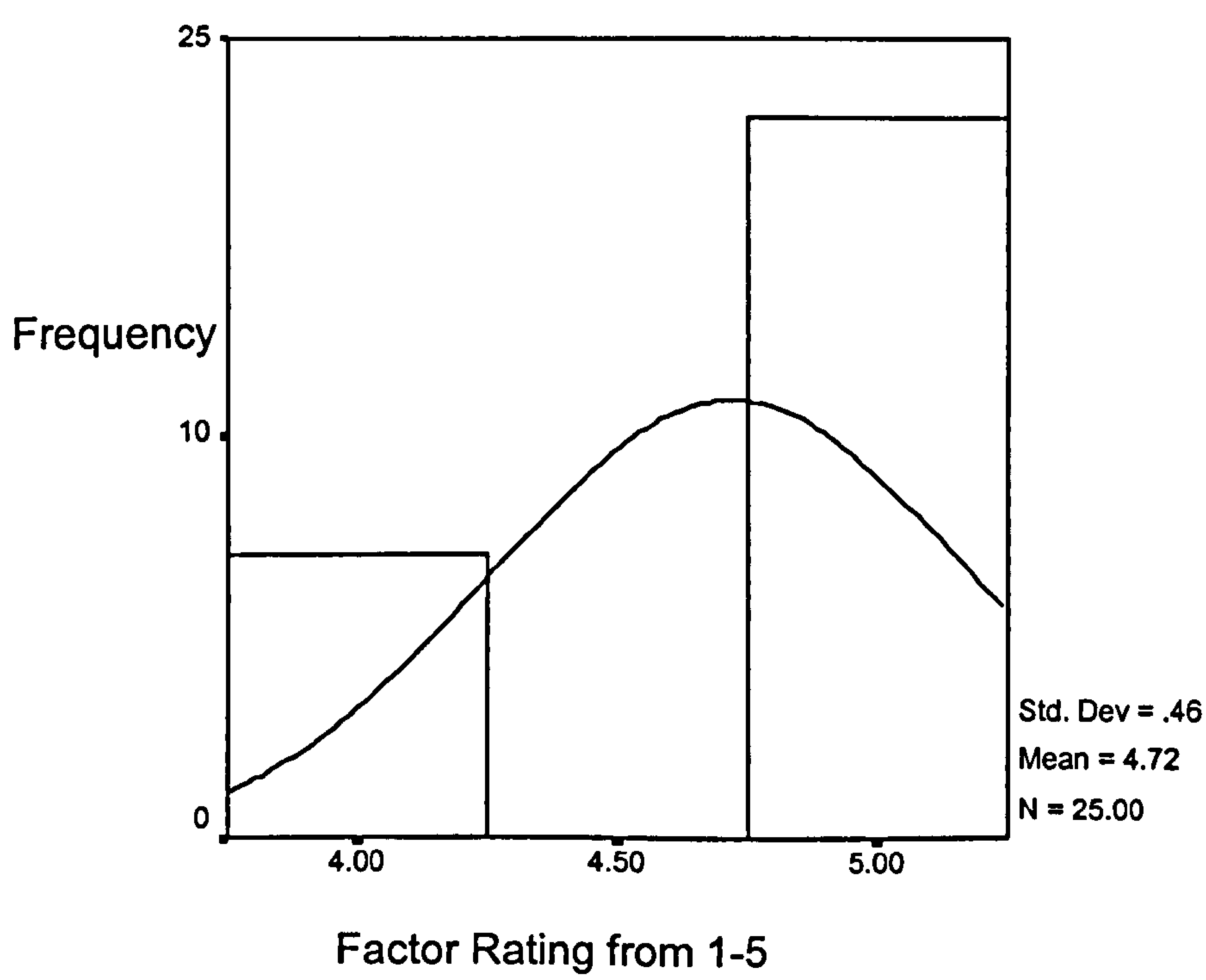
Care FM related risks	≥4	3	≤2	Total	Relative Importance Index	Rank
Customer satisfaction	25	0	0	25	0.94	1
Return on capital employed	24	1	0	25	0.93	2
Provider Reimbursement method	24	0	1	25	0.92	3
Partnerships	22	2	1	25	0.85	4
Working capital	23	0	2	25	0.85	5
Purchaser's financial reputation	23	0	2	25	0.85	6
Health and Safety	23	0	2	25	0.84	7
Customer involvement	23	1	1	25	0.84	8
Service value management (Best Value)	21	4	0	25	0.83	9
Service quality reliability	12	10	3	25	0.82	10
Staff motivation and knowledge	21	1	3	25	0.73	11
Innovation (service and core business)	22	3	0	25	0.73	12
Service speed	19	5	1	25	0.73	13
Customer care	12	8	5	25	0.73	14
Health Legislation compliance	21	1	3	25	0.73	15
Business transfer costs	21	3	1	25	0.73	16
Service Cost certainty	20	4	1	25	0.72	17
Benchmarking best FM practice	20	4	1	25	0.72	18
Staff participation and partnership	20	5	0	25	0.72	19
Price competition	21	3	1	25	0.72	20
Continuous service improvement	21	1	3	25	0.72	21
TUPE	20	1	4	25	0.71	22
Service measurement	20	3	2	25	0.71	23
Service variations	17	7	1	25	0.71	24
Change management (cultural)	17	7	1	25	0.71	25
NHS Trust image	17	6	2	25	0.71	26
Service competition	21	3	1	25	0.71	27
Service level agreement	20	0	5	25	0.71	28
Service contract design	17	7	1	25	0.71	29
Financial transfer/stability	16	8	1	25	0.69	30
Information Strategy & confidentiality	16	4	5	25	0.69	31
Clinical strategic fitness	19	10	1	25	0.69	32
National minimum wage requirements	14	7	4	25	0.69	33
Performance guarantees Profit margin	20	4	1	25	0.69	34
Environmental impact/issues	15	5	5	25	0.69	35
Management accounting systems	16	4	5	25	0.69	36
Organisation cultural disparities	19	5	1	25	0.69	37
Management development	18	5	2	25	0.68	38
Market intelligence	14	10	1	25	0.68	39
Economy (International & national)	16	6	3	25	0.68	40
Social corporate responsibility (SCR)	13	4	8	25	0.68	41
Flexible working	14	6	5	25	0.67	42
Medical technology innovation	19	3	3	25	0.67	43
Corporate business taxation	18	4	3	25	0.65	44
Business process re-engineering	14	10	1	25	0.64	45
Clinical-related	16	1	8	25	0.64	46
Technology transfer/exchange	13	7	5	25	0.64	47
Third way (Political, Physcho-social)	14	5	6	25	0.62	48
Stakeholder resistance	13	7	5	25	0.61	49
Agency/ delegating decision-making	13	10	2	25	0.61	50
Primary care impact	14	10	1	25	0.61	51
Service availability	12	2	11	25	0.68	52
Insurance liability costs	13	11	1	25	0.68	53
Sourcing risk	13	5	7	25	0.56	54

4 Partnerships (0.856)
5 Working capital (0.856)
6 Purchaser's financial reputation (0.856)
7 Healthy and Safety (0.846)
8 Customer involvement (0.840)
9 Service value management (0.830)
10 Service quality reliability (0.824)

7.36 Customer satisfaction

Commercial providers ranked *customer satisfaction* as the most important risk construct they faced when developing business strategies in healthcare FM operations. Table 7.21 shows that customer satisfaction had an overall index of 0.944 and was highly rated with a repeated rating score of 4 or more on the importance scale by all the 25 (100%) commercial providers surveyed. Furthermore, Figure 7.9 also shows that the mean score for customer satisfaction was 4.72, and the standard deviation was 0.46. The results for this construct signify how important it has become for external FM service providers to meet customers' clinical needs and expectations when delivering hospital services in the NHS.

Figure 7.9: Frequency distribution of Customer satisfaction



In hindsight, Figure 7.9 clearly indicates that the distribution of the factor scores was closely related as shown by the standard deviation and a mean value of 4.72.The results obtained in this survey are not surprising given that the need to deliver customer-focused facilities solutions has become the ultimate goal for every successful FM commercial provider that seeks to be competitive and reduce operating costs and overheads. It can also be said that customer satisfaction is extremely important in the NHS, as costs associated with service mistakes in a sensitive sector such as healthcare are highly unacceptable, as they can put public healthcare at risk (i.e. health deterioration or death). Thus, in delivering customer-driven non-clinical services, commercial providers will be seeking to enhance clinical services which are core to the healthcare process, and simultaneously allowing for more repeat business.

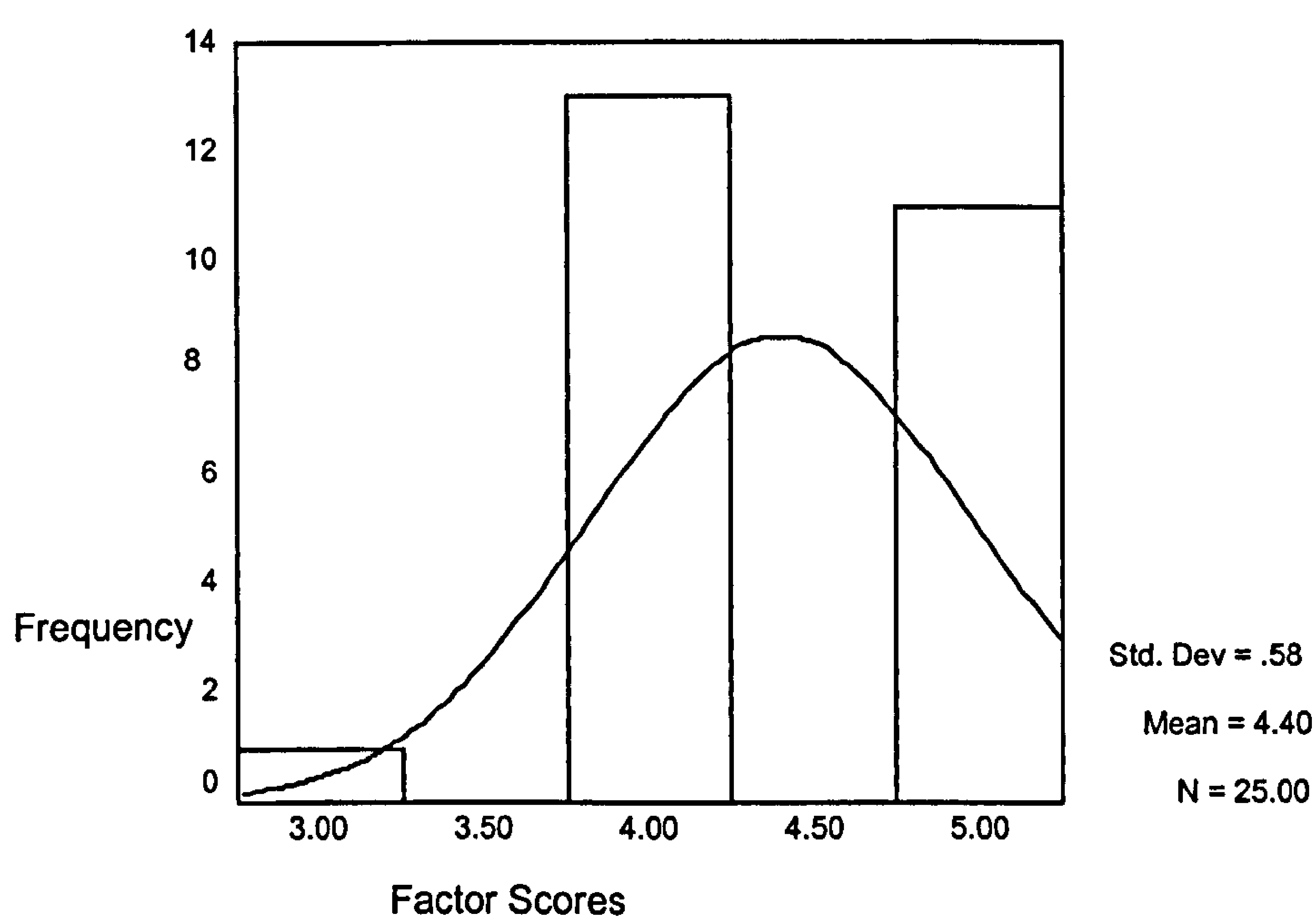
As a consequence of commercial providers meeting their customers' non-clinical service needs in hospitals, risks associated with the service provision of responsive healthcare are drastically reduced resulting in improved patient focused care in the NHS. As for commercial healthcare executives, FM allows them to plan and manage the practical delivery of a range of integrated and complex non-clinical services to their internal (hospital departments) and external customers (patients, staff and visitors) in an environmentally friendly workplace. Customers are the sole purpose for any healthcare business and its survival. As a result, it follows that the importance of customers and meeting their clinical needs is central to the provision of high quality support services that can contribute to the efficiency, economy and effectiveness of purchaser in the NHS. It is through having an understanding of the healthcare business environment, and knowledge (market intelligence) about non-clinical customers' needs that FM directorates become more focused in managing the dynamic clinical outcomes of customers in NHS Trusts. Therefore market intelligence becomes a very effective way of matching clinical resources to business risks. According Payne and Rees (1999) customer satisfaction in NHS trusts provided by FM departments (commercial/internal) has become the "vital" link in the process of delivering clinical and support services in the current post modern era of a "24 hour shopping" culture which exists in the NHS. Furthermore, Alexander (1992) considers customer care provided through service excellence as a key niche for designing and delivering best value responsive support services that reduce service risks and failures.

The implications of customer satisfaction are therefore that commercial providers should use business models that focus on providing best value facilities that meet customers' expectations in order to avoid service failures or else risk business discontinuity. Customer satisfaction becomes a measure of the overall commercial provider's business perceived performance relative to customer expectations. As noted in the purchasers' survey, this is often measured by various customer focus group surveys using a repeatable process to track service needs or changes over time.

7.37 ROCE

Table 7.21 shows that ROCE was rated as the second most important construct faced by commercial providers when managing FM operations effectively in the NHS. Furthermore, Figure 7.10 also shows that the mean score for ROCE was 4.40, and the standard deviation was 0.58. Figure 7.10 clearly indicates that the distribution of the construct scores was closely related as shown by the standard deviation and a mean value of 4.40.

Figure 7.10: Frequency distribution of ROCE



Since external FM providers are commercial entities, their main objective in business is to maximise the overall profitability and capital performance or yield (ROCE) of their organisations.

ROCE becomes an important financial performance indicator in the sense that, it is the percentage return on capital employed by the external provider. Therefore in healthcare FM operations, ROCE is defined as the business profit made by external providers before interest and tax are deducted divided by the initial capital employed (investment) and multiplied by hundred. A positive ROCE is normally achieved by managing effectively the financial resources invested by commercial providers towards the effective management of support services and hence the business process in order to minimise service failure risks. This is to say that for any FM service transaction they will have entered into, commercial providers will expect a sustainable investment yield. The yield obtained in such operations should always justify the amount of risks providers carried in order to maximise profitability in their healthcare FM operations. In this survey, it not surprising therefore that most commercial providers ranked return on capital employed as the second most important risk construct they faced when managing FM businesses.

7.38 Provider reimbursement method

Provider reimbursement method was ranked third with an overall relative index of 0.928. In overall, Table 7.21 shows that 24 (96%) external providers surveyed highly rated this factor with a score of 4 or more. This is surprisingly high compared to its relative index even though there is no mathematical relationship between these two sets of measurement. It should be noted that the percentage of respondents scoring 4 or more is just a way of expressing the importance of the constructs. In this case, the high value may be due to the fact that most commercial providers rated this construct with a score or 4 or more, signifying that it was contractually binding that commercial providers be paid in time by their purchasers/clients for FM services they will have rendered. The time for paying certified FM claims by the external provider is normally fixed in the terms and conditions of the FM contract. As a result of this, any service variations from the agreed scope of FM work, payment methods and dates by the purchaser (i.e. the purchaser did not honour the payment certificate in accordance with the FM contract), would cause serious cash flow problems on the part of the commercial FM service provider to perform the work agreed in the service contract.

Recently, most purchasers have been facing resource constraints especially finance to pay for services rendered by various commercial FM providers. As this situation is normally a result of restrictions in funding from central government, most commercial providers might have had in the past their payment certificates not honoured in time resulting in operational inefficiencies under the contract. So, it seems that it was essential from contract initiation that commercial providers were aware of the time schedules and the current method of payment for certificates to be honoured in their FM service contracts. The method of payment is normally part or stage payment until completion of FM works. In some instances, it can be a lump sum payment for minor FM service works (i.e. can be completed within 30 days). In this survey, it would appear that external providers knew that, the failure to be paid in time by purchasers poised huge business problems related to the strategic operation of non clinical services effectively, as well as the lack of cashflow to use and pay FM staff they employed.

7.39 Partnerships

Partnership was ranked fourth with a relative importance index of 0.856. It can be seen in Table 7.21 that 22 (88%) commercial providers surveyed highly rated the need to have strategic *partnerships* with a score of 4 or more. In this analysis it can be said that since commercial providers were aware that the provision of value for money services coupled with the transfer of service operation risks in the NHS had an inescapable social, commercial and political dimension. Hence the need to form strategic partnerships that apportion risks fairly and squarely among commercial providers, purchasers and other stakeholders would continuously improve the delivery of healthcare services. The advantage of partnerships is that they allow for a free flow of information among commercial providers and purchasers resulting in service operators designing and managing the FM service process that will underpin the delivery of healthcare more efficiently. Perhaps commercial providers through their past commercial experience were aware that to balance business objectives against cost, quality, risk and quantity in healthcare FM operations was too difficult a task to achieve although given that there is a market for the healthcare service. In this case commercial providers would make sure that by using partnership arrangements also reduces overheads in service contract management.

This approach would make it a more economically viable option for both purchasers and providers when delivering FM services. However, the main merits of corporate partnering as a business strategy for delivering FM services in the NHS are that it brings the following; additional management and service expertise; marketing and commercial strength; modern methods, the much needed business information and medical technology and equipment; capital investment and greater career development potential for staff.

7.40 Working capital

Working capital was ranked fifth with a relative importance index of 0.856. It can be seen in Table 7.21 that 22 (88%) commercial providers surveyed also rated *working capital* with a score of 4 or more. Therefore, in healthcare services provision external provider should always have enough capital to invest in the total delivery of FM services if their businesses are to be commercially viable. It seems that commercial providers were well aware of the problems related to effective cash flow management in healthcare FM operations in the NHS, in order to maintain business continuity (as seen in section 7.37).

In light of this, having sufficient working capital to run FM capital projects was a key performance indicator that reflected the amount investment commercial FM providers were prepared to inject towards the effective management of non-clinical services. Any shortages in working capital would result in inefficiencies related to the normal day-to-day support service provisions that are much needed to front the clinical business process in the NHS. Recently, the lack of working capital to manage integrated non-clinical services effectively has been seen by NHS customers as a failure on the part of commercial providers to deliver value for money services to FM purchasers.

7.41 Purchaser's financial reputation

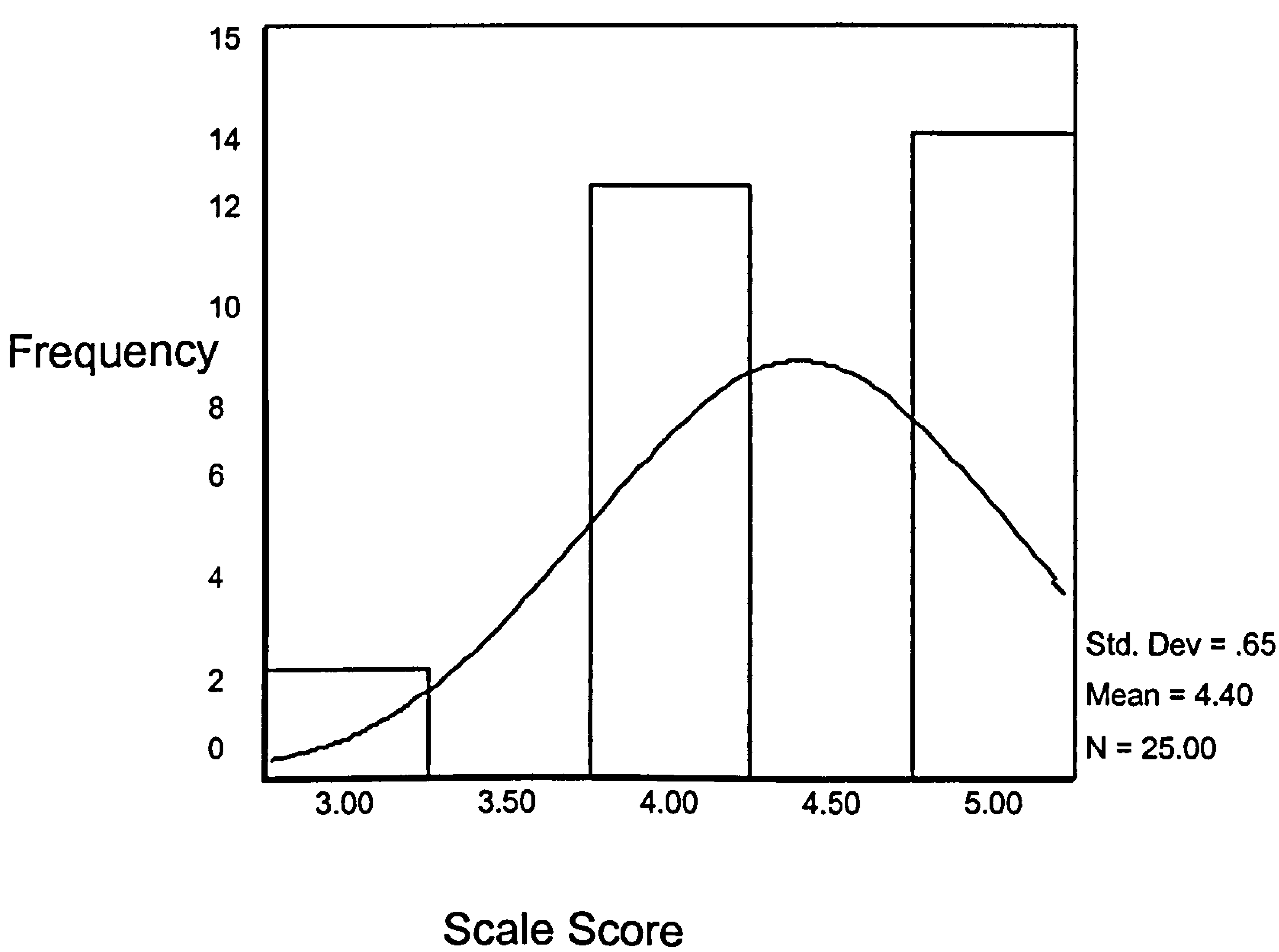
The *purchaser's financial reputation* was ranked as the sixth critical construct that affected the commercial providers' FM service process, and had a relative index of 0.856. It can be seen in Table 7.21 that 21 (84%) commercial providers surveyed rated *purchaser's financial reputation* with a score of 4 or more.

The results here are not surprising given that most FM purchasers/trusts recently have been suffering from serious cashflow and financial difficulties. As a result of this crisis, commercial providers needed to evaluate the financial stability of their clients (purchasers) in order to see whether they would be paid for FM work done. It not surprising that commercial providers needed to first vet the financial stability of the purchasers they were dealing with before engaging into an FM contract. The problem of financial stability has been one of the biggest risks in the healthcare business management. Probably commercial providers due to their vast business experience were well versed with the implications of working for a purchaser/client who was not financially stable. The business implication of this construct might have led commercial providers to rank the purchaser's financial reputation as a critical construct to be managed when providing FM services in the NHS.

7.42 Health and safety policy

Health and safety was ranked seventh by 22 (88%) external providers surveyed and had an overall relative index of 0.846. These commercial providers also rated *health and safety* with a score of 4 or more.

Figure 7.11: Frequency distribution of Health and safety



Furthermore Figure 7.11 also shows that the standard deviation was 0.65, while the mean rating score for *health and safety* was 4.4. It is of paramount importance that any commercial FM provider operates a strategy that promotes public health, clinical governance and a culture of delivering safe non-clinical services to NHS customers. This approach allows customers to have maximum confidence and guarantee in the patient environment that is that are provided in the NHS. As a result, the success or failure of any external FM provider's health and safety management system is drastically affected by the corporate and service culture within that organisation.

This also indicates external provider organisation's high commitment to public health and safety when delivering support services. Therefore, an effective health and safety policy for the external provider organisation would function as the first place that employees (i.e. FM staff) and others can go to determine the basic health and safety responsibilities and arrangements to ensure safe systems of work within their organisation in the NHS. There is a legal requirement to ensure that hospitals facilities and support services are publicly safe to use and work in, properly managed and that external service providers are correctly trained. The key piece of health and safety legislation that governs this is the Health and Safety at Work Act 1974 s. 2(3). It includes specific duties for external service providers working for purchasers and users of healthcare facilities (as well as others) for which failure to comply is a criminal offence. The European legislation also has an impact on health and safety in the provision of non-clinical services in the UK NHS. These legal requirements are covered under risk assessment in the Health and Safety at Work Act 1974. The Health and Safety at Work etc. Act 1974, s. 2(3) gives a legal requirement for the preparation of this policy. However, the size and scope of the documentation for it can range from a single simple statement to detailed sets of safety manuals. There are three components to the policy: the method statements, the external provider organisation's policy and the arrangements for carrying out the policy aims. As important as the content are, the means by which the policy is communicated and distributed allows for adequate review and revision of its contents. So in this case, it is not surprising that external providers were aware that when providing FM services to customers in the NHS, there is a dire need for external providers to follow an effective health and safety policy or business strategy that reduces the risk of public danger.

7.43 Customer involvement

Commercial providers identified *customer involvement* in the design and delivery of integrated non-clinical services as the eighth most important construct in the management of healthcare FM operations. Table 7.21 shows that 23 (92%) commercial providers surveyed rated *customer involvement* with a score of 4 or more resulting in an overall relative index of 0.840. These findings are very encouraging and informative given that *customer involvement* was also seen in the purchasers' survey as the third most critical risk factor in the management of FM operations (see section 7.16). Therefore, it is not surprising that these two surveys revealed that the effective management of non-clinical services in the NHS heavily dependant on the needs, expectations, and involvement of customers. NHS customers are the core users of healthcare services and will have both varying clinical and non-clinical service needs.

It can also be concluded in this survey that commercial providers had much intelligence about modern business strategies that specify for the effective utilisation of customers' knowledge, experience and expectations in designing and managing support services in the NHS. Furthermore, Payne and Rees (1999) in their work on healthcare FM decision-making also support the view that, customer service knowledge must first be elicited through FM audits and market surveys and then used as expert knowledge in the service delivery process. Payne and Rees value customer involvement as central to the effective management seamless support services in a core public organisation such as the NHS. In this survey it can also be said that commercial providers were aware of service failure risks that are associated with the lack of incorporating customers' views in designing the delivery process. Hence, the setting of service levels and specification of facility related service attributes and elements was not complete without involving or consulting internal and external customers (end-users and the other in-house departments) that use non-clinical services when receiving healthcare. Therefore, it becomes imperative that when support service output levels are being designed, they should have measures or performance indicators that allow customers to specify their clinical needs and expectations.

Furthermore, they should also allow external providers through service level agreements to determine what service deliverables they need, and when they can be delivered at the POSD?

7.44 Service value management (best value for money)

Service value management was ranked as the ninth most important risk construct with an increased business effect on commercial providers' business process strategies in the NHS. Table 7.21 clearly shows that 21 (84%) providers surveyed valued this construct as being important with a rating score of 4 or more. Therefore, well-defined support services and their associated service levels are fundamental components of any successful FM service management contract. In this case, the key to successful service value provision in healthcare encompasses defining services and service levels, that:

i. can be measured and managed in various demand driven situation in the NHS; can be audited;
ii. can be provided at a cost effective price to meet customers' service needs and expectations and;
iii. is capable of delivering maximum value to the users of FM services.

It is within the above context that commercial providers saw adding value to non-clinical services in the NHS as the critical success factor and their niche in healthcare management. As seen in the purchasers' survey in section 7.21, the addition of service value could be negative if it subtracted from the basic core value. So, it should be borne in mind that not all purchasers perceive an added value, either because some cannot use the extra services, or because the augmentation reduces an offering's value. Furthermore Figure 7.12 shows that the standard deviation of *service value management* was 0.75, while the mean value was 4.32. The statistical results (standard deviation and mean) obtained in Figure 7.12 carefully illustrate that the management and re-engineering of the entire FM service process was a critical factor towards the continued delivery of seamless and responsive non-clinical services in the NHS. Furthermore, the standard deviation of 0.75 shows that there was not much variation in terms of rating of the construct.

As service innovation has become of paramount importance in providing customers with the correct service expectations and needs, it follows that Akhlaghi's (1996) 3"Es": *economy* – providing support services to NHS customers at the lowest optimum cost; *efficiency* – delivering customer care services at the correct POSD and *effectiveness* – providing effective FM services and measuring their performance. The 3 Es sum up how commercial providers should focus on managing the non-clinical services process to produce better business performance results that will foster the management of the healthcare service provided in NHS trusts. Therefore, it can be concluded that according to external providers, FM has the potential to contribute significantly to the total integrated hospital services delivery plan. In hindsight, external providers also saw it as being important to identify and measure the "threshold" degree at which FM supports clinical businesses in the NHS. Probably, so that it can be adapted to the changing needs of customers and NHS organisations in order for it to contribute to the commercial FM service provider's business objectives of productivity, profitability and the delivery of service quality care. In this case it seems commercial providers were very much aware that service value in healthcare FM operations was specifically about managing the relationship between the service cost or price and quality or performance.

7.45 Service quality reliability

Service quality reliability was ranked as the tenth most important construct and had an overall relative index of 0.824. In addition 12 (48%) commercial providers surveyed scoring it with 4 or more on the importance scale. In this survey service quality refers to the total evaluation and service delivery system used by commercial providers, while reliability is the final process that brings customer satisfaction with regards the FM services being delivered at the POSD at the correct times. In healthcare business external service providers view quality reliability as the service loyalty that customers have towards the delivery of support services. This is largely influenced by the amount of FM service each customer receives at a particular moment. It not surprising that commercial providers saw cost, quality, risk and quantity, given that there were readily available customers for the service as being linked. Hence, the FM capacity required is a direct consequence of customer demand. Commercial providers have traditionally concentrated on managing cost.

The added dimension has been that of risk brought about by not providing the correct service quality in the NHS and may be commercial, clinical, political, physical or financial. In this survey it seems that commercial providers were also aware that there is a fine balance between acceptable risk and perceived service quality delivered responsively in the NHS.

7.46 Factor grouping using principal component factor analysis

To have an "insider view" of how the surveyed FM risk construct work together influencing the commercial providers' decision to manage effectively healthcare FM operations, and also to further explore the structure of the data. The PFCA technique was employed. Initially, suitability checks of the external providers' data collected were performed using the data reduction statistic test. The determination of the correlation matrix shown in Table 7.22 is 0.000041 that is greater than the required 0.00001. The results obtained in this survey clearly indicated that the data matrix did not suffer from multicollinearity or singularity (Kinear and Gray, 1999).

Table 7.22: Descriptive Statistics for Providers' FM risk constructs

Risk Construct	Average construct score	Standard Deviation
Customer satisfaction	4.4400	0.8206
Return on capital employed	4.6400	0.4899
Provider Reimbursement method	4.1200	0.4397
Partnerships	4.5600	0.6506
Working capital	4.2400	0.5972
Purchaser's financial reputation	4.1200	1.2356
Health and Safety	3.7200	0.9363
Customer involvement	4.1600	0.6880
Service value management (Best Value)	4.1600	1.0279
Service quality reliability	3.6000	0.8660
Mean score	**4.176**	**0.775**
Factor correlation matrix		**0.002377**
Kaiser-Meyer-Oklin		**0.6**

Kaiser-Meyer-Oklin measure of sampling adequacy was found to be 0.6 which greater than 0.5 confirming that the sampling adequacy is acceptable.

Secondly, a summary of the descriptive statistic for the mean scores and standard deviations of the most critical construct faced in the management of commercial providers' healthcare FM operations are presented in Table 7.22. Furthermore, a close analysis of Table 7.22 shows that the average score for the ten constructs is 4.176, while the mean standard deviation was 0.775. The results obtained in this survey if construed using the nominal scale (also used in purchasers survey see Figure 7.3), they show that commercial providers' ten constructs were highly valued with a *positive effect* on the FM service management process. In overall, the top ten risk constructs shown in Table 7.22 generally reflect a drive towards business and profit maximisation on the part of the surveyed commercial providers. In today's business world that is risky commercial providers offer their FM services with the view of improving their business performance (i.e. profit maximisation and shareholder growth). These results suggest a similar trend to that previously identified in the FM purchasers' survey. The purchasers' top ten constructs had a mean score of 4.28 and a mean standard deviation of 0.7. Such closeness in data results can be explained by the fact that risk management strategies of both FM purchasers and commercial providers in healthcare operations have, to date, been modest (i.e. risk averse) with all the average success scores clustered around the midpoint of 4 on the likert scale.

However, it is interesting to note that, whilst the overall risk exposure of non-clinical services on direct patient care was generally perceived to be less by healthcare executives. Its positive contribution through risk management to clinical service efficiency and managerial decision-making is readily acknowledged. The remainder of this section uses the summary success score to extensively explore other multivariate analysis approaches. The relationship between commercial providers' individual constructs and the overall performance measure of the ten constructs was explored by generating a series of correlation coefficients. These correlations utilised a one-tailed test and the correlation matrix that shows their loadings and significance. These results are presented in Table 7.23. A close examination of the correlation matrix of the ten constructs identified as the most critical factors in healthcare FM operations in Table 7.23 shows that the first three constructs extracted from the analysis which are *customer satisfaction*, *return on capital employed* and *provider reimbursement method* had high factor loadings.

In this survey, factor loadings provided a measure of the effectiveness of the analysis, while loadings are standardised correlations between components and items. As a result in this, high loading values suggest a high correlation between constructs. The three variables or constructs in Table 7.23 identified in the commercial providers' survey have a relationship with a score that is statistically significant at the 0.01 and 0.005 level. The highest of the coefficients was for *customer satisfaction*. The importance of offering customer-driven facilities solutions is recognised as a best practice factor in the maintenance of customer loyalty and delivery of seamless support services in NHS trusts. Therefore, its significant score in this analysis simply supports this existing business management theory. It is also important to note that non-clinical services in trust hospitals are necessity-led as a result would require a high degree of service focus on the customers' needs.

Table 7.23: Factor-Loading before varimax rotation – External providers' risk constructs

Variables	**Factors**			**Achieved Communalities**
	1	**2**	**3**	
Customer satisfaction	.903	.05265	.241	.876
Return on capital employed	.679	.501	.08539	.719
Provider Reimbursement method	-.145	0.06014	.963	.951
Partnerships	.377	.550	.519	.715
Working capital	.463	.729	.08539	.746
Purchaser's financial reputation	.450	.659	.244	.697
Healthy and Safety	.474	.05323	.828	.914
Customer involvement	.301	-.614	.675	.924
Service value management (Best Value)	.942	.282	.02038	.967
Service quality reliability	-.06984	-.875	.237	.827
Eigenvalues:	3.065	2.751	2.519	
Percentage of variance	30.650	27.509	25.190	
Cumulative % of variance:	45.704	73.051	83.349	

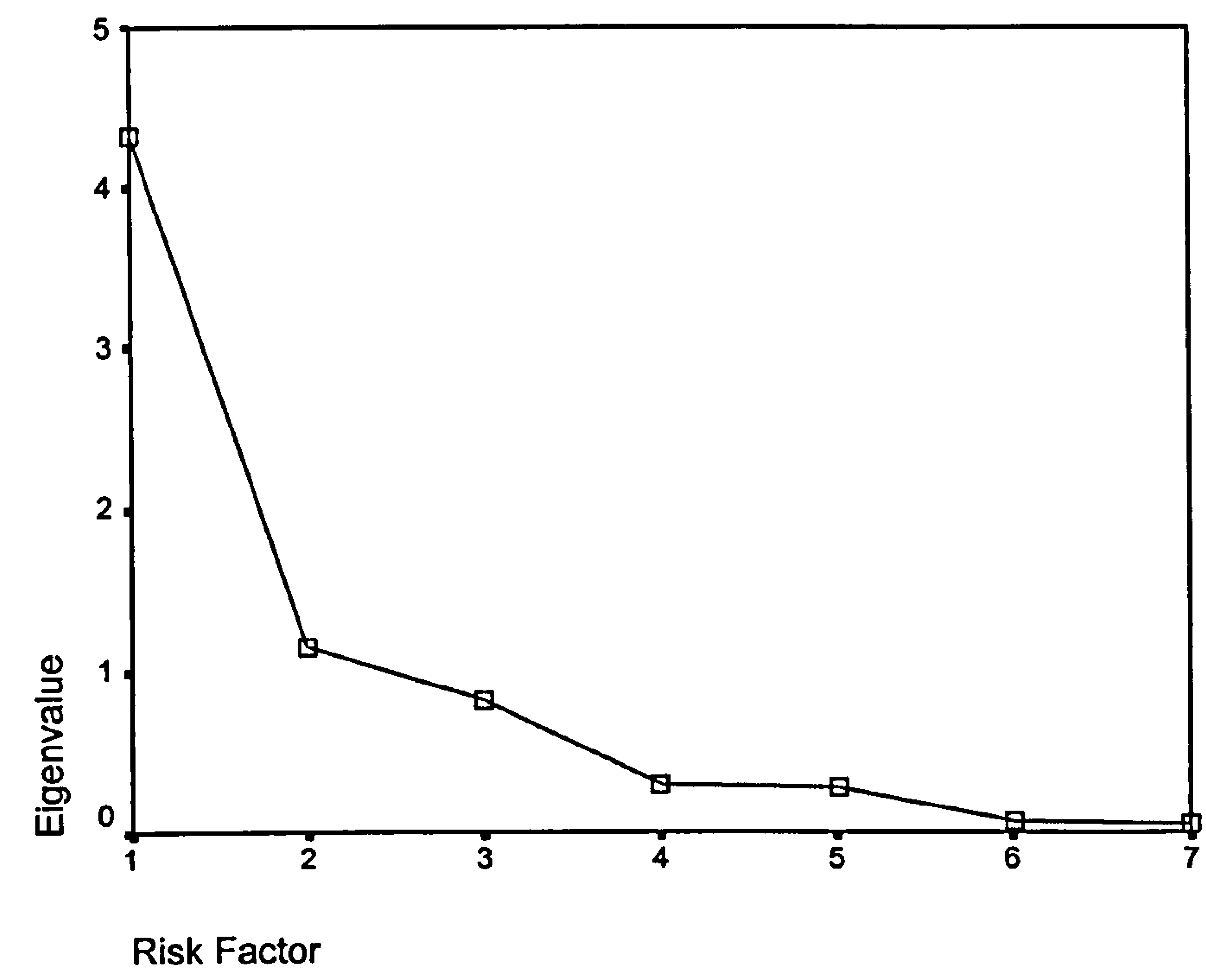
Other pertinent risk constructs that were also found to have significant correlations in the commercial providers' risk management and decision-making process, at the 0.01 and 0.05 per cent level, were *partnerships*, *health and* safety, *purchaser's financial reputation*, *customer involvement and service value management*. The use of the relative importance index technique earlier on in the analysis provided further evidence of the criticalness of these healthcare FM risk constructs.

In overall, the identified risk constructs reflect the need for commercial service providers to pursue effective strategic and competitive business approaches when managing risks in healthcare FM operations. Furthermore, Table 7.22 shows that all the ten constructs with their eignevalues, percentage of variance and cumulative percentage of variance. The first three component factors and their loadings were extracted from the analysis based on their eigenvalue being greater than 1 (see Table 7.23). Loadings are standardised correlations between components (in this case, FM risk constructs). High loading values suggest a high correlation between the represented commercial providers' construct or component. Table 7.23 also shows a summary of commonalities that show how much of the variance in the factors has been accounted for by the four factors extracted. For example, about 60% of the variance in customer satisfaction is accounted for. A close examination of the commonalties revealed that the four components account for over 60% of the variance in all the variables suggesting that the factor analysis has been very effective. Table 7.23 also shows the associated percentage of variance of the four factors; factor 1-87.6%, factor 2-14.59%, factor 3 -13.22% and factor 4 - 79.04% for factors *customer satisfaction, return on capital employed, provider reimbursement method, Partnerships, Working capital and purchaser's financial reputation* respectively. Like the percentage of variance in Table 7.23, the eigenvalues indicate the relative importance of various factors in accounting for the total variance in the data set. It is also important to note that factors with eigenvalues that are less than 1 (i.e. *service availability, Health and safety, service value management, staff partnership and motivation, health legislation compliance and service cost certainty*) are not selected because an eigenvalue value is a measure of standard variance with a mean of 0 and standard deviation of 1; and the variance that each standard variance contributes to the principal components extraction is 1. A component with an eigenvalue value of less than 1 is less important than an observed variable and can therefore be ignored.

In order to achieve factor loadings that are easier to interpret than those shown on Table 7.23, a varimax rotation was carried out on the factors. The objective of rotation is always to achieve final component loadings that maximises the variance of the squared loading in each column, and enable the factors to be identified. This had the effect of minimising the number of factors on which the variables have high loadings.

The new factor-loadings are shown on Table 7.24, and are easier to interpret psychologically. The new factor loading is simply the correlation coefficient between an original variable and an extracted factor. Thus the higher the absolute value of the loading the more the variable contributes to the factor. After the rotation it was self-evident that *customer satisfaction, return on capital employed, service value management and service quality reliability* all loaded substantially on factor 1 in that order, while *working capital, purchasers' financial reputation, health and safety, partnerships and service quality* also loaded only on factor 2 and *provider reimbursement method, return on capital employed, working capital, health and safety and customer involvement* loaded on factor 3.

Figure 7.12: External Providers' scree plot



Moreover, a scree plot of factors shown in Figure 7.12 revealed that the data lies close to two dimensional subspace and would therefore represent the whole data and thereby reduce any concentration on the none principal factors of the data. Further analysis shown in Figure 7.12 classified risk factor loadings into seven main groups. Taking the eigenvalue in Table 7.24 as a measure of importance, it is self evident that factor 1 had the highest eigenvalue of 3.065 and the most import group of risk factors that influence the commercial FM service provider's FM service delivery process. This was followed by factor 2 and 3 with eigenvalues of 2.751 and 2.519 respectively.

Table 7.24: Initial statistics of Principal Component Factor Analysis – Providers risk decision factors

Component Factors	Initial eigenvalues Total	Percentage(%) of Variance	Cumulative % of variance
1	4.57	45.704	45.704
2	2.735	27.347	73.051
3	1.03	10.298	83.349
4	0.872	8.721	92.07
5	0.345	3.447	95.517
6	0.211	2.106	97.623
7	0.106	1.062	98.685
8	0.07906	0.791	99.475
9	0.03541	0.354	99.83
10	0.01704	0.17	100

7.47 Summary

From this analysis, it can be concluded that commercial providers also faced a multivariate of risk constructs that were similar to those identified in the purchasers' survey. The constructs are related to their core business objectives when delivering effective non-clinical services that underpin the delivery of healthcare in the NHS. In this survey, commercial providers identified fifty-four risk constructs that had a significant (i.e. negative, positive or neutral) effect towards the effective management and delivery of FM services in the NHS. The conclusion that can be made from this analysis is that the management of non-clinical services in the NHS involves a number of complex risk constructs that if managed (identified, evaluated and quantified) effectively can become the critical success factors of managing healthcare FM operations in the NHS.

In-house FM in-house providers' survey

7.48 Introduction

This section presents results of a questionnaire survey carried out on twenty-five (25) facilities executives working for FM in-house providers managing healthcare operations in the NHS.

7.49 Characteristics of the in-house FM providers surveyed

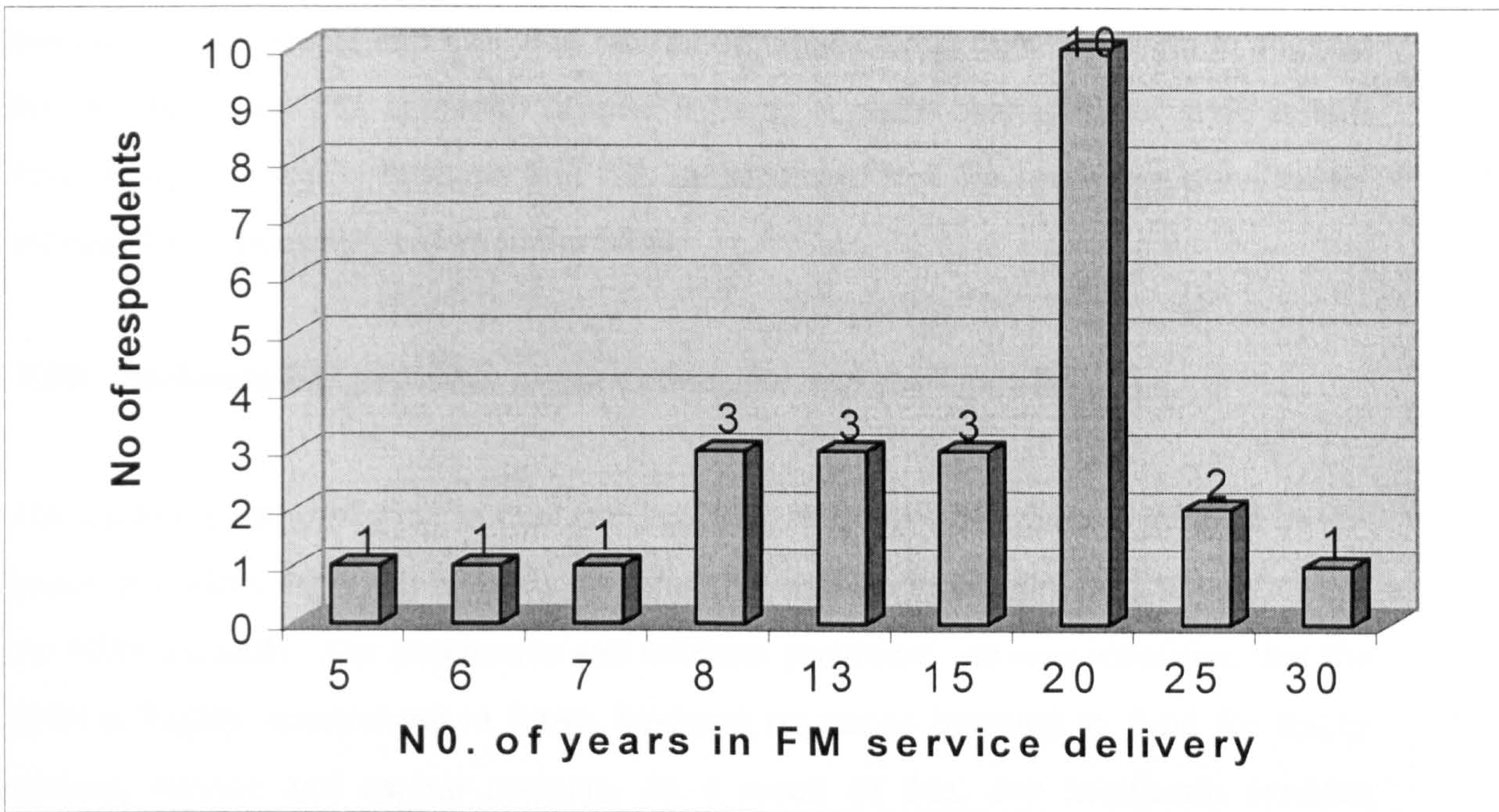
Table 7.25 shows the type of in-house providers that were providing non-clinical services to those purchasers identified earlier on in this study.

Table 7.24: In-house FM providers surveyed

Type of FM in-house provider	N0. Surveyed	Percentage (%) Surveyed
Acute	7	28
Acute and Community	5	25
Teaching	3	12
Community/Mental	3	12
Integrated Acute	7	28
Total	25	100

In terms of years of experience in managing non-clinical services under an FM directorate, Figure 7.13 shows that the frequency range of distribution of the in-house providers was 25 (5-30) years in the NHS. If these results were compared with those from the purchasers and external providers' surveys, a distribution range of 25 years obtained in this survey is not surprising. This is considering the fact that the management of non-clinical services using FM directorates in the NHS is a new management style (post-modern) of patronising the entire range of support services. More also, given that FM in both the UK and NHS is still in its embryonic stage, it can also be inferred that the integrated FM approach in the majority of in-house providers was steadily developing into becoming the best practice in the NHS.

Figure 7.13: Experience in FM service delivery



N0	Kurtosis	Mode	Mean	Median	Std. Deviation	Skewness	Range	Variance
25	-1.073	20.00	16.24	15.00	7.032	-.136	30.00	49.46

In addition to Figure 7.13 also shows some descriptive statistics on the FM experience possessed by the in-house providers. It can be seen that the average number experience in-house providers had in delivering non-clinical services the FM approach was 16 years. Although the results in Figure 7.13 indicate a relatively low rate of FM development in the NHS, they compare very well with the purchasers and commercial providers' surveys. Furthermore, the number of years shown in Figure 7.13 also indicates that 18 (72%) in-house providers were more experienced and also possibly more competent than the other 7 (28%) in-house providers surveyed in managing non-clinical services their FM directorates in the NHS. On close analysis of Figure 7.13, it can be seen that 16 (64%) in-house providers had more than 15 years of FM experience, of which 13 (52%) had more than 20 years in providing integrated non-clinical services. The experience possessed by these in-house providers although slightly higher in this case could well be due to the reasons established in the purchasers' survey about the use of different management approaches by in-house providers, and service development in the NHS (see section 7.1).

As a consequence of this, it not surprising that those in-house providers that had more than 15 years of experience might have been using these other variant systems of managing non-clinical services. The results obtained in this question seem to suggest that an integrated FM approach despite it being a recent management style is still developing as a useful business and risk management tool for managing non-clinical services by in-house providers in the NHS.

7.50 In-house FM provider organisation size and staff employed

The question was designed to evaluate business resources that were employed by in-house providers surveyed towards the effective management non-clinical services in the NHS annually. The purchasers and external providers' surveys identified that the NHS is highly constrained in terms business resources invested to fund for major clinical, service and capital projects. As a result of this, any healthcare services modernisation initiative has always hinged on having adequate business infrastructure, human and operating resources to meet FM customers' service needs and expectations in the NHS. In order to provide integrated care services in Trusts, there must be sufficient and knowledgeable in-house staff (FM expertise) to manage healthcare facilities and support services. In turn these support services will serve to satisfy both new and loyal service customers being provided with long or short-term care in hospitals, to sustain the core (clinical) business. Thus, for any purchaser (trust) to have effectively managed healthcare facilities and support services, in-house providers must have sufficient resources that can sustain the delivery of non-clinical services 24-hours a day.

Tables 7.25 and 7.26 show the number of FM staff employed by in-house providers against their annual operating budgets. In Table 7.25, it can be seen that 7 (28%) in-house providers managed FM services for those purchasers who provided integrated care services to NHS customers. Furthermore, on average (mean) 202 FM staff were employed by these in-house providers to deliver FM services in the NHS. The results above show that those in-house providers managing non-clinical services to underpin the delivery of integrated care services were serving the largest number of customers in the NHS.

As these in-house providers had the highest number of staff they employed, it can also be inferred that they were working for large and much more complex hospital trusts. These results are not surprising at all given that purchasers who manage integrated care services as part of centralised clinical services in the NHS now provide a mixture of acute, community, teaching and mental care services on one hospital site (one stop shop) to patients, staff and visitors

Table 7.25: Number of FM staff employed

Type of in-house FM provider	No. of respondents	Mean	Median	Standard deviation
Integrated	7	202	202	25
Acute	7	139	130	25
Acute and Community	5	52	47	22
Teaching	3	28	25	14
Community/Mental	3	14	14	13

As the provision of care has become 24 hours, most integrated FM purchasers would be expected to have larger in-house FM directorates supporting the delivery of their core (clinical) business in the NHS. This normally results in high costs of expenditure in managing effectively support services and remunerating staff employed to provide these non-clinical services efficiently. Table 7.25 also shows that 7 (28%) in-house providers fronting acute care services were second largest, in terms of the average number of FM staff employed and the operating budget used to manage non-clinical services. Again, Table 7.25 shows that those in-house providers delivering non-clinical services to purchasers providing acute services employed on average 139 FM staff, while Table 7.26 shows that they were also operating an annual budget of £12 million. These results are interesting and signify that these in-house providers were regarded as medium to large directorates, and were servicing medium to large FM purchasers delivering less complex non-clinical service solutions to NHS customers. In overall, Tables 7.25 and 7.26 show that those in-house providers who were providing non-clinical services to purchasers managing acute and community care services employed on average 52 FM staff, and were also operating an annual budget of £9.9 million. The results here show that these in-house providers can be considered as medium sized FM directorates proving non clinical services to less customers compared to those providers fronting integrated and acute care services in the NHS.

Tables 7.25 and 7.26 also show that in-house providers delivering FM services to purchasers managing integrated care services used twice as much resources than those in-house providers fronting acute and community services to NHS customers. The inference which can be drawn out from these results this is that those in-house providers delivering non-clinical services that front acute and community services had a less customer segment base than their counterparts managing FM services for those purchasers providing integrated care services.

Table 7.26: Annual FM budget

Type of in-house FM provider	No. of respondents	Mean £Million	Median £Million	Standard deviation
Integrated	7	21	21	109
Acute	7	12	10.8	105
Acute and Community	5	9.9	11	18.8
Teaching	3	7	6.0	12.2
Community/Mental	3	4.5	5.1	15.5

As a result they can be regarded in this survey as being medium to large service organisations due to the FM staff and annual income resources they employed in the NHS. Furthermore, Table 7.25 also shows that 5 (20%) in-house providers surveyed were delivering FM solutions to purchasers providing teaching clinical services in the NHS. In addition, these in-house providers also employed an average of 28 FM staff while also operating a budget of £7 million annually. The results here are not surprising given that most purchasers who provide teaching and clinical services in the NHS now require their in-house providers to manage modern healthcare facilities and qualified staff to deliver FM services that enhance the delivery of research and care services to customers. As a result of this, the effective management of such support services required a sizeable amount of FM resources to expand in order to improve the levels of service delivery. Tables 7.25 and 7.26 also show that teaching hospital trusts (teaching hospitals) in the NHS can be regarded as medium to small size. As a result of this, they required less FM staff and capital resources to deliver high quality non-clinical services that front community and teaching services in the NHS. It is not surprising that these resources have always been limited as they are scarce, resulting in less competitiveness on the part of in-house providers to match competition-geared and publicly funded commercial providers.

The main reasons as to why in-house providers have limited resources has already been highlighted above and in chapter 2 (Section 2.8), as being due to traditionally the over-dependence of in-house providers on FM purchasers and central government to fund their FM business operations without having private funding sources. It is only now that most in-house providers have started to look for FM resources outside their organisations to form strategic partnering or becoming SBUs to allow them to compete competitively with other in-house providers in the NHS Okoroh *et al.,* (2001). The results obtained in Table 7.26 seem to reflect the way which in-house FM providers generally manage non-clinical services in the NHS. Therefore, it can be concluded that in general in-house providers employed far less FM staff and also managed a much lesser budget than the purchasers and commercial providers investigated in this survey.

7.51 FM procurement systems used in the NHS

This question sort to evaluate the procurement systems used for managing FM services by in-house providers surveyed to enhance the delivery of care in the NHS. Table 7.27 shows that 15 (60%) in-house providers favoured the traditional system possibly which they were more knowledgeable about using it in the design as well as management of FM operations in the NHS. The main advantages as to why this system might have been preferred by in-house providers have already been identified in the purchasers and commercial providers' survey and are many, and have been highlighted in the purchasers' survey (see 7.4)

Table 7.27: Best value procurement systems used by in-house providers

Type of procurement system	No. of respondents	Percentage (%) of respondents
Traditional contracting	15	60
SLA-based	3	14
Strategic partnerships	5	25
Performance contracting	2	10

In overall, in-house providers might have preferred this type of arrangement as it allows FM functions to be provided in small packages.

As a result of smaller FM packages being provided, in-house providers would also benefit from service integration through economies of scale. Table 7.27 also shows that the second utilised procurement system by in-house providers was strategic partnering. Strategic partnerships were used by 8 (32%) in-house providers signifying how important it has become for in-house and commercial FM providers to partner in the provision of non-clinical services that are modernising the NHS. In-house providers preferred this method possibly because it has the least overheads that are shared between in-house and commercial providers in contract management, making it a more advantageous to management accounting and operations. Partnering allows for free flow of information while service risks are shared between commercial providers and in-house providers fairly. This method also allows external providers to use their marketing and commercial strength and also business methods to modernise the provision of value adding facility services in the NHS. In addition to this, external providers also bring along with them capital, human and technology resources to continuously enhance service development. Also, it is true to say that the use of partnerships is growing in popularity given that the present Government is pushing forward a policy that is promoting PPP.

Although service level agreements have recently become the most commonly used procurement system of managing NHS necessity-based services such as FM services, surprisingly only 3 (12%) in-house providers surveyed used them. The less usage of the SLAs might well just be the fact that SLAs are a new performance management tools that in-house providers have recently started to use for managing FM services in the NHS (Akhlaghi, 1996). In addition to this, according to Akhlaghi there are no clear benefits of using output as opposed to input specifications in healthcare FM services. These in-house providers who used SLA as a methods of specifying FM service levels might have favoured to do so, possibly due to the fact that their FM services were dynamically driven by less customer needs. The least favoured route was the corporate PFI system. This system was used by 2 (8%) in-house providers surveyed signifying that it had a low response rate. The low rate of the corporate PFI route can be attributed the fact that it is a fairly new model of funding capital projects and providing a wide range of support services using mostly in-house and commercial FM providers in the NHS.

It also requires a huge capital outlay from commercial providers as the main stakeholders, contrary to most procurement systems that allow in-house providers to operate healthcare facilities with minimum resources in the NHS.

7.52 Service quality management in non clinical services

In line with the importance of pursuing total quality management approaches to improve the clinical service chain, this question was designed to evaluate quality systems used by in-house providers. Table 7.28 shows that 15 (60%) in-house providers used ISO 9000. The use of ISO 9000 by most in-house providers could well be that, ISO 9000 contains a more simple and broad-based set of quality systems standards that are recognised in other clinical directorates of the hospital as well as in global business environments. Furthermore, ISO 9000 allows for standards and quality certification that is designed to meet both the FM purchaser organisation and customers' needs. In this study, not all of the surveyed FM in-house providers used ISO 9000. Out the 25 in–house providers surveyed, 10 (40%) stated that they were not using ISO 9000 at all. It is most probably that they could have been using more advanced and specific quality management systems such as ISO 9002, ISO 14000 and business excellence models (i.e. European Business excellency model) which are highly recommended in the NHS, or completely none at all (Jackson, 1999). The reason behind using ISO 14000 may be that, it is a more specific quality management system that is used by in-house FM directorates whose business is highly affected by the environment more. In this case since the provision of healthcare facilities services in the NHS was based on managing the physical and business environment. It is highly likely that most in-house providers probably found ISO 14000 more useful. The other important issue that could have pushed in-house providers to using ISO 14000 is probably the fact that social corporate responsibility in most NHS hospitals has become of paramount importance. Hence, the use of quality management systems that improved continuously the provision of value adding non-clinical services to NHS customers was much welcome by purchasers/clients. The other most obvious explanation could well be that these in-house providers might have been using other TQM approaches and business excellence systems of managing service value and risk in support services that are common in the NHS estates economy.

Table 7.28: FM quality systems used by in-house providers

NO. of in-house providers using ISO 9000	NO. of In-house providers not using ISO 900
15	10

The main objective of this question was to evaluate the methods used by in-house providers to design and manage the total FM service process in order to enhance the quality of support services they provided in NHS Trust hospitals. Table 7.28 shows that in-house providers used a variety of methods to design and manage non-clinical services in the NHS. Furthermore, Table 7.28 also shows that of the most popular technique used for monitoring and managing the FM service process by the surveyed in-house providers was the service level agreement (SLA). In this survey 20 (80%) in-house providers stated that they designed the delivery of quality facilities using SLAs. The use of SLAs as performance management tool in this case shows that they are increasingly being used by in-house providers to manage the FM business process in the NHS. Furthermore, besides being used for specifying service levels, they have also been used to measure and monitor performance in non-clinical service operations regularly. Firstly, they can be used as a service contract for specifying contractual responsibilities of the in-house provider in delivering high quality non-clinical services to customers.

Table 7.29: Service quality management tools

Service quality management tools	No of respondents
SLA (service output specification)	20
Service Quality Plan	8
SERVIQUAL Scale	10
Patient and Service quality Charter	3
Method statement	10

Quite often, SLAs define the level of support services to be provided and how and when these services will be packaged and delivered to customers? Second, the use of SLAs might have preferred by most in-house providers probably due its flexibility in that it can be used as a means for managing any service variations in non clinical services delivery in the NHS.

After the SLA, the second most popular method of managing service quality in healthcare FM operation the use of service quality plans. Table 7.29 shows that 8 (32%) in-house providers surveyed used quality plans for managing service quality. It is not surprising that only these in-house providers used this method given that quality plans are normally incorporated in SLA in most healthcare FM service operations. As this may be the case most in-house providers therefore considered quality plans as performance measurement tools and tended to design performance management tools that are based on FM quality plan.

The other reason as to why service quality plans did have such a low response, could well be that quality plans in some cases are mere service delivery statements that show how service quality strategies are to be designed and adhered to in support services delivery as opposed to the control mechanisms and non-performance compliance. However the use of service quality plans may have been preferred by those in-house providers who are accustomed to managing service outcomes as opposed service inputs. This approach is typically relevant to the management of performance related FM services where the purchaser/client only details customers' FM needs. However, this method can lead to disastrous consequences, and in some cases the in-house provider may carry huge service management risks relating to service variations (i.e. demand and supply) and legislation control. As a result, most in-house providers might not have preferred this method. Apart from using SLAs and service quality plans, 10 (40%) providers stated that they used the SERVIQUAL Scale as a service quality measurement tool. The SERVIQUAL Scale was preferred possibly due to its flexibility in determining the five most important dimensions that influence NHS customers' overall quality perception of support services, and these were explained in the purchasers' survey (see section 7.5).

The five dimension used in the SERVIQUAL are probably the ones that might have attracted in-house providers to use this method. Moreover, there is an added advantage of using this method, as its application is generally widespread in most clinical directorates in the NHS. Other quality management tools used by in-house providers were the Patient Service Charter (PSC). The PSC was used by 3 (12%) in-house providers, as it probably did not have much detail regarding total care quality control process and the management of services.

It only provides the specification or service level of the clinical outcome the customer will expect to receive from NHS hospitals or purchaser. As a result of this, the use of this technique might have been restricted to a few informed FM in-house providers.

7.53 FM risk identification techniques

Table 7.30 shows that in-house providers used a variety of business methods to identify non-clinical risks in healthcare operations. Interestingly, most FM in-house providers were now monitoring most of their service risks using customer complaint systems in order to improve the quality of support services they provided to NHS customers. According to Table 7.30, customer complaint systems were used by 22 (88%) in-house providers surveyed.

Table 7.30: FM provider risk identification techniques

Risk identification methods	Frequency	Percentage (%) of responses
Analysis of customer complaints	22	88
Brainstorming	20	80
Case studies, best practice and benchmarking forums (e.g. public sector approaches)	15	60
Checklists	15	60
Financial and investment appraisals	20	76
Flow charts, frequency impact analysis, fault/event tree	14	56
FM performance team review and audits (including use of focus groups)	15	66
Legislation compliance (e.g. healthy and safety and NHS Acts) audits	15	60
Formation of strategic partnering arrangements	8	32
SWOT analysis	15	56
Research, surveys, seminars, conferences, interviews and questionnaires	12	66
Seven quality tools use	18	48
Internet and multi-media information sources	10	40

The popularity of this method indicates that service delivery problems customers experience in hospitals when using support services were the best indicators of how well in-house providers were delivering responsive FM services to their customers. It is through the analysis of support services delivery problems that customers' experiences can be identified and incorporated into the delivery process, that will continuously improve the levels of high quality support services delivered. This approach was popular may because it measures the real service problems or experiences faced by customers in using FM services. Again, it is well researched that every dissatisfied support service customer can influence more service users (i.e. generally 16 more customers) normally in a bad or good way, not use or use the service any more. Apart from using customer complaints in-house providers also used other useful risk techniques such as brainstorming, investment appraisals, peer group discussion, SWOT analysis, flow charts, fault/event tree analysis, group discussions, research surveys, seven tools of quality and multi-media information.

Interestingly, more in-house providers were using brainstorming as one of their main techniques of identifying FM risks. This method was used by 20 (80%) respondents. The use of brainstorming was considered important as it allows risk knowledge to be communicated among healthcare facilities managers, so that it can be used effectively to improve the support services process. Table 7.30 also shows that brainstorming was followed closely by investment appraisals that had a 76% response rate. As more capital projects in the form PFI and PPP are coming on stream, more resources such as finance and IT are now being invested into the national health economy. This situation has resulted in the need to use techniques that identify risks associated investment returns on FM projects against the in-house providers' business objectives. Other risk management methods that in-house providers used were, FM performance audits (60%), checklists (60%), flow charts and fault/event tree analysis (56%), but to a considerably lesser extent. If compared to the purchasers and commercial providers' surveys, Table 7.30 shows that 15 (60%) in-house providers continue to compare risk profiles of various FM projects by relying on past and present service delivery experiences (i.e. in terms of cost, time and service quality), as well as learning from other public sector organisations (benchmarking best practices). These results seem to suggest that risks identified on most FM projects can be compared with other public sectors and measured.

This may be in cases where in-house providers may have been using similar FM strategies to improve care services delivered in new service operations (post or pre-contract). Table 7.30 also shows that other techniques were employed to a considerably lesser extent. These risk techniques were healthcare legislation compliance audits and carrying out environmental impact analysis with a 60% response rate. These techniques may have been used to analyse risks related to clinical governance and health and safety of customers using effectively non-clinical services.

7.54 FM risk analysis methods

This question was designed to evaluate the broad methods in-house providers used in analysing the FM risks. Table 7.31 shows that the majority (i.e. more than 88%) of the in-house providers used the quantitative approach more frequently than the qualitative approach. Under the quantitative approach, the most applied techniques for analysing risks cited by in-house providers were risk-based matrix (88%), probability theory (72%) mean-ends analysis (48%), decision trees (32%), sensitivity analysis (28%) and Monte Carlo simulation (20%).

Table 7.31: Risk management techniques used by in-house providers

Type of risk tool	Frequency	Percentage of responses %
Risk exposure matrix	22	88
Probability theory	18	72
Mean-ends analysis	12	48
Decision trees	8	32
Sensitivity analysis	7	28
Monte Carlo simulation	5	20
Others	10	40

The use of such techniques shows that in-house providers as decision makers used a variety of techniques to manage their strategic FM operations. Such risk analysis techniques were useful in the identification and measurement of the business exposure of FM risks identified. Furthermore, the application of these risk analysis techniques in the FM business process has also been discussed in chapter four of this thesis.

In hindsight Table 7.31 shows that the risk based matrix, probability theory, mean-end analysis and decision tree were the commonly used techniques for analysing risks mostly probably in line with the most tools used by most healthcare executives in other clinical departments in the NHS (NAO, 1997). In overall, it seems clear that in-house providers had some general benefits they gained from competitively using and analysing FM risks in the NHS. These can be summarised as follows:

i. supports strategic and business planning;
ii. detailed overview of new FM business opportunities and threats;
iii. reassures FM stakeholders ;
iv. fewer shocks and unwelcome surprises;
v. enhances communication between the non clinical and clinical departments;
vi. supports effective use of resources;
vii. customer satisfaction;
viii. promotes continual service delivery improvement and;
ix. helps to focus internal FM audits and performance review

7.55 In-house providers' risk constructs influencing healthcare FM

The main aim of the in-house providers' data analysis was to establish a relative weighting index or measure for each risk construct which would be a true representative of its value or effect to the in-house providers' risk management process in healthcare FM operations. The measure identified would allow for the appropriate discrimination of critical risk constructs based on value judgements (scale weight between 1-5) placed on each construct by in-house providers. Thus, if the relative importance index was used, it would facilitate for ranking of these constructs in order of importance. The use of such an importance index as outlined in the purchasers and external providers' survey might be debated at this stage due to lack similar FM studies that currently exist for comparative purposes. In this phase, a three-stage data analysis protocol similar to the one used in the purchasers and commercial providers' surveyed was also used. This approach has already been explained these two surveys (see section 7.10).

This procedure allowed the survey to have an in-depth knowledge of the FM risk constructs faced by in-house providers underpinning strategic decisions made by in-house providers in healthcare operations.

7.56 Multivariate risk construct analysis

As a result of this, the data collected needed to satisfy the normality and reliability tests before any further exploration took place. The same procedure used in the purchasers and external providers surveys for testing for normal distribution of the sample was used to evaluate the in-house providers' survey results. In order to test for sample distribution, the **Kolmogorov-Smirnov test** was used for testing the distribution of normality or goodness-of-fit. The normality test shown in Table 7.32 shows that the scores for each construct are normally distributed at least at 93% level of significance. According to normality test results obtained in Table 7.32, it is possible to continue further with the analysis of the data using normal distribution statistics.

7.57 Reliability analysis

This section details the assessment procedure used to test the reliability of the Likert scale in the assignment to each measure of the fifty-four (54) identified risk constructs assessed. Permissible alpha values can be somewhat lower for new measures, suggesting reliabilities of 0.70 or higher suffice. As the researcher developed the measurements used in the in-house providers' survey, they can be deemed to be novel, a criterion alpha value of 0.70 was considered adequate for these new measures. The reliability coefficients in Table 7.32 ranged from 0.9 to 2.2 for all the FM constructs used, indicating a strong reliability of the data collected. Table 7.33 shows the computation of relative importance indices and a ranking order for the main 54 risk constructs used in the in-house providers' survey. On visual examination of the indices in Table 7.33, it can be seen that the majority (i.e. 53) of the risk constructs had indices high morethan 0.50, signifying how critical in-house providers rated all their constructs towards the provision of seamless support services to customers in the NHS. The only construct that had a score of less than < 0.5 was *corporate business taxation*. In fact, *corporate business taxation* had a scored of 0.496.

Table 7.32: Test of distribution for normality on In-house FM providers' constructs

Risk construct	Statistic	Significance
Customer satisfaction	2.247	0.00
Service delivery certainty (time)	1.579	0.014
Customer involvement	1.518	0.014
Service quality reliability	1.768	0.004
Service availability	1.572	0.014
Customer care	1.630	0.10
Healthy and Safety	1.491	0.023
Service value management (Best Value)	1.429	0.034
Staff participation and partnership	1.418	0.036
Health Legislation compliance	1.798	0.003
Service Cost certainty	1.885	0.002
Service speed	1.156	0.138
Benchmarking best FM practice	1.209	0.108
Staff motivation and knowledge	1.681	0.007
Service price competition	1.156	0.138
Continuous service improvement	1.257	0.085
TUPE	1.005	0.265
Service measurement	1.263	0.082
Service variations	1.382	0.044
Change management (cultural)	1.040	0.230
Partnerships	0.998	0.272
NHS Trust image	1.226	0.099
Service competition	1.528	0.019
Service level agreement	0.921	0.365
Service contract design	1.045	0.225
Financial transfer/stability	1.252	0.087
Information Strategy	1.140	0.149
Clinical strategic fitness	1.239	0.093
Provider's financial reputation	1.214	0.105
National minimum wage requirements	1.057	0.214
Innovation (service and core business)	0.966	0.309
Performance guarantees	1.111	0.169
Environmental impact/issues	0.819	0.513
Management accounting systems	1.035	0.235
Organisation cultural disparities	1.264	0.082
Management development	1.257	0.085
Market intelligence	1.310	0.065
Economy (International & national)	1.173	0.128
Social corporate responsibility (SCR)	1.073	0.200
Business transfer costs	1.696	0.006
Medical technology innovation	1.386	0.043
Sourcing risk	1.229	0.097
Business process re-engineering	1.158	0.137
Clinical-related	1.246	0.089
management transfer	1.484	0.024
Provider Reimbursement method	1.067	0.205
Third way (Political, Physcho-social)	0.815	0.082
Stakeholder resistance	1.257	0.085
Return on capital employed	0.949	0.329
Agency/ delegating decision-making	1.024	0.245
Primary care impact	1.549	0.16
Insurance liability costs	1.170	0.129
Profit margin	0.882	0.418
Corporate business taxation	1.189	0.118

The results here are not surprising given that most in-house providers are normally considered as part of the purchaser organisation, and as a result their non-clinical operations are also funded by central government as well. As a result of this, they are also exempt from corporate business taxation. Thus, the need to pay corporate business tax was found not to be a major consideration by all the surveyed in-house providers working in NHS trusts hospitals. As would be expected, whilst some risk constructs have strong (close to 1) leverage on the in-house providers' decision-making strategies of effectively managing FM performance, unfortunately others do not. In this section, we shall first consider the first most ten-risk constructs ranked by in-house providers as salient constructs in FM operations. The rationale being that once a systematic and proactive approach is adopted for the analysis of these ten constructs, it can then be extended further to the rest of the remaining constructs.

7.58 The relative importance index

The relative importance index was designed in the survey to mirror the facilities managers' (i.e. for the FM service in-house providers) perceived importance of each risk construct established by the research study. This was measured using numerical scores established from a Likert scale. The rationale and procedure for using such a scale has already explained in the purchasers' survey (see section 7.11). In order to demonstrate the calculation of the relative importance index technique, Table 7.33 was produced using this procedure. The fist stage of the analysis was to consider the risk construct with the highest possible index: *effective clinical strategy* (see Table 7.33). Each of the 25 respondents rated this construct with a numerical score of between 0 to 5 depending on its influence on the provider's decision to manage FM risks effectively. Therefore, the:

Relative Importance Index for *effective clinical strategy*

= 124/5*25 = 0.9

In this instance, the relative importance index of *effective clinical strategy* is 0.9 and was ranked as the most important risk construct that in-house providers had to consider when managing effectively NHS FM businesses.

Table 7.33: In-house Providers' group ranking of FM risk constructs

Healthcare FM related risks	≤ 4	3	≥ 2	Total	Relative Importance Index	Rank
Effective clinical strategy	25	0	0	25	0.9	1
Good working capital	24	1	0	25	0.8	2
High customer satisfaction	23	2	0	25	0.784	3
Intelligent client function	23	1	1	25	0.776	4
Good value for money services	22	2	1	25	0.768	5
Third way (Political, Psycho-social)	21	4	0	25	0.768	6
Effective management development	21	4	0	25	0.768	7
High customer involvement	21	2	2	25	0.752	8
High service quality care	19	6	0	25	0.752	9
High employment security	20	4	1	25	0.752	10
Health Legislation compliance	21	1	3	25	0.744	11
Return on capital employed	18	7	0	25	0.744	12
Service speed	18	7	0	25	0.744	13
Benchmarking best FM practice	17	8	0	25	0.75	14
Staff motivation and knowledge	16	9	0	25	0.75	15
Price competition	16	9	0	25	0.75	16
Continuous service improvement	16	8	1	25	0.75	17
TUPE	15	10	0	25	0.75	18
Service measurement	14	11	0	25	0.75	19
Service variations	15	8	2	25	0.75	20
Change management (cultural)	14	8	3	25	0.68	21
Partnerships	18	4	3	25	0.68	22
NHS Trust image	16	5	4	25	0.68	23
Service competition	18	4	3	25	0.68	24
Service level agreement	18	4	3	25	0.68	25
Service contract design	17	6	2	25	0.68	26
Information Strategy & confidentiality	20	4	1	25	0.680	27
Clinical strategic fitness	20	3	2	25	0.664	28
Provider's financial reputation	16	6	3	25	0.664	29
National minimum wage requirements	17	4	4	25	0.656	30
Innovation (service and core business)	19	4	2	25	0.656	31
Performance guarantees	16	5	4	25	0.656	32
Environmental impact/issues	17	6	2	25	0.648	33
Management accounting systems	18	4	3	25	0.640	34
Organisation cultural disparities	14	11	0	25	0.632	35
Financial transfer/stability	14	10	1	25	0.63	36
Market intelligence	16	7	2	25	0.63	37
Economy (International & national)	15	9	1	25	0.63	38
Social corporate responsibility (SCR)	14	10	1	25	0.62	39
Business transfer costs	6	16	3	25	0.62	40
Medical technology innovation	17	4	4	25	0.62	41
Sourcing risk	13	12	0	25	0.62	42
Business process re-engineering	14	9	2	25	0.61	43
Clinical-related	16	4	5	25	0.60	44
Technology transfer/exchange	12	12	1	25	0.60	45
Provider Reimbursement method	13	9	3	25	0.60	46
Third way (Political, Physcho-social)	14	7	4	25	0.60	47
Stakeholder resistance	11	12	2	25	0.59	48
Service Cost certainty	13	8	4	25	0.59	49
Agency/ delegating decision-making	11	10	4	25	0.57	50
Primary care impact	11	10	4	25	0.57	51
Insurance liability costs	15	2	8	25	0.57	52
Profit margin	11	5	9	25	0.53	53
Corporate business taxation	7	8	10	25	0.34	54

These ten risk constructs shown in Table 7.33 and ranked in order of relative importance to the in-house providers' best practice FM process are;

1) Effective clinical strategy (0.9)
2) Working capital (0.792)
3) Customer satisfaction (0.784)
4) Intelligent client function (0.776)
5) Good value for money services (0.768)
6) Third way (Political, Psycho-social (0.768)
7) Effective management development (0.768)
8) Customer involvement (0.752)
9) Service quality care (0.752)
10) Employment security (0.752)

7.59 Effective clinical strategy

In-house providers ranked the need to have an *effective clinical strategy* as the most important risk construct they faced when developing business strategies in healthcare operations. *Effective clinical strategy* had an overall index of 0.9 (see Table 7.33). In terms ranking, all i.e. 25 (100%) in-house providers surveyed ranked this construct with a repeated rating of 4 or more on the importance scale signifying how important it has become for any in-house provider to strategically align their FM businesses with the core (clinical) business objectives of their purchasers. An effective clinical strategy in healthcare operations is one based on clinical governance and customer service focus whilst having a good synergy with the in-house provider or SBU's non-core business (FM) objectives and business planning intelligence.

It will also focus on short and long-term objectives of the in-house provider's FM services delivery strategies that enable purchasers to develop the additional capacity (modern healing and caring environment) needed to deliver high quality services to patients, staff and visitors. First, the internal provider's objective is always that of providing non-clinical service excellence (customer satisfaction and business continuity).

In addition to this, in-house providers will also ensure employment security for their valued FM staff who are responsible for managing effectively non clinical service operations effectively (in terms of time, cost and quality dimensions). As a result of this, in-house providers will normally develop effective business strategies that set key performance targets, potential for efficiency gains and service quality improvements of non-clinical services across all hospital service directorates. When designing an effective clinical strategy providers will need to consider service innovation issues, people plans, business process re-engineering activities, their procurement strategy and IT strategies that will enhance, enable or disable the clinical business success need in the NHS. It of immense importance that an effective clinical strategy incorporated into the in-house team's business culture focuses on customer and market orientation and a clear objective understanding of the purchasers' facilities needs, that will drive in-house staff into continuous service improvement actions. Internal providers need to view their non-clinical services strategy as a value-adding element to the core/clinical business plans and operations of the purchaser. Furthermore, this process will allow for senior management processes to continuously monitor the strategic relevance of healthcare facilities provision and operational requirements, and monitoring their performance over time. As a result of pursing an effective clinical strategy, this will develop the much needed FM business skills while taking advantage of advances in medical, technological and service modernisation in clinical services that create a service delivery culture based core NHS and customer values.

7.60 Good working capital

The continuous delivery and improvement (clinical governance) of high quality FM services in NHS hospitals is highly dependent on having adequate working capital (daily cashflow or budget) to manage both strategic and operation FM service process activities. These can be, to pay for human resources employed, procuring drugs, economic and effective management and procurement of healthcare facilities, equipment and utility services (improving capacity), and for developing competitive service strategies. Furthermore, this servicing requires that in-house providers set a return on investments (i.e. 6%) mostly on healthcare facilities that allows for the continued effective management of healthcare FM operations.

In Table 7.33, in-house providers ranked having *good working capital* as the second most important risk construct that they faced in order to finance for the delivery of seamless and responsive FM services in the NHS. Furthermore, Table 7.33 also shows that 24 (96%) of the in-house provides surveyed ranked this construct with a score of more than 4, while only 1(4%) ranked it with a score of 3. Therefore, in order to ensure that key strategic and operational FM decisions are made regarding the effective management of healthcare facilities, in-house providers valued the need to have adequate working capital that they would utilise in order to make strategic financial decisions while also avoiding business and service disruptions. Strategic financial decision-making refers to the identification and implementation of major working capital and cashflow actions that enhance the whole service organisation (in-house plus the purchaser) and its long-term relationship with the competitive business environment and healthcare facilities management. In such a service delivery scenario, strategic financial management issues become an integral part in many business decisions and success, and therefore facilities investment advice needs to be set out in a business context. Strategic healthcare facilities management is based on an understanding of a hospital organisation's business plan (budget and working capital) in order to estimate facilities service, people and technology requirements and identifying where value can be added. It is strategic FM that is driven by the business strategy. Examples of strategic FM that have a financial (cashflow) implication include;

i. review and reduction of healthcare FM operating costs;
ii. FM portfolio reviews (after a merger or take-over for example), due diligence on proposed investments, including mergers, acquisitions and take-overs;
iii. advice on financing options and the handling of healthcare facilities in the corporate balance sheet;
iv. project management of capital projects;
v. business appraisals and development of business plan; and
vi. feasibility studies.

Nowadays, in-house FM providers are increasingly acknowledging that modern healthcare facilities and support services are an investment asset as well as an operational cost in their business plans.

As a result of this, from a financial perspective, healthcare facilities occupied by businesses for clinical service operational reasons should be appraised for risk and return characteristics in the same way as they are for the core (clinical) business functions. A primary objective of strategic FM should be to allocate adequate financial resources (i.e. working capital) that will improve the rate FM performance and improvement in line with the business's attitude to risk (i.e. without affecting the smooth running of both the in-house and purchaser/host organisation). However, despite widespread recognition of the importance of having a good cashflow in FM at the strategic level, there is little evidence of its practical manifestation to date (Barrett, 2000; Loch, 2000). At an operational level good working capital in healthcare FM is required for many business decisions including for;

i. space planning and measuring the efficiency of space utilisation;
ii. disposal of surplus hospital accommodation and premises;
iii. site identification, acquisition and negotiation of planning approvals;
iv. feasibility studies for (re)development, acquisition and restructuring programmes;
v. development management acting as a in-house provider on behalf of purchaser;
vi. valuations for accounts;
vii. tax planning;
viii. financing options (e.g. sale and leaseback, rent or buy decisions); and
ix. representation in negotiations under lease contracts terms.

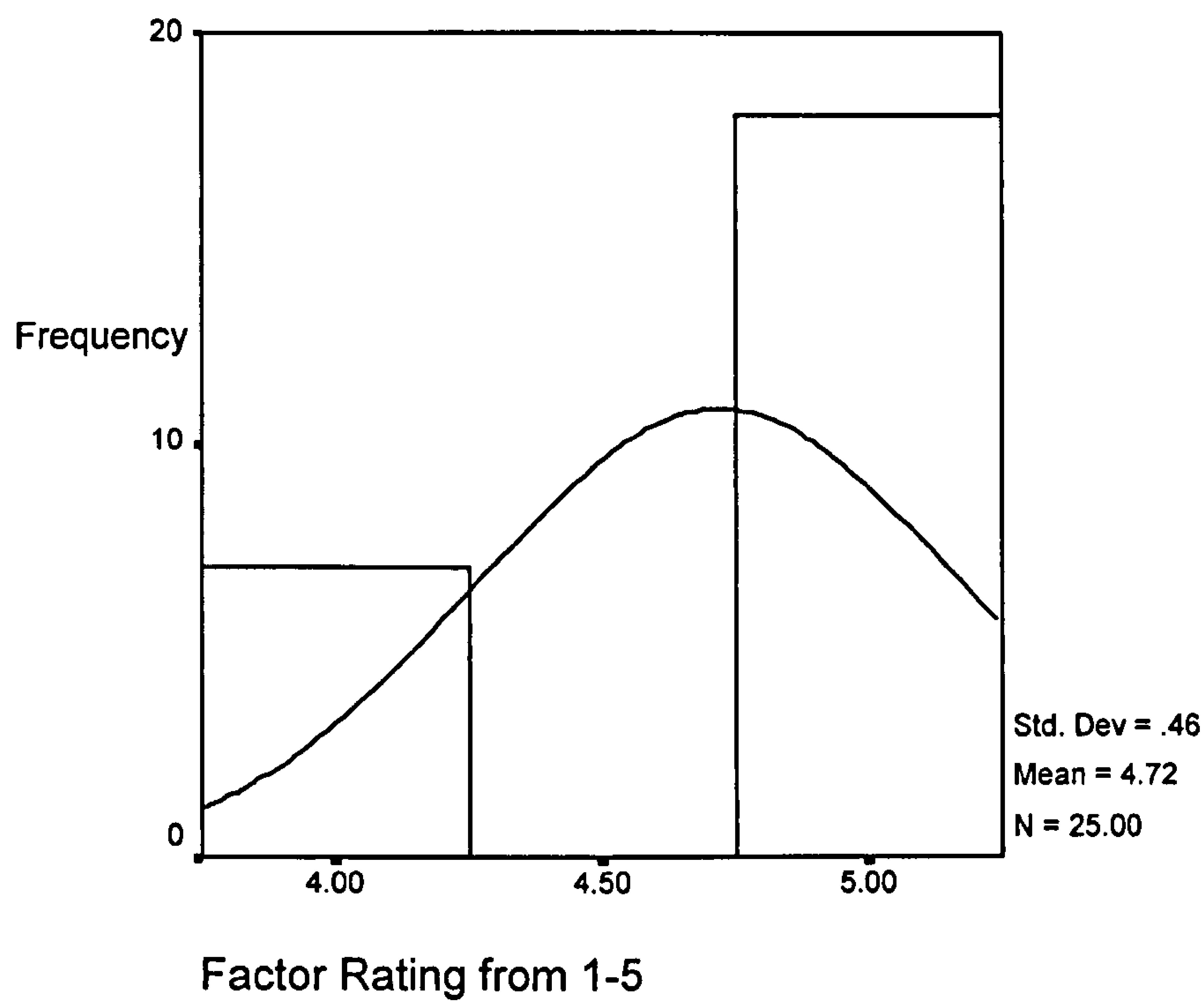
Therefore, in most healthcare operations in-house providers should have sufficient working capital, if they are to be competitive and deliver best value FM services that continue to front the delivery of clinical services in the NHS.

7.61 Customer satisfaction

In-house providers ranked *customer satisfaction* as the third most important risk construct faced by FM in-house providers when developing business strategies in healthcare operations. Table 7.33 shows that *customer satisfaction* had the relative index as an aggregate measure of the risk construct's strength of 0.784.

From Table 7.33 it can be seen that 23 (92%) in-house providers had a repeated rating score of more than 4 on the importance scale, signifying how important it has become in NHS organisations to meet customer non-clinical solutions when delivering hospital services. Furthermore, a histogram showing the frequency and normal distribution curve of scores for respondents is shown in Figure 7. 14. The histogram shows that the mean score for customer satisfaction was 4.72 and its standard deviation was 0.46.

Figure 7.14: Frequency distribution of Customer satisfaction



The results obtain from this survey if compared to the purchasers and external providers' surveys are not surprising given that the need to deliver customer driven facilities solutions is the ultimate goal for every successful care business that seeks to be competitive and improve clinical service excellence. It should be noted that while purchasers and external providers rated customer satisfaction as the most important construct in their business operations, in-house providers rated it as the third most important construct possibly because they were still coming to terms with using effective commercial approaches (consumerism) in the NHS.

Thus, in delivering customer driven support services in-house providers would be seeking to enhance clinical services which are core to their business process, and simultaneously allowing for more repeat business. As a consequence of in-house providers meeting their customers' clinical support service needs in hospitals, risks associated with the service provision of responsive care are drastically reduced resulting in improved patient focused care in the NHS. In Trusts FM customers are the patients, visitors and staff that use support services as part of the healing environment of receiving care. As for staff, FM allows them to plan and manage the practical delivery of a range of diverse, sophisticated non-clinical services to direct (internal departments) and external customers (patients and visitors) in an environmentally friendly workplace.

Furthermore, past work done on customer service management in the NHS revealed that those customers who were delighted with clinical services they received in hospitals are six times more likely to do repeat business or recommend others. The reverse also applies to those customers who were not satisfied with the care service they received. The implications of customer satisfaction are therefore that in-house providers have to re-engineer their business processes to provide the best value facilities that meet customers' expectation in order to avoid service failures or risk business disasters. *Customer satisfaction* becomes a measure of the overall organisation business perceived performance relative to customer expectations. This is often measured using customer focus groups and through customer loyalty surveys carried continuously out by in-house providers at various service level intervals.

7.62 Intelligent client function

Intelligent client function as a construct was highly valued by in-house providers signifying how important it has become for in-house providers to best deliver non clinical services using competitive and effective customer service strategies on behalf of their purchasers. As a result of this, intelligent client function had a relative importance index of 0.777. It not surprising that in-house providers valued this construct given that they had a huge amount service delivery experience they possessed in providing best value non-clinical services to customers in the NHS.

In-house providers have traditionally managed support services in the NHS on behalf of their purchasers/clients who might have had little or no competitive knowledge for managing non-clinical services under an FM directorate. It is probably because of this huge wealth FM and healthcare management expertise that in-house providers valued the intelligent client function role as a critical success factor in the effective delivery of FM services in the NHS. Therefore in healthcare operations, in-house FM in-house providers will need to have business intelligence of how to add value to healthcare FM operations in order that they can compete with commercial providers, while contributing towards the aim and objective of the purchaser's clinical business over a short or long term. The main objective of FM in-house providers is to continuously improve customers' experience through providing modern and high performing healthcare facilities when receiving care in the NHS. Lack of effective healthcare business and customer service knowledge will risk the in-house provider from being outsourced to external providers who are commercially geared towards improving the total service delivery of healthcare services in the NHS. Possibly providers saw that they needed to have business intelligence to do with open market competition and delivering service innovation in relation to various aspects of the FM business process to customers.

7.63 Service value management (best value for money)

Service value management was ranked as the 5th most important risk construct with an increased business effect on in-house providers FM business process strategies. As a result of this, 22 (88%) in-house providers rated this construct with a score of 4 or more. Furthermore, Table 7.33 shows that service value management had a relative importance index of 0.768. The results here are not new given that in healthcare operations, service value management allows in-house providers to disaggregate their non-clinical service functions and questions their efficacy with the view of identifying alternative methods of achieving best performance results and to explore future business opportunities. It is in this light that effective service value management was seen by in-house providers facilitating an intra- and inter-organisational review of the cost efficiency of resource management. This approach has often resulted in the design and management service delivery strategies by in-house providers that result in customer satisfaction.

Value management therefore comprises of all those activities involved in delivering the service attributes that are considered to be necessary to create customer satisfaction and to maintain an ongoing, long-term relationship with customers and in so doing build competitive advantage. This contrasts with many views that consider that an organisation adds value by offering competitive advantage. Hence, in-house providers probably saw service value management as the best way of managing non-clinical services that front clinical services using the highly recommended commercial FM models business in the NHS. It is in this context that in-house providers saw their main business objective as that of managing effectively FM services that enhance the clinical services being delivered by purchasers and developing service capacity to meet service needs of NHS consumers in accordance with the NHS Plan.

7.64 Third way

This construct was rated as the 6th most important factor in-house providers faced when managing non-clinical services effectively in the NHS. As a result, this construct had a relative importance index of 0.768. These results are not surprising given there has been mixed views about this concept in the NHS. The *Third Way* implies a political philosophy and economy that is distinctive but is defined by its relationship to the alternative models of service delivery used in the NHS. So, in order to understand what the Third Way is, it is important to understand the alternative challenges central government faces in improving the quality of life for those customers consuming both non-clinical and clinical services in the NHS. These results suggests that in-house providers were aware of the current Labour government's way of thinking in term of delivering public services in the NHS. As a result saw this construct as highly affecting the delivery of their business strategies in the delivery of non-clinical services as it had a high inclination towards partnerships and privatisation of healthcare operations in the NHS. The privatisation of public services has recently been heavily opposed by in-house FM providers and their unions in the NHS.

This is because, it is deemed as transferring most non-clinical service operations to commercial providers who are only interested in making huge profits and maximising their shareholders' value without the interests of the majority of in-house FM staff, in term securing their employment contracts.

In this instance, in-house providers viewed the Third Way approach as being driven by this political objective. To in-house providers, it seems that goals such as economic growth should explicitly be seen as secondary tools in the effective management of FM services. In overall, it is possible that in-house providers saw the Third way in three different forms: firstly, as the valuing of subjective well-being of NHS customers; secondly, as the need to protect the healthcare built environment (facilities); and lastly as the business need to create a less dehumanised society that is based on individual healthcare needs

7.65 Management development

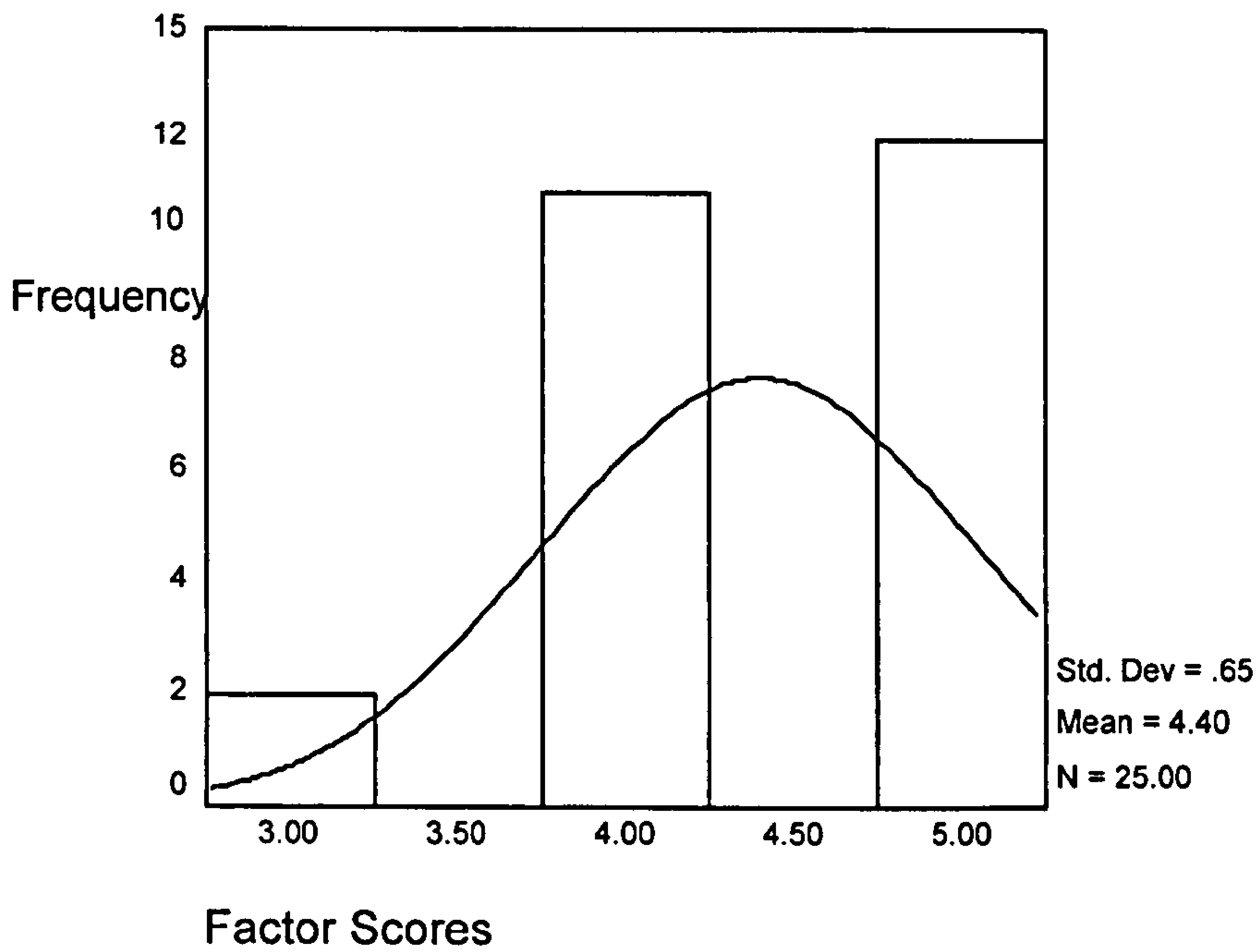
Table 7.33 shows that *management development* as a construct was valued by in-house providers as one of the major reasons for encouraging senior facilities managers to save money by reducing overspending when delivering high quality non-clinical services. In-house providers might have seen management development as a better way of training their senior managers in managing effectively FM business processes, in particular the perennial problem of inadequate resources not meeting FM customers' demands for non-clinical services. While in-house providers continue to make business decisions in relation to the commitment of FM resources it is reasonable to conclude that the efficient management of these FM resources could not be realised without the co-operation and active participation and continuous development of their senior management responsible for making strategic FM decisions. Therefore, the involvement of the in-house provider's senior management staff in continuously developing effective organisational strategies to decentralise the management decision-making process by delegating accountability down to those managers responsible for delivering the FM services can be seen as critical success factor in the NHS. It also complements the rapid developments that continue to occur in information management and service delivery processes such that appropriate, accurate and timely information is available to those FM staff expected to actually manage the provision of non-clinical services in the NHS. In addition, of course, the subsequent involvement and co-operation of senior managers of in-house providers assisted in the design and implementation of innovative service delivery systems that allowed in-house staff to compete with commercial providers as well as delivering best value for money FM services to customers.

Another positive aspect of involving the in-house providers' staff in management development is the business opportunity to support and work in partnerships with all staff involved in the delivery of best value for money FM services to customers in an NHS organisational sense. Other perceived benefits of incorporating senior managers into the business planning and management development of non-clinical services include improved clarity among in-house providers about their purchasers' core business objectives; improved quality of planning and higher budgetary control; decentralisation and therefore develop faster, decision-making processes, leading to greater flexibility in the organisation effectiveness to respond to changing customer and service demands. It is in this context that the above business management issues that in-house providers highly valued management development as critical success construct in the effective management of FM in the NHS.

7.66 Customer involvement

Customer involvement in the design and delivery of various diverse non-clinical services was identified by in-house providers as the third most important risk construct in the management of healthcare FM operations. Table 7.33 shows that respondents rated it with an overall relative index of 0.784. Furthermore, Figure 7.15 shows a histogram together with the normal distribution curve of those respondents who ranked customer involvement as the third salient risk construct faced by in-house providers in their bid to provide cost effective support services in the NHS. Out of all the respondents who participated in the survey Figure 7.15 shows that 21 (92%) respondents scored *customer involvement* with 4 or more on the importance scale. These findings are very encouraging given that the designing, specifying and delivery of responsive non-clinical services in the NHS heavily dependants on the needs and expectations of customers who use the services and have both varying clinical and non-clinical services needs. Therefore, in this study it can be seen that in-house providers were in tune with modern business strategies that specify for the utilisation of the service users' knowledge and expectations in designing support services in the NHS.

Figure 7.15: Frequency distribution of customer involvement



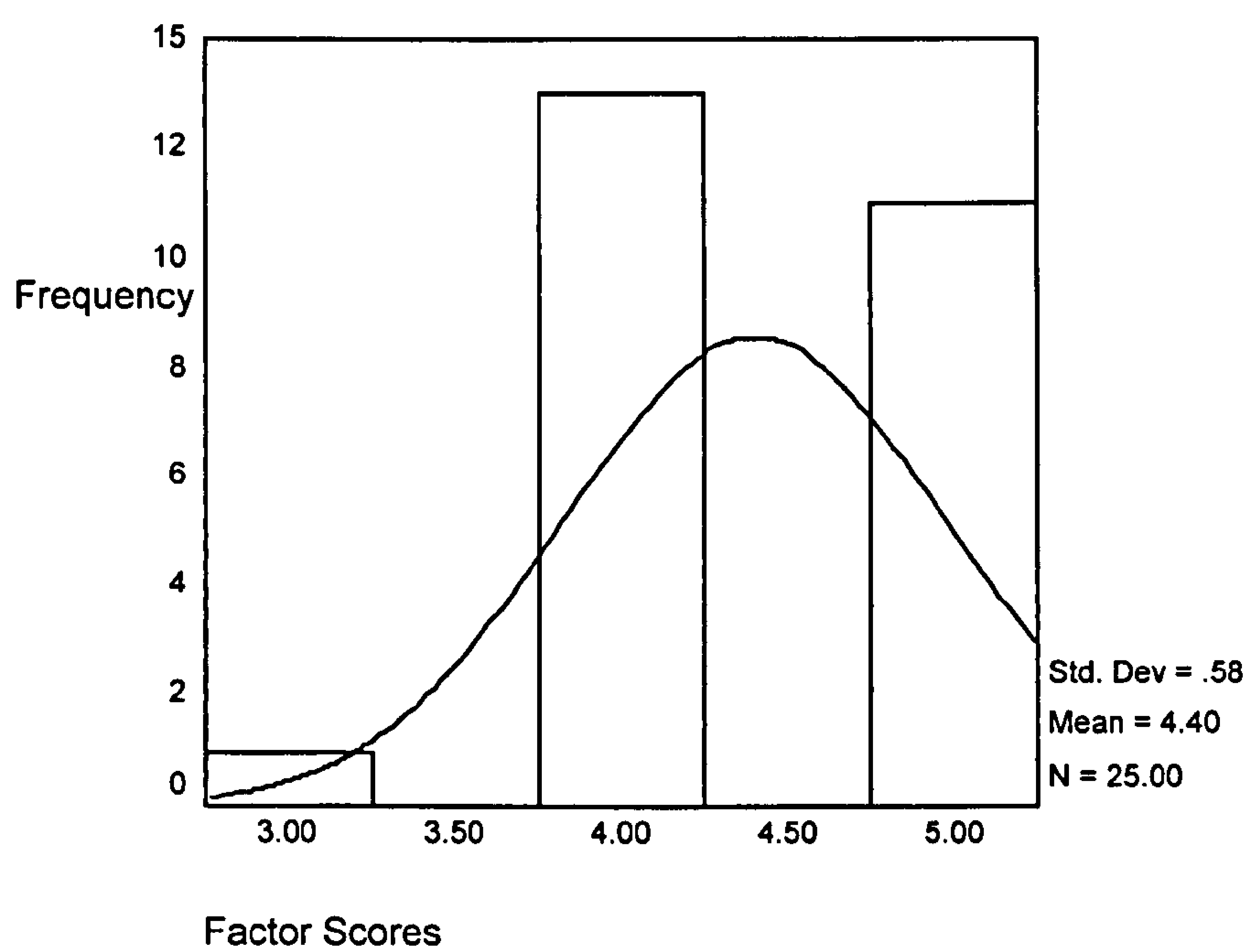
It is therefore apparent that in FM decision-making customers' needs must first be gathered through FM audits and then used as smart knowledge in designing the service delivery process. It may be that in-house providers valued the inclusion of service users as the first and foremost critical success constructs of managing seamless support services in most public organisation. In this survey it can also be said that in-house providers were well aware of the service failure risks that are associated with the lack customer involvement in the design delivery process. Possibly, they knew that FM service users were central in determining how responsive non-clinical services provided were, to meeting the ever-changing needs of customers. Hence the setting of service level agreements for non clinical services by in-house providers in trusts would not be complete without incorporating FM customers views, who are the sole users of the service. Therefore, it becomes essentially important that when support service output levels are being designed in-house providers will need to engage customers to specify their clinical needs and expectations through service level agreements. These SLAs will specify the service deliverables (KPIs) and when they can be delivered at the correct point of service delivery.

In other words, the involvement of customers in the service design process will determine the support services and eventually clinical services to be delivered (now and the future) to customers. This approach also allows for future service development in a politically uncertain business environment such as the NHS

7.67 Service quality care

Service quality care was ranked as the 9th most important risk factor with the greatest business effect on the in-house providers healthcare FM operations after customer involvement. It had a relative importance index of 0.752 (see Table 7.33). Furthermore, Figure 7.16 shows that 19 (76%) providers surveyed ranked this variable with a score rating of 4 or more signifying how important support service response times have become in underpinning the treating and caring for those who are critically and terminally ill as well day treatment patients.

Figure 7.16: Frequency distribution of high service quality



In this survey, it seems that FM in-house providers were aware that the evaluation of service value by customers was not only based on the clinical outcome but also on the total service chain (clinical and non clinical) process.

Hence, the need for in-house providers to consistently reduce service variations and failures and deliver output based demand levels in NHS facilities was also an important service consideration. Effective FM service delivery will ensure that waiting times for service consumption are drastically reduced through innovative practices and customers receive high quality FM services that are safe and risk free. In rating service quality care as a critical construct in-house providers might have been aware that they needed as part of their organisation's business objectives, to improve customers' perception of the non-clinical service attributes (add service value) that would contribute to an increase in the overall evaluation of FM services (measured as overall customer satisfaction, overall service quality perception, or overall service performance perception) they were providing in the NHS. Service quality care in FM operations places the prime focus of quality improvement on the continuous interaction that takes place between purchasers, providers and customers, who are the recipients of high quality support services in the NHS. In order to deliver these high quality FM services in-house providers have to empower their operational employees who are continuously exposed to the public to help and provide these responsive and seamless support services effectively.

7.68 Employment security

This construct was valued as the 10th most important construct by in-house providers towards the effective delivery of non-clinical services in the NHS. It had an importance index of 0.752 signifying how important it has become for most in-house providers to consider employment security issues first. These results are not surprising at all given that, the NHS is currently undergoing a number of commercial reforms such as PFI and PPP that have had a direct impact on the employment conditions for most FM staff working for in-house providers in the NHS. The main problem has been that of outsourcing in-house staff to the commercial providers under TUPE. Under this situation, existing staffs for the in-house providers are transfered to the commercial provider with some legal protection, but this will only last for a while. Jobs, pay and conditions will be squeezed to achieve 'efficiency savings' for the trust and to boost profits for commercial providers. These results seem to suggest that in-house providers were aware that if they did not deliver best value for money services to FM customers, they would risk being outsourced under TUPE.

This situation would result in loss of employment security which has always been guaranteed as part of most in-house staff's contracts in the NHS. Probbably, due to the emmergence of the PFI and PPP as part of central government's iniative, most in-house providers did not feel secure with their jobs. Hence, they found that employment security was one of the key constructs they faced in the management of non clinical services in the NHS.

7.69 Factor grouping using principal component factor analysis

To have an inside view of how critical risk constructs influence the in-house providers' strategic and competitive decision making process to manage healthcare FM service process, and to further explore the structure of the collected data, the PFCA technique was employed. Before commencing any statistical data analysis, certain statistical tests had to be performed. These tests facilitated to ensure that data collected from in-house providers was suitable for this analysis. The determination of the correlation matrix shown in Table 7.34 is 0.002377 that is greater than the required 0.00001 indicates that the data matrix used was not suffering from multicollinearity or singularity (Kinear and Gray, 1999). Kaiser-Meyer-Oklin measure of sampling adequacy was found to be 0.6 that is greater than 0.5 confirming that the sampling adequacy is acceptable. As mentioned earlier in the purchasers and external providers' surveys, the PFCA was conducted.

The results in Table 7.34 also suggest that risk management decisions of FM in-house providers in healthcare operations has, to date, been modest with all the average success scores clustered around the midpoint of 4 on the Likert scales. However, it is interesting to note the *priori* that in the in-house providers' survey, whilst the overall impact of support services operations "as backroom services" on direct patient care is generally perceived to be limited by less knowledgeable healthcare executives, its positive contribution through risk management to clinical efficiency and managerial decision making all the surveyed in-house providers was readily acknowledged.

Table 7.34: Descriptive Statistics for In-house providers' FM risk constructs

Risk Construct	**Average construct score**
Working capital	4.5400
Clinical strategy	4.6400
Customer satisfaction	4.1200
Intelligent client function	4.5600
Good value for money	4.2400
Third way (Political, Psycho-social)	4.1200
Management development	3.7200
Customer involvement	4.1600
Service quality care	4.1600
Employment security	3.8000
Factor correlation matrix	**0.0023**
Kaiser-Meyer-Oklin	**0.6**

The relationship between each risk construct and the overall success measure was explored by generating a series of correlation coefficients, utilising one-tailed tests; the results are presented in Table 7.34 above. These results indicate that the ten most important risk constructs identified by the in-house providers have a relationship with a score that is statistically significant at the 0.01 and 0.005 level. The highest of the coefficients was for *working capital.* The importance of having adequate cashflow to manage the delivery of effective FM service solutions was seen by in-house providers recognised as the best practice for managing business continuity and customer loyalty in NHS trusts, and therefore its significant score in this analysis simply supports existing theory. It is also important to note that non-clinical services in trust hospitals are resource-led and as a result would require huge investment in the of cashflow in order to deliver best value for money FM services to customers in the health economy. Other pertinent risk constructs that were also found to have significant correlations in the in-house providers' risk management and decision making process, at 0.01 and 0.05 per cent level, are *clinical strategy, customer involvement* and *service quality care* which ensures that customers receive safe and responsive FM services in user-friendly facilities, ensuring adequate user involvement and maintaining support for the service provision from top management. Furthermore, Table 7.35 shows all the constructs with their eignevalues, percentage of variance and cumulative percentage of variance. Four component constructs and their loadings were extracted from the analysis based on their eigenvalue being greater than 1 (see Table 7.35).

Loadings are standardised correlations between components (in this case, FM risk constructs). High loading values suggest a high correlation between the represented in-house providers' construct or component.

Table 7.35 shows a summary of cummunalities of how much variance in the constructs was accounted for by the four constructs extracted: for example, about 60% of the variance in customer satisfaction is accounted for. A close examination of the communalties revealed that the four components account for over 60% of the variance in the entire variables suggesting that the factor analysis has been very effective. Table 7.35 also shows the associated percentage of variance of the four constructs; factor 1-39.02%, factor 2-53.6%, factor 3 –66.8%, factor 4 - 79.04% and factor 5 – 88,3%: for constructs *Working capital, clinical strategy, customer satisfaction, intelligent client function* and *good value for money services* respectively. Likewise the percentage of variance in Table 7.35, the eigenvalues indicate the relative importance of various constructs in accounting for the total variance in the data set. Note that constructs with eigenvalues that are less than 1 (i.e. *third way (political, psycho-social), management development, customer involvement, service quality care and employment security*) were not selected because an eigenvalue value is a measure of standard variance with a mean of 0 and standard deviation of 1; and the variance that each standard variance contributes to the principal components extraction is 1.

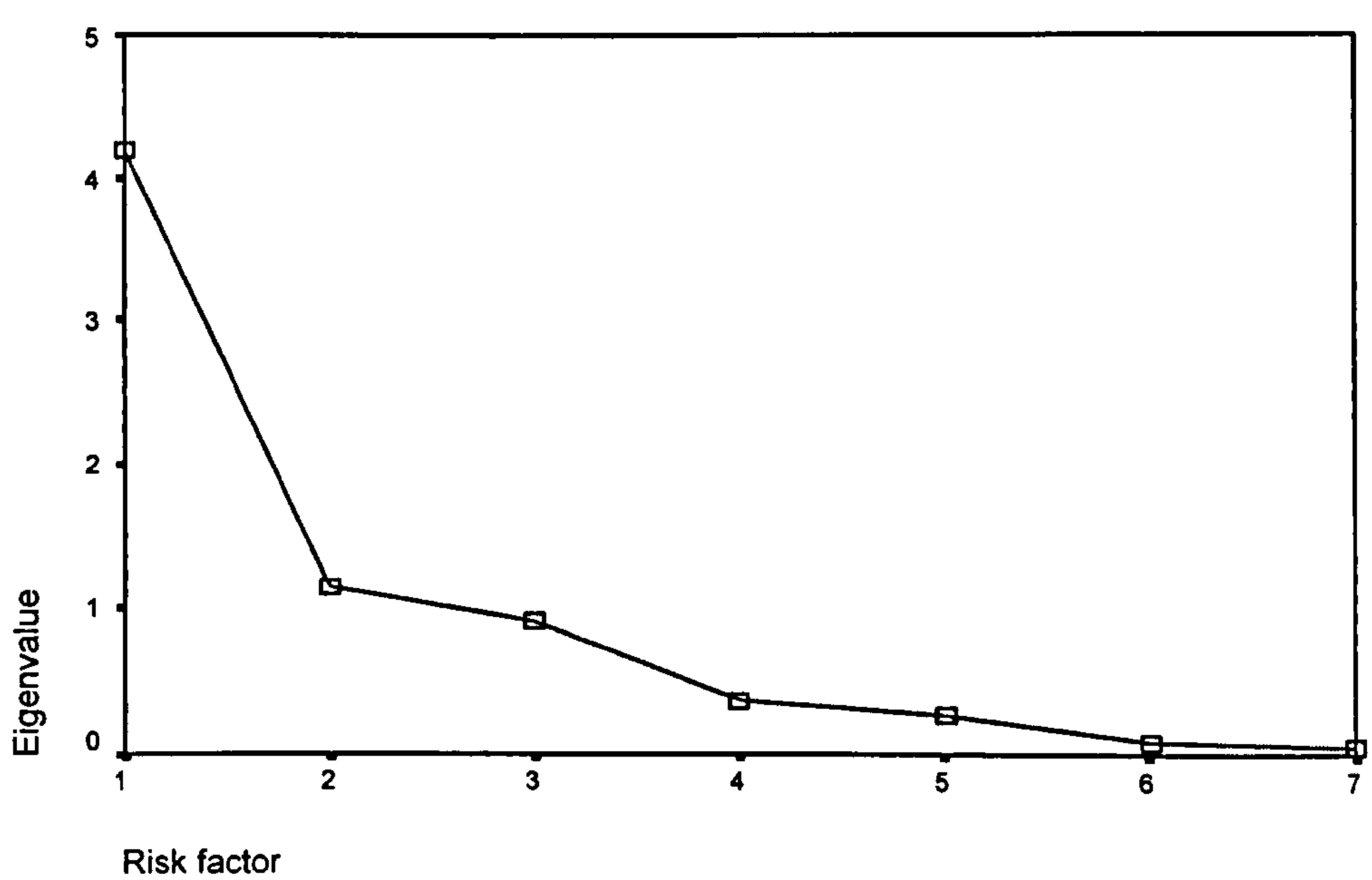
A component with an eigenvalue value of less than 1 is less important than an observed variable and can therefore be ignored. In order to achieve factor loadings that are easier to interpret than those shown on Table 7.35, a varimax rotation was carried out on the constructs. The varimax rotation attempts to minimise the number of variables that have high loadings on a factor, thus enhancing the interpretability of the constructs. This had the effect of minimising the number of constructs on which the variables have high loadings. The new factor-loadings are shown on Table 7.36 that is easier to interpret psychologically. The new factor loading is simply the correlation coefficient between an original variable and an extracted factor. Thus the higher the absolute value of the loading the more the variable contributes to the factor.

Table 7.35: Factor-Loading before varimax rotation – In-house providers risk decision constructs

Variables	**Constructs**				**Achieved Communalities**
	1	**2**	**3**	**4**	
Working capital	-.319	.357	.426	.435	0.600
Clinical strategy	.464	-.152	.753	.202	0.847
Customer satisfaction	.873	-.355	-.105	0.01601	0.899
Intelligent client function	.595	.357	-.103	.428	0.675
Good value for money	.720	.493	-.226	-.305	0.907
Third way (Political, Psycho-social)	.943	-.212	0.01186	.125	0.951
Management development	.233	.499	-.117	.551	0.621
Customer involvement	.352	-.527	-.463	.462	0.830
Service quality care	.684	-.151	.516	-.219	0.805
Employment security	.643	.466	0.07753	-.366	0.771
Eigenvalues:	3.902	1.459	1.322	1.222	
Percentage of variance	39.020	14.592	13.217	12.215	
Cumulative % of variance:	39.020	53.611	66.828	79.043	

After the rotation it was evident that *customer involvement*, *intelligent client function*, *good value for money*, *third-way (political and psychosocial)*, *service quality care and employment security* are loaded substantially on factor 1 in that order, and only *customer involvement* is loaded only on factor 2, and *clinical strategy* and *service quality care* are loaded on factor 3.

Figure 7.17: Internal Providers' Scree Plot



Only *management development* was loaded on factor 4 signifying how important it has become for in-house providers to have senior FM managers who are able to deliver service excellence on behalf of the purchaser. Moreover, a scree plot of factors shown in Figure 7.17 revealed that the data lies close to two dimensional subspace and would therefore represent the whole data and thereby reduce any concentration on the none principal factors of the data. Further analysis shown in Figure 7.17 classified risk factor loadings into seven groups. The components with an eigenvalue exceeding 1.00 are considered significant and therefore subject to further analysis. Taking the eigenvalue as a measure of importance it is self evident that in Table 7.36 that factor 1 (working capital) had the highest eigenvalue of 3.902 and was the most important risk construct that influenced the in-house provider's FM service delivery process. This was followed by factors 2 and 3 and with eigenvalues of 1.459, 1.322 and 1.222 respectively.

Table 7.36 Initial statistics of Principal Component Factor Analysis – In-house providers risk decision constructs

Component Constructs	Initial Eigenvalues total	Percentage(%) of variance	Cumulative % of variance
1	3.902	39.020	39.020
2	1.459	14.592	53.611
3	1.322	13.217	66.828
4	1.222	12.215	79.043
5	.929	9.294	88.337
6	.618	6.179	94.516
7	.230	2.301	96.817
8	.198	1.978	98.795
9	.112	1.116	99.911
10	0.08865	0.08865	100.000

7.70 Summary

The major survey discussed in this chapter has fully investigated various business strategies used by the three FM service operators – purchasers, in-house and external FM providers, to manage their non-clinical business processes risks in the NHS.

From this investigation, it has been seen that although the three FM service operators used almost similar business and risk management strategies, they had different core business objectives. For example, the core business objectives for commercial providers were the need to maximise their organisations' investment objectives (i.e. shareholder value and profit maximisation) while purchasers and in-house providers had similar business objectives. Their main business objectives were that of providing best value non-clinical services and enhancing the delivery of care to their customers at best value and also using minimum resources while protecting continuous employment benefits for their FM staff. In overall, the major survey has identified that the key and common FM risk constructs faced by purchasers, in-house and external providers in healthcare operations were fifty-four (54). These main risk constructs were also found to critically affecting the ability of the three FM service operators to manage non-clinical services effectively and delivering their core business objectives in the NHS.

Taking into account that the sample size used in the three surveys was not very large and more also given that these results are extensive, they were based on the perception of the participants which tends to change with time especially in the NHS, where there are number of commercial and political reforms being pursued. Further evaluation and analysis is needed of the key risk constructs identified using; (a) a different type of research method that would need to be used to validate these results and also show that in future any changes in perception by participants has been thoroughly considered; (b) these key non-clinical risk constructs identified in this survey would need to be further classified or categorised if possible into major classes as they are only sub-attributes or constructs by their very nature; (c) more important also, these risk constructs will need to be transformed into quantitative data which can be used as business knowledge or information for developing the proposed risk management system which is a DSS, in order to satisfy the primary objective of this research. Therefore, the next chapter (chapter eight) will focus on addressing these three main issues raised in this chapter in order to develop a more systematic method of evaluating the effect of these constructs on the FM business in healthcare operations.

CHAPTER EIGHT

ANALYSIS OF REPERTORY GRID RESULTS

8.1 Introduction

This chapter presents results of personal interviews held with sixty (60) senior healthcare managers responsible for the strategic management of non-clinical services in NHS Trust hospitals identified in the major survey. The interviewed healthcare facilities managers were working for FM purchasers, in-house and external providers with an FM outfit in the NHS. Furthermore, all the results of RGT analysis are shown in Appendix C.

8.2 Visual focusing

The first and simple method of analysing Repertory Grid data is by using visual examination of the elicited data structure and content. For example, visual examination of the rows and columns of the grid matrix in the purchasers' consensus grid in Table 8.1 revealed valued information about purchasers' approaches regarding risk management and decision making in healthcare FM operations. In normal cases it is more useful to concentrate on the ticks and crosses as opposed to using numerical values in the matrix. This is because the matrix can show how each construct is being used to describe the element. It also indicates which element and constructs are alike or different. For example, looking along the first row of Table 8.1, it can be seen that the mean score of all FM purchasers using the construct "high customer satisfaction" to show how important it is to the element "hotel and catering" services was 5, out of a possible maximum rating of 5.

It is possible to go on to examine other rows and to compare the entries in different rows noticing, for instance, the constructs "high service speed" and "good organisational image" provide nearly very similar ratings while constructs "best value for money" and "good financial stability" if compared were rated quite differently. It is also possible to examine further other columns and rows. For example, "soft" FM elements "hotel and catering" and "portering" services are very closely and highly rated on all constructs and can be evidently treated as paragons of all virtues. Furthermore, there is a remarkable difference in the rating of FM element "health and safety" when construct "service price competition" comes up.

Thus, the grid on visual examination displays an experimentally selected part of the system produced by the nebulous relationship and interaction of all the FM service purchaser's elements with all the constructs. This interaction evidently reveals a much more intelligent structure, hence the need for computer analysis becomes quintessence.

8.3 Analysis of variance, mean rating and construct variability

In order to determine the sources of variation in data elicited, GRIDSCAL was used to explore further the five basic components of FM managers' risk construct systems namely:

i) risk factor categories;
ii) decision rules;
iii) core values;
iv) construct complexity; and
v) construct commonalities.

In addition, the intraclass variation for constructs was performed to provide a quantitative analysis. The analysis of variation was performed on all the three (purchasers, in-house and external providers) FM operators' constructs to determine whether there was any significant difference in construct perception among the subjects. The measure of variation in the FM operators' constructs can also be utilised as a useful instrument of determining the concept of "cognitive complexity" used by the three FM groups when making strategic FM and risk management decisions in the NHS (Bell and Keen, 1981). The results of this analysis are shown in Table 8.1. For the purposes of precision, only ten constructs with the largest and smallest standard deviation will be considered in Table 8.2. Details of all the quantitative analysis performed on the FM operators' grids are presented in Appendix C. According to Slater (1992), and Smith (1986) constructs that account for the most variation within a grid are constructs which posses most meaning for that particular FM manager, while low variation indicates less valued constructs. As there has been no comparative data for similar work published, the interpretation of the results obtained in this repertory grid analysis may prove to be complex in nature.

Table 8.1: Purchasers' average Repertory Grid

CONSTRUCTS	Hotel and Catering	Portering	Security	Building Services	Grounds and gardens	Mech & Elect	Reprographic	Health and safety	Waste management	IT management	EBME/Medical equipment	Patient transport	Car parking	Domestic	Estates & maintenance	Low patient care	Cleaning	BI-CONSTRUCTS
High Customer satisfaction levels	5	5	5	4.1	3.2	4.1	4.1	5	5	4.1	4.1	5	4.1	4.1	5	4	5	Low customer satisfaction levels
Good Service delivery certainty (time)	4	4	4	4	4	3	3	5	4	4	4	4	4	4	4	4	5	Poor service delivery certainty
High Customer involvement levels	4	4	4	3	3	3	3	5	3	5	4	3	4	3	3	3	3	Low customer involvement levels
High Service quality care	5	5	5	4	4	5	4	5	4	5	4	5	5	5	5	5	5	Service quality failures
Service availability	4	4	4	5	4	4	4	5	4	4	4	4	4	4	4	4	4	Service delays
High Customer care	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	Customer carelessness
Sound Health and Safety policy	5	5	5	4	4	4	4	4	4	5	4	4	5	4	4	4	5	Poor Health and Safety policy
Best value for money service	5	5	5	4	3	3	3	4	4	4	4	3	3	3	3	3	3	Poor value for money service
High Staff participation and partnership	4	4	4	4	4	4	4	4	4	4	4	4	3	3	4	3	3	Staff participation and partnership
Sound Legislation compliance policy	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	Poor health legislation compliance
High Service Cost certainty	5	5	5	4	4	4	4	5	4	4	4	5	4	4	4	4	4	Service Cost escalations
High Service speed	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	Service delays
Benchmarking best FM practice	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	Benchmarking worst FM practice
High Staff motivation levels	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	Low staff motivation levels
Price competition	4	4	4	3	3	4	4	1	4	3	3	3	3	3	3	3	3	Price monopoly
Continuous service improvement	4	4	4	3	3	4	4	5	5	5	5	4	4	4	4	4	4	No service improvement
TUPE	4.7	3.8	3.8	3.9	3.8	3	3	4	4	5	2.9	2.9	2.9	2.9	2.9	2.9	2.9	High employment security
Service measurement	4	4	4	3	2	3	2	4	4	3	3	3	3	3	3	3	3	Poor service measurement
Service variations	3	3	3	2.5	3	3	2	3	3	3	3	2	3	3	3	3	3	Service variations
Change management (cultural)	3	2.5	3	3	2	3	3	3	3	3	3	3	3	3	3	3	3	Change management (cultural)
Strategic partnerships	3.7	3.8	3.8	3.8	3.8	3	3	4.7	3.8	2.9	2.9	2.9	3.8	2.9	3.8	3.8	3.8	Traditional arrangements
Good organisation image	5	5	4	4	4	4	4	5	5	5	5	4	5	5	4	5	5	Poor organisation image
Service price competition	4	4	4	4	3	3	3	4	3	3	3	3	3	3	3	3	3	Service competition
Flexible Service level agreement	5	5	5	5	4	3	3	4	4	4	4	4	4	3	3	4	4	Rigid Service level agreement
Good Service contract design	5	4	4	4	3	3	3	5	4	4	3	3	2	3	4	3	3	Bad service contract design
Good Financial stability	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	Bad Financial stability
High Information confidentiality	2.1	2.1	2.2	2.1	2.1	2.1	2.1	2.3	2.3	2.3	1.2	1.3	2.2	2.2	2.2	2.2	2.2	Public information
Clinical strategy	5	5	5	3	3	2	2	4	3	3	3	3	3	2	2	2	3	No clinical strategy
Provider's financial reputation	4	4	4	3	4	4	5	4	4	4	4	4	4	4	4	4	4	Provider's financial reputation
National minimum wage requirements	3	3	2	2	2	2	3	3	2	2	2	2	2	2	2	2	2	Performance related wages
Service innovation	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	Service innovation
Performance guarantees	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	Performance guarantees
Good Management accounting systems	5	4	4	3.9	4	3.9	4	4	4	3.9	4	4	4	4	4	4	4	Bad Management accounting systems
Organisation cultural disparities	3	3	3	1	1	2	2	2	2	2	2	2	2	2	3	2	2	Organisation cultural similarities
Management development	5	5	5	3	3	3	2	4	3	4	4	3	3	3	4	3	3	Management development
Good Market intelligence strategy	4	4	4	2	2	2	3	2	3	3	3	2	2	3	3	3	3	Poor Market intelligence strategy
Social corporate responsibility (SCR)	3	3	3	2	2	2	2	3	3	2	2	3	3	3	2	3	3	Low Shareholder value
Low Business transfer costs	5	5	5	2	2	2	2	4	4	5	5	4	4	4	4	4	5	High Business transfer costs
Business process re-engineering	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	Business process re-engineering
Management responsibility transfer	3	3.1	3.9	3.8	3.9	3.8	3	3.1	3.1	3	4.9	3	3.1	3.1	3.1	3.1	3.1	Management responsibility transfer
Good Provider Reimbursement method	4.8	4.7	4.8	4.9	4.7	4.7	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	4.8	5	5	Poor Provider Reimbursement method
Third way (Political, Physcho-social)	4	3	3	1	1	2	2	3	3	2	2	2	2	2	2	2	2	Third way
Stakeholder resistance	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	Stakeholder involvement
Return on capital employed	4.8	4.8	4.7	4.7	4.8	4.8	4.8	4.6	4.7	4.6	4.8	4.7	4.7	4.8	4.6	4.6	4.6	Return on capital employed
Low Insurance liability costs	3.8	3	3.8	3.8	3.8	3.8	3.8	3.8	2.9	3.8	3.8	3.8	2.9	3.8	2.9	3.8	2.9	High Insurance liability costs
Good Working capital	5	5	4	5	5	4	5	5	5	4	5	5	5	5	5	5	5	Poor Working capital
Low staff Absenteeism	5	5	5	4	4	4	4	4	4	4	4	3	4	4	4	4	4	High staff absenteeism
High flexibility working	4.8	4.8	4.8	3.8	4.7	4.6	4.7	4.6	4.7	4.7	4.8	4.7	4.7	4.8	4.8	3.9	4.9	Low flexibility working levels

Table 8.2: FM service purchasers' Constructs with Largest and Smallest Variation

S/N	Most valued Constructs with largest variation	Standard Deviation	Mean Rating
	Effective clinical strategy	1.20	4.5
	High customer satisfaction	1.13	4.0
	Flexible Service level agreements	1.02	3.1
	Good Financial stability	0.85	3.5
	High Service quality care	0.84	4.7
	High Information confidentiality	0.80	4.6
	Management responsibility transfer	0.78	3.5
	Management development	0.76	3.6
	Best value for money service	0.73	2.7
	Continuous service improvement	0.71	2.8
	High working flexibility levels	0.70	3.5
	Variability = 0.889		
S/N	**Least valued Constructs with smallest variation**	**Standard Deviation**	**Mean Rating**
	Good legislation compliance policy	0.20	3.0
	High service speed	0.10	4.8
	Benchmarking best FM practice	0.08	4.0
	High staff motivation levels	0.06	3.0
	High service variations	0.06	3.0
	Change management	0.04	3.0
	Good financial stability	0.04	3.2
	High service innovation	0.02	3.0
	Effective performance guarantees	0.02	4.0
	Good management accounting systems	0.02	4.1
	Good return on capital employed	0.00	4.1

However, by contrasting the standard deviations (variation) and the mean ratings, it is practical to provide some significant analysis that supports Slater and Smith's valued knowledge on personal constructs.

8.4 Analysis of the FM service Purchasers' grids

Table 8.2 shows a list of salient risk constructs commonly faced by FM service purchasers when effectively managing healthcare operations in order to enhance their chances of business success in NHS trusts. The aim of this classification was to determine whether there was any aggregation of risk constructs in any of the defined membership groupings.

The constructs are arranged in ascending order and ranked starting with the ones with the highest standard deviation and mean as a measure of variation. The purchasers' constructs standard deviations ranged from a minimum of 0.70 to a maximum of 1.20, which clearly indicates that some constructs are more highly regarded by purchasers than others, when managing the FM business process in the NHS. Further examination of Table 8.2 reveals that the most meaningful constructs to the purchasers were: the continued need to have an "effective clinical strategy" (1.20), for the business to deliver "customer satisfaction" (1.13), to all the support service users. Purchasers also valued the need to have "flexible service level agreements" (1.02), that are dynamic in specification to allow for variations in customer service needs and varying response times for the provision of value adding non clinical services.

According to purchasers, the provision of "high service quality care" (0.84) or cost effective and efficient support services was based on the purchasers having a "good financial stability" (0.85) to invest in service innovation and support the day-to-day business FM operations. Since the NHS is a highly politically and socially sensitive sector, purchasers also valued the need to have "high information confidentiality" (0.80) regarding customer information (needs and expectation) used in the NHS which is used in the design and mapping of responsive and seamless support services and also for business and market intelligence purposes. The need for "management responsibility transfer" (0.78) or the outsourcing non-core business services such as non clinical services was seen by most purchasers as way a of focusing on the organisation's main business objective, while operating efficiently and also adding value to the core clinical services chain of the products and services. Other constructs which were meaningful to purchasers' FM business where the need to provide NHS customers with "best value for money" (0.73) healthcare services that are based on "continuous service improvement" (0.71) by support service staff in purchaser organisations where the need to have "high working flexibility" (0.70) for those staff involved in the process of delivering non clinical services will lead to staff motivation and business improvement, creating an unbeatable corporate image in the NHS. The explanations provided by FM purchasers for using these constructs in healthcare FM operation are provided below as follows:

8.5 Effective clinical strategy

An effective clinical strategy in healthcare operations is one that has good synergy with the purchasers' non-core business (FM) objectives and the overall corporate business plan. It will also focus on short and long term objectives of the purchaser's service delivery strategies. The purchaser's objectives, needs and policies may be that of delivering service excellence (customer satisfaction) to the NHS while managing effectively critical risk/success factors (in terms of time, cost and quality dimensions) that affect the smooth running of healthcare FM operations. Purchasers normally develop effective strategies that set key performance targets, potential for efficiency gains and service quality improvement across hospital service directorates. When designing an effective clinical strategy purchasers will need to consider service innovation issues, people plans, business process re-engineering activities, their procurement strategy and IT strategies that will enhance, enable or disable clinical business success in the NHS.

It of immense importance that an effective strategy focuses on customer and market orientation and clear objective of understanding of the purchasers' facility service needs that will spur both non clinical and clinical staff into action. Purchasers also need to view the non-clinical services strategy as a value-adding element to their core (clinical) business plans and operations. The requirement for an appropriate linking strategy for considering facilities implications of business decisions by promoting meaningful dialogue between business corporate planners and healthcare facilities staff will obviously be of extreme value and providing flexibility in service and capital planning at corporate levels. Furthermore, this process will also allow for management processes to continuously monitor the strategic relevance of facilities provision and operational requirements, and monitoring their performance over time. As a result, adding the much needed skills and competencies required within the facilities function to monitor and continuously review procurement strategies that take advantage of advances in medical, technological and service innovation development and market offerings on the supply and demand side of healthcare FM services.

8.6 High Customer satisfaction

The main business objective of FM purchasers in the NHS is to re-engineer their non-clinical business operations in order for them to aid the core NHS organisations to provide more cost-effective healthcare delivery and heightened customer satisfaction. How an NHS hospital is performing through the eyes of its customers has therefore become a priority issue for healthcare business managers. As a result this perspective captures the ability of the FM purchasing organisation to provide high quality non-clinical services, and achieve overall customer satisfaction. FM purchasers in the NHS are aware that if they are to survive in an ever changing and competitive environment of facility service providers, they need to provide super support services that can be awarded by customers a better value-/cost relationship or quality-/cost relationship. To deliver customer satisfaction and achieving best value money goals, purchasers will need to act as "informed" or intelligent clients. The intelligent client function is demanded of any purchaser that requires non-clinical services to underpin their core business service delivery regardless of how healthcare facilities are procured. As a result of this situation purchasers need to be market-oriented organisations that will pay attention to both their customers (internal and external) and competitors.

To purchasers, customer satisfaction is a key business performance indicator. It can also be a good starting point for measuring the provision of value for money services, which are quality certified against customer expectations throughout the value chain of support services, as it can affect the core (clinical) business in the NHS. This process further allows for the development of the healthcare services brand that normally promotes customer loyalty within the NHS. The maintenance of customer loyalty will be of paramount importance if any FM purchaser is to succeed in the internal market. Clinical outcomes, which are beyond the scope of this research, are probably the most subjective area. A useful technique in helping to focus on these issues from the customer's perspective is to use the concept of "a moment of truth" (Peters and Waterman, 1987). This is considered to be any moment of interface healthcare facilities services have with the purchaser's internal and external customers, i.e. the real ones. This can be quite enlightening and learning to purchasers as it does on consumer behavior towards the delivery of support services knowledge in the NHS.

8.7 Flexible Service level agreements

Effective and flexible SLAs in healthcare operations are used by purchasers as tools for measuring service performance and delivery levels that foster organisational improvement, where there is a substantial degree of departmental autonomy. Such a situation is likely to exist in NHS trust hospitals because of the differentiated nature of the work performed by each service directorate. This is so due to the varying degrees of specialisation and professionalism, access to patients, use of technology and differing cost bases while also having an interdependence on the direct services to the support services. In non-clinical services delivery, SLAs can be used to promote improved integration between hospital departments, quality assurance and provide a framework for cost transfer charging. As a result of the introduction of SLAs, it has become the best practice for purchasers to use SLAs for specifying the performance required of the support service functions against fluctuating customer needs and expectations, and to put in place measurement mechanisms whereby actual performance against targets can be monitored. This normally avoid service failures that are common in the NHS given that customers' threshold and optimum support services needs will always vary 24 hours a day. Typical features which may be included in a SLA to the advantage of purchasers are, hours of service availability, response times, punctuality targets, maximum acceptable service "down time" in a given period and reliability targets. SLAs also form a basis for contractual agreements between purchasers and other FM service providers, in that they can be used to monitor business success or service failure times in order to benchmark future improvements.

8.8 Financial stability

The increasing role of business approaches that are being pursued to manage both clinical and non-clinical outcomes in the NHS requires huge capital outlay and cashflow for them to be carried out efficiently. Therefore, purchasers' financial performance measures define the long/short-run objectives of the FM business unit and indicate whether the strategy, implementation and execution are contributing to bottom-line improvement.

This point serves to illustrate that for most FM decisions made in the NHS regarding the delivery of quality care services to customers to succeed, purchasers must be financially sound to meet their current and future business and capital expansion plans. This situation therefore calls for the total management of the purchaser' business resources using cost effective and service efficiency measures. The management of resources especially in healthcare FM operations represents a substantial financial investment for purchasers managing modern hospital environs that need to be serviced at all business times in order for them to support the core business objectives of the purchaser in the NHS. In view of the current situation in the NHS regarding the effective modernisation (privatisation and public management) of healthcare facilities and the centralisation of clinical services, a good cashflow outlay to finance such capital intensive operations is essential on the part of purchasers. Financial stability of the purchaser is an element of effective healthcare FM business, to ensuring that the business of delivering non-clinical services by providers (in-house/external) on behalf of the purchaser does not fail. Given that the NHS is heavily under-funded for major technological and capital intensive projects, purchasers have found themselves with no financial resources option except to bring in private sector participation using three pathways; the first directed to estates, site services and hotel investment decisions, the second to the management of property assets, the third to the management of facility operating costs, all within the context of the FM market, which tends to be the most illiquid vehicle for investment. As a consequence of the above, the financial trail has led to estates consolidation, downsizing, cost-cutting exercises, dis-investment and disposal, all for the short-term advantage of businesses and shareholders. Reductionist measures of this kind certainly produce "balance sheet" improvements. They cannot be continued indefinitely without damaging the operations that they assume to support. Therefore, purchasers highly valued having huge financial capital outlay as a critical FM business factor in order to successfully manage integrated FM services in the NHS everyday of the year.

8.9 Service quality care

Customers judge service quality in healthcare FM operations as the competence of the FM service purchaser through its provider organisations to deliver FM solutions that underpin the delivery of healthcare at correct response times and consistently.

Purchasers are also increasingly viewing the delivery of service quality as a foundation for a competitive strategy. Therefore, purchasers' FM quality focus should address all customers, employees and providers' needs through providing high non-clinical services. All product and service characteristics that contribute value to the customer and lead to customer satisfaction and preference have become the target of the purchaser organisation's management system. Success requires more than solving management and service quality delivery problems. Merely meeting specifications and reducing complaints is not sufficient. In addition, the purchaser's success in recovering from service mistakes in the NHS is very crucial towards building customer relationships and customer retention (healthcare). With continued change in the NHS, where greater focus now lies with customer service management, there is a requirement for purchasers to implement business approaches (best practices) presently being offered in other service sectors such as retailing and banking. These approaches if used effectively can lead to improved levels of customer service and ensure patients, staff and visitors (users) are targeted to define their levels of satisfaction. Therefore, as service quality is basically perceived as a customer's subjective interpretation of their consumption experience, Lehtinen and Lehtinen (1991) found out that different criteria are used in healthcare services by different purchaser groups to evaluate consumption of services, and these criteria vary depending on the situation and the circumstances. Furthermore, quality as a major determinant of the type of healthcare service to be delivered can also be seen by FM purchasers and stakeholders in a three dimensional perspective:

(1) FM client functional quality - what purchasers and healthcare managers (clinicians) want from support services they are procuring from FM providers;

(2) Professional/technical quality - whether the service meets the needs as defined by professional (in-house/external) providers and referrers and whether it correctly carries out techniques and procedures which are believed to be necessary to meet client/customer needs; and

(3) Management quality - the most efficient and productive (best value) use of resources within limits set by the NHS trust board/authorities.

An important contribution and criteria to the measurement of service quality has been provided with the Servqual approach by Parasuraman *et al.,* (1985), which originally identified ten dimensions of service quality: i.e. access, communication, competence, courtesy, credibility, reliability, responsiveness, security, tangibles and understanding the customer. These dimensions if refined can be classified into five domains that are applicable to the FM purchaser's business improvements. These five factors have been explained in the major survey analysis (see section 7.5). The Servqual as a business management approach measures customers' expectations (derived from their individual needs, their past experience and word of mouth) and their perceptions of the service actually delivered. This measurement normally results in five potential service gaps that are created by the need to match the supply and demand of FM solutions in the NHS, and these service gaps are as follows:

GAP 1- Customer expectations/purchaser (management) perceptions.
GAP 2 - Purchaser perceptions/service quality specifications.
GAP 3 - Service quality specifications/service delivery.
GAP 4 - Service delivery/external communications.
GAP 5 - Customer perceptions/expectations.

8.10 High Information confidentiality

A fundamental principle for the duty of care and customer loyalty embodied in the Service and Patients' Charter regarding non clinical service information strategy in the NHS is that purchasers of FM services will protect business (customer, medical and corporate) information/data, which is kept in confidence and stored in safe databases by senior healthcare managers. Therefore, business information held about customers' healthcare records or to be used by purchasers for support services delivery purposes will only be accessible and linked to the responsible FM staff and healthcare managers using a unique identifier (the new NHS number). As a result of this most purchasers have put in place a hospital service-wide (for use by internal customers) network, for sharing and integration of EPRs, and specific corporate information needs that are thought to be met more easily (for example, the need for management information and the need for information supporting non clinical and risk management audits).

Computerisation, especially if information is patient-based, related to health and potentially sensitive, raises questions concerning the confidentiality, being "the prevention of unauthorised disclosure of information (Official Secrets Act), Data protection Act". Formal rules to protect automatically processed data in the NHS have been recorded in the 1984 Data Protection Act especially in healthcare FM contracts. Given that the need to integrate in-house and outsourced deliveries into a seamless service are part of the organisation and cultural changes in the NHS, FM purchasers are now working on their own non-statutory guidance on confidentiality, use and disclosure of personal health information, of which will protect the abuse of corporate and customer information by service providers and other FM stakeholders commercially. The guidance, which does not specifically apply to computerised information, proposes, besides common law and the Data Protection Act, that employment contracts and professional codes for enforcement should be used. It is a moot point whether this is enough to safeguard confidentiality of personal health data, especially in today's digital environment. The issue of confidentiality and, consequently, data security could be a serious stumbling block to the implementation of an effective FM strategy, and ultimately the delivery of responsive healthcare if sufficient detailed attention is not paid to by senior management in healthcare operations. Some of the key issues which can improve the delivery of healthcare services at a micro-scale facilitated by a pleasant and desirable healing environment (modern facilities) in the NHS to customers in terms of usage are to do with:

i) Checking-in and having private clinical discussions;
ii) offering clinical and non clinical services help;
iii) personalised treatment and healthcare;
iv) customer consultation and complaint making; and
v) customer hotel and commercial services

8.11 Management responsibility (risk) transfer

This refers to the ability of the FM purchaser to transfer business risks that are associated with the day-to-day and strategic management control of non-clinical services when the FM business is transferred to the new service provider.

Outsourced FM contracts that the provider will be managing on behalf of the purchaser and delivering are typical examples where business risks associated with operating healthcare support services will have been transferred to the new provider organisation to manage, with the purchaser/client having a certain percentage of control. Contrary, in the case of PFI contracts, management responsibility is totally transferred to the new provider, implying that the purchaser will not take on the financing and revenue risk for delivery FM services. FM business services will be managed under a contractual arrangement for an agreed period with the new provider taking on operational or service failure related risks. The advantages that can be derived from transferring the management healthcare FM services to external providers are those that result from the use of economies of scale. This situation freely leaves the purchaser to concentrate effectively on their core clinical business needs.

Secondly, the new managing provider will have control of a large, directly employed workforce that can be trained to demonstrate a high degree of flexibility and carry out a multitude of "soft" support services, such as portering, cleaning, security, catering, and business office support. Subsequently, the purchaser also benefits from a highly responsive, seamless services provision, which is free from performance hitches caused by sickness, holidays and staff turnover. Both the transferred and new FM staff to the contract will have the advantage of job variety that leads to job satisfaction, and a higher degree of motivation. Overheads in contract management are also likely to be reduced with this commercial arrangement, thus making it a more economically viable option for the customer. However, some purchasers have reservations about the business ethics of allowing a single provider to provide the management and the effective delivery of non-clinical services. To overcome this situation, it is essential for purchasers to form strategic partnerships with providers based on trust and information sharing of both parties, to provide super support services to NHS customers. On the whole this type of partnering arrangement favours larger NHS trust healthcare facilities, where it presents itself as the only method of benefiting from service integration through economies of scale.

8.12 Management development

The continuous ability of the purchaser to develop effective facilities managers in a bid to improve managerial effectiveness and learning process, while implementing conscious systems to control the development of managerial resources within the organisation is extremely important for the achievement of the purchaser's business goals and strategies. In order for purchasers to achieve a more comprehensive view of development in FM, they will need to monitor effectively the following:

i. frameworks for setting, linking and balancing individual staff and organisational objectives;
ii. systems for identifying and selecting FM managers;
iii. structures to support, motivate and reward, not rating them - Deming's (1986) 14 points for management;
iv. plans to enable career development and progression;
v. mechanisms to measure and evaluate performance.

Therefore, purchasers will need to develop a more holistic, integrated model for staff and management development. If such measures are established, management development can be utilised as a source of promoting competitiveness and a strategic tool for developing organisational effectiveness. It will also be seen as a function of the business strategy, and achieving congruency between strategic and management development. These propositions represent a useful basis on which to formulate an effective management development policy by FM purchasers in the NHS.

8.13 Best value for money service

In overall terms, the challenge for a more effective NHS where FM purchasers achieve greater healthcare service value for public money appears to be the need to use less business and management resources to produce better management, while simultaneously ensuring that the limited resources are optimised intelligently on direct healthcare. This has to happen concurrently with reforms in many aspects of service delivery and the general introduction of a more service-oriented culture.

Such challenges call for more service innovative approaches that break traditional boundaries and perceptions of healthcare delivery that have been considered in the past decade as less responsive to customer needs. A simple balance-sheet mentality has been seen by purchasers to only help in a limited way and is unable to create significant performance improvements. In taking these matters on board, FM purchasers as healthcare managers in the NHS are beginning to acknowledge the strategic importance of the role of facilities and non-clinical staff in the successful delivery of support services. The key realisation appears to be the fact that it is only at the interaction points (which creates the first impression of the service brand) between the front-line staff and the customers that the "product" of a support service is finally made. It is in these moments of truth that the ability of the FM staff involved to cope successfully decides the outcome – customer satisfaction or dissatisfaction. Most purchasers use value for money as a key performance indicator or measure for determining the trust's sourcing strategy whether or not to outsource or to use the tradition route used in the NHS in the past, of retaining the management of hotel services and estates works to in-house providers. Despite this, there is a great dearth of commercial information as to whether purchasers are aware of the extent to which they can improve value for money or business risks involved in healthcare delivery. Considering that purchasers are motivated by the need to improve the FM process in healthcare operations, value can be concerned with the relationship between cost or price and service quality or performance.

In real business economic terms value is equated with achieving a reduction in cost (value engineering). Thus purchasers understand value as being concerned with cost only. This is perhaps because most businesses' performance is measured using financial measures that are easier to measure. However, according to Akhlaghi (1997) value is known to be restricted to the famous 3Es (economy, efficiency and effectiveness) in which healthcare services are delivered, while also considering the quality of those services. Purchasers should, therefore, set themselves cost and quality objectives for managing their healthcare facilities. Quite often than usual due to financial constraints, the cost objectives will take the highest priority over quality objectives. This may lead to a sub-standard service production. When selecting service delivery options and service purchasers will need to consider not only service implications, but also quality enhancement to customers' satisfaction process.

Therefore purchasers will use a service delivery approach and service provider capable of managing business risks associated with providing facilities driven solutions and offering best value, not simply the lowest cost, and should, measure performance using a balance scorecard approach (Kaplan and Norton, 1982). Aramatunga *et al.,* (2000) have demonstrated unequivocally this need to use other critical FM performance factors such as continuous learning growth, business process re-engineering and customer satisfaction. In traditional healthcare FM operations the achievement of best value for money has been demonstrated under market testing by the acceptance of the lowest bid price in a competition where all other criteria (quality, performance, terms and conditions) are given less consideration. Today VFM has been obtained recently by purchasers pursing strategic partnerships with providers to optimise strong delivery relationships, in some cases outsourcing total FM services from providers. This approach has clearly been demonstrated in purchaser organisations that it has economies of scale advantages and also allows the sharing of business risks between purchasers and providers. A dramatic change of culture is what is needed in which case management can exemplify and coach a different way. If FM purchasers can provide all this while delivering basic threshold services at reasonable costs, then it must be best value for money.

8.14 Continuous service improvement

FM business and service improvement has always been a proactive function of management, not simply a reaction to service delivery problems and competitive threats. Many opportunities for service improvement exist, including the obvious reduction in service defects and response times. Purchasers have to improve their FM working systems in healthcare operations by considering issues such as those to do with the improvement of employee morale, customer satisfaction, cooperation, improving managerial practices, improving the service or product design process with features that better meet customers needs, which achieve higher performance, higher reliability, and other market-driven dimensions of quality. Achieving the highest level of FM service quality and competitiveness requires a well-defined and well-executed approach to innovation and continuous improvement. This approach to improvement must be embedded in the way the FM purchaser functions, which means that improvement is part of the daily work of all FM work units that need to:

i) service processes seek to eliminate problems at their source;
ii) is driven by opportunities to do better if not to excel in service excellence.
iii) continuous improvement is nothing special to best FM purchaser organisations; it is just the way best value services are delivered to NHS customers.

Therefore, it goes without say that any service activity or action that the purchasers will perform to enhance service quality care will be based on a long-term commitment approach to the improvement of their non clinical businesses.

8.15 Purchasers' least meaningful constructs

Table 8.2 also shows the lists of constructs with the lowest standard deviations. The constructs which are least meaningful to purchasers included "good legislation compliance policy" (0.20); "benchmarking the best FM practice" (0.10); "high service speed" (0.10); "high staff motivation levels" (0.08); "high service variations" (0.06); "change management" (0.04) and "good financial stability" (0.02). It is surprising to observe that service purchasers did not feel very strong about "good legislation compliance policy" in relation to healthcare and facilities operations and the need for enforcement before customers receive these responsive healthcare services. This unexpected low variation for legislation compliance can be attributed to the fact that FM service purchasers are concerned with the core purpose of the NHS trusts of delivering seamless and responsive care services. In short, purchasers did not pay much attention to the service design process of support services as it has become based on the FM provider's ability to innovate. This is totally in contrast to what most customers expect from the NHS as a service provider.

The failure to observe and comply with legislation and standards that govern the delivery of healthcare support services goes on well to explain why most purchasers in the NHS have failed strategically to cope up with service delivery demands and also given that there has been sudden rise in clinical service negligence cases in the NHS. Recently, a report published by the NHS on HAIs showed that at least 100 000 patients are affected by HAIs while 5000 die every year as a result of clinical negligence (NAO, 1999). The NAO (1999) revealed that during 1996/7, negligence cases cost health authorities and trusts £200 million.

This figure is expected to rise by 25% a year over the next five years. As a result of this, NHS trusts have to set aside each year £80 million for negligence cases already going through, but also identified that these could cost up to a further £1.6 billion. Furthermore, other outstanding cases of medical negligence where claims had not yet been made could cost the NHS another £1 billion. On one hand customers expect their clinical service needs and high expectations of receiving service quality care to be matched. While on the other hand customers do not only expect to receive valued healthcare services, but also impose indirectly a duty of care for FM purchasers to deliver FM services in compliance within the current legislation in order not to endanger public health and safety. NHS customers do not tolerate non-compliance in the delivery of responsive support services that eventually support healthcare service provision, as it will cause reductions in quality of customers' lives or deterioration of those who are ill. Purchasers did not feel very strong about "high service speed" as a key determinant factor in the delivery of high quality care. This low variation may be a result of the fact that purchasers are aware that the management of clinical outcomes is not wholly based on service response times, but is a gradual process that can take days if not months depending on the diagnosis of the sickness made by clinical experts. These findings tend to manifest a problem given the fact that the NHS has been battling hard to "free up" healthcare facilities (i.e. beds) in order to reduce the waiting times to receiving care in Trusts.

Purchasers also least valued "benchmarking the best practice in FM" as a risk construct. This is probably because benchmarking mainly measures and compares performance using financial measures only, compared to NHS trusts where business is driven by economics as opposed to delivering value added care to customers. FM purchasers have traditionally measured facilities performance by financial indicators alone and there has been a tendency to record unit costs in many areas of FM. These may have been appropriate in the past, but in today's 24 hour shopping society customers live in, which depends on user-information there is a growing consensus that financial or cost performance, however conclusive they are seem to be inadequate, and are neither an adequate measure of competitiveness nor a guide to future facilities performance in the NHS.

Table 8.3: External providers' Consensus Grid

CONSTRUCTS	Hotel and Catering	Portering	Security	Building Services	Mech & Elect	Grounds and gardens	Reprographic	Health and safety	Waste management	IT management	EBME/Medical equipment	Patient transport	Car parking	Domestic	Estates & maintenance	Low patient care	Cleaning	BI-CONSTRUCTS
High Customer satisfaction levels	5	5	5	4.1	3.2	4.1	4.1	5	5	4.1	4.1	5	4.1	4.1	5	4	5	Low customer satisfaction levels
Good Service delivery certainty (time)	4	3	4	4	4	3	3	5	3	4	4	4	3	4	4	3	5	Bad Service delivery certainty (timeless)
High Customer involvement levels	4	4	4	3	3	3	3	5	3	5	4	2	4	3	3	3	3	Low customer involvement levels
High Service quality care	5	5	5	4	4	5	4	5	4	5	4	5	5	5	5	5	5	Service quality failures
Service availability	4	4	4	5	4	4	4	5	4	4	4	4	4	4	4	4	4	Service delays
High Customer care	4	3	4	4	1	2	3	4	4	4	4	4	4	4	4	4	4	Customer careless
Sound Health and Safety policy	5	5	5	4	4	4	4	4	4	5	4	4	5	4	4	4	5	Poor Health and Safety policy
Best value for money service	5	5	5	4	3	3	3	4	4	4	4	3	3	3	3	3	3	No value for money service
High Staff participation and partnership	4	4	4	4	4	4	4	4	4	4	4	4	3	3	4	3	3	Staff participation and partnership
Sound Health Legislation compliance policy	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	Poor Health Legislation non compliance
Service Cost certainty	5	5	5	4	4	4	4	5	4	4	4	5	4	4	4	4	4	Service Cost escalations
High Service speed	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	Service delays
Benchmarking best FM practice	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	Benchmarking worst FM practice
High Staff motivation levels	3	3	3	2.5	3	3	3	3	3	3	3	3	3	3	3	3	3	Low Staff motivation levels
Price competition	4	4	4	3	3	4	4	4	4	3	2	3	3	3	3	3	3	Price monopoly
Continuous service improvement	4	3	4	3	3	4	4	5	5	5	4	4	4	4	4	4	4	No service improvement
TUPE	4.7	3.8	3.8	3.9	3.8	3	3	4	4	5	2.9	2.9	2.9	2.9	2.9	2.9	2.9	High employment security
Service measurement	4	4	4	3	3	3	3	4	4	3	3	3	3	3	3	3	3	Service measurement
Service variations	1	3	3	3	2	3	4	3	3	2	3	3	3	3	3	3	3	Service variations
Change management (cultural)	3	3	3	1	3	2	3	3	1	3	3	3	3	3	3	3	3	Change management (cultural)
Partnerships	3.7	3.8	3.8	3.8	3.8	3	3	4.7	3.8	2.9	2.9	2.9	3.8	2.9	3.8	3.8	3.8	Partnerships
Good organisation image	5	5	4	4	4	4	4	5	5	5	5	4	5	5	4	5	5	Poor organisation image
Competitive service price	4	4	4	4	3	3	3	4	3	3	3	3	3	3	3	3	3	Uncompetitive service price
Flexible Service level agreement	5	5	5	5	4	3	3	4	4	4	4	4	4	3	3	4	4	Rigid Service level agreement
Flexible service contract	5	4	4	4	3	3	3	5	4	4	3	3	3	3	4	3	3	Fixed service contract
Good Financial stability	3	4	3	3	3	3	4	3	3	3	3	3	3	3	3	3	3	Bad Financial stability
High Information confidentiality	2.1	2.1	2.2	2.1	2.1	2.1	2.1	2.3	2.3	2.3	1.2	1.3	2.2	2.2	2.2	2.2	3	No Information Strategy & confidentiality
Clinical strategy	5	5	5	3	3	2	2	4	3	3	3	3	3	2	2	2	3	No clinical strategy
Provider's financial reputation	4	4	4	3	4	4	5	4	4	4	4	4	4	4	4	4	4	Provider's financial reputation
National minimum wage requirements	3	3	2	2	2	2	3	3	2	2	2	2	2	2	2	2	2	Performance related wage requirements
Service innovation	4	4	4	4	4	3	3	4	4	4	4	4	4	4	4	4	4	Service innovation
Performance guarantees	4	4	4	3	3	3	3	4	4	4	4	3	3	4	4	4	4	Performance guarantees
Good Management accounting systems	5	4	3	3	2	2	3	4	3	3.9	3	2	4	3	4	3	3	Bad Management accounting systems
Organisation cultural disparities	3	3	3	1	1	2	2	2	2	2	2	2	2	2	3	2	2	Organisation cultural similarities
Management development	5	5	5	3	3	3	2	4	3	4	4	3	3	3	4	3	3	Management development
Good Market intelligence strategy	4	4	4	2	2	2	3	2	3	3	3	2	2	3	3	3	3	Poor Market intelligence strategy
Social corporate responsibility (SCR)	3	3	3	2	2	2	2	3	3	2	2	3	3	3	2	3	3	Low Shareholder value
Low Business transfer costs	5	5	5	2	2	2	2	4	4	5	5	4	4	4	4	4	5	High Business transfer costs
Business process re-engineering	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	Business process re-engineering
Technology transfer/exchange	3	3.1	3.9	3.8	3.9	3.8	3	3.1	3.1	3	4.9	3	3.1	3.1	3.1	3.1	3.1	No Technology transfer/exchange
Good Provider Reimbursement method	4.8	4.7	3	4	4.7	4.7	3	3	4	3	4	4.8	4.8	4.8	4.8	5	3	Poor Provider Reimbursement method
Third way (Political, Physcho-social)	4	3	3	1	1	2	2	3	3	2	2	2	2	2	2	2	2	Third way (Political, Physcho-social)
Stakeholder resistance	4	4	2	1	2	2	3	1	3	3	3	3	3	2	3	3	2	Stakeholder involvement/support
Return on capital employed	4.8	4.8	4.7	4.7	4.8	4.8	4.8	4.6	4.7	4.6	4.8	4.7	4.7	4.8	4.6	4.6	4.6	Return on capital employed
Low Insurance liability costs	3.8	3	3	3.8	3.8	3	3.8	3.8	2.9	3.8	3.8	3.8	2.9	3.8	2.9	3.8	2.9	High Insurance liability costs
Good Working capital	5	4	5	5	5	4	3	5	5	5	4	3	3	4	5	5	3	Low Working capital
Low staff Absenteeism	4	4	3	3	3	2	2	4	4	4	4	3	3	4	4	4	3	High staff absenteeism
High Multiskilling levels	4.8	4.8	4.8	3.8	4.7	4.6	4.7	4.6	4.7	4.7	4.8	4.7	4.7	4.8	4.8	3.9	4.9	Low multiskilling levels

Table 8.4: In-house FM Providers' Consensus Grid

CONSTRUCTS	Hotel and Catering	Portering	Security	Building Services	Mech & Elect	Grounds and gardens	Reprographic	Health and safety	Waste management	IT management	EBME/Medical equipment	Patient	Car parking	Domestic	Estates & maintenance	Low patient care	Cleaning	BI-CONSTRUCTS
High Customer satisfaction levels	5	5	5	4	3	4	4	5	5	4	4	5	4	4	5	4	5	Low customer satisfaction levels
Good Service delivery certainty (time)	4	4	4	4	4	3	3	5	4	4	4	4	4	4	4	4	5	Bad Service delivery certainty (timeless)
High Customer involvement levels	4	4	4	3	3	3	3	5	3	5	4	3	4	3	3	3	3	Low customer involvement levels
High Service quality care	5	5	5	4	4	5	4	5	4	5	4	5	5	5	5	5	5	Service quality failures
Service availability	4	4	4	5	4	4	4	5	4	4	4	4	4	4	4	4	4	Service delays
High Customer care	4	4	4	4	4	4	3	4	4	4	4	4	4	4	4	4	4	Customer careless
Sound Health and Safety policy	5	5	5	4	4	4	4	4	4	5	4	4	5	4	4	4	5	Poor Health and Safety policy
Best value for money service	5	5	5	4	3	3	3	4	4	4	4	3	3	3	3	3	3	No value for money service
High Staff participation and partnership	4.5	4.5	4.5	4.5	4.5	4.5	4	4	4	4	4	4	3	3	4	3	3	Staff participation and partnership
Sound Health Legislation compliance policy	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	Poor Health Legislation compliance
Service Cost certainty	5	5	5	4	4	4	4	5	4	4	4	5	4	4	4	4	4	Service Cost escalations
High Service speed	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	Service delays
Benchmarking best FM practice	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	Benchmarking worst FM practice
High Staff motivation levels	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	Low Staff motivation levels
High employment security	3.5	3.5	3.5	3	3	3.5	3.5	3.5	4	3	3	3	3	3	3	3	3	TUPE
Continuous service improvement	4	4	4	3	3	4	4	5	5	5	5	4	4	4	4	4	4	No service improvement
Smart Client	4	3.5	3	3.5	4	3	3	3	3.5	3.5	2.5	3	2.5	3	3	2.5	3	Less knowledgeable client
Service measurement	4	4	4	3	3	3	3	4	4	3	3	3	3	3	3	3	3	Service measurement
Service variations	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	Service variations
Change management (cultural)	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	Change management (cultural)
Partnerships	4	4	4	4	4	3	3	5	4	3	3	3	4.5	3	4	4	4	Partnerships
Good organisation image	5	5	4	4	4	4	4	5	5	5	5	4	5	5	4	5	5	Poor organisation image
Service price competition	4	4	4	4	3	3	3	4	3	3	3	3	3	3	3	3	3	Service competition
Good Service level agreement	5	5	5	5	4	3	3	4	4	4	4	4	4	3	3	4	4	Bad Service level agreement
Good Service contract design	5	4	4	4	3	3	3	5	4	4	3	3	3	3	4	3	3	Bad Service contract design
Good Financial stability	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	Bad Financial stability
High Information confidentiality	2	2	2	2	2	2	2	2	2	2	1	1	2	2	2	2	2	No Information Strategy & confidentiality
Clinical strategy	5	5	5	3	3	2	2	4	3	3	3	3	3	2	2	2	3	No clinical strategy
Purchaser's financial reputation	3.5	3	3.5	3	3	3.5	5	4	4	4	4	4	4	4	4	4	4	Provider's financial reputation
National minimum wage requirements	3	3	2	2	2	2	3	3	2	2	2	2	2	2	2	2	2	Performance related wage requirements
Service innovation	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	Service innovation
Performance guarantees	3.5	3.5	3.5	4	4	3	3	3	3	3.5	3.5	3	3.5	3.5	3	3.5	3.5	Performance guarantees
Good Management accounting systems	4	4	4	3.5	4	4	4	4	4	4	4	4	4	4	4	4	4	Bad Management accounting systems
Organisation cultural disparities	3	3	3	1	1	2	2	1.5	2	2	2	2	2	2	3	2	2	Organisation cultural similarities
Management development	4.5	5	5	3	3	3	2	4	3	4	4	3	3	3	4	3	3	Management development
Good Market intelligence strategy	3.5	3.5	3.5	2	2	2	3	2	3	3	3	2	2	3	3	3	3	Poor Market intelligence strategy
Social corporate responsibility (SCR)	3	3	3	2	2	2	2	3	3	2	2	3	3	3	2	3	3	Low Shareholder value
Low Business transfer costs	5	5	5	2	2	2	2	4	4	5	5	4	4	4	4	4	5	High Business transfer costs
Business process re-engineering	4	2.5	3	3	3	3	2.5	3	2	3	2	3	3	3	3	3	3	Business process re-engineering
Technology transfer/exchange	3	3	4	4	4	4	3	3	3	3	5	3	3	3	3	3	3	No Technology transfer/exchange
Good Provider Reimbursement method	1	2	3	3.5	3.5	3	3.5	3.5	3	3.5	3	3	3.5	3.5	2	3.5	3.5	Poor Provider Reimbursement method
Third way (Political, Physcho-social)	4	3	3	1	1	2	2	3	3	2	2	2	2	2	2	2	2	Third way (Political, Physcho-social)
Stakeholder resistance	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	Stakeholder involvement/support
Return on capital employed	4.5	4	4.5	3.5	4	4	3.5	3.5	3.5	4	4	4	4	4	4	4	4	Return on capital employed
Low Insurance liability costs	3.5	2.5	4	3	4	4	4	4	3	4	4	4	3	4	3	4	3	High Insurance liability costs
Good Working capital	4	4	5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3	3	3.5	3.5	3	3	3.5	Poor Working capital
Low staff Absenteeism	5	5	5	4	4	4	4	4	4	4	3	3	4	4	4	4	4	High staff absenteeism
High working flexibility	4	4	4	3	4	4	4	4	4	4	4	4	4	4	4	3.5	4	Low working flexibility levels

8.16 Analysis of external and in-house FM service providers' Grids

After analysing the purchasers' grids, the external and internal FM service providers' grids were also analysed in great detail. Tables 8.3 and 8.4 provide a list of FM risk constructs commonly encountered in healthcare FM operations in the NHS by service providers (i.e. in-house and external). In addition Table 8.5 was produced and shows the external providers' constructs listed in ascending order ranking according to their standard deviation or variation.

8.17 External FM providers' grid

Similarly, in Table 8.5 the variation of the External FM service providers' constructs (in terms of standard deviations) range from a minimum of 0.70 to a maximum of 1.13. The most salient risk constructs to FM external providers were customer satisfaction" (1.13); "business transfer costs" (1.04); " effective clinical strategy" (1.02); good management development (0.85); "return on capital employed" (0.84); " high flexible working" (0.8); "TUPE" (0.78); " best value for money services" (0.76); "Strategic partnerships" (0.74); " flexible service level agreements" (0.71), "Third way (political and psycho-social)" (0.71) and "market intelligence strategy" (0.71).

Thus the most meaningful constructs indicated by external FM providers gave credence to the hypothesis that there are key risk constructs which these FM service providers are regularly exposed to when managing healthcare FM business operations in the NHS. The explanation and justification provided by external FM providers for using such constructs may well be as follows:

8.18 Customer satisfaction

The results obtain from this survey are not surprising at all given that the need to provide customer driven facilities solutions is the ultimate goal for every successful healthcare business that seeks to be competitive and reduce operating costs and business overheads (Jones, 1997).

It can also be said that "customer satisfaction" is extremely important in the NHS as costs associated with service mistakes in a sensitive sector such as healthcare are highly unacceptable and can put the public care at risk (health deterioration or death).

Table 8.5 External FM service Providers' Constructs with Largest and Smallest Variation

S/N	Most valued Constructs with largest variation	Standard Deviation	Mean Rating
	High customer satisfaction	1.13	4.1
	Low business transfer costs	1.04	4.5
	Good clinical strategy	1.02	4.0
	Good management development	0.85	3.5
	High return on capital employed	0.84	4.7
	High working flexibility	0.8	4.1
	TUPE	0.78	3.9
	Best value for money	0.76	4.4
	Strategic partnership	0.74	3.6
	Good market intelligence	0.71	3.8
	Variability = 0.900		
S/N	**Least valued Constructs with smallest variation**	**Standard Deviation**	**Mean Rating**
	High customer care	0.29	3.9
	Health legislation compliance policy	0.20	3.0
	High service speed	0.18	5.0
	Benchmarking best FM practice	0.18	4.0
	High staff motivation levels	0.16	3.0
	Service variations	0.15	3.0
	High change management levels	0.14	3.0
	Good financial stability	0.12	3.0
	High service innovation levels	0.10	4.0
	Performance guarantees	0.08	4.0
	Good working capital	0.06	5.0

Thus, in delivering customer driven support services commercial FM providers will be seeking to enhance non -clinical services which are core to their business process, and simultaneously allowing for more repeat business. As a consequence of providers meeting their customers' clinical support service needs in hospitals, risks associated with the service provision of responsive care are drastically reduced resulting in improved patient-focused care in the NHS. In Trusts, FM customers are the patients, visitors and staff that use support services as part of the healing environment or service value chain process of receiving care.

As for the commercial provider's staff, FM allows them to plan and manage the practical delivery of a range of diverse, sophisticated non-clinical services to direct (internal departments) and external customers (patients and visitors) in an environmentally friendly workplace. Customers are the backbone of any business service delivery or survival. As a result, it follows that the importance of customers and meeting their needs is central to provision of quality support services management and can contribute to the efficiency, economy and effectiveness of any NHS FM provider. It is having an understanding of the clinical business environment, and knowledge (market intelligence) about FM customers' needs that commercial FM provider directorates become more flexible in managing the dynamic clinical demands of both internal and external customers in NHS Trusts. Therefore market intelligence becomes a very effective way of matching clinical resources to business risks. Alexander (1992) considers customer care delivered by commercial providers through service excellence as a competitive strategy for designing and delivering best value responsive services that reduce service delays and failures. Therefore, commercial FM providers need to focus on managing effectively non-clinical services that front the patient focused care system in order to meet the satisfaction levels of the customer that are affected by perception. It is also vital that these services are delivered to customers within the context of a seamless service provision.

8.19 Business transfer costs

These are total costs related to the outsourcing and transfer of FM services or business resources to the managing external provider who normally has to fund such costs. In most cases they involve the total transaction cost relating to the take-over of managing and delivering responsive non-clinical services by the external provider. In today's uncertain market, service providers in most cases have to prepare good business cashflow plans that show the financial, legal commercial implications of any FM business contract they would have decided to enter into. The costs associated with the outsourcing of FM services will include:

i) redundancy costs for staff
ii) purchase of capital assets and intellectual property costs

iii) recruitment of and transfer of staff to the external provider
iv) the cost of transfer and goodwill of a business.

As commercial FM providers are driven by mainly profit objectives, they are normally sensitive to business transfer costs risks which if not seriously considered will cause business viability problems. In some cases this type of risk (business transfer) has seen commercial providers going into voluntary or compulsory liquidation due to lack of cashflow caused by massive business transfer costs or debt mounting. Thus, providers are often exposed to this business and financial risk quite often. In this case business transfer costs have to be monitored against business plans of the whole contract in order to improve the viability of healthcare FM operations. The transfer of business costs to the new service provider calls into question the following issues regarding the financial capabilities of the external provider to effectively manage the FM business. The following financial questions can be asked;

a) How financially secure is the FM provider?
b) What happens if the provider goes into voluntary or compulsory liquidation?

All these questions of financial viability although very difficult may be easier to assess and manage than intangibles such as commitment to service quality and sympathy with the purchaser's service values which need to be pursued effectively after the transfer of the business. It is therefore the duty of the commercial provider to identify all possible risks affecting the 24-hour delivery of high quality facilities and support services at a cost the market can afford. The added dimension in most healthcare FM outsourcing is risk caused by the business transfer that may be commercial, clinical, political, physical or financial.

8.20 Effective clinical strategy

It is essential that each commercial FM provider develops a facilities service strategy that is aligned with its business plans and that of the purchaser they are currently providing non-clinical services for or to.

This will stimulate the development of shared values and vision, creating synergy and integration within the trust so that facilities and business support services providers can be seen as a strategic part of the corporation and not just as an arm's length service provision of contractual services or non-core activity. As a result of this, FM service providers in healthcare operations are now vying for market share and seeking to find a competitive edge and will therefore, require business information and intelligence to define their strategic direction, business and operational plans within the NHS context. As this scenario is quite common in business, an ideal commercial FM provider's strategy must always match the market demand for healthcare with the available input resources – human, financial and physical assets that will always lead to an unbeatable corporate image delivering cost-effective healthcare. According to Hanson and Hinks (1998) ignorance of the strategic worth of FM to the core (clinical) business objectives of the organisation or vice versa represents a clear risk for the overall business competitiveness in what is increasingly becoming a global market. Thus, external FM service providers have to consider the delivery of non clinical services within a much broad-based business scope which allows the host NHS organisation (FM service purchaser) to incorporate FM service issues as part of the overall strategic business plan. Johnson and Scholes (1993) define organisational strategy as:-

"..... the direction and scope of an organisation over the long term: ideally which matches its resources to its changing environment, and in particular its markets, customers or clients so as to meet stakeholder expectations".

Thus, FM in healthcare operations can therefore be seen strategically as creating a healing environment that is conducive to the provision and delivery of non clinical and support services, using an integrated approach of the services' infrastructure, and capitalising this advantage to deliver facilities driven solutions that add value for money to the core clinical business in the NHS. It is therefore extremely important that external providers will design and deliver support services in the NHS within the organisational context that healthcare FM operations will add value to those NHS customers increasingly in need of "a safe environment (the estate), clean surroundings and an appropriate diet (hotel services)" as integral parts their diagnosis, treatment and recovery or improving their quality of life (Rees, 1998).

External service providers are continuously realigning themselves with evolving healthcare environments. In the NHS, FM providers would tend to agree that all strategies, facilities management included, should be linked to this otherwise increasingly dynamic marketplace. The facilities strategy must also be current and relevant to the operational environment. The facilities strategy of commercial providers also needs to be readily understandable and motivate staff to effectively manage the FM business process and thus reducing business risk exposure of their organisations as well the host NHS trust they will be providing with support services. In order to achieve the much-needed focus between organisational structure, service delivery processes and the enabling physical environment, the provider organisation's strategic intent must clearly reflect the facilities dimensions in its strategic business plans. In this respect, literature reviewed in this research, highlighted three emerging themes, which point to the need for further research needs to be executed to justify the strategic consideration of FM under the following aspects of healthcare business management:

(a) sweating or effective use of healthcare assets (i.e. facilities and business support services) , that is make them highly cost effective and efficient;
(b) provide competitive advantage to the delivery of care service in NHS trusts;
(c) add value to the corporate image of service providers and trusts;
(d) enable future change in the use of the physical hospital setting environment; and
(e) deliver seamless and responsive healthcare services to customers.

Furthermore, the need to link FM decisions to the corporate strategy while proactively managing functional space as a business resource will result in the need to develop conceptual models and frameworks. These will then be used for integrating the emerging evaluation tools and management development skills in business resource management, as they are applied to the provision and management of the corporate operational assets and associated facilities support services in their business settings. The above emerging themes, in turn, lead to at least three strategic requirements of FM in any organisational setting:

i) The requirement for an appropriate linking mechanism for considering facilities implications of business decisions by promoting meaningful dialogue between business corporate strategists and facilities personnel.

ii) The requirement for management processes to continuously monitor the strategic relevance of facilities provision and operational requirements, and monitoring their performance over time.

iii) The requirement of appropriate skills and competencies within the healthcare facilities function to monitor and continuously review procurement strategies to take advantage of advances in technological development and market offerings on the supply side.

8.21 Continuous management development

The management philosophy of W. Edwards Deming (1986) with its profound implications for management-led business transformation is underpinned by the practice of innovation and continuous improvement of systems and processes, based on understanding and knowledge via continuous management development (learning). More recently, business process re-engineering has been adopted by external FM service provider organisations as a total quality management tool for their key healthcare operations in an increasingly uncertain NHS business environment. This has proved to be and is providing many opportunities for healthcare quality improvements. It can also provide the added opportunity to design into the new FM service processes, the capability of continuous ongoing improvement. Success in this area from a commercial service provider organisation's perceptive in healthcare operations entirely depends on the ability of the providers' support services managers as leaders to manage business risks associated with, working to improve the FM service process. This will also involve the strategic management of the entire healthcare delivery system in which it operates, to create an environment where learning and innovation can be facilitated to other FM operational staff by senior management. As for continuous learning in provider organisations to be achieved the BIFM has proposed major competencies that need be pursed in order for management to achieve service excellence and reduce operational risks.

The core competencies and management development functions outlined by the BIFM for senior FM managers are (Bell, 1994; and Clark and Hinxman, 1994):

(1) understanding business organisation;
(2) managing support service staff;
(3) managing premises;
(4) managing support services;
(5) managing the working and service environment (servicescape); and
(6) managing resources.

Given such management development needs and requirements for the external providers' management teams, providers will need to concentrate on the whole process of identifying corporate training needs, customer care needs, conducting staff training, examining FM service and business performance and looking at career development. More also, the fact that healthcare FM is still in its embryonic stages the need for provider organisations to continuously improve the corporate learning skills of their senior managers who are involved in strategic decision making pauses a huge risk if not addressed effectively. Furthermore, from the results above, it can be seen that external service providers view " management development" as the key FM risk construct to be managed in order for their organisations to achieve effectiveness. Some of the key aspects which they may have considered to improve the learning process can be classified under the following areas (Clark and Hinxman, 1999):

i) communications;
ii) teamworking and empowerment;
iii) training and development and;
iv) performance management and reward systems.

8.22 ROCE

External FM providers are commercial entities and their main business objective is to maximise the overall financial investments and business capital performance of their organisations. ROCE as a financial performance indicator is important, as it is the percentage return on capital employed and is defined as profits on service transactions before interest and tax divided by capital employed multiplied by 100.

A positive as opposed to a negative ROCE is normally achieved by managing effectively the financial resources injected by FM providers towards the management of support services and the business process in order to minimise service failure risks in healthcare FM operations. This is to say that, for any FM service deal providers are involved in, an investment yield will be expected which will justify the amount of risks carried by providers in order to maximise profitability of such business ventures. In this study most external FM service providers ranked construct "return on capital employed" as the critical risk factor they faced when managing FM businesses in the NHS. Due to the current modernisation in the NHS, commercial providers have to compete and demonstrate that any financial investment that they will be put into healthcare FM services delivery will be matched by a commercial return on capital to supplement the limited finance available.

8.23 High flexible working

To commercial FM providers, flexible working represents an innovative and useful organisational style of work made possible by the resourceful use of developing information technology. Flexible working combines the opportunity for reducing providers' organisational support services costs, and the associated expenses of travel time to and from the workplace, with the claim of also increasing productivity and efficiency. This new working practice allows healthcare service staff to carry out their business activities within a broad scope of enabling facilities. These incorporate various IT and premises strategies such as telecommuting, shared space/hot desking, touch down-space, tele-work from home, and tele-cottaging. In the very best cases these IT and premises strategies have been integrated completely to contrast the virtual and technologically-based hospital as a workplace with a social and informal setting in the physical workplace. Working flexibility represents the materialisation of elements of the 'virtual' NHS organisation as an organisation made up of networks of contract FM providers and in-house small groups who spontaneously combine, co-ordinate, and disperse again to create virtually instantaneous, responsive services to healthcare customers. Financial advantages associated with flexible working become particularly apparent when the utilisation of NHS facilities is analysed in time instead of a function of beds number or business areas.

The percentage of useful activity that directly contributes to the achievement of the organisation's defined objectives is found to be significantly low. This is due the reduction in the opportunities of effective facilities utilisation due to social expectations and the management of the workplace. Such results to the organisation's objectives have a detrimental effect on the quantity of 'real' relevant work.

Flexible working in the NHS also poses major risks to both providers and the FM staff. Commercial FM providers will have to build their corporate cultures of enterprise, motivation and loyalty across the barriers of multi- hospital sites, multi-venue and multi-time working arrangements. For the provider's staff the problem will be to maintain commitment, confidence and service performance in diverse and often isolated support service environments. The development of completely different attitudes to organisational culture and leadership will be required to support the new ways of working.

8.24 TUPE

External FM service providers as commercial business entrepreneurs are, of course, accustomed to facing new business risks posed by procurement systems, transactional costs and healthcare legislation. But the TUPE regulations have crept up in FM contract services delivery in the NHS with stealth. The transfer of FM staff employment from the (host organisation) purchaser to the external provider is an extremely unclear area of business that poses some legal and financial uncertainties both in the short and long-term strategy for FM operations. Commercial FM providers in today's business environment that is unpredictable have become increasingly adept at treading the minefield of the regulations. They find, however, that too many FM purchasers in the NHS sector seek to transfer most business risks associated with TUPE to providers who will be managing non-clinical services. Providers are not the only FM operators who face TUPE risks. TUPE risks also affect purchasers and other stakeholders involved in healthcare FM operations. As a result of this lack of understanding the impact of TUPE regulations and the uncertainty in legal reforms regarding healthcare business services can have adverse effects to all operators.

Most external providers providing non-clinical services over the past years have encountered problems with the Transfer of Undertakings (Protection of Employment) Regulations (TUPE). The legal uncertainties surrounding the issue of when the regulations apply, and the resultant dilemmas facing purchasers outsourcing non-clinical service contracts have brought chaos to public sector contracting under the Government's market testing, compulsory competitive tendering and the best value approaches. If the contract involves staff transfer under TUPE, the service providers will usually incur a potential liability that will be priced for within the proposal. Not only will this potential liability be reduced over a longer contract period, but also the cost of the risk will be spread over a longer period.

8.25 Best value for money

This is perhaps the fundamental influence towards shorter FM contract duration. External providers have to satisfy NHS customers that support services they are delivering to underpin the purchaser's core healthcare services represent the best possible value for money they could get from an open market economy. Many FM purchasers in the NHS perceive that this is most readily demonstrated through privatisation and best value approaches introduced by the government in the NHS. Value in service terms and its relationship to quality that can be defined and monitored is in fact more about the degree to which the provider's delivered services are perceived by customers to enhance and add value to the core business of an organisation. It often manifests itself for example, as flexibility in service delivery within an environment where the balance between the risks and benefits of such flexibility is constantly monitored and positively managed. Furthermore, many services such as facilities services are delivered and received by people and thus the understanding of cultural and human behavioural issues must play a prominent role in the recognition and delivery of added value, which is a crucial aspect of the total value side of the equation.

Money, in service terms, is not only to do with the costs of specific operations and investments in medical and operational facilities, etc. but is also about the net financial effects of complex transactions, often confused by a changing picture of organisational overhead recoveries.

This is made more complex in FM purchaser organisations by the actual and potential opportunities for income generation from the provision of support services within and outside their own sector. The key question in contract facilities services thus becomes that of making sure that the cmmercial provider is delivering added value (contribution to core business success) for money (often defined as reduction from current levels of costs). Almost all the added value referred to in such a context is beyond the mere competence-related threshold requirements and is thus incremental. A good starting point in this context for the measurement of value for money is customer satisfaction as a function of customer expectation throughout the value chain of support services as it affects the core (clinical) business.

8.26 Strategic partnerships

Successful commercial FM providers in the NHS have started building internal and external working relationships based on teamwork, trust, non adversarial business approaches, confidential information sharing, openness and sharing of risks (i.e. partnerships) to accomplish their overall business goals better. The key elements to be considered in the changing roles and responsibilities in healthcare facilities management are brought about by the need to innovate a sharper focus towards patient care (Okoroh *et al.,* 2001). One such solution is to develop a commercial partnership. Internal partnerships include those that promote labour-management co-operation, such as mutual agreements with unions or workforce and creating network relationships among other provider units to improve their business service flexibility and responsiveness. External partnerships include those entered by providers with purchasers of FM. Partnership relationships between commercial providers and purchasers in changing healthcare operations today go beyond the narrow contractual boundaries, but towards more open and creative business arrangements. FM contracting such as partnering in the NHS currently is merely based on respect, trust and transparency in business information sharing and productive use. Therefore from a commercial provider's perceptive FM-partnership contracts originate from two different angles: (a) from the core business (the primary process); and (b) from the technological possibilities (e.g. document processing).

In practice a partnership contract for cleaning services is essentially different from a contract in which document processing is arranged. Cleaning services is a marked output based on a specification, whereas a document-management process has to be based on strategic choices of the FM providing company. Here the process of growth takes much more time between commercial providers and internal FM departments. It is therefore effective that the healthcare FM operators (providers and purchasers) must take on the partnership responsibility and incorporate within their strategic business plans issues such as:

i) mission statement;
ii) business philosophy;
iii) culture and goals;
iv) patient-care requirements;
v) environmental, welfare and safety requirements.

The responsibility for service delivery success or failure should firmly lie with the partnership. A committed partnership will succeed in deriving these service benefits much needed by customers.

8.27 Market intelligence strategy

Any external FM provider competing in an open market (i.e. healthcare) is obliged, for survival, to have intelligence about its performance with respect to other competitors such as in-house and partnership providers. This requires reliable, consistent, appropriate and timely information. The NHS "best value" market is no different in this respect. External providers delivering non-clinical support services in trusts are vying for market share and seeking to find a competitive edge. Therefore, commercial providers do not only require information to define their strategic direction, business and operational plans but also for the purchaser they will be delivering service for. The ideal commercial provider's strategy must always match the market demand for healthcare with the available input resources – human, financial and physical assets. Usually these input resources are managed separately by various hospital service directorates in the NHS, in order to develop information systems that meet their particular customer needs.

In business planning terms, cost, quality, risk and quantity, given that there is a market for the service, are linked. Quantity is a direct consequence of market demand. External providers in the NHS consider top-level business data gathering as an important priority, of managing effectively the FM process in the NHS. Understanding business market intelligence allows provider to also manage business information technology (IT) and management systems while sharing high-level information with competitors (external providers) and others outside the healthcare business (i.e. for benchmarking purposes). Furthermore this business intelligence gathering approach has drastically improved the decision-making process of external providers in delivering superior support services in the NHS.

8.28 In-house FM providers' grid

Table 8.6 shows the variation of the in-house providers' constructs. The in-house providers' constructs variation ranged from a minimum of 0.63 to a maximum of 1.50. The most meaningful constructs to the in-house providers were " good working capital" (1.50); "good clinical strategy", (1.14); "high working flexibility" (1.01); "intelligent client" (0.78); "best value for money" (0.77); "third way (political, psycho-social)" (0.73); "effective management development" (0.71); "high customer involvement" (0.70); "good performance guarantees" (0.68); "flexible service level agreements" (0.68); "high customer satisfaction" (0.68) and high employment security" (0.63). The explanation given by in-house providers for using these constructs were as follows:

8.29 Working capital

The purpose of working capital in FM in-house organisations' healthcare operations is to manage the current accounts (i.e. strategic financial management of non clinical service operations), so that in-house providers can attain a desired balance between clinical service enhancement and risk. Almost all healthcare FM decisions have a serious financial implication in terms of resource level usage as a result will need to be considered in the business plan of the host purchaser in order to predict the cashflow outlay requirements for the continuous supply of high quality support services.

Given that financial resources in the NHS are always limited for major capital and technical projects. In-house providers through their purchasers of FM services have to source for funds/investment from the open market (call in private providers) as well as practising effective resource management. Furthermore, they would need to practice effective budgeting of which an integrated FM is the major driver for the improvement in the delivery of cost effective and efficient healthcare services (value for money).

Table 8.6: In-house FM service providers' constructs

S/N	Most valued Constructs with largest variation	Standard Deviation	Mean Rating
	Good working capital	1.50	3.6
	Good clinical strategy	1.14	3.1
	High working flexibility	1.01	3.9
	Intelligent client function	0.78	3.1
	Best value for money services	0.77	3.6
	Third way (Political, Psycho-social)	0.73	2.2
	Effective management development	0.71	3.5
	High customer involvement	0.70	3.5
	High service quality care	0.68	3.4
	Flexible service level agreements	0.68	4.0
	High customer satisfaction	0.66	4.4
	High employment security	0.63	4.1
	Variability = 0.863		
S/N	**Least valued Constructs with smallest variation**	**Standard Deviation**	**Mean Rating**
	Benchmarking best FM practice	0.20	4.0
	Legislation compliance	0.18	3.0
	High service innovation	0.15	4.0
	Management responsibility transfer	0.15	3.4
	Service variations	0.12	3.0
	Change management (Culture)	0.11	3.0
	Service availability	0.10	4.1
	Stakeholder resistance	0.09	3.1
	Good management accounting system	0.07	4.0
	Service price competition	0.05	3.2
	High staff motivation	0.02	3.0

Finance, in healthcare service terms, is not only to do with the costs of specific operations and investments in capital, technological and clinical equipment, but is also about the net financial effects/control of complex support service transactions, often confused by a changing picture of organisational overhead recoveries. This is made more complex, in in-house provider organisations, by the actual and potential opportunities for income return generation from the provision of support services within and outside their own parent organisation that is the sponsor. Working capital therefore is the amount of cashflow required by the in-house providers to deliver customer facilities solutions on a daily basis in the NHS. It is important in the sense that the lack of working capital totally disrupts the constant delivery of support service resources that underpin the delivery of effective care in the NHS. The under delivery of customer facilities solutions poses a major risk in that they will lead to high numbers of customers being unsatisfied with the service delivery and management process.

8.30 Working flexibility

Most in-house FM providers as part of the virtual NHS trust organisation, almost without exception, value organisational and working flexibility highly in order to deliver FM services which are in line with changing core business objectives in the NHS. It is also a valuable management tool for managing change and re-engineering the FM business process among in-house providers in order to promote business agility, service innovation and competitiveness not formally associated with the in-house teams, particularly if it can be afforded at little or no expense. On one hand in-house providers have been grappling with the need to transfer intellectual and financial capital quickly and effectively to any business operation (directorate/unit) that needs them, whilst on the other hand they are constantly on the look out for new competitors (i.e. external and partnership providers) emerging from anywhere logistically, and quite often from any market sector. Any barriers to entry for most markets are rapidly crumbling. At the same time the products and services that traditionally represented the organisation's 'brand' are becoming less important as increasingly discerning customers look at the total 'offering' available – the whole service package offered by in-house providers' 'product/service' enablers - and how that can be tailored to meet their specific needs.

Customers want flexibility in business and the organisation in general. As a result of this in-house providers have to contribute immensely to the organisational working need of being flexible. Another added value advantage with in-house teams focusing on business adaptability is that, flexibility and role identity with respect to generic working practices (i.e. multiskilling) for facilities management staff have been considered and implemented resulting in organisation and service improvement in those forward-looking Trusts (breaking down traditional demarcation boundaries). In his research into the impact of multiskilling on support staff in for FM purchasers, Akhlaghi (1996) concluded that "many NHS Trusts have already made real savings of about five (5%) per cent while at the same time improving the quality of care to patients".

8.31 Informed client function

Some in-house providers are now part of the SBUs/directorate system introduced recently in the NHS that are autonomous. This business move has made them become profit centres capable of competing with other internal and contract FM providers to allow much flexibility in the purchaser organisation. As a result of this, every in-house provider now needs to act on behalf of the purchasers as an informed or intelligent client if they are to guarantee customers the delivery of super support services that will add value to the healthcare service chain.

In the business of managing integrated non clinical services given that singular customers' needs are frequently changing and becoming complex everyday, there will always be the need for informed in-house providers acting on behalf of the purchaser, in providing the FM brief and overall management to complement the services of external providers in order to close the perceived gap that has been exhibited in most healthcare provision episodes that highlight the interface point where in-house service provision stops and contract provision starts. An informed client function will need to be taken up by in-house providers if they are to provide an effective strategic FM brief regarding the service level requirements and customer needs at various response times of the FM service process. Therefore, in-house providers will have to perform the following duties if they are to add value and provide facilities solutions competitively to the healthcare delivery system;

i) understand the purchaser's organisation, its corporate culture, customers (internal/external), needs and expectation through out the whole continuum of care;
ii) Strategic planning of non clinical services;
iii) Comprehend and clearly design and monitor FM service requirements and targets;
iv) Managing the implementation of other sourcing arrangements such as contracting out, PFI and strategic partnering;
v) Business risk management – minimise risk to the host purchaser organisation's business survival;
vi) Agree monitoring and benchmarking service performance standards all service being delivered to the purchaser;
vii) Manage and compete with other providers to deliver high value support services;
viii) Perform customer satisfaction and complaints surveys to evaluate failures and levels of customer delight;
ix) Provide management reports to users and the host NHS organisation;
x) Perform FM service audits to ensure that services are continuously improved to the levels customer want;
xi) In-house providers must focus on the supply and demand side of FM (market intelligence);
xii) Compliance to relevant FM legislation and changes in health and safety;
xiii) Management of service variations and omissions;
xiv) Staff development and continuous learning and finally; and
xv) Protect and safeguard public funds while improving staff job security.

All these aspects show that there is a strong need for in-house providers to act as the purchasers' informed project managers to continue to be innovative and being flexible in order to improve the delivery super support services in the NHS.

8.32 Best value for money services

In-house FM providers must continually carry out FM performance audits to evaluate if non-clinical services being delivered are "adding cost" or "adding value" to the healthcare process.

By doing so, providers will be guaranteeing both their customers and the host purchaser organisation that, not only are they providing value for money but also that the support services are being delivered in the correct response times, serviceability and to the appropriate standards at the correct point of service delivery. This strategy improves business continuity and the effective delivery of high quality non-clinical services that improve customers' satisfaction. These quality services should always be procured at the best-value money can buy (getting high quality from a little cost).

In the NHS healthcare facilities management is provided by a virtual organisation using mostly grouped elements of in-house and contract service providers. This means that in-house providers have to be competitive and demonstrate that they can provide superior support services that delight customers to match what commercial providers will offer to deliver. This calls for in-house teams to have a continuous service improvement and total quality management culture that is customer and performance-driven at the same time being effective and efficient in doing business. There is nothing so far that stops in-house teams to be the purchaser's informed representatives or providers, and from providing best value for money support services given that they have always possessed more knowledge about the demand and market side of healthcare needs, clinical outcomes implication and customer service knowledge that is required to design intelligent FM services in the NHS. The other advantage that in-house providers will have over other providers that will give them a niche, is the already existing communication and operational link and service relationships within NHS trusts. To the customers and people who use healthcare facilities services there must be no perceived gap highlighting the interface point where in-house service provision stops and contract provision starts. In other words, it is vital that in-house facilities services providers will need to adopt modern business learning and flexible approaches that will deliver non clinical services within the context of a seamless service provision.

8.33 Management development

Service value driven by FM leadership on the part of non clinical managers will allow the overall in-house provider business unit to have strategic focus, executional excellence, control of destiny, trust-based relationships, investment in employee success, acting small, brand cultivation, and generosity.

Furthermore, if FM managers continuously learn to implement best FM practices that improve service delivery processes, this will lead to the introduction of new a business culture, ethics and leadership that will allow flexibility in new ways of working introduced in the NHS. In this instance, to improve the quality of support services being delivered to internal and external customers, senior FM management will be required to pursue continuous service quality enhancement or a TQM approach as a primary goal for managing effectively their FM businesses. Management development also allows the in-house providers to collect the necessary market and business intelligent information and skills which will allow them to be competitive enough with external providers who have been in recent days seen to be more innovative, performance-driven and customer-focused in terms of delivering non clinical services in healthcare operations. The responsibility to create a customer orientation, clear and visible quality values, and expectations requires substantial FM staff commitment and involvement. As a result the top in-house support services managers will need to be personally involved in the growth and development of their staff and encourage, empowerment, partnership participation and service creativity and innovation from everyone working to improve non clinical services provision in trusts. Therefore if senior healthcare managers are to deliver super-support services in the NHS, there is need for the following:

i) management commitment to service quality improvement as a way to increase service performance and acceptability by customers;
ii) management commitment to setting objectives for service quality improvement;
iii) management takes action towards executing its quality improvement policies;
iv) management supports the belief that service quality must be "built into" the product/service and not "inspected into" it
v) management makes long term plans to improve and invest in the quality of staff and service being provided to the purchaser in order to avoid service delivery failures.

All the above if implemented will allow organisational flexibility and promote a culture where support services staff are motivated to improve the service levels and delivery responses to customer needs and expectation in the NHS.

8.34 Variability of constructs

The variability of the three FM groups' (purchasers, in-house and external providers) constructs ranges between 0.863 to 0.900, whilst their mean ratings varied between a minimum of 2.7 to a maximum of 4.7 as shown in Tables 8.2, 8.5 and 8.6. These two values provided an indication of the general agreement in rating of the various constructs among purchasers and providers' facilities managers. Variability gives an overall impression of how well purchasers and providers used the rating scales. The higher the variability the better, and according to Slater (1992) the normally acceptable value is between 0.6 and 0.8. Again as shown in Tables 8.2, 8.6 and 8.7, the variability of the purchasers' grid was (0.889) whilst that of external providers was (0.900) and that of internal providers was (0.863). In this analysis, it can be seen that the external providers' variability was much higher than that of internal providers and purchasers, which clearly indicated that external providers valued these risk constructs as having a critical influence in their decisions to manage healthcare FM operations more than purchasers and internal providers. This observation is very important as it shows that commercial providers are driven mainly by business (financial) performance as a result will tend to feel very strong about the constructs they use.

Strictly speaking all the three had constructs with much higher variability, which also indicated that although external providers felt very strong about their constructs they used, purchasers and in-house teams also viewed these constructs as having a strong effect on decision-making and risk management regarding the FM service process delivery in their healthcare businesses as well.

8.35 Most and least meaningful constructs of purchasers and providers

Taking a close look at the providers and purchasers' construct grids in Tables 8.2, 8.5 and 8.6 respectively, it can be seen that the five most meaningful constructs used by the three groups were "high customer satisfaction"; "good clinical strategy"; high working flexibility; flexible SLAs" and best value for money". While the three groups had these five constructs in common, it is clear that the three groups used four common constructs that were least meaningful to them.

These were "benchmarking best FM practice"; "legislation compliance"; "high service innovation" and "high staff motivation". The common use of most and least meaningful constructs in this case serves to illustrate that the three FM groups used similar personal construct systems when evaluating their business exposure levels in healthcare FM operations.

8.36 Correlation Analysis of FM operators' Grids

In order to investigate further the construct commonality that the above results indicated and also to investigate if there was any conceptual relationship between the FM groups and constructs system: the GRIDSCAL programme was used. All constructs were normalised to facilitate comparison across all constructs in the purchasers and providers grids as well as providing a rationale for determining their correlation from origin. It is assumed that the lower the correlation the greater the amount of disagreement.

The purchasers' Grid was formed by aligning the purchasers' grids using the forty-eight common constructs and 17 FM elements. The grids comprised of 960 rows of constructs and 17 columns of elements. Similarly, the external and internal providers' Grids were formed by aligning the providers' grids using the forty-eight salient constructs and 17 FM elements. The grids comprised of 960 rows each of constructs and 17 columns of elements.

The results of the correlation analysis for FM service purchasers shown in Table 8.10 indicated that the correlation among the 48 constructs ranged from a minimum of 0.55 to a maximum of 0.98. This trend of correlation in results suggests that there is a strong agreement of FM business risk constructs faced by purchasers in healthcare operations. There were six constructs where the correlations were particularly strong. These were the provision of a "flexible service level agreement" (0.98); followed by the need to provide customers with "high service quality care (0.94); which is based on "good service contract design" (0.92); based on "high information confidentiality" (0.92); and allowing continuous management development (0.90); in healthcare.

Apart from the high correlation exhibited above, it was surprising to note that high "customer satisfaction levels" (0.58); "sound legislation compliance policy" and "high staff participation" (0.53); had relatively low correlations. A plausible explanation for this strong correlation can be attributed to the fact the delivery of responsive healthcare facilities management services is, by its nature, dynamic, bespoke and constantly changing to support the delivery of healthcare. As a result of constant healthcare service needs and expectations by customers, service specifications that are flexible to healthcare users' needs have become the key to successful facilities delivery process.

Purchasers in this study were aware that healthcare FM operation being complex business operations as they are, require well designed and "living" SLAs that continuously monitor day-to-day customer service demands and quality improvements (FM performance) in order to avoid service failures. It has become extremely essential for FM purchaser organisations to take note of those critical aspects to get right when introducing SLAs were "agreeing realistic standards and procedures" and "details of the specification". In ensuring that the specification drawn up is precise and correct the specification would need to be drawn up and agreed in consultation with the customers of the service. The information that is required for this exercise can be gained in a number of ways such as questionnaires, staff interviews or focus groups. For example with particular reference to cleanliness and domestic standards for prevention of cross-infection in hospital facilities and specialist for FM providers (FM consultants) advice which is cost effective must be sought for inclusion in specifications in order to avoid service delivery failures. The proper specification of service demand will aid the development and design of an effective FM contract that spells out the duties and commercial relationship between the purchaser and the provider allowing variations in FM services to be delivered to the appropriate standard at the point of service delivery (i.e. internal clinical directorates and external customer customers). It is important that the process of contract design and specification is well executed given that there is no healthcare FM "standard contract" for providing non-clinical services and protecting both FM purchasers and providers in the UK NHS.

Within healthcare, purchaser organisations that deliver soft healthcare support services such as catering, portering and housekeeping have a significant impact on the outcome of the core service (healthcare services). This is particularly relevant for the patient environment (i.e. wards) in which post-operative recuperation takes place. It is, therefore, vital that standards of cleanliness and cleaning processes are very clearly stated in the specification (often tailored to suit individual internal clinical department needs).

Results also show that non-clinical service projects are capital intensive and require sound cash flow on the part of the FM service purchasers 365 days a year. Given that the 24 hour shopping society healthcare business today is operated in, support services have become necessity-led at all times in the NHS. Thus, purchasers have to be able to invest sufficient working capital for the development and management of non-clinical services regularly. The other extremely important element of delivering core public services is that, the service processes are highly sensitive such that healthcare needs to be taken with regards to information concerning customers, as it has to be kept highly confidential mostly for competitive and corporate image reasons. This procedure is undertaken by purchasers as way of improving customer confidence and business continuity (customer care). While seamless and responsive facilities services continue to be delivered frequently, there is need for relentless management support from the top of the purchaser organisation in order that the trust develops a facilities strategy that is aligned with its business plan. This will stimulate the development of shared values and vision, creating synergy and integration within the trust so that facilities can be seen as a vital part of the organisation and not just as an arm's-length service supplier of contractual services or non-core activity. This will result in the creation of value adding services that are continuously improved to meet the trusts' core business objectives. It is therefore important that purchasers of FM services must continually review service provision and determine if they are "adding cost/risks" or "adding value" to the healthcare process. It is surprising to note that the constructs "customer satisfaction" (0.58), followed by "sound legislation compliance" (0.58) and "high staff participation" (0.55) have the lowest three correlations as shown in Table 8.7.

The possible explanation for this is that it is difficult to regard patients as customers as compared to other service sectors given that patients are necessity led, and patients themselves cannot choose or determine their clinical outcome or the final product. Therefore, it was difficult for purchasers to actually value the construct "customer satisfaction" with precision. This problem if compared with other service sectors such as the retail and hotel sectors were customers are easily identifiable unlike in the NHS, might have mislead purchasers in terms of offering their value judgement to this construct.

Table 8.7: Purchasers' Correlation Results (Consensus grid)

S/N	Constructs	Correlations
1.	Good Service level agreement	0.98
2.	Good Financial stability	0.96
3.	High Service quality care	0.94
4.	Good Service contract design	0.92
5.	High Information confidentiality	0.92
6.	Management responsibility transfer	0.90
7.	Management development	0.86
8.	Best value for money service	0.85
9.	Continuous service improvement	0.85
10.	Change management (cultural)	0.84
11.	High working flexibility levels	0.83
12.	Low Business transfer costs	0.82
13.	Clinical strategy	0.80
14.	Good Market intelligence strategy	0.80
15.	Service innovation	0.79
16.	High Staff motivation levels	0.78
17.	Service price competition	0.78
18.	Good Management accounting systems	0.78
19.	High Service speed	0.76
20.	Provider's financial reputation	0.74
21.	Good Provider Reimbursement method	0.74
22.	Performance guarantees	0.72
23.	TUPE	0.60
24.	Service availability	0.59
25.	High Customer satisfaction levels	0.58
26.	Sound Legislation compliance policy	0.58
27.	High Staff participation and partnership	0.55

Another important consideration could be that, due to resource limitations and changing healthcare needs, it extremely difficult for providers to satisfy their customers' needs and a result will be more concerned with managing the outcome as opposed to managing service quality. Most purchasers are not willing to follow the highly prescriptive and bureaucratic legislations which affects their service delivery performances in the NHS, and a result will tend to design their service processes based on providing service quality and providing value for money services. Quite often, legislation in FM operations in the NHS is normally very costly as there is a lot of new and up-coming regulation to be maintained which normally proves costly for purchasers to deliver effective healthcare services. In some cases purchasers will have complied with the legislation and most of their service delivery will encompass the appropriate legislation. These may have been the main reasons as to why purchasers valued "customer satisfaction" very lowly in this particular instance. The explanation also given to the lowly rating of the construct "staff participation and partnership" is that, it seems most FM purchasers interviewed were are not willing as employers to work as a team in pursuit of TQM principles with their FM staff, and did not value their staff as important assets or resources, and wanted their Fm staff to deliver the best customer service yet rewarding them very lowly.

As a result, the "top to bottom" approach that is highly adversarial is rampant in most purchaser organisations that have in the past provided healthcare support services without changing their traditional cultural values which are no longer flexible to cope within the current business needs in the NHS. The need to limit the power of trade unions have over staff working in the NHS was cited by purchasers as the major reason as to why high staff participation was valued so low. Purchasers believed that if they empowered staff with much power in the delivery of FM services, this might encourage trade unions to promote wage increases, changing of employment contracts and more employment related issues that raise the cost of staff employment in the NHS as a result all these issue would just raise the employer/employee working relationship to be adversarial in nature. For example, a current problem issue is the one to do with minimum wage enforcement. Furthermore all these aspects have financial implications on the part of purchasers as the host-employing organisations.

8.37 Providers' consensus grid

A similar analysis was performed using the commercial providers' combined grid. The results obtained are shown in Table 8.8. All the constructs shown in the table displayed a very strong correlation (0.58 to 0.98). These results suggest that there was again a strong agreement among the commercial providers on the risk constructs they were exposed to when managing healthcare operations. In particular, constructs "customer satisfaction" (0.95); "service innovation" (0.94); "TUPE" (0.86); "return on capital employed" (0.86); "Third way" (0.82); and "customer involvement" had very strong correlations.

Table 8.8 Extērnal Providers' Correlation Results (Consensus grid)

S/N	Constructs	Correlations
1.	High customer satisfaction	0.95
2.	High service innovation levels	0.94
3.	TUPE	0.86
4.	High return on capital employed	0.86
5.	Third-way (political and psycho-social)	0.82
6.	High customer involvement	0.80
7.	High working flexibility	0.75
8.	Good clinical strategy	0.73
9.	Low business transfer costs	0.71
10.	Good working capital	0.68
11.	Good market intelligence	0.68
12.	Service variations	0.65
13.	Performance guarantees	0.65
14.	High staff motivation levels	0.65
15.	High customer care	0.65
16.	High change management levels	0.65
17.	Health legislation compliance policy	0.65
18.	Good financial stability	0.65
19.	High service speed	0.64
20.	Best value for money	0.62
21.	Benchmarking best FM practice	0.60
22.	Good management development	0.60

The reasons for such a high correlation on "customer satisfaction" can be attributed to the fact that customer satisfaction is the ultimate business and service excellence objective of every FM provider in order to improve business performance and to build and retain customer care.

The "customer is the king" and a result facilities strategies that providers use to deliver customer solutions will improve the service delivery and reduce service failures in healthcare FM operations. The provision of customer facilities driven solutions is based on innovating or re-engineering the existing service process in order to come up with some new creative and value adding practices. Since commercial providers are driven by financial objective they are ever in search of service delivery options that focus on "service innovation" which will in turn reduce the risk associated with the FM business process failure. If the FM contract involves staff transfer under TUPE, the service providers will usually incur a potential liability that will be priced for within the proposals. Not only will this potential liability be reduced over a longer contract period, but also the cost of the risk needs to be identified early enough for the cost to either be reduced, transferred to a captive company that will cover it for the duration of the contract or spread over a longer period. It is also important that FM providers when dealing with TUPE issues, need to develop a clear corporate strategy to be pursued.

Providers would also need to set out clear dispute resolution lines to consider previous and present disputes between themselves, the purchaser and trade unions connected with TUPE transfers particularly in the NHS. The other major problem faced by providers is that of offering an unambiguous policy or commitment to honouring existing terms, multiskilling, flexitime, job sharing and other arrangements and conditions of FM staff they will have transferred from the purchaser against their own staff, given that providers' business strategy will based on innovating the current FM process to achieve service excellence and the desired business performance. On the other hand the transferred FM staff will also be worried about remaining in their present posts and salary after transfer. The above-described risks pose a huge threat to the overall performance of the external provider given that certain legal and commercial procedures that might threaten or improve business success will need to be followed. As a result of TUPE, there may be more redundancies planned which might have an extensive effect on the business process of both the purchaser and the provider. Lastly, the issue of changing pay or wages is another huge risk that can be introduced under TUPE. Any changes in the contract or business structure will affect the provider's cash flow and business investment operations in particular.

Therefore, an effective way to encourage the service provider to improve and develop the delivery of non-clinical services is to agree with the purchaser for reward innovation. This would typically take the form of a shared cost and quality savings in agreement and maximisation of every capital spent in healthcare operations i.e. car parking and business space charging and retailing businesses of medical and drug equipment vending. Such innovation often requires a deep understanding of the nature of the support services, which would be difficult to develop over a shorter contract period. Innovation often also requires investment; business cases for investment will almost always be more attractive over a longer period.

8.38 Internal providers' consensus grid

The results of the correlation analysis for in-house providers in Table 8.9 indicated that the correlation among 27 common constructs ranged from a minimum of 0.52 to a maximum of 0.95. This wide range suggested that there was again a strong agreement among the groups on these constructs. There were particularly three main constructs with very strong correlations. These were "high employment security" (0.95); "flexible service level agreements" (0.92); "third way (political and psycho-social)" (0.92) and as expected "management transfer responsibility" (0.58); "service price competition" (0.58) and "change management" (0.52) exhibited a low correlation. A plausible explanation for this correlation among in-house purchasers' the top three constructs may be attributed to the fact that the management of healthcare FM operations by in-house teams has always been based on traditional and cultural NHS values that are primarily based on employment related and service quality care measures. It not surprising that in-house providers were much concerned about employment security due the organisational politics that is in the NHS. Alexander's (1992) findings support the view that NHS support service directorates were still traditionally and political, personality and culturally sensitive. Given that there has been many reforms in the NHS which have adversely affected the service and employment performance of directly organised teams, the need to "fear for the worse" (cultural change) regarding employment changes was inevitable amongst in-house providers.

Furthermore the introduction of private sector participation has opened up the lucrative internal market that used to be traditionally managed by in-house works department, and is now forced to compete with commercial providers who have a much large resource base to innovate the service delivery process better than in-house teams.

Table 8.9: In-house Providers' Correlation Results (Consensus grid)

S/N	Constructs	Correlations
	High employment security	0.95
	Flexible service level agreements	0.92
	Third way (Political, Psycho-social)	0.92
	Good clinical strategy	0.90
	High working flexibility	0.86
	Intelligent client function	0.86
	Best value for money services	0.82
	High customer satisfaction	0.81
	Service quality care	0.81
	Effective management development	0.80
	High staff motivation	0.75
	High customer involvement	0.73
	Legislation compliance	0.70
	Good working capital	0.68
	Good performance guarantees	0.66
	Benchmarking best FM practice	0.65
	High service innovation	0.65
	Good management accounting system	0.63
	Stakeholder resistance	0.61
	Service variations	0.59
	Management responsibility transfer	0.58
	Service price competition	0.56
	Change management (Culture)	0.52

The introduction in the NHS of new business strategies in non-clinical services delivery has also heightened the need for in-house teams to innovate or otherwise risk loosing more jobs and staff transfers to the competitive commercial providers under TUPE. These modern approaches have been viewed by in-house teams as promoting a profit-making environment that contradicts with the core business objectives and corporate image that the NHS stands for. In-house providers also value the introduction of flexible SLAs that promote the delivery of necessity-led clinical support services.

The introduction of flexible SLAs is a competitive way of measuring FM performance and promoting organisational and service development that has been lacking in in-house teams for quite sometime now in the NHS. While employment related constructs were seen to be more powerful and useful by in-house providers, the need to deliver FM services following a defined clinical strategy was also seen as a basis for business success in the NHS. Taking a close look at the two FM providers' correlations, it can be seen that construct, "Third way" was highly valued by both in-house and external providers. The importance of politics has already been discussed in detail in this chapter. Third way risks have become more important due their adverse impact on the FM contracting and management process in the NHS. FM providers can be affected immensely by any change in NHS reform that specifies the regimes or business environment in which providers will have to benchmark their practices. This environment sometimes is often too costly and uncertain to predict in terms of resource optimisation. In overall, internal providers had a higher correlation on their constructs.

8.39 Principal component analysis (PCA)

To have an overview of how risk constructs work together influencing the FM operators' decision to manage healthcare FM and business risks and to further explore the structure of the data, the PFCA technique was employed. This meant that to ensure suitability of the data for this analysis, certain statistical tests had to be performed. The determination of the correlation matrix shown in Tables 8.10, 8.11 and 8.12 is 0.002377 that is greater than the required 0.00001 indicates that the data matrix used was not suffering from multicollinearity or singularity. Kaiser-Meyer-Oklin measure of sampling adequacy was found to be 0.505 which was greater than 0.5 confirming that the sampling adequacy is acceptable. The PCA was performed on the combined RGs of FM purchasers and in-house and external providers. As a result of this, the three mode principal component form of analysis based on Gruvaeus *et al.*, (1971) and Tucker (1996) was used as a data reduction method for large number of correlated risk constructs. This was done by reducing them to a smaller number of independent measurements, ordered from largest to the least according to the amount of variation they recorded. Principal component analysis involves transforming an original set of variables into a set of hypothetical variables that are uncorrelated.

Table 8.10: PCA results for Purchasers

	Return on capital employed	High working flexibility	Good working capital	Strategic partnerships	Good provider payment methods	High information confidentiality	TUPE	Customer satisfaction	Continuous service improvement	Change management (culture)
Return on capital employed	3.385*									
High working flexibility	.126	-2.960*								
Good working capital	-.310	.335	2.393*							
Strategic partnerships	.099	.099	.419*	-2.201*						
Good provider payment methods	-.256	.071	.486**	.405	-2.057*					
High information confidentiality	-.335	.463	.932**	.555**	.518**	-2.038*				
TUPE	-.017	.147	-.088	.358	.300	.192	-1.184*			
Customer satisfaction	-.172	.843**	.516**	.160	.004	.438	.078	-1.105*		
Continuous service improvement	-.249	.589**	.526**	.260	.349*	.621**	-.004	-.043	1.029*	
Change management (culture)	-.059	.151	.434**	.333	.797**	.429	.068	-.006	.305	1.000*
Return on capital employed										
High working flexibility	.274[a]									
Good working capital	.066	.051								
Strategic partnerships	.318	.320	.019							
Good provider payment methods	.108	.368	.007	.022						
High information confidentiality	.050	.010	.000	.002	.004					
TUPE	.569**	.241	.338	.039	.072	.179				
Customer satisfaction	.205	.420	.004	.223	.492	.014	.355			
Continuous service improvement	.115	.001	.003	.105	.044	.500**	.492**	.488**		
Change management (culture)	.390	.236	.015	.052	.000	.016	.373	.489**	.069	0.01

Keiser-Meyer-Oklin Measure of Sampling Adequacy = 0.505 Barlett Test of Sphericity Approx. Chi-Square = 165.499, df = 45 Sig = 0.000

* 1.00 level Significance ** 0.5 level Significance **Note:** [a] Analysis of factors done using Significance (1-tailed)

8.40 Purchasers' principal component analysis

This complex statistical technique (PCA) is also concerned with explaining the variance-covariance structure through a few linear combinations of the original variables. It attempts to explain as much of the total variation in the data as possible with as few factors (i.e. principal components) as possible. The first hypothetical principal component, PC (1), is the weighted linear combination of the variables that accounts for the largest amount of the total variation in the correlation matrix or factor loadings. The second component accounts for the maximum subject to being uncorrelated to the first and so on. A detailed description of the analysis is given by Slater (1992) and Tucker (1996). In the purchaser' analysis shown in Table 8.10, the first three factors were extracted as being heavy performers. The constructs, which were shown to carry heavy loadings in Component 1, were "return on capital employed" (3.385); "high working flexibility" (-2.960); "good working capital" (2.393); "strategic partnerships" (2.201); "good provider payment methods" (-2.057); "high information confidentiality" (2.038); and "TUPE" (1.184). The PCA also revealed that constructs "customer satisfaction" (1.029) also loaded heavily on component 2, while "continuous service improvement" (-1.105) also loaded heavily on component 3.

8.41 External providers' principal component analysis

The principal component analysis for external providers' combined grids extracted three (3) components with values greater than 1 that were useful for analysis as shown in Table 8.11. Thus the constructs, which were shown to carry heavy loadings on the three components, were also "return on capital employed" (3.385); "high working flexibility" (2.960); "good working capital" (2.393); "strategic partnerships" (-2.201); "good provider payment methods" (-2.057); "high information confidentiality" (2.038); "TUPE" (-1.184); "customer satisfaction" (1.029); and "continuous service improvement" (-1.105)

Table 8.11: PCA results for External Providers

	Customer satisfaction	Return on capital employed	Provider Reimbursement method	Partnerships	Working capital	Purchaser's financial reputation	Healthy and Safety	Customer involvement	Service value management (Best Value)	Service quality reliability
Return on capital employed	3.385*									
High working flexibility	.514*	-2.960*								
Good working capital	.079	.015	2.393*							
Strategic partnerships	.612**	.397*	.338*	2.201*						
Good provider payment methods	.456*	.592**	-.114	.498**	-2.201*					
High information confidentiality	.439*	.832**	.202	.431*	.637**	-2.057*				
TUPE	.601**	.407*	.692**	.610**	.274	.426*	-2.038*			
Customer satisfaction	.387*	-.069	.623**	.164	-.300	-.171	.655**	-1.184*		
Continuous service improvement	.852**	.781**	-.136	.546**	.614**	.575**	.481**	.139	-1.105*	
Good market intelligence	-.094	-.354*	.350	-.547**	-.612**	-.382*	.113	.601**	-.346*	1.029*
Return on capital employed										
High working flexibility	.004									
Good working capital	.455**	.471**								
Strategic partnerships	.001	.025	.049*							
Good provider payment methods	.011	.001	.293	.006**						
High information confidentiality	.014	.000	.166	.016*	.000					
TUPE	.001	.022	.000	.001**	.092	.017				
Customer satisfaction	.028	.371	.000	.217	.072	.207	.000			
Continuous service improvement	.000	.000	.258	.002**	.00	.001	.007	.254		
Good market intelligence	.328	.041	.043	.002**	.001	.030	.495**	.001	.045	

Keiser-Meyer-Oklin Measure of Sampling Adequacy = 0.565 Barlett Test of Sphericity Approx. Chi-Square = 245,882 df = 45 Sig = 0.000

* 1.00 level Significance ** 0.5 level Significance **Note:** [a] Analysis of factors done using Significance (1-tail

Table 8.12: PCA results for internal providers

	Good clinical strategy	Good working capital	High customer satisfaction	Intelligent client function	Best value for money services	Third way (Political, Psycho-social)	Effective management development	High customer involvement	High service quality care	High employment security
Good working capital	-5.751*									
High flexible working	.126	-4.421*								
Return on capital employed	-.310	.235	-3.996*							
Provider payment method	.099	.099	.319*	-2.779*						
Performance guarantees	-.256	.071	.486**	.405	-2.477*					
Intelligent client function	-.336*	.453**	.912**	.555	.418**	-1.819*				
Third way (Political, Psycho-social)	-.017	.147	-.088	.358	.300	.192	-1.053*			
High customer involvement	-.172	.043	.516**	.160	.004	.438*	.078	1.471*		
High service quality care	-.249	.489**	.526**	.260	.349*	.621**	-.004	-.043	1.010*	
High employment security	-.059	.151	.434**	.333	.797**	.429*	.068	-.006	.305	1.000*
Good working capital										
Good clinical strategy	.274[a]									
High customer satisfaction	.066	.051								
Intelligent client function	.318	.320	.019*							
Best value for money services	.108	.368	.007**	.022						
Third way (Political, Psycho-social)	.040*	.010**	.000**	.002	.004**					
Effective management development	.469	.241	.338	.039	.072	.179				
High customer involvement	.205	.420	.004**	.223	.492	.014*	.355			
High service quality care	.115	.001**	.002**	.105	.044*	.000**	.492	.418		
High employment security	.390	.236	.015*	.052	.000**	.012*	.373	.489	.069	

Keiser-Meyer-Oklin Measure of Sampling Adequacy = 0.545 Barlett Test of Sphericity Approx. Chi-Square = 165.499, df = 45 Sig = 0.000

* 1.00 level Significance ** 0.01 level Significance **Note:** [a] Analysis of factors done using Significance (1-tailed

8.42 Principal component analysis for in-house service providers

The PCA for in-house service providers combined grids is outlined in Table 8.12 and also revealed that three component factors used in the analysis. Thus the constructs, which were shown to carry heavy loadings on component 1, were "good return on capital employed" (-5.751); "high working flexibility" (-4.421); "return on capital employed" (-3.996); "provider payment method" (-2.779); "performance guarantees" (-2.477); and "intelligent client"(-1.819). On component 2, the constructs which loaded heavily were "good working capital" (1.260); and "intelligent client" (-1.053). Component 3 had one construct that loaded heavily on it, which was "intelligent client" (1.471).

8.43 Classification of risk constructs

The main aim of this section was to summarise the FM risk data analysis performed in this chapter in terms of classification. This procedure allowed for the appropriate discrimination of risk factors and their sub-risks based on value judgements made by the three FM operators. Thus, if the relative importance index was used, it would facilitate for ranking of these factors in order of importance. The use of such an importance index might also be debated at this stage of the study due to lack similar FM studies that currently exists for comparative analysis. As can been seen in the classification of the purchasers' risk constructs in Table 8.13, risk factors were analysed to show their effect the purchasers FM business process in terms of classification. As a result of this, Table 8.13 shows that *customer care* risks were valued by FM purchasers as the most important risks that affected the FM process in the NHS. Table 8.13 also shows that the relative importance index for *customer care risks* was 0.715. The results here are not surprising given that the need to provide customer-focused services in the NHS has become the prerequisite for any successful organisation having business dealings with the NHS. The results in Table 8.18 also show that for *customer satisfaction* to be achieved, FM purchasers have to pursue business strategies that put the support service users' needs first in order to improve the quality of support services provided.

Although *customer care* risks were valued as the most important risks that FM purchasers faced in a bid to improve the provision of value adding support services, *business transfer risks* were also valued as the second important group of risks that affected the purchasers' FM business. As a result, business transfer risks had a relative importance index of 0.71. Again it is not surprising that most FM purchasers were now turning to outsourcing and partnering of FM services with external service providers. The use of external providers has resulted in low NHS staff morale, uncertainty regarding their future employment security and the transactional cost of transferring the management of support service to the third party provider. It is not surprising that the new service provider would not engage in any form of business that is not profitable. As a result, the new FM providers might decide to downsize staff number, introduce flexible working and introduce more innovative practices that deliver value for money services to customers.

These changes have adverse effects on the transfer of FM services to the external providers, thus business transfer cost would normally be a cause of concern to both FM purchasers and providers in terms of compensating financially redundant staff, including the transactional costs and also improving FM operations. Table 8.18 also shows that *legal risks* (with a RII of 0.669) were valued as the third most important by purchasers, possibly due to the fact that for FM services to be transferred to either the in–house team functioning as a strategic business unit (SBU) or the external provider, the service design and management of such contractual relationships need to be considered carefully. Legal risks were also important, as they are concerned with the compliance of FM purchasers to the relevant legislation FM legislation in the NHS. Other risks which were found to be of importance were *facility transmitted risks*, they had a relative importance index of 0.662, signifying how important it has become for FM purchasers to manage the physical hospital setting environments and to improve the delivery of high quality support service which are responsive the customer's needs. Finally *corporate risks* (0.654) were found to be the least important risks by FM purchasers in the management of FM operations. This could possibly be due to the fact that FM purchasers did not consider the provision of healthcare services as a highly commercial business.

Table 8.13: Purchaser's group ranking of FM risks

Risk factors/constructs	Relative important index of construct	Ranks of constructs	Overall index for risk factors	Overall rank risk factors
CUSTOMER CARE RISKS			X = 0.75	1
Customer satisfaction	0.8	1		
Service delivery certainty	0.792	2		
Customer involvement	0 784	3		
Service quality reliability	0.776	4		
Service value management (Best value)	0.752	5		
Service speed	0.744	6		
Service measurement	0.72	7		
Medical technology innovation	0.624	8		
BUSINESS TRANSFER RISKS			X = 0.71	2
Service cost certainty	0.784	1		
Service availability	0.768	2		
Staff participation and partnership	0.752	3		
Continuous service improvement	0.728	4		
TUPE	0.72	5		
Performance guarantees	0.72	6		
Service innovation	0.656	7		
Management accounting systems	0.64	8		
Business transfer costs	0.624	9		
LEGAL RISKS			X = 0.669	3
Health statutory compliance	0.752	1		
Service contract design	0.68	2		
Service level agreement	0.68	3		
National minimum wage	0.656	4		
Agency	0.576	5		
FACILITY TRANSMITED RISKS			X = 0.662	4
Health and safety	0.768	1		
Environmental issues	0.648	2		
Medical technology innovation	0.624	3		
Clinical related	0.608	4		
CORPORATE RISKS			X = 0.654	5
NHS trust image	0.688	1		
Information strategy	0.680	2		
Clinical strategy	0.664	3		
Environmental issues	0.648	4		
Organisational culture	0.632	4		
Management development	0.632	5		
Social corporate responsibility	0.624	6		
COMMERCIAL RISKS			X = 0.63	6
Information strategy	0.688	1		
Partnerships	0.688	2		
Service competition	0.68	3		
Market intelligence	0.632	4		
Medical technology innovation	0.624	5		
Business process re-engineering	0.616	6		
Technology transfer	0.608	7		
Third-way (Political and Physcho-social)	0.6	8		
Stakeholder involvement	0.592	9		
Primary healthcare impact	0.576	10		
FINANCIAL AND ECONOMIC RISKS			X = 0.615	7
Service cost certainty	0.744	1		
Price competition	0.728	2		
Financial transfer/stability	0.68	3		
Economy (national and International)	0.632	4		
Provider reimbursement method	0.6	5		
Return on capital employed	0.592	6		
Insurance liability costs	0.576	7		
Working capital	0.568	8		
Profit margins	0.536	9		
Corporate business taxation	0.496	10		

X = mean index of risk constructs giving overall of the critical risk factors

It is surprising that FM purchasers have not paid a great deal of attention to corporate risks, as this has resulted recently in most FM purchasers' organisation image being dented due the constant rise in service non- performance. In today's business environment a good organisational image is of paramount importance in maintaining a service brand that customer will be delighted in.

Table 8.14 also shows a membership classification of all risk factors that were analysed for external FM providers. These risk classes were developed in order to further evaluate their effect on commercial providers' FM operations in the NHS. As a result of this Table 8.14 shows that *customer care* risk factors were highly valued by commercial FM service providers as the most important risks identified in the survey as affecting the FM business process in the NHS. Table 8.19 also shows that the overall relative importance index for customer care risks was 0.78. Similarly, the FM purchasers' survey also showed that customer care risks were also the most critical risks faced by purchasers when effectively managing the healthcare FM process in the NHS. The purchasers' survey also found out that customer care risks had an overall high relative index of 0.75 that was slightly lower than the one obtained in the commercial FM service providers' survey (0.78). The results obtained in both surveys are a true reflection of the customer-focused society any commercial business today is being operated in. As a result of this, these results are not surprising given that the need to provide customer-focused services in the NHS has become the prerequisite for any successful service provider organisation delivering best value FM services in the NHS. The results in Table 8.14 also show that for total customer care to be achieved in the NHS, commercial FM service providers working for purchasers (Trusts) have to pursue business strategies that put the non clinical service users' needs first in order to improve the quality of healthcare services provided. Although customer care risks were valued as the most important business process risks that commercial FM service providers faced in a bid to improve the provision of value adding support services, *financial and economic* risks were also rated as the second important group of risks which affected the commercial FM service providers' healthcare FM business. As a result, financial and economic risks had an overall high relative importance index of 0.71.

Table 8.14: Commercial providers FM risks classification

Risk factors/constructs	Relative important index of construct	Ranks of constructs	Overall index for risk factors	Overall rank risk factors
CUSTOMER CARE			**X = 0.7790**	**1**
Customer satisfaction	0.94	1		
Service value management (Best value)	0.830	2		
Service quality reliability	0.824	3		
Customer involvement	0.784	4		
Service speed	0.7733	5		
Service variation	0.707	6		
Service measurement	0.707	7		
Medical technology innovation	0.667	8		
FINANCIAL AND ECONOMIC RISKS			**X = 0.7573**	**2**
Return on capital employed	0.936	1		
Provider reimbursement method	0.928	2		
Working capital	0.856	3		
Service cost certainty	0.72	4		
Price competition	0.72	5		
Financial transfer/stability	0.6933	6		
Profit margins	0.6933	7		
Economy (national and International)	0.68	8		
Insurance liability costs	0.68	9		
Corporate business taxation	0.667	10		
COMMERCIAL RISKS			**X = 0.7489**	**3**
Partnerships	0.856	1		
Service competition	0.707	2		
Information strategy	0.6933	3		
Market intelligence	0.68	4		
Medical technology innovation	0.67	5		
Business process re-engineering	0.64	6		
Technology transfer	0.64	7		
Third-way (Political and Physcho-social)	0.627	8		
Stakeholder involvement	0.6133	9		
Primary care impact	0.6133	10		
LEGAL RISKS			**X = 0.7133**	**4**
Health statutory compliance	0.846	1		
Service contract design	0.707	2		
Service level agreement	0.707	3		
National minimum wage	0.6933	4		
Agency	0.6133	5		
FACILITY TRANSMITED RISKS			**X = 0.7123**	**5**
Health and safety	0.846	1		
Environmental issues	0.6933	2		
Medical technology innovation	0.67	3		
Clinical related	0.64	4		
BUSINESS TRANSFER RISKS			**X = 0.711**	**6**
Service innovation	0.733	1		
Business transfer costs	0.733	2		
Service cost certainty	0.72	3		
Staff participation and partnership	0.72	4		
Continuous service improvement	0.72	5		
TUPE	0.707	6		
Performance guarantees	0.6933	7		
Management accounting systems	0.6933	8		
Service availability	0.68	9		
CORPORATE RISKS			**X = 0.7**	**7**
NHS trust image	0.707	1		
Information strategy	0.6933	2		
Clinical strategy	0.6933	3		
Environmental issues	0.6933	4		
Organisational culture	0.6933	5		
Management development	0.68	6		
Social corporate responsibility	0.68	7		

X = mean index of risk constructs giving overall of the critical risk factors

Again, it is not surprising that, as commercial FM service providers operated commercial businesses which needed to be viable in order to make profit and improve shareholders' value, they considered seriously financial and economic issues in order to achieve their commercial and business objectives. Contrary to financial and economic issues being the second most important risks faced by commercial FM service providers, purchasers in the earlier survey chose *business transfer* risks as the second most important overall risks. The difference in rating choice here between purchasers and commercial FM service providers simply shows that the business strategies and objectives for both FM operators were different. In this analysis it can be seen that a correlation exists between *financial and economic* and *business transfer* risks. The main correlation between these two classes of FM risks is that they are both business process related factors, and as a result purchasers and commercial providers were aware of the need to pursue a business approach in healthcare FM operation as being critical. Table 8.14 also shows that *commercial risks* (with a RII of 0.7489) were valued as the third most important. This could have been possibly due to the fact that for healthcare FM services to be procured, designed and delivered to NHS customers effectively external providers need to consider carefully the transfer or sharing business FM risks and also comply with contractual arrangements they would have entered into. Furthermore, under commercial risks business intelligence information needs and management factors such as *stakeholder involvement, technology transfer and third-way (political and social)* have to be explored carefully as they can have an adverse effect (i.e. negative, neutral or positive) on the day-to-day effective management of FM operations in the NHS.

Still under commercial risks, another important business consideration that has become of paramount importance in the NHS has been the need for commercial FM service providers to form strategic *partnerships* with their purchasers. These long-term commercial relationships have allowed purchasers and external service providers to share freely business intelligence and strategies that focus on satisfying NHS customers' non-clinical services needs. In contract to the past due to adversarialism in the healthcare sector, business and competition information on FM risks has never been shared amongst FM service operators in the NHS. Possibly, all these considerations might have made commercial FM service providers to value commercial risks as the third important risks.

While *commercial risks* were valued as third important by the surveyed commercial FM service providers, purchasers in a similar survey on the other hand ranked *legal risks* as the third important factors in their healthcare FM business operations. This might have been probably due the fact that purchasers are highly concerned with their compliance to relevant healthcare FM legislation and avoiding clinical negligence in the NHS when providing healthcare services. This is true, as NHS trust hospitals now lack the Crown Immunity they used to enjoy in the past.

Recently, most NHS FM purchasers have suffered huge claims for compensating customers in cases of clinical and organisational negligence arising from poor service delivery in the NHS. Other risks that were found to be of importance in the effective management of non clinical services and ranked 4th, 5th, 6th and 7th were *legal risks, facility transmitted risks, business transfer risks and corporate risks.* These risk classes had overall importance indices of 0.713, 0.7123, 0.711 and 0.7 respectively. Unlike in the purchasers' survey the other risk classes that were found to be more important using the same order of relative importance in the commercial providers' survey were *facility-transmitted risks, corporate risks, commercial risks* and lastly *financial and economic risks*. In this survey, commercial FM service providers rated legal *risks* the fourth most important risks with an overall relative importance index of 0.713. Although legal risks were ranked fourth, it can however be noted that this classification signifies how vital it has become for commercial FM service providers to manage their contractual relationships and discharge legal duties with their FM service purchasers diligently. It is also interesting to note that legal risks were valued as equally important as in the purchasers' survey as both FM operators needed legal protection in cases where service variations, delivery failures and contract abuses occurred.

Table 8.14 also shows that *Facility transmitted* risks were rated fifth by commercial FM service providers, signifying how important it has become to manage the hospital facility environment that customers use when receiving care in order to improve the delivery of high quality non clinical services that are responsive the customer's needs. It is not surprising that *facility transmitted risks* have become a great concern in today's healthcare system of delivery, given that more customers in the past have contracted more air borne and facility-related diseases inside NHS hospitals.

As a result of this, the need to improve the general hygiene and cleanliness standards, air quality, medical equipment, facilities and other environmental issues within hospitals have taken centre stage today in the NHS. *Business transfer risks* were found to be the sixth most important risks in the commercial FM service providers' business process. The explanation to this significance can only be that, the use of external providers has resulted in low NHS staff morale, uncertainty regarding their future employment security, opportunities and the transactional cost of transferring the management of support services to a commercial provider. Hence, the basic assumption towards outsourcing of healthcare FM services has been that commercial providers would not engage in any form of business that is not profitable. In most business cases, the new FM provider might decide to downsize staff numbers, introduce flexible working and innovative practices that deliver value for money services to customers. Hence, these changes have adverse effects on the transfer of FM services to the external providers. Given such a scenario, business transfer costs associated with such a service transaction are usually high to both the purchaser and commercial FM service provider in terms of compensating financially redundant staff and improving efficiently FM operations. Finally, *corporate risks* with a relative importance index of 0.7 were found to be the least important risks faced by commercial providers when the managing of integrated healthcare FM operations. This could possibly be due to the fact commercial FM service providers did not consider corporate issues and services as highly affecting their commercial business performance.

The other reason might well be that corporate risk management is a new approach to business management and as a result there is a generally lack of expertise in this area of business knowledge. Hence, the significance of these risks might have been ignored or overshadowed by other well-known risk factors. It is surprising that commercial FM providers did not pay a great deal of attention to corporate risks, given that recently in the NHS corporate and organisational image issues are of strategic value to customers and stakeholders. Recently, the lack of taking into account corporate issues has resulted in most FM provider organisations denting their business and corporate reputation due the constant rise in service failures.

In today's business environment a good corporate image, effective strategic planning and information strategy are all of paramount importance in delivering safe non-clinical services that NHS customers will be delighted with. Table 8.15 shows a careful analysis of all the constructs in risk factors that were analysed to show their impact on the in-house providers FM business process in terms of importance and group classification. As a result of this, Table 8.15 shows that *customer care* risks were highly valued by in-house providers as the most important risks that affected their FM business process in the NHS. Table 8.15 shows that the relative importance index for *customer care risks* was 0.8. The results here are not surprising given that the need to provide customer-focused services in the NHS has become the prerequisite for any competitive and successful in-house FM organisation providing best value for money non clinical service solutions and seeking to retain its loyal customers in the NHS. The results in Table 8.15 also show that for maximum *customer care* in the NHS to be improved, in-house providers have to pursue business and integrated service strategies that put the support customers' non-clinical needs first, in order to improve the quality of support services provided. Although *customer care* risks were valued as the most critical risks that in-house providers faced in a bid to improve the provision of value adding support services, *corporate risks* were also valued as the second important group of risks which affected the in-house providers' FM business. As shown in Table 8.15, corporate risks had a relative importance index of 0.71. Again here, it is not surprising that most in-house providers were now focusing on their organisation's environmental (internal and external) services that created a good image while providing care service excellence to customers. It is not surprising that in-house providers have now started to pay a great deal of attention to corporate risks, due to recent developments in the NHS that has left most in-house providers' organisation image being dented (clinical negligence) due the constant rise in service non- performance (DoH, 1999). Recently in today's postmodernism customer service society, the lack of service performance and consideration of organisational competitiveness in the NHS has resulted in more and more in-house providers being outsourced to external providers (Okoroh *et al.,* 2001). The above facts might have contributed to corporate risks being considered to pose potential hazard towards the continued delivery of FM services by in-house providers.

Table 8.15: In-house Providers' group ranking of FM risks

Risk factors/constructs	Relative important index of construct	Ranks of constructs	Overall index for risk factors	Overall rank risk factors
			X = 0.800	1
CUSTOMER CARE				
Customer satisfaction	0.800	1		
Service delivery certainty	0.792	2		
Customer involvement	0.784	3		
Service quality reliability	0.776	4		
Service value management (Best value)	0.752	5		
Service speed	0.744	6		
Service measurement	0.72	7		
Medical technology innovation	0.624	8		
			X = 0.710	2
CORPORATE RISKS				
Clinical strategy	0.900	1		
Information strategy	0.768	2		
NHS trust image	0.752	3		
Environmental issues	0.728	4		
Organisational culture	0.720	5		
Management development	0.720	6		
Social corporate responsibility	0.656	7		
			X = 0.669	3
LEGAL RISKS				
Health statutory compliance	0.752	1		
Service contract design	0.680	2		
Service level agreement	0.680	3		
National minimum wage	0.656	4		
Agency	0.576	5		
FACILITY TRANSMITED RISKS			X = 0.662	4
Health and safety	0.768	1		
Environmental issues	0.648	2		
Medical technology innovation	0.624	3		
Clinical related	0.608	4		
			X = 0.654	5
BUSINESS TRANSFER RISKS				
Service cost certainty	0.688	1		
Service availability	0.680	2		
Staff participation and partnership	0.664	3		
Continuous service improvement	0.648	4		
TUPE	0.632	4		
Performance guarantees	0.632	5		
Service innovation	0.624	6		
Management accounting systems	0.62			
Business transfer costs	0.600			
			X = 0.630	6
COMMERCIAL RISKS				
Information strategy	0.688	1		
Partnerships	0.688	2		
Service competition	0.68	3		
Market intelligence	0.632	4		
Medical technology innovation	0.624	5		
Business process re-engineering	0.616	6		
Technology transfer	0.608	7		
Third-way (Political and Physcho-social)	0.600	8		
Stakeholder involvement	0.592	9		
Primary care impact	0.576	10		
FINANCIAL AND ECONOMIC RISKS			X = 0.615	7
Working capital	0.800	1		
Price competition	0.728	2		
Financial transfer/stability	0.680	3		
Economy (national and International)	0.632	4		
Provider reimbursement method	0.600	5		
Return on capital employed	0.592	6		
Insurance liability costs	0.576	7		
Service cost certainty	0.568	8		
Profit margins	0.536	9		
Corporate business taxation	0.496	10		

X = mean index of risk constructs giving overall of the critical risk factors

Today's business environment in the NHS requires good in-house FM corporate identity that will allow seamless and responsive care services to be fronted in line with strategic planning objectives of the purchaser organisation. Table 8.15 also shows that *legal risks* (with a RII of 0.669) were valued as the third most important possibly due to the fact that, FM services have been traditionally managed by in-house providers autonomously via the purchaser (i.e. departmental management) as result this arrangement did not pause huge legal complications. The other reasons at to why *legal risks* were considered third could have been in relation those providers that might have already been transferred to function as a SBU or the external provider. The service design and management of such contractual relationships need to be considered carefully (Smith, 1997). Legal risks were also important, as they are concerned with the compliance of in-house providers to the relevant FM legislation in the NHS. Other risks which were found to be of importance were *facility transmitted risks*. These risks had a relative importance index of 0.662, signifying how important it has become for in-house providers to manage the physical hospital setting environments and to improve the delivery of high quality support service which are responsive to the NHS customer's experiences in hospitals. In-house providers ranked business transfer risks as the fifth critical risk factor in the effective management of healthcare operations.

Furthermore, in-house providers also ranked *business transfer risks* as the 5^{th} most critical factor that threatened the business survival of in-house providers in the management of healthcare FM operations. The use of external providers (i.e. outsourcing) as opposed to in-house resources team (insourcing) has resulted in low NHS staff morale, uncertainty regarding their future employment security and the transactional cost of transferring the management of support service to the commercial provider. It is not surprising that the new/commercial service provider would not engage in any form of business that is not profitable. As a result, the new FM providers might decide to downsize staff number, introduce flexible working and introduce more innovative practices that deliver value for money services to customers.

These changes have adverse effects on the transfer of FM services to the external providers, thus business transfer costs would normally be a cause of concern to both in-house providers and providers in terms of compensating financially redundant staff, including the transactional costs and also improving FM operations.

Although most in-house FM organisations have been exposed to *commercial risks* relating to service procurement competition on an open market with commercial providers, it is rather not surprising to see that, most in-house providers surveyed ranked this risk factor as the sixth most important. Furthermore, given that most writers have criticised in-house providers for lacking business, market intelligence and innovative practices already utilised by commercial providers in providing best value FM services, commercial risks were seen to be of less critical risks (Smith, 1997; and Okoroh *et al.,* 2001). As a result of this, Table 8.52 shows that commercial risk factors had a RII of 0.63. In healthcare FM commercial risks relate to the service procurement and change costs on an open competition and dynamic healthcare facilities market structure in line with the in-house organisation's business strategies. These risks also cover issues relating to the internal and external NHS business environment (globalisation and service innovation) with other service competitors.

Finally *financial and economic risks* (0.654) were found to be the least important risks faced by in-house providers in the management of FM operations. This could possibly be due to the fact that in-house providers did consider the provision of healthcare services as driven by clinical governance and customer care as opposed to business profitability and shareholder value. Although financial and economic risks were valued as having a least impact on the FM business by in-house providers, they had a relative importance which was above 0.5, meaning that financial and economic issues were also important towards achieving FM service delivery success for these providers. From a financial perspective, in-house FM providers, particularly those in highly competitive, turbulent service markets (i.e. the NHS), are under considerable pressure to reduce costs, while still delivering a quality care services with limited financial resources. Some providers have responded with wholesale changes to the structure and operation of their business (business reengineering) with a view of reducing the cost of service mistakes that are always very expensive to mitigate.

Others have sought cost savings through the integration of their FM services by turning into SBUs or by partnering and making strategic partnerships with commercial providers. The latter can lead to improved facilities performance, reduced financial risk through a greater presence in new markets, shorter lead times in service design and provision to care customers, and lower costs through innovation. In overall the three FM operators' risk constructs in healthcare operations were broadly grouped into seven novel categorises/classes as follows:

(1) Corporate related criteria

These constructs related to the overall organisation's service culture, image, the operating/corporate environment, vision, values, beliefs and the welfare of its staff and customers in meeting the core business objectives.

(2) Legal related criteria

These are constructs relating to the contractual, service performance arrangements and relationship between the provider(s) and the purchaser when managing healthcare FM operations in the NHS

(3) Commercial related criteria

These are constructs relating to the service procurement and change costs on an open competition and dynamic facilities market structure in line with an organisation's business strategies. These constructs also cover issues relating to the internal and external NHS business environment (globalisation and service innovation) with other service competitors.

(4) Financial and Economic related criteria

These are constructs relating to the funding (investments) of strategic and operational FM work processes using the working capital tied into the management of healthcare facilities by either the provider or the purchaser to meet the clinical business objectives.

(5) Business transfer related criteria

These are constructs relating the whole economic/financial transaction of transferring of FM businesses including resources from and to either purchaser or the new FM service provider in the NHS.

(6) Facility transmitted related criteria

These are constructs associated with, and resulting from the continued (in a 24 hour shopping society healthcare business is operated in) use by customers of hospital facility environs and support services resulting in acquired infections due to internal environment quality conditions, prolonged stay, additional outpatient consultations, clinical treatment and other medical diseases caused by "sick hospital facilities".

(7) Customer care related criteria

These are constructs related to the provision of best value care and clinical service excellence outcomes that satisfy customers' clinical needs and expectations that promote organisational continuity or repeat business in an ever dynamic servicescape such the one which exists in the NHS.

8.44 Hierarchical Rule-based decision model

The PCA analysis of the forty eight (48) ideal and least preferred risk constructs of FM purchasers and in-house and external providers provided the basis for a hierarchical decision framework (knowledge) for the proposed risk management system for healthcare FM operations. The proposed model provides a means for providing FM operators' business knowledge into multivariate processes, thus formulating a risk management and decision support system that ca be used strategically to manage business FM risks encountered in healthcare operations. Using these all FM operators' valued constructs in Tables 8.14, 8.14 and 8.15; it is possible to construct a simple hierarchical inference model that can be used as a risk management system to evaluate risk exposure and decision making strategies in the NHS.

The proposed model would also provides a systematic and logical method of sub dividing the key criteria (risk membership classes/factors) into a number of sub-criteria (constructs). Thus, there exists a hierarchy of sub-criteria upon which each individual criterion is dependent. Associated with each criterion and sub-criteria are simple decision rules. The decision rules are presented as an object-oriented knowledge representation format. The rationale for this model is two-fold. Firstly, to provide healthcare FM operators with a structured aid to the decision-making involved in the management of risks associated with healthcare FM business operations in the NHS. Secondly, as an attempt to compile a simple heuristic risk management decision-making process for use in the business decision support system.

8.45 Degree of detail

The level of business risk exposure detail required from any FM purchaser or provider is a function of the method of contract procurement route and value, management experience, economic situation, duration and complexity. The rationale for including the above detail is to provide the user (i.e. healthcare facilities manager) of the model with a structured system that helps them to make effective business and risk management decisions in healthcare FM operations. It is at executive level where strategic FM decisions are made and therefore, the prerogative is on the model users to include or exclude facts or knowledge that they feel does not offer competitiveness or is appropriate for the evaluation.

8.46 Knowledge representation and uncertain inference

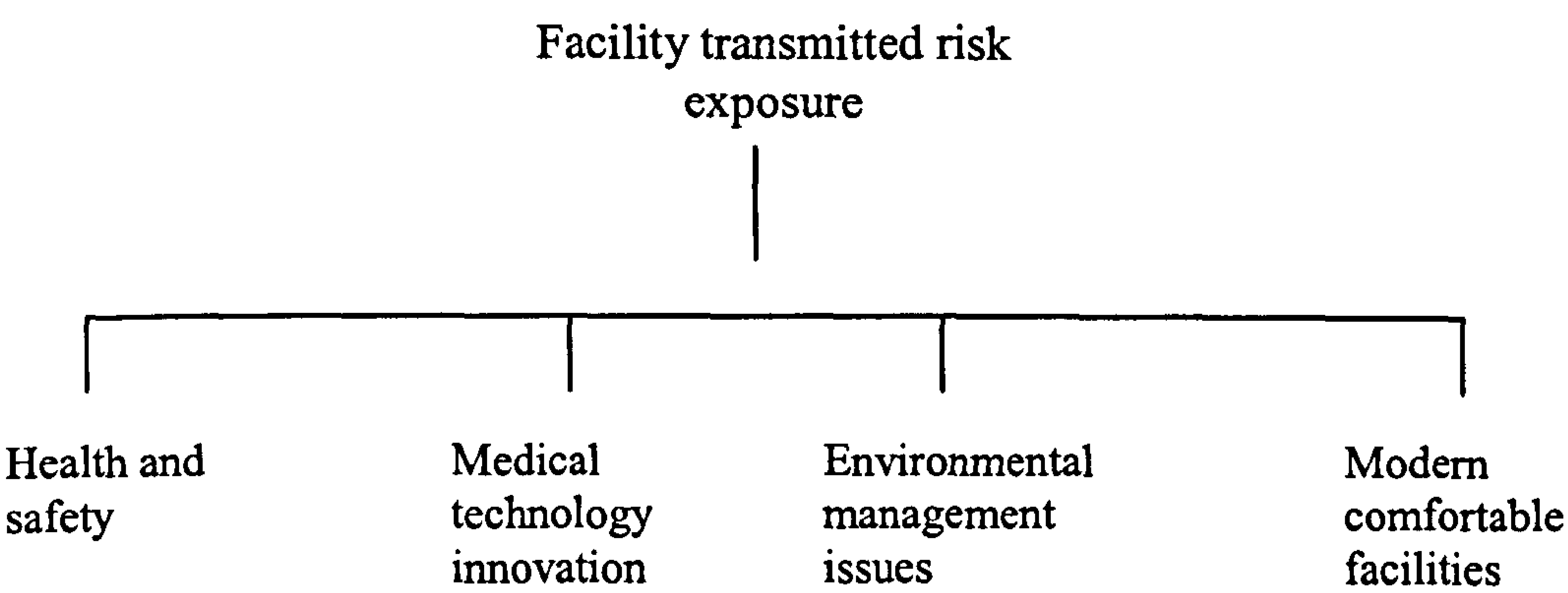
Each criterion within the knowledge base has a series of attributes or sub-criteria. The sub-criteria help to describe the main characteristic of the proposition. For example, the criterion facility transmitted risks exposure is composed of four sub-attributes as shown in Figure 8.2. Furthermore, if we restrict the system to deal with the evaluation of risk exposure level(s) of facility transmitted risks (FTRs), we have to consider the second factor sub-attributes which compose FTRs class as shown in Figure 8.2. Furthermore in a computerised system, merit values can have a range of built-in value corresponding to linguistic variables as a guide to the decision maker.

This is demonstrated by using risk factor facility transmitted risks to determine the risk exposure index shown in Figure 8.2.

Table 8.16: Risk exposure index for measuring FM business exposure

Definition of risk exposure symbol	Linguistic variables - Risk exposure Index	Suggested range of risk exposure value
NN	High negative	$\mathbf{I} \leq 0.2$
N	Medium negative	$0.2 < \mathbf{I} \leq 0.4$
O	Neutral	$0.4 < \mathbf{I} \leq 0.6$
P	Medium positive	$0.6 < \mathbf{I} \leq 0.8$
PP	Low positive	$0.8 < I \leq 1.0$

Figure 8.2: Facility Transmitted Risk Exposure Representation



If facility transmitted_risk_exposure is (NN, N, O, P, PP) done

and health_safety_ is done

and modern _comfortable_facilities_ is done

and medical_technology_innovation_ is done

and environmental_management_issues is done

Then facility transmitted risk exposure level done

The risk factor exposure index was determined by using RII technique and symbol classification of the providers and purchasers' degree of importance of the business factors to the healthcare FM operation in the NHS, which can mapped back to risk exposure levels in terms of the factors' weight to linguistic variables as shown the scale in Table 8.16.

Table 8.16 shows a risk exposure scale that uses five symbolic variables to cover the range of possible outcomes that FM operators need to consider. The risk exposure scale is used in this study to measure the effects of each risk factor and the total risk exposure to the FM operator's organisation, in order to implement strategic risk management decisions that minimise risks and improve FM business success or continuity. The risk scale is also used as a performance scale for the model variables/factors to describe the scenario produced by ANNs in order to evaluate the total risk exposure of either the purchaser or provider's FM business process to the host NHS trust. Each symbolic variable is associated with a probabilistic definition shown in Table 8.16.

8.47 Conclusion

In this chapter, the elicited grids from FM Purchasers and Providers (in-house and external) were analysed using GRIDSCAL. The main objective of analysing personal knowledge using the Repertory Grid Technique have been discussed extensively. The most meaningful results obtained in this chapter can be summarised as follows:

a) FM service operators (purchasers, in-house and external providers) all applied similar criteria when managing business risks associated with the delivery of effective non-clinical services that front the delivery of clinical services in the NHS. It was possible to identify the most important and least important constructs that non-clinical service managers considered when managing FM risks in healthcare operations.

b) The combined grids formed by aligning FM operators' grids suggested the existence of conceptual relationships between constructs used for decision-making. The relevance of construct relationships derived from combined grids is not only that they highlighted the existence of conceptual relationships between the service operators' constructs. It also validated the earlier interpretations of constructs commonality derived from the FM operators' individual grids and also draws attention to the similarities and differences between FM Purchasers, In-house and External Providers' decision making process reading the management of support services risks in healthcare business operations.

c) The constructs were found to complement each other rather than contradicting each other and thereby providing a broader insight into FM operators' decision-making processes.

d) There was a high level agreement between NHS facilities managers regarding the relative degree of importance attached to these criteria.

e) The results of the PCA identified the key criteria that influence the decision making process when managing FM healthcare operations. Furthermore, the number of decision parameters has been reduced to a more manageable number for strategic purposes. Each of these identified criteria was characterised by relevant sub-criteria.

As a result, the proposed risk management system based on the FM operators' ideal and least preferred risk factors may be formulated by combining the groups' respective value judgements, thereby encompassing a broad based risk management approach. This will facilitate a structured systematic, and rationale approach to the strategic management of healthcare FM business risks and decision-making system used by purchasers and providers. The hierarchical rule base illustrates how rules can be used to manipulate business information from one frame to the other using values of various slots. The combination of frames and rules, offers a very robust and powerful tool for representing business information intelligence. Updating, maintaining and expansion of the system can be achieved with relative ease. Business information concerning a particular object can be traced easily by calling its frame. Information can be changed; rules can be updated if necessary and new information can be added. This feature makes such representation more favourable than using production rules only. The result confirms that healthcare operators use similar constructs when managing business risk associated with the effective provision of high quality non-clinical services that underpin the delivery effective healthcare service in the NHS.

CHAPTER NINE

MODEL DEVELOPMENT AND PERFORMANCE

9.1 Introduction

This chapter describes the risk management system developed in this investigation called National Health Service facilities risk evaluation system (NHSFRES). It has also been developed as a decision support system that can aid healthcare facilities management operators to execute effective business planning and decision-making strategies. NHSFRES can be used to identify, analyse and manage potential business process risks faced by FM service operators when delivering high quality non-clinical services in NHS hospitals. NHSFRES has been developed to run on IBM compatible personal computers and can be supported by most Windows environments.

9.2 Risk management model description

The general system architecture of NHSFRES is shown in Figure 9.1, and is based on a standard risk management process used in the NHS (HFN 17, 1998). The standard risk management process used in the NHS has been described in chapter three of this thesis. Figure 9.1 shows that NHSFRES has been developed in this research as expert system that comprises a database, decision-making model and a knowledge base. As shown in Figure 9.1, NHSFRES has a model base that contains artificial neural network heuristic rules and a decision making model that processes non-clinical services risk information (i.e. FM risk factors/variables) provided by the three groups service operators (i.e. purchasers, in-house and external providers). These non-clinical service risks and constructs are stored in the database with a dialogue facility-like as in a conventional DAS. In addition, NHSFRES has a separate knowledge base containing detailed healthcare FM knowledge (decision fact and rules). Therefore, the important components of NHSFRES are its unique database, an ANN decision-making model and a separate knowledge base.

9.3 Risk database

The database is shown as module (1) of Figure 9.1 in NHSFRES and consists of information on the common key business process risks faced by the three FM service operators (purchasers and in-house and external providers) surveyed in this study when managing of integrated non-clinical services in NHS trust hospitals.

Figure 9.1: NHS Facilities Risk Exposure System (NHSFRES)

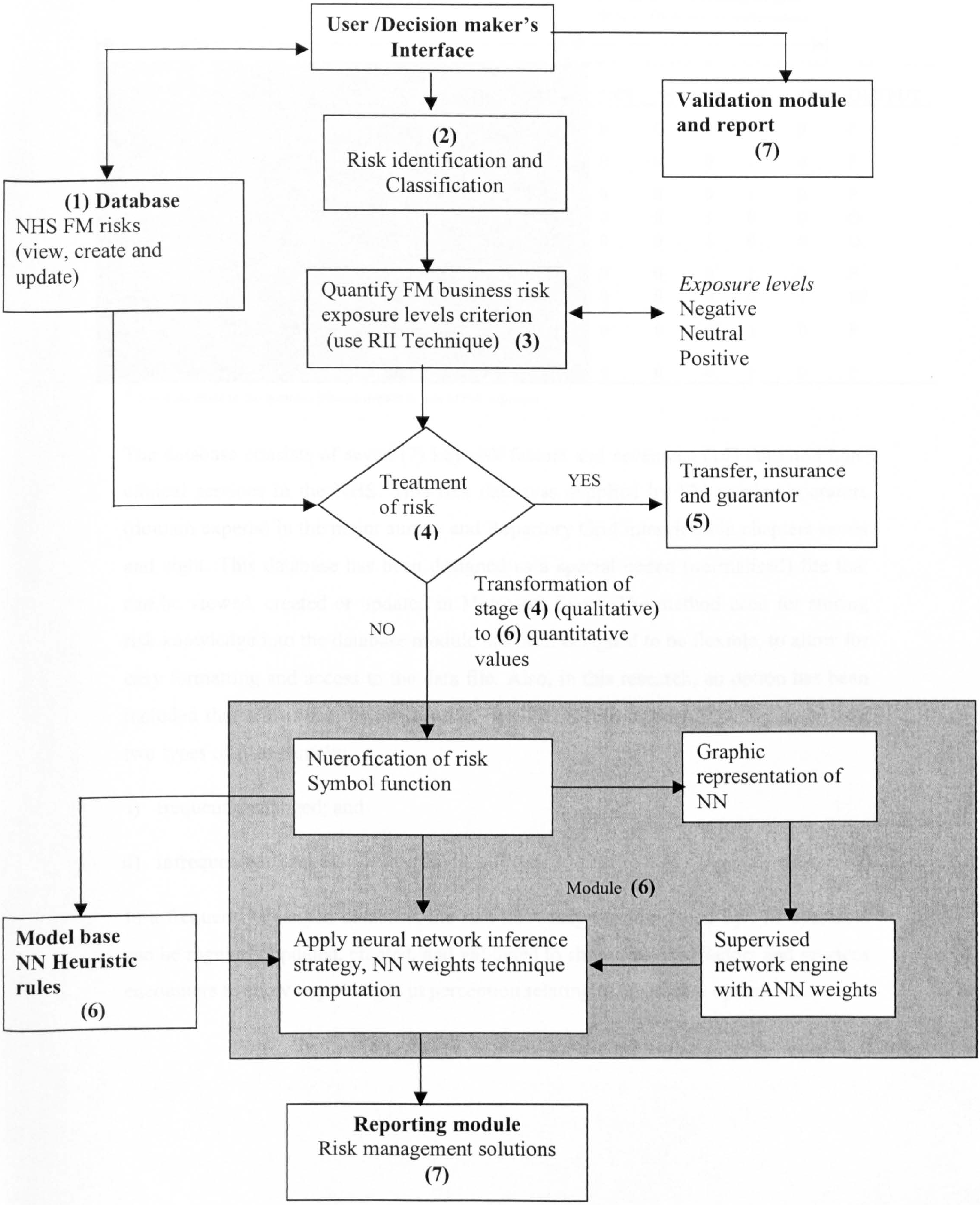


Table 9.1: Example of normalised input data

FM elements	Main risk factor classes					Formatting or coding of grid data to form input parameters					
SERVICES	**BUSI**	**LEGAL**	**FAC**	**CORP**	**FIN**	***NN**	***N**	***O**	***P**	***PP**	**OUTPUT**
Hotel and Catering	4.13	4.17	3.67	3.88	4.5	0	0	0	1	0	P
Health and safety	4	4	3.67	3.63	4.25	0	0	0	1	0	P
Waste management	4	3.67	4	3.5	4.38	0	0	0	1	0	P
Car parking	3.5	3.67	3.67	2.88	4.13	0	0	1	0	0	O
Domestic	3.38	3.33	3.67	2.88	4.13	0	0	1	0	0	O
Low patient care	3.5	3.17	3.67	2.88	4.25	0	0	0	1	0	P
Cleaning	3.5	3.33	3.33	2.75	4.38	0	0	0	0	1	PP
Estates management	4.13	3.83	3.33	3.38	4.38	0	0	0	1	0	P
Patient transport	3.88	3.5	3.33	3.25	4.13	0	0	0	1	0	P

* Symbols relate to the business process impact or rate of risk exposure

The database consists of seven (7) key risk factors and seventeen (17) common non-clinical services in the NHS. This risk data was supplied by FM service operators (domain experts) in the major survey and Repertory Grid interviews in chapters seven and eight. This database has been designed as a special coded (normalised) file that can be viewed, created or updated in Microsoft Excel. The method used for storing risk knowledge into the database module has been designed to be flexible, to allow for easy formatting and access to the data file. Also, in this research, an option has been included that allows for the database in NHSFRES (the model) to be separated into two types of files namely:

i) frequently changed; and

ii) infrequently changed.

In a frequently changed database, the risk knowledge/factors faced by FM operators can be regularly updated, created, and validated to show new risk factors and services encounters to show any changes in perception relating to healthcare operations.

To illustrate how a frequently changed database can be used, Table 9.1 shows only ten (10) out of the seventeen (17) identified non-clinical services that were valued against the five (5) out of seven (7) key risk factors commonly faced by FM operators when managing non clinical services in the NHS. This type of database shown in Table 9.1 was first formatted, normalised and then coded into Microsoft Excel as a special comma separate value (CSV) file (i.e. purchaser/provider.csv) before being integrated into the NHSFRES model. In a situation where risk factor values are manupilated against FM services by healthcare facilities managers as domain experts, it will result in new impact levels on the FM business process. These changes may be a result of new FM risk knowledge coming to light or perception changes by FM operators. Hence, this new knowledge will need to be analysed in terms of its business consequences to both FM and clinical operations.

Furthermore, detailed formatting of input data for NHSFRES is shown in Appendix D. The specially formatted data as shown in Table 9.1 is then fed into Trajan 4.0, an expert system shell to allow for risk prediction and inference (analysis). This process allows the user (i.e. FM manager) to interface easily with the NHSFRES when using symbolic and heuristic rules implemented in ANNs. It is important therefore to note that, Trajan 4.0 just like any other expert system shell will not accept or process unformatted data (i.e. data not properly categorised as shown earlier on in chapter eight: Tables 8.1, 8.5 and 8.8), as it won't recognise the values or symbol parameters attached to the input data. These symbols are also shown in Table 9.1 (see left side not shaded). Using the relative importance index technique (RII) as the mathematical and training algorithm coded into the ANN model, the business effect of each risk factor to the healthcare FM process can be processed immediately as single output value between 0 and 1. The above procedure illustrates how a frequently changed data file is used in the development of NHSFRES. The major advantage of using the frequently changed data file approach is that, it is very convenient as it allows users to modify their risk knowledge and values, as more business intelligence is gained to effectively manage healthcare FM operations in the NHS. This situation is typical in healthcare FM operations where services delivered are highly influenced by internal and external clinical governance issues. The second (i.e. infrequently changed), is one in which FM risk knowledge in form of key business factors is kept in the database as original as possible and cannot be frequently changed.

Again, using Table 9.1 to illustrate how this approach works, once the business process risks faced by FM operators when managing non-clinical services have been identified and properly formatted into the database, they cannot be modified. In addition, even if new FM and business knowledge about customer service needs and expectations, competition and the healthcare service environment comes to light, no risk factors can be added or changed to the database. In using such type of a data file, certain business management assumptions have to be made by healthcare facilities managers as domain FM experts in healthcare decision-making. The use of such an approach therefore requires the user to be highly experienced and competent in making strategic healthcare FM decisions. Once key risk factors have been identified and properly formatted into the database, they cannot be changed when evaluating their business effect on the non-clinical service delivery process.

For example, certain micro-business and environmental factors in the NHS that have a political, economical, social and technological (PEST) effect on the FM business process will need to be taken into account by the decision-maker. Due to this uncertainty, logically it becomes inefficient to use this type of data file in an object-oriented programming environment. Thus, the frequently changed database in this research was used to develop NHSFRES. This data file is then processed using the relational database process. In light of the above, NHSFRES was designed using the 'frequently changed' data file to have three main modules: the database, decision-making process that contains the ANN model base and a discrete knowledge base. These are all described below.

9.4 Model base

The model or symbolic base of NHSFRES is shown as module (6) in Figure 9.1, and consists of the decision-making model that is an ANN (i.e. the environment) model. The specific ANN model development was based on three phases namely:

i) Model design
ii) Model implementation and;
iii) Model simplification

9.5 Model design

NHSFRES is an artificial neural network model designed to solve two main objectives: the domain problem analysis, and classification of the model attributes (risk factor analysis). The analysis of the research problem started with a hypothesis earlier proposed in chapter three (Section 3.19). This hypothesis was formulated to test the multivariate and predictability nature of FM business risks in healthcare operations. This approach focused on a detailed analysis of the anatomy and sources/types of risks in FM operations in NHS trust hospitals. Thus, the research problem in this investigation was to develop a best practice FM model that can be used to identify, quantify and manage the business impact of those strategic and competitive risk factors that affect FM operators (purchasers, in-house and external providers), when managing effectively the non clinical business process in NHS trust hospitals.

In hindsight, these critical non-clinical risk factors and their sub-attributes were quantitatively classified into seven main classes. These risk classes were measured using qualitative approaches firstly, using a questionnaire survey and then the Repertory Grid Technique. The qualitative data obtained from using these techniques was the then systematically transformed, normalised and coded into risk knowledge for the proposed ANN model, NHSFRES. Furthermore, NHSFRES shown in Figure 9.1 consists of a risk database that stores FM risk knowledge (i.e. risk factors) obtained from healthcare facilities managers as domain experts managing FM operations in the NHS. NHSFRES has also a knowledge base that contains detailed FM knowledge about the levels of business impact (risk warning signs) and the risk management solutions or strategies than can be adopted by FM service operators in order to improve their business performance. Apart from the database and knowledge base, NHSFRES has also a model base that contains a quantitative model used to compute output values (risk exposure levels). NHSFRES has also a separate user-interface that allows the healthcare facilities manager as a decision maker, to interface with the database, model base and knowledge base in order to evaluate the risk profiles of various FM decision strategies that will improve the delivery of high quality FM services that underpin the continuous delivery of integrated healthcare services.

As a result, NHSFRES can also be used to benchmark the best practice for managing and improving performance in healthcare FM operations. In hindsight of the above, the research aim was based on the knowledge that the identification, analysis and management of critical FM risk factors in the provision of customer-driven solutions in healthcare operations will continuously lead to improved seamless and responsive support services (i.e. reduce service failure). This approach facilitates the effective management of healthcare FM services delivered using an integrated business approach on the basis of clinical needs in NHS trusts. As a result of these business objectives in the NHS, most FM service operators' core (clinical) service provision strategies can be enhanced or fronted effectively through FM performance. In pursing such an effective business strategy, many business and facilities management-related risk factors that might have a potential to adversely affect, or even negate attempts of the provision of best value clinical services are minimised. In management terms, effective healthcare service management in NHS trusts through benchmarking best business practices will lead to an uninterrupted supply of non clinical services that front the core (clinical) business objective in NHS trust hospitals.

In overall, this strategy will result in minimising risks associated with business disruption and the NHS corporate image of delivering cost-effective healthcare services. Earlier on in chapter three: section 3.11, it was established that, in order to test the research hypothesis, there was a special need to develop model parameters used by healthcare facilities managers in their "personal FM world" to define critical business factors that affect the effective delivery of non-clinical services in the NHS. From this survey, a total of forty-eight (48) risk variables were identified to have a strategic and competitive business impact (i.e. negative, positive or neutral) towards benchmarking the best practice FM performance in trusts. These variables were qualitatively classified into seven (7) main hierarchal risk classes/categories. Accordingly, these risk variables were principally used to develop the NHSFRES model. The seven risk variables were also used to form and predict the pattern associated with the management of critical risk factors (CRFs) that would become the critical success factors (CSFs) in improving FM service operators' businesses in the NHS. The selection of the main attributes for NHSFRES involved the evaluation of seven key risks that were later subdivided into seven (7) main FM risk classes.

This was then followed by a further investigation of their performance (correlation) on the seventeen integrated FM services commonly managed in the NHS. Immediately, after collecting FM risk data from 60 healthcare facilities managers interviewed who were managing the integrated 17 non-clinical services, 1020 FM cases were produced through expansion (i.e. 60*17). These 1020 FM cases were automatically split into three sets of 340 cases by a special facility in Trajan 4.0 before being formatted and coded. Out of the three sets, one set with 340 FM cases, and representative of the general knowledge of the problem to be modelled was randomly chosen, while the other two sets were hidden for future use. This set was chosen for use in the training and testing of the model (see Appendix E). The 340 FM cases fed into Trojan 4.0 were then shuffled and split into two sets (170 FM cases), resulting in 85 cases for training, and another 85 cases for testing.

The training set in Appendix E is shown with a red colour, while the test data is represented in blue. As for the other 170 cases not selected for the model development, they are shown with a black colour. These were hidden (not introduced for training) and later used for further testing of the model. The colour-coding scheme was adopted in Trojan 4.0 to show the various data sets used for either training or testing. This approach is very user-friendly and allows the user of Trojan 4.0 to either change the data set arrangement in order to suit their problem requirements. This procedure is called *data splitting or shuffling*, and is a common procedure used in the training and testing of ANN models. By further using Trojan 4.0, the data set editor facility incorporated in the program is able to show the classification pattern and measurement approach used for the FM risk factors used to develop the NHSFRES model base.

A sample of randomly selected cases from the training data set of the coded data is shown in Figure 9.2 below, while the full data shuffling procedure adopted for this problem is shown in Appendix E. It is only after the research problem has been properly defined and the important risk modelling parameters identified that an ANN based model can be developed efficiently.

9.6 ANN model Implementation

The implementation stage of NHSFRES comprised of four main development stages namely: input-output data file construction, neural topology selection, data processing and finally simulation of neural network.

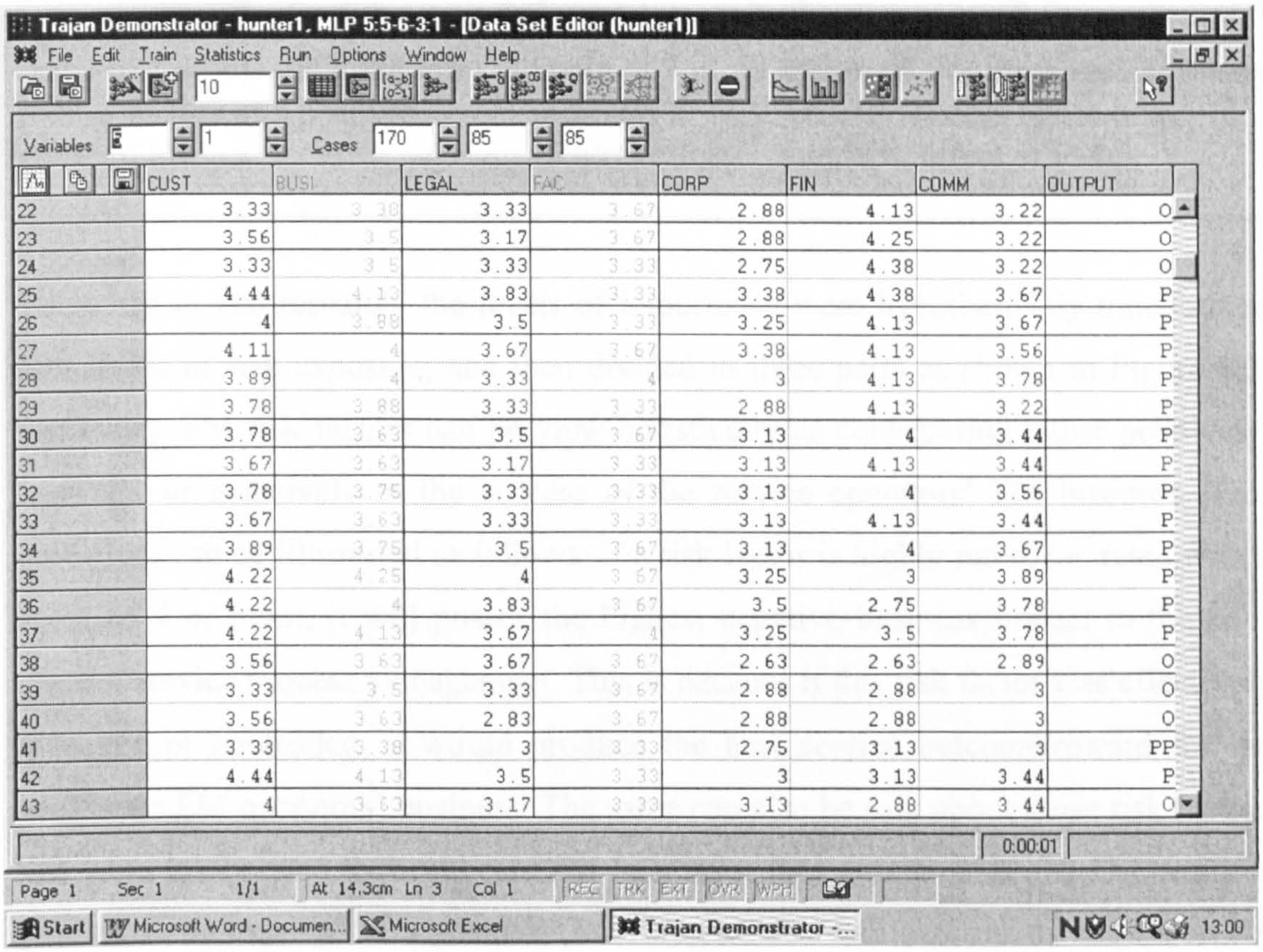
9.7 Input-output data file construction

This simply involves labeling the data observations as either input or output (where the latter is trained to be the desired output). A sample of input data values comprising of the principal seven risk variables for the research problem are shown in Figure 9.2. Figure 9.2 also shows the desired output that is formatted in symbolic expression. The desired output or risk exposure level have already been described in section 8.62 and are shown by way of linguistic symbols. Generally, the method of evaluating the business impact of FM risks on healthcare FM operations can be expressed in both linguistic and symbolic (that is nonnumeric in format) nature using a nominal risk scale such as; PP = high positive, P = medium positive, O = neutral, N = medium negative and NN = high negative (Ramachandran, 1999; Akitonye and Macleod, 1997; Alarcon and Bastias, 2000; and Kometa, 1995).

These symbols (risk exposure levels) are a result of using the relative importance index technique earlier explained in the major questionnaire survey in section 7.11. The desired output was then classified to predict the total resultant/business impact on the FM process using the risk index scale shown in Figure 9.3 below. This method is then subsequently subjected to risk assessment and analysis for further application with a view of providing effective management solutions. This stage also involves the selection of the neural network paradigm and the simulation package in order to map out the neural compilation of risk variables based on categorical data observations elicited from the surveyed NHS FM service operators (i.e. 20 purchasers, 20 in-house and 20 external providers). The ease of the implementation stage is a function of the correct software resources or computer package. At this stage, the input data of the neural algorithms after being specially formatted was fed into the expert system simulator Trajan 4.0.

First, in order to perform a risk factor impact assessment on the 17 integrated non-clinical services established in this survey; a number of procedures were applied for this assignment. As the main focus of this research was to identify, quantify and manage non-clinical risk factors that affect healthcare operations. Healthcare facilities managers currently working in selected major NHS trust hospitals surveyed were asked to rate using a five-point score scale those critical risk factors that impacted their non clinical business processes.

Figure 9.2: A sample of input and output data



	CUST	BUSI	LEGAL	FAC	CORP	FIN	COMM	OUTPUT
22	3.33	3.38	3.33	3.67	2.88	4.13	3.22	O
23	3.56	3.5	3.17	3.67	2.88	4.25	3.22	O
24	3.33	3.5	3.33	3.33	2.75	4.38	3.22	O
25	4.44	4.13	3.83	3.33	3.38	4.38	3.67	P
26	4	3.88	3.5	3.33	3.25	4.13	3.67	P
27	4.11	4	3.67	3.67	3.38	4.13	3.56	P
28	3.89	4	3.33	4	3	4.13	3.78	P
29	3.78	3.88	3.33	3.33	2.88	4.13	3.22	P
30	3.78	3.63	3.5	3.67	3.13	4	3.44	P
31	3.67	3.63	3.17	3.33	3.13	4.13	3.44	P
32	3.78	3.75	3.33	3.33	3.13	4	3.56	P
33	3.67	3.63	3.33	3.33	3.13	4.13	3.44	P
34	3.89	3.75	3.5	3.67	3.13	4	3.67	P
35	4.22	4.25	4	3.67	3.25	3	3.89	P
36	4.22	4	3.83	3.67	3.5	2.75	3.78	P
37	4.22	4.13	3.67	4	3.25	3.5	3.78	P
38	3.56	3.63	3.67	3.67	2.63	2.63	2.89	O
39	3.33	3.5	3.33	3.67	2.88	2.88	3	O
40	3.56	3.63	2.83	3.67	2.88	2.88	3	O
41	3.33	3.38	3	3.33	2.75	3.13	3	PP
42	4.44	4.13	3.5	3.33	3	3.13	3.44	P
43	4	3.63	3.17	3.33	3.13	2.88	3.44	O

As precedence for using the five-point score system in the development of the NHSFRES, Kometa (1995) used a similar system to develop a risk management system for evaluating consultants' risk exposure to construction services providers. Furthermore, a similar methodology was used by Ahmad (1988) when he developed BIDEX, an intelligent system that utilises linguistic variable as management solution guides to the decision maker.

The FM service operators' RGT data was then transformed using a nominal risk impact scale, which converts the final risk values (OUTPUT) by using the RII technique to a scale between 0 to 1 as shown in Figure 9.3. The OUTPUT value was then normalised by dividing it by 100 to give a range values (between 0 and 1) that can be classified by the risk index scale shown in Figure 9.3.

Figure 9.3 Risk index scale

0.2 = NN*	0.4 = N	0.5 = O	0.8 = P	1.00 = PP
Score of 2 or less indicates less critical factors or a positive effect of FM		Score of 3 indicates a Neutral effect	Score of 4 or more indicates very critical success factor or a negative effect of FM	

Therefore in this research, the levels of importance were hypothetically transformed into levels of risk exposure, and then divided in three parts as shown in Figure 9.3. Generally, FM risk factors can be view holistically as contributing either positively, neutrally or negatively to the success of the service operators' FM business. This procedure can be illustrated as follows: if a risk factor is highly rated, i.e. rated with a score of 4 or more, it will posses the highest negative business impact to the non-clinical service process management. This is because if this risk factor was effectively managed or controlled, it would produce the best service outcome/reward for the healthcare FM operators' business. The same can also be said about those risk factors that were lowly rated by healthcare FM operators; they would cause the FM business process to be exposed to a positive (low) impact. In relative terms as shown on the nominal scale, the percentages of respondents scoring 2 (positive) or less, 3 (neutral), and 4 (negative) or more on the nominal scale was calculated for each variable. This was used to rank the variables where their relative importance indices are equal. The interval scale was transformed into a nominal scale showing that:

i) if a risk factor was ranked critically important by most healthcare facilities managers, it would achieve a score of 4 or more (5 being maximum), and will have the highest negative effect with relative index of 1).

ii) with decline in perceived importance being mirrored by a decrease in relative importance, down to between 1 and 2, will have the lowest positive effect with relative importance down to 0).

In hindsight, the section below will illustrate how NHSFRES can be used to make effective healthcare FM operation decisions in the NHS.

9.8 Risk management process of NHSFRES

A healthcare facilities manager requires the processing of FM risk information for strategic decision-making, business risks control and assurance (clinical governance). Conventional information systems for non-clinical services management usually stress problem solving by employing management by exception. Management by exception uses a backward-looking concept and it focuses on a comparison of the facts. The approach used by the NHSFRES for problem solving is based on evaluating the business impact of critical risk factors against the best support services performance, and thus providing possible management solutions. In this case, the ability of NHSFRES to predict effectively FM risks in healthcare operations at certain business performance intervals becomes more powerful and easy to use, as it provides healthcare facilities managers with an insight into object-oriented decision support system and management solutions. The concept that supports problem finding (i.e. risk exposure) is management by perception or experience.

This forward-looking business management system is a vehicle for predicting pre-and post FM risk factors in healthcare operations before they occur and allows non-clinical managers to determine their impact. The effectiveness of this management system depends entirely on; (a) the type of FM services managed; (b) healthcare servicescape; (c) delivery problems; (d) staff expertise and economic resources available to the healthcare facilities manager wanting to make risk management solutions. Furthermore, it also needs both the exception and perception types of management system to be used in a combined way. These factors were taken into consideration when developing the NHSFRES. Therefore its effectiveness highly depends on the FM service operator's ability to identify and manage the domain key non-clinical risks affecting healthcare operations.

The management solutions that can be implemented for control assurance can either be to mitigate risks, plan for business continuity and control various FM risks using modern risk analysis tools earlier evaluated in chapter three of this thesis. In this case, the NHSFRES becomes a vital business process improvement and risk management tool for the delivery of high quality non-clinical services in the NHS. In healthcare FM, risk identification process is a critical stage as it can be sometimes too fuzzy for non-clinical service managers to know which FM business risks will occur, and from which source. It can also be difficult for non-clinical service managers to precisely identify which FM risks have a positive, neutral or negative performance effect on the total FM business process in NHS trust hospitals and their service delivery strategies. Therefore, when the healthcare facilities manager uses NHSFRES for decision-making and quality control assurance in NHS trust hospitals, this process can be illustrated by incorporating the risk management process model shown in Figure 9.1. As a result, the following steps are followed as a best practice approach:

Step 1: Assign attribute values (between 1 and 5) for each of the 17 FM services/elements against the 48 risk constructs that are then decomposed into 7 main groups and normalised in Microsoft Excel. This procedure is shown in Figure 9.1 modules 1 and 2: – risk data formatting and identification

Step 2: Evaluate the identified risk constructs in terms of their treatment (i.e. whether they are insurable, transferable, guaranteeable or management-related). If tangible or physical, then these risks can be best managed or transferred in order to minimise the organisation's risk exposure. These risks can also be transferred to the responsible operator, insurer or guarantor. If the identified risks cannot be transferred (NO) i.e. are management related as shown in module 3 then go to next step;

Step 3: Use the nominal scale to classify the risk factors according to their relative importance using the relative importance index technique already explained in the chapter 7 (main questionnaire results analysis). This stage is shown in figure 9.1 as module 5. Module 5 involves the transformation of risk linguistic (qualitative) values in Excel into a symbol coding system (see Figure 9.1) changing the value into input attributes of Trajan 4 ANN model shown in module 6.

Step 4: Input the transformed risk values as inputs of the ANN model which learns to predict the various risk classes used as output values. This is called model simulation and training the ANN system. This procedure is done in the symbolic base in module 6. Simulate the ANN network using Trajan 4.0 software to select the correct network paradigm and train it. The type of training used here is the supervised training and is done for at least 10 minutes to all for data processing and analysis.

Step 5: Analyse the results of the ANN model to forecast predictions and classification of the risk factor values. Measure the error, MAPE and the APE. If ANN model is fully trained then test and compare with other modeling approaches (i.e. in this research MRA was used), validate or seek domain expert opinion regarding the NHSFRES performance accuracy

Step 6: Use Table 9.5 to forecast the FM operator's total risk exposure to the various FM cases evaluated in the model. Further examination of the total organisation's risk exposure can be done by summing up, and averaging the number of FM cases total risk exposure.

Step 7: Provide management course of action or solutions (rule-based if-then) suggested by the total and overall risk exposure index (Risk classification reference).

Example

To demonstrate how well the above seven steps were used to develop NHSFRES, the first and foremost stage was that of collecting forty-eight (48) risk constructs that were identified by 60 healthcare FM service operators as commonly having a strategic and competitive business impact (i.e. negative, positive or neutral) towards benchmarking the best FM services performance in NHS trust hospitals. In turn, these constructs were classified in terms of their relationship and treatment to the FM business process. This process resulted in the 48 risk constructs being classified according to their effect on the FM business process in the NHS.

Therefore, in according with step 2, if these risk constructs cannot be insured against or transferred to a guarantor, they will need to be managed effectively by FM service operators. Next, these constructs were then rated using a likert scale (between 1-5) against the seventeen commonly managed non-clinical services in the NHS to determine the individual impact of the identified 48 FM risk constructs.

The 48 risk constructs were qualitatively classified into seven (7) main hierarchal classes as shown in chapter eight, Figures 8.18, 819 and 8.20. Immediately after the collection of FM risk data from 60 healthcare facilities managers, 1020 FM cases were produced through expansion (i.e. 60*17) and were specially formatted and coded. These cases are all shown in Appendix E. Next, these 1020 FM cases were automatically split into three sets of 340 cases as earlier described above by a special facility in Trajan 4.0 before being formatted and coded into a special "csv" file using Microsoft Excel to develop a the risk database. Out of the three sets, one set with 340 FM cases representative of the general knowledge of the problem to be modelled was randomly chosen. This set was chosen for use in the training, testing and validating of the model. The 340 FM cases fed into Trojan 4.0 were then shuffled and split into two sets (170 FM cases), resulting in 85 cases for training and another 85 for testing. The training set is shown with a red colour while the test data is represented in blue. As for the other 170 cases not selected for the model development, they are shown with a black colour. As part of the main risk database file used to develop NHSFRES, Table 9.2 was extracted from the main risk database file shown in Appendix E. Table 9.2 will be used to illustrate the risk management using the above seven steps.

In order to demonstrate how the business impact of a single or multi-FM service(s) affect the healthcare business process in the NHS, Table 9.2 has been used at micro-scale to show how NHSFRES was developed. In addition to this, Table 9.2 shows seven input risk constructs for FM case 22 which represents *ground and gardens* services. Since Table 9.2 is part of large data set used for developing NHSFRES, cases are used to represent the 17 main FM services commonly managed using an integrated approach in the NHS. Hence, *grounds and garden* were regarded as the fifth FM element out of the seventeen (see Table 9.1) non-clinical services managed in the NHS using the integrated FM approach.

Table 9.2: Management solutions (Risk classification reference)

Risk exposure index (I) range (Warning signs)	**Symbol/linguistic expressions**	**Management solutions**
0.8 <I 1.0	PP High negative impact	Operators should concentrate most resources on managing such FM services effectively as business rewards are greatest. Continuous service improvement and benchmarking the best practice must always be performed
0.6 <I 0.8	P Medium negative impact	Operators should continue to deliver best value FM services effectively in order to increase reward opportunities. Operators should also concentrate more resources on managing the FM process.
0.4<I 0.6	O Neutral	Operator's business process has fewer opportunities and can be exposed to average FM risks. FM business performance is gradually decreasing and should be monitored closely. SLAs should be constantly redesigned and monitored or else risk low rewards and poor service response times.
0.4<I 0.2	N Medium positive impact	The operator should carry out immediately an FM audit to assess business performance. FM strategy needs re-engineering or rethinking to avoid business immediate service failure. Long-term management of such services will result in lack of commercial viability.
0<I 0.2	NN Low negative impact	Operators should avoid managing such FM services even if they are desperate for work. Such FM services should be outsourced to risk taking operators, or avoided at all costs as they are not commercially viable. Partnering may be a service delivery option to consider.

Note* It should be noted that the decision taken by the FM service operator providing non clinical services after assessing Table 9.2 depends entirely on their economic circumstances and attitude (risk propensity) towards taking risk in healthcare operations (Finch , 1992; and Pablo, 1997).

The seven risk factors regarded as the input to the model were rated by non-clinical services to illustrate their relative importance towards the effective management of NHS FM operations.

Therefore, in order to calculate the relative importance of *grounds and garden* services to the FM business, all the seven principal risk factors that are rated against FM case 22 are computed as follows: As a result of the formula below, we can calculate the relative importance of an individual FM service/element, *grounds and garden* services to the FM business in the NHS as follows:

Relative Importance Index =

Where:

$$\frac{\Sigma \ W}{A * N}$$

W = weighting given to each risk factor by the respondents and ranges from 1 to 5 where '1' is the least important and '5' the most important;

A = is the highest weight or score (i.e. 5 in this survey);

N = total number of risk constructs in every case.

$$\frac{3.33+3.38+3.33+3.67+2.88+4.13+3.22}{5(7)}$$

RII = 0.6

Therefore, the interpretation of these results in healthcare operation terms is that, *grounds and garden* services pose a neutral effect on the FM business process. In terms of the risk management solution shown in Table 9.2, FM service operators should continue to deliver best value FM services effectively in order to increase business reward opportunities. In addition to the above, FM service operators would also need to concentrate more resources on managing the FM business process to improve deliver high quality support services. The same procedure is adopted to rank all the other FM cases shown in Table 9.2; as well the survey data collected from all the surveyed FM operators in order to develop NHSFRES.

Since, this research sought to investigate the business risks faced FM service operators using an integrated approach, the total risk exposure index for the FM operators' business can be achieved by averaging the risk exposure indices for the seventeen FM services.

This approach can also be used when more than seventeen FM services are used. The final risk exposure index obtained would then represent the total business impact of the healthcare FM service operations. This result can then be represented using the nominal risk scale so that, FM operators can provide a management solution.

Steps 5 to 7of the risk management solution shown above were used to expediently predict risk exposure for the 1020 FM cases. This is because the risk knowledge collected for NHSFRES was large and could only be solved using artificial intelligence as opposed to human knowledge. In addition, the calculation of relative importance for the 1020 FM cases is too laborious, time-consuming and complicated to remember using human memory. Hence, NHSFRES that uses ANN modeling was used to speed up this process. It has been designed as a business performance improvement tool that can be used in the strategic management and identification of potential FM business risks, and also service improvement opportunities that will lead to customer satisfaction.

In this research, NHSFRES has been developed in such a way that it acts as a decision support system that can aid non-clinical managers to develop an organisational risk management policy that identifies and evaluates business risks, as well as modelling them. This management approach used here allows for the effective planning, implementation, auditing and solving of service delivery failures. The approach also provides an optimum solution. For example, it provides the best value approach of managing healthcare FM services, and possible risky support service encounters. In practice, this approach may not always satisfy healthcare facilities managers' risk propensity in making effective business decisions. These decisions may be related to, for example economics, medical technology innovation and resources to improve healthcare operations. The actual management solution process may be complex. It requires multivariate business factors, information and intelligent business expertise to make effective service delivery decisions. On the other hand, the decision-centered approach, another type of problem solving method, provides results, which are satisfactory rather than optimal. It cannot be concluded which approach is better in this research. The effectiveness of any approach depends entirely on the type of FM business problem to be solved.

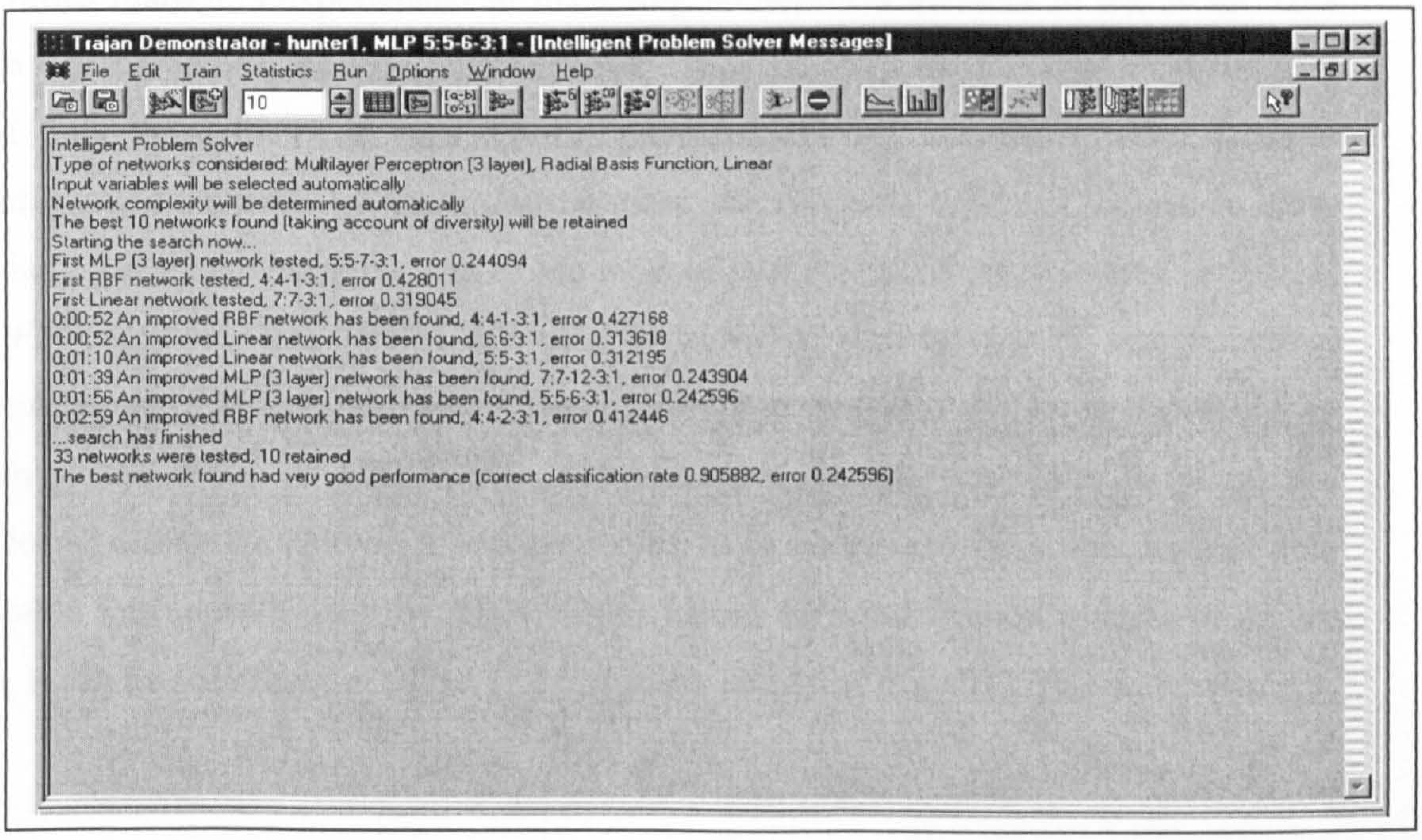
In a situation where there are limitations on delivery response times, service quality costs, information to solve FM problems, the decision-centered approach is quite effective. The decision making process for the NHSFRES in this research is defined by the relationships between these two decision making process approaches, as well as the types of FM business decisions made by service operators (i.e. purchasers, in-house and external), the relative importance index characteristics, and ANN decision making models. The NHSFRES is integrated with artificial intelligence (i.e. ANNs) as an expert shell supports the risk identification (problem finding), analysis and management (problem solving) of the FM business process. The decision making models and RII technique that affect each type of FM decision are incorporated into the decision making process. Several management solution strategies to the decision making process that are shown in Table 9.2 may be selected in order to provide a suitable FM solution for any non-clinical service problem. In this research data contained in a Microsoft Excel spreadsheet was specially formatted as the database file. This file contained numerical risk variables. However other more sophisticated languages and environments can be used to develop any AI prediction system. It is important note that other modern programming languages can be used such as C++, Prolog, Java, HTML and others. For an elaborate use of these computer languages, the user needs an extensive understanding of computer programming knowledge. In addition, a huge amount of time is needed to develop a full environment for the model. Hence, in this research input data was first normalised then coded into a special Microsoft Excel file that was invoked into a neural network simulation package Trojan 4.0 supplied by Trajan Software Ltd UK. This type of simulation software is run on an IBM PC. Because the software package itself deals with the vast range of algorithmic details, the user merely contemplates model topology. Trajan 4.0 is a fully-featured neural network simulation package. It includes support for a wide range of neural network types, training algorithms, and graphical and statistical feedback on neural network performance.

9.9 Neural topology selection

The first and foremost stage towards the implementation of an ANN model is to choose the most appropriate network paradigms by matching the problem to relevant aspects of system architecture.

For example, by selecting the number of input processing elements; the number of output processing elements; the number of hidden layers; PE transfer functions and learning rules. The neural network architecture varies with regards to typology and the type of input and output patterns produced during the learning or training processes. This aspect of ANNs has been demonstrated in chapter four of this thesis. In practice, there are no algorithms or rules for selecting the best neural network architecture for a domain problem. However, the potential problem areas in healthcare facilities management that can benefit from the application of ANN techniques have also been identified in chapter four, with suggestions for suitable network structure. Considering the nature of the research problem in this study, a simple three layers MLP feedforward with backpropogation neural network structure was automatically chosen by Trajan 4.0 simulator to model the total risk exposure in various healthcare FM service operations in the NHS. The selection process of the MPL network is shown in Figure 9.4. This type of neural network is currently the most popularly used and also suited well the research problem due to the nature of the input data (risk values) being used. The first input layer consist of seven processing PEs, determined by the number of main risk factors that were established as having an influence on the management of FM operations in the NHS. This layer operates a simple input buffer and uses a sigmoid transfer function to distribute each of the input values to each of the processing elements of the second layer.

Figure 9.4: Network paradigm selection

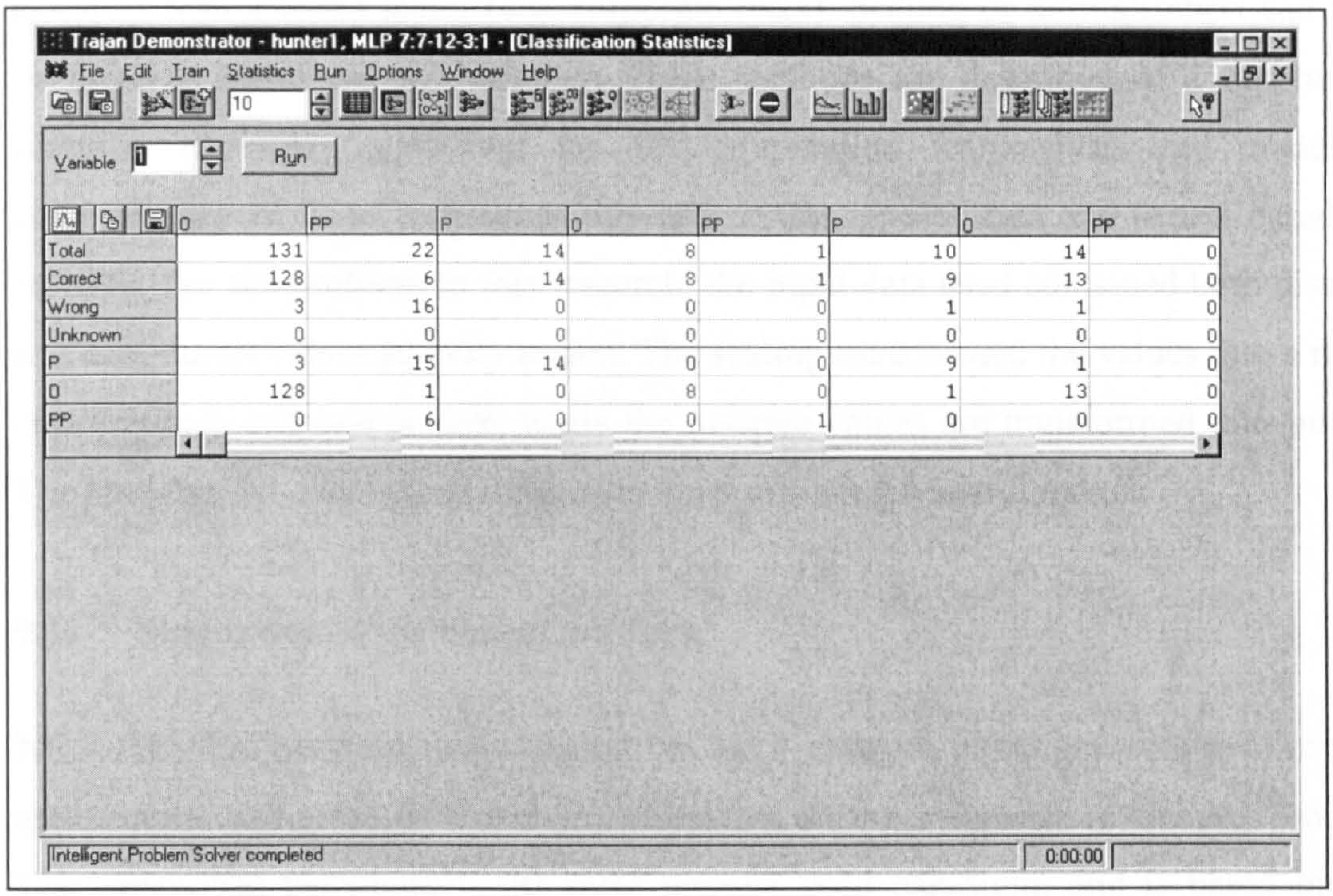


The second layer is the hidden layer. The determination of the number of the PEs in this layer was performed by Trajan 4.0 using the intelligent problem solver facility on a trial and error basis. The rationale for this approach was to start with one hidden layer and add more if necessary, however a single layer was found to be adequate to solve the research problem. The initial number of PEs in the layer to start with was determined by a rule of thumb based on trial and error. Since there is only a single layer, Trajan 4.0 starts evaluating with the equal number of PEs, i.e. seven. This approach is based on the concept that too many PEs incur a long training time or allow the network to memorise the data rather that extracting the general pattern that will allow it to handle out of sample data (i.e. data not used in training). After applying this rule the initial number of PEs were reduced experimentally. The optimum number of PEs is five. Each of the processing elements uses a non-linear sigmoid transfer that has the same number of weights as the number of input attributes. The final layer, the output layer consists of a single processing element that would be interpreted as a regression node giving the estimated total risk exposure of FM services. The output signals from each of the hidden layer's transfer functions feed into the output element and is further processed by the output layer function to predict what the total risk exposure would be.

9.10 Data processing

The data used to develop the input to the NHSFRES was solicited from 60 healthcare facilities managers experienced in managing non-clinical services in the NHS. This data was based on measuring the total risk exposure of 17 main non-clinical services that front the delivery of care services provided to NHS customers under a single management umbrella by trusts. Furthermore, the risk data collected for use as input variables is a business reflection of the most critical risk parameters valued as critical by FM operators. The type of data used consisted of both categorical and numerical measurement that was normalised into symbolic expressions shown in Figure 9.5 to become the input of NHSFRES. Normalisation process was done to allow the collected research data (which was imprecise) to be coded into the proper form of data suitable for inputting into the ANN model. Using the classification process in Figure 9.5, it can be seen that out of the 131 FM cases classified only 3 (2.3%) were wrong.

Figure 9.5: Classification statistics of the training data



	O	PP	P	O	PP	P	O	PP
Total	131	22	14	8	1	10	14	0
Correct	128	6	14	8	1	9	13	0
Wrong	3	16	0	0	0	1	1	0
Unknown	0	0	0	0	0	0	0	0
P	3	15	14	0	0	9	1	0
O	128	1	0	8	0	1	13	0
PP	0	6	0	0	1	0	0	0

The statistic results here show that the classification of the FM data using ANNs to develop NHSFRES was highly accurate. The input and output data was then used to train and test the ANN model for the NHSFRES model. Thus, ANNs can extract essential hidden relationships among the raw information to form new data patterns. However without data normalisation, the neural network model would be too complex, and would take a very long time to compute the model. It is therefore a prerequisite for the input data to be properly normalised in order to reduce both the model complexity and computation time. Normalisation of data mainly involved changing of the raw data into a format suitable (input) for ANN modeling.

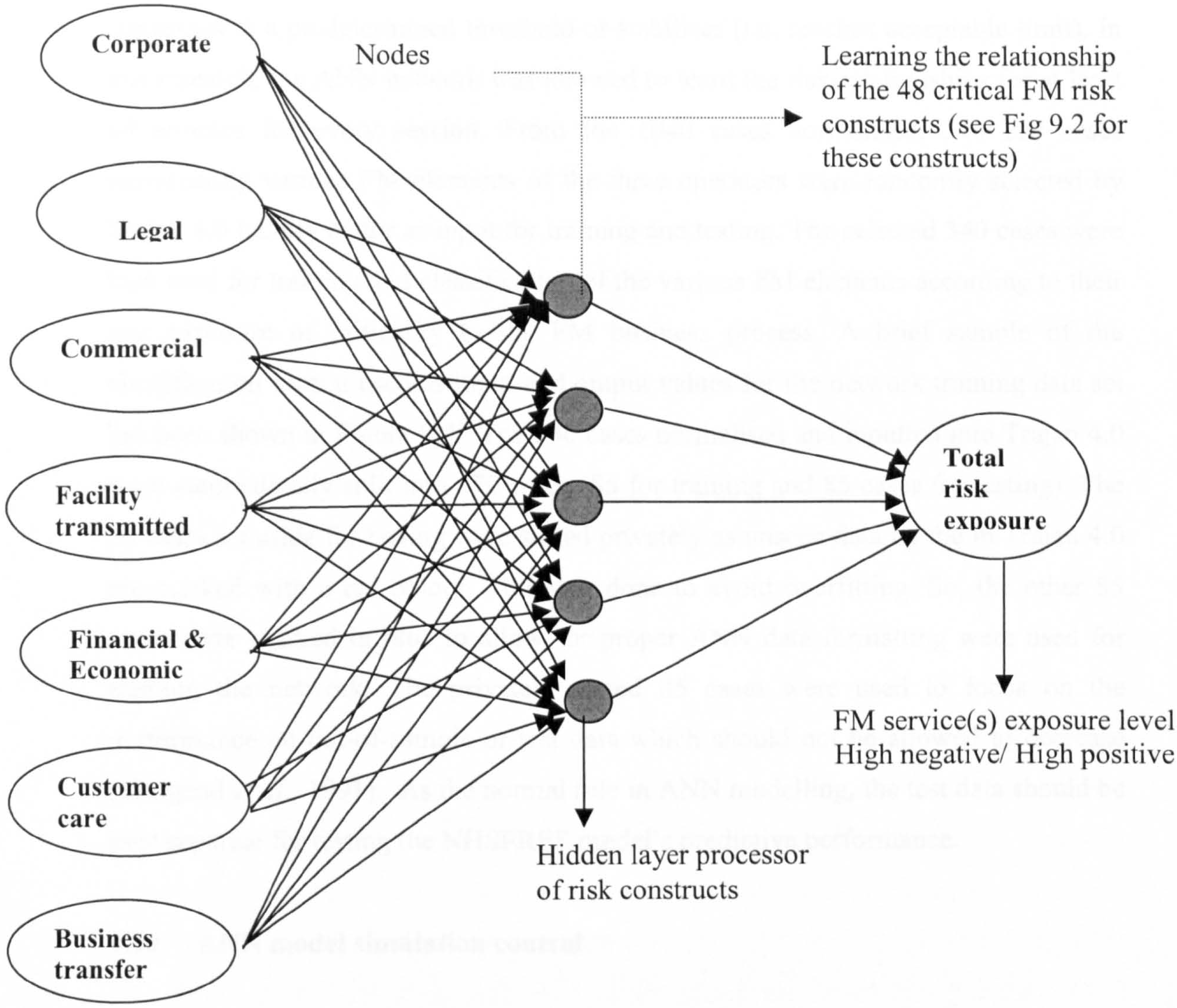
Normalisation involves the transformation of the raw data into either discrete or continuous formats that are meaningful to artificial neural network architecture. Discrete value transformation is executed by assigning 'zeros' and 'one' for the applicable constructs. Purchasers or providers' risk factors were originally rated using a five-point score system in terms to distinguish important constructs from the non-important ones. This also provided data for training and testing the network. The degree of relative importance used in this research was then smartly transformed into a performance index scale for risk factor exposure ranging from 0 to1.

In continuous value transformation, the raw data is adjusted into real numbers, each assigned with a given factor (e.g. corporate risks). Scaling or normalisation can then be done to transform this number. These methods are described in a number of literature providing guidelines for data preparation for analysis and modeling. Adopting any of these techniques depends on the type of data and neural paradigm selected. For the problem in this research, the input data used contained both discrete and continuous values suitably scaled. The scaling transformed the values into a range between zero and one or five, while the discrete values are transformed into binary. The transformed data is then utilised as input to train the neural model.

9.11 Simulation of the neural network

NHSFRES has been developed using the MLP network paradigm with feedforward architecture, using the BPN training algorithm during a supervised training process. The supervised technique is the most popular used paradigm, and is based on the network learning to predict outcomes for input and output variables for known FM project examples (Edwards *et al.*, 2000; Lam *et al.*, 2000; and Khosrowshahi, 1999). This network was used to compare its outcome prediction against the desired risk exposure levels and "learns" from its past training errors. The multilayer feedforward network used is a computational structure with algorithm that maps from an input variable to an output variable. The multilayer ANN used this research shown in Figure 9.6 has 7 input layers, 5 intermediate and 12 hidden layer(s), and 1 output layer. In a fully interconnected backpropagation network with 7 input nodes, one hidden layer with 1 nodes, and an output (total risk exposure) layer with one node, the signal is received by each hidden layer node from the input layer. The input signal is then transformed into the output signal of the hidden layer node by one of several transfer functions. The most common transfer function is sigmoidal, which is a continuous, non-decreasing function, generating values between 0 and +1. The output signal of the hidden layer node using the sigmoidal transfer function allows for processing of the desired output. The output node also accepts the sum of the signals from the hidden layer nodes as its input, and normalises it using a transfer function already described in chapter four of this thesis.

Figure 9.6: Architecture of the MLP network model



Training data comprised of a set of 60 grids, each comprising of 48 risk constructs (which were decomposed into main 7 classes) by 17 FM services were used as inputs. The desired output (risk exposure) for various FM services to be predicted was calculated using the RII technique. The corresponding symbolic expressions used to categorise the risk exposure scale using the RII for learning the output categories adopted from Alarcon and Bastias' (2000) work, are used to teach the ANN in supervised learning (see Table 9.2). Predicted results of the output layer were then compared with the desired output from the training set. The difference between desired and actual output is computed as the error. This error is then propagated backwards through the network and the weights are changed according to an algorithm that reduces the error. The process of modifying weights in response to sets of input and desired outputs is called *learning*.

Training a network is an iterative process that continues until the error either converges to a predetermined threshold or stabilises (i.e. reaches acceptable limit). In this research, the ANN network was allowed to learn the risk relationships for at least 10 minutes for every session. From the 1040 cases normalised, 340 FM cases representing various FM elements of the three operators were randomly selected by Trajan 4.0 facility editor as input for training and testing. The selected 340 cases were then used for training and classification of the various FM elements according to their risk exposure or criticality to the FM business process. A brief sample of the classification format used as input and output values for the network training data set has been shown in Figure 9.2. The 340 cases normalised and inputted into Trajan 4.0 were automatically split into 170 cases (85 for training and 85 cases for testing). The 85 cases set aside for testing were stored privately as unseen data by the in Trajan 4.0 are marked with a red colour. This was done to avoid overfitting. So, the other 85 cases were marked in blue to allow for proper ANN data formatting were used for training the network. The privately stored 85 cases were used to focus on the performance on out-of-sample or test data which should not be allowed to decrease (Weigend *et al.*, 1991). As the normal rule in ANN modelling, the test data should be kept separate for testing the NHSFRES model's predictive performance.

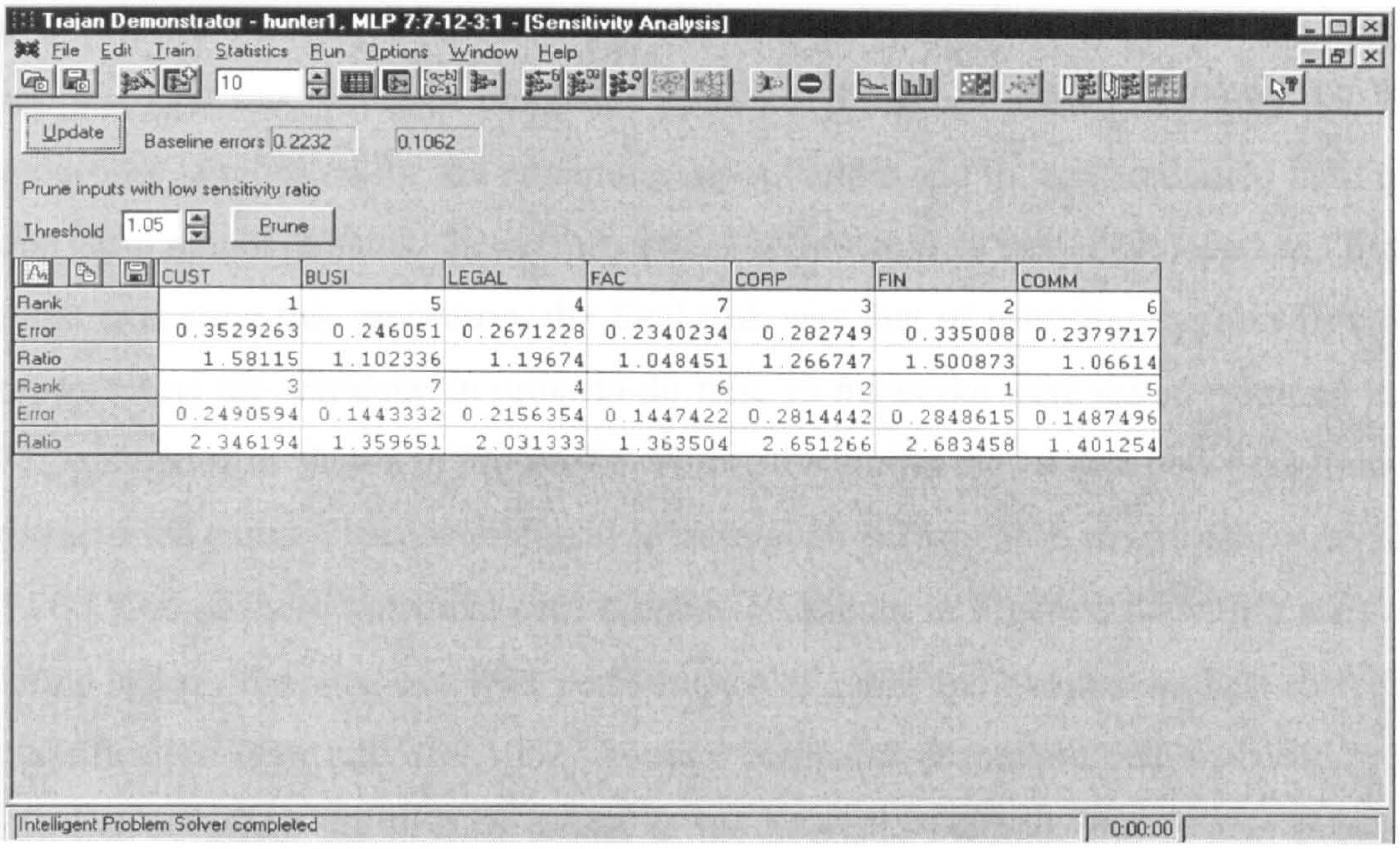
9.12 ANN model simulation control

The final stage of the ANN model development is the simplification of the resulting network model. The law of parsimony states that, when alternative explanations of a phenomenon are given, the simplest explanation would be preferred. Building a simple and a more coherent model saves time in data collection for testing and validation of the resulting ANN model to be used as a business decision protocol tool. Model simulation control is primarily a process of examining by "pruning" the developed network model to determine those input factors that are not necessary (or contributing) for the development of the model solution (Fausett, 1994). By pruning the network, the model dimensionality is reduced removing those less contributing input factors with no effect on the model predictive capability. A wide range of commentators have, over the past years, proposed a number of innovative approaches for simplifying network models through casual analysis of the input factors and the output prediction of ANN models.

Garson, (1991) for example, proposed a technique based on network weight to determine the relative importance of ANNs input attributes, and also partitioning the output layer connection weights associated with input attributes. However, this technique involves complex mathematical calculus that makes the technique laborious, time consuming and not easy to use. Trajan 4.0 neural networks program does offer a sensitivity analysis facility that can be used to determine the overall contributing effect of individual FM risk factors to the output of the model. The rationale for using sensitivity analysis is to shift and adjust minimally, each input factor and note the corresponding changes in the learned output. Using the sensitivity facility within the neural network simulation program, the performance of each of the seven main risk factors was determined using the 85 FM cases chosen for training. The contribution of each risk factor was determined by adjusting each risk variable a number of times while the other variables remained constant. By so doing, the effect of the factor being varied to final output would be computed.

Figure 9.7 shows the graphical representation in terms percentage contributions, ranking, ratio, error and rate of each of the input factors to the total predicted business risk exposure of the 85 cases trained. The percentage contribution of the factors is then used to rank each individual factor according to their relative importance. Figure 9.6 also shows that pruning was done to those risk factors with a low sensitivity ratio at a threshold of 1.05. In overall, the baseline errors for the 85 FM cases shown in Figure 9.7 after pruning was between 0.2232 and 0.106. Figure 9.7 shows that *Customer care* risks were ranked as the most important with a learning error of 0.353 and ratio of 1.58, followed by *Financial and Economic* risks with a total learning error of 0.335 and ratio of 1.5, followed by *Corporate* risks with a learning error of 0.282 and a ratio of 1.2.The fourth ranked was Legal risk with a learning error of 0.267 and a ratio of 1.110. The fifth, sixth and seventh ranked factors were *Business Transfer* with a learning error of 0.246 and a ratio of 1.1, followed by *Commercial* risks which had a learning error of 0.237 and a ration of 1.06. The least ranked were *Facility related* risks with a learning error 0.234 and a ratio of 1.04. It is interesting to note that the ranking of the main risk factors done by the ANN model is similar to earlier ratings determined in the major questionnaire and the Repertory Grid analysis of the healthcare facilities managers survey, described in chapters seven and eight respectively.

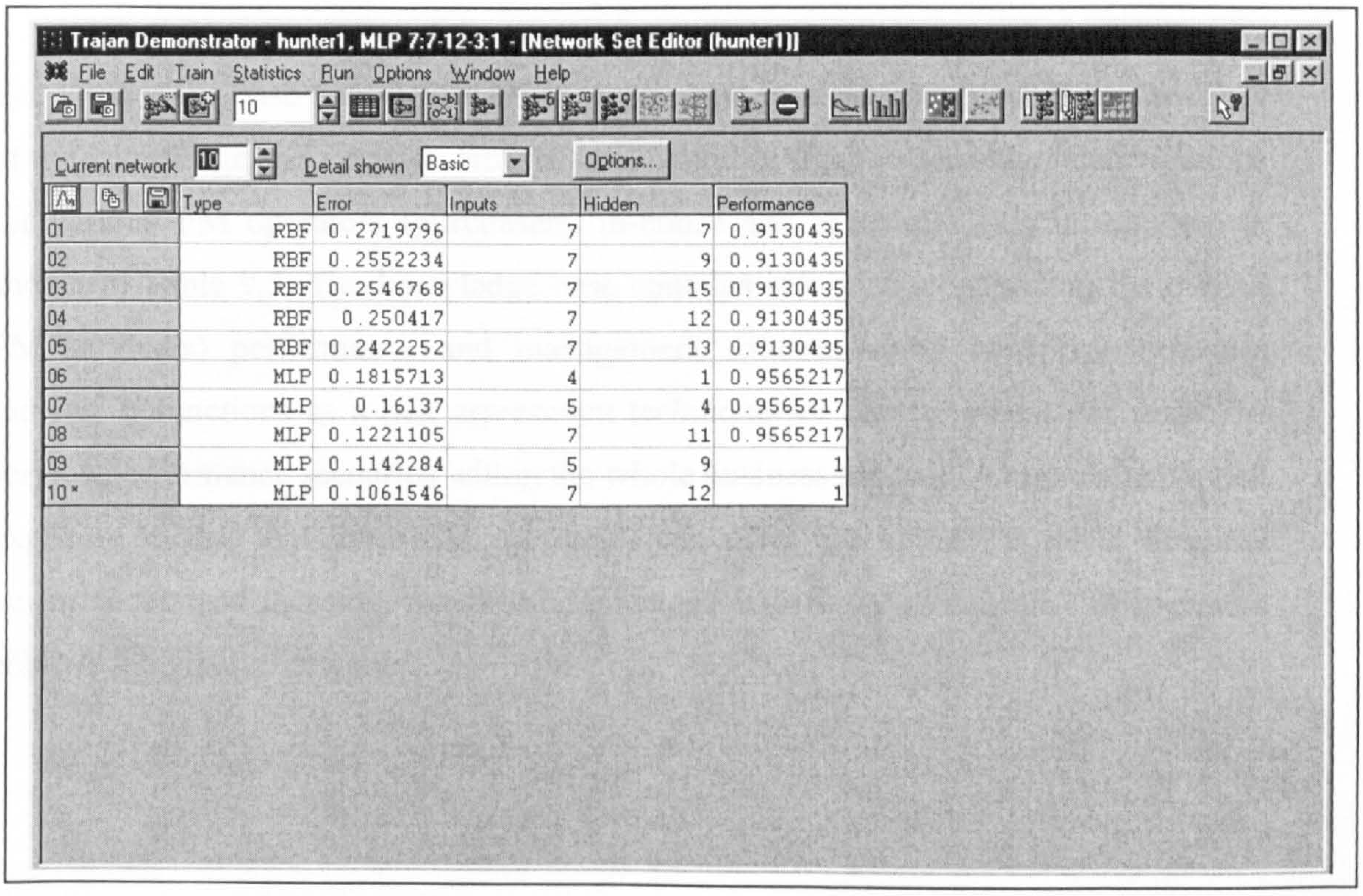
Figure 9.7: Sensitivity analysis of the seven main risk factors



	CUST	BUSI	LEGAL	FAC	CORP	FIN	COMM
Rank	1	5	4	7	3	2	6
Error	0.3529263	0.246051	0.2671228	0.2340234	0.282749	0.335008	0.2379717
Ratio	1.58115	1.102336	1.19674	1.048451	1.266747	1.500873	1.06614
Rank	3	7	4	6	2	1	5
Error	0.2490594	0.1443332	0.2156354	0.1447422	0.2814442	0.2848615	0.1487496
Ratio	2.346194	1.359651	2.031333	1.363504	2.651266	2.683458	1.401254

After determining the relative importance hierarchy of all the input factors, a "forward" elimination approach was then used to discriminate the less important input factors. Discriminant factor analysis was carried out to each risk parameter starting with the ones that had the smallest contribution towards the model development.

Figure 9.8: Selection best-fit 10 networks



	Type	Error	Inputs	Hidden	Performance
01	RBF	0.2719796	7	7	0.9130435
02	RBF	0.2552234	7	9	0.9130435
03	RBF	0.2546768	7	15	0.9130435
04	RBF	0.250417	7	12	0.9130435
05	RBF	0.2422252	7	13	0.9130435
06	MLP	0.1815713	4	1	0.9565217
07	MLP	0.16137	5	4	0.9565217
08	MLP	0.1221105	7	11	0.9565217
09	MLP	0.1142284	5	9	1
10*	MLP	0.1061546	7	12	1

Every time an input was dropped, the model would be retrained (16, 000 iterations) and tested. As a result of the above procedure, the standard error of both the training and test data sets would be computed or noted. These are shown in Figure 9.8. This procedure is repeated for the remaining input factors and in turn continued until only one input model remains. In overall, a total of 340 models were developed and tested. After executing this procedure, the final task was that of selecting the best-fit model representing the test data. In order to do this, 33 networks were tested resulting in 10 being retained as shown in Figure 9.8. Figure 9.8 shows the 10 best networks found in the selected cases. These were found to have good performance ranging form 0.913 to 1.000. Out of these networks case number 10 shown in Figure 9.8 (with a star) was found to have the most excellent performance of 1.000 and had the smallest correction classification error rate of 0.1062. Another comparative method that was used in this research to select the best-fit model is the heuristic method, and is also shown in Table 9.3. The heuristic method was employed to evaluate the mean standard error (MSE) of the training models' predictions. In using this method the model with the minimum MSE is chosen as the bet fit model. The best-fit model chosen consists of input factors accounting for 86% of the total variance of all the risk factors used to develop NHSFRES.

9.13 Knowledge base

The knowledge base for NHSFRES is represented in a separate module that consists of the knowledge and decision criteria - risk warning signs and management solutions for various FM operators (purchasers, in-house and external). This information is shown in Table 9.3. The knowledge base contains information regarding the overall FM service(s) performance and management solution about total risk exposure indices. It functions as a risk assessment technique for detecting best and poor FM service performance scenarios within the whole business process. A high negative risk exposure means that these FM service(s) can offer the highest possible business performance, and therefore needs to be managed effectively so that the FM operators achieve the greatest rewards.

Table 9.3: MPL ANN model architecture

Parameters	Value
Type of input	Bolean "binary" and continuous variables
Transfer function	Sigmoid
Network connectivity	Fully connected
Learning algorithm	Momentum
Learning rate coefficient (η)	0.1 and 0.1
Momentum coefficient (α)	0.3 and 0.3
Number of hidden layers	One hidden layer
Number of PEs in input layer	Seven PEs
Number of PEs hidden layers	12 (determined by network set editor)
Number of PEs in output	One

Similarly, low positive risk exposure means that these FM service(s) can cause less favorable service disruptions (i.e. affect the FM business process) to the operator's business, as a result need to be audited and then managed effectively, or else outsourced to an experienced FM service provider. If the FM service operator is able to classify and predict the total risk exposure of various integrated FM services using results obtained in the model base. This knowledge is then used by the FM service operator to evaluate their service and business delivery strategies with a view of monitoring and improving continuously their FM performance. The risk classification chart in Table 9.2 shows the management decision solution strategies (knowledge) about meaning of 5 risk exposure categories (between 0-1) for the domain FM services of interest and for identifying the FM service problems. This chart also functions as the reporting module and has solutions about selecting the 'best fit' management approach for the decision making process. The details of these management solutions are represented by the production rules such as; IF-THEN.

9.14 Major functions of NHSFRES

Apparently, there is no universal decision-making model available in the NHS to aid healthcare FM service operators evaluate and assess their non-clinical business risks emanating from various FM service operations and contractual arrangements.

In NHS hospital FM operations, this is done in an ad-hoc manner and is often based on individual facilities managers' interpretation and experience without a generic "industry standard" decision support and risk management system such as NHSFRES. Its decision making process has two major functions: (a) for FM risks assessment (i.e. identification and diagnosis) and, (b) for risk analysis of exposure and providing management solutions. The risk exposure analysis clarifies the overall levels of FM performance for the operators' businesses.

The solution analysis is a guide, reached on the basis of the results of risk exposure levels in various FM services being delivered to NHS customers by service operators (purchasers and providers). This approach is also used to select a management solution strategy that allows for the minimisation of business risk exposure and improves business continuity. The RII (relative importance index) technique in the development of NHSFRES has been used for both risk exposure evaluation and providing management solutions. For example, when an FM operator needs to evaluate the total risk exposure of their business operations, they would need to evaluate the total risk exposure of various FM services in order to provide management solutions that are effective.

9.15 NHSFRES Performance

The model predictive performance was assessed by examining the residual difference, i.e. the difference between the actual and the model's predicted total risk exposure of the operators' FM process. Using visual and qualitative examination of the model values, an assessment was carried out. The visual examination requires plotting of both the actual and the predicted values for all cases, and a cross examination of the differences. The quantitative examination used two relative measures of prediction performance based on the model prediction error. The two measures are the MPE and the MAPE.

The measures were calculated based on the model predicted values using the below stated formulas:

MEAN PERECENTAGE ERROR (MPE)

$$\text{MPE} = \frac{\sum_{i=1}^{n} PE_I}{n}$$

$$\text{PE}_i = \left(\frac{\chi_I - P_I}{\chi_I}\right)100$$

Where PE_i is the percentage error of FM service/element i; χ_i is actual total risk exposure for the FM business process or operation(s) *i*; p_i is the predicted value for service element *i*; and *n* the total number of FM service elements for a given contract or operation.

MAPE computation

$$\textbf{MAPE} = \frac{\sum_{i=1}^{n} (AE_I)}{n}$$

$\textbf{AE}_i = \sqrt{(x_i - p_i)^2}$ Where AE_i = absolute error of FM case/element i

The results for the performance analysis of the ANN model for FM operators are summarised in Tables 9.4. Table 9.4 shows the model predictions of 30 out of 80 FM cases randomly selected for training compared with the actual output values (total risk exposure). As shown in Table 9.4 the model prediction error ranges between 0 % to 0.8 % with a MAPE of only 11.56 %. A small MAPE derived from the model predictions signifies that the network has achieved internal validity. At this stage, the network can be regarded as having been fully trained and is fully fit for testing and validation purposes (Akinsola, 1997; Lam *et al.*, 2000; and Khosrowshahi, 1999).

When this stage has been reached in any neural network modelling problem solving, the developed model can either be recalled or validated for consistency using one of the following methods:

a) comparing with any other traditional model for performance measurement; and accuracy and;
b) seeking expert opinion and guidance regarding the practical use of the model.

Table 9.4: ANN model performance results

FM Case Number	Total risk exposure	ANN Prediction	Error	PE	APE
1	.82	0.617244	0.202	24.72633	0.202
2	.78	0.612423	0.167	21.48426	0.167
3	.80	0.651146	0.148	18.6067	0.148
97	.70	0.64	0.06	8.571429	0.06
98	.82	0.8183	0.0017	0.207317	0.0017
105	.76	0.7397	0.0203	2.671053	0.0203
111	.67	0.6427	0.0273	4.074627	0.0273
113	.68	0.6306	0.0494	7.264706	0.0494
119	.68	0.394	0.286	42.05882	0.286
137	.67	0.647	0.023	3.432836	0.023
138	.66	0.637	0.023	3.484848	0.023
141	.73	0.7298	0.0002	0.027397	0.002*
143	.68	0.679	0.00004	0.005882	0.004*
211	.68	0.6	4.416E -07	6.49E-05	4.416E –07*
217	.82	0.81997	2.554E -05	0.003115	2.554E -05
258	.76	-0.0564	0.8164	107.4211	0.8164
264	.67	0.669999	9.075E-07	0.000135	9.075E-07*
266	.68	0.679999	1.337E-06	0.000197	1.337E-06
267	.70	0.7	2.993E-07	4.28E-05	2.993E-07
271	.69	0.69	4.687E-07	6.79E-05	4.687E-07
273	.67	0.512218	0.1577824	23.54961	0.1577824
274	.66	0.56238	0.09762	14.79091	0.09762
299	.67	0.67	1.337E-07	2E-05	1.337E-07
303	.77	0.769999	6.142E-07	7.98E-05*	6.142E-07
337	.69	0.689994	6.314E-06	0.000915	6.314E-06
338	.67	0.669981	1.898E-05	0.002833	1.898E-05
339	.68	0.679989	1.142E-05	0.001679	1.142E-05
340	.68	0.679926	7.404E-05	0.010888	7.404E-05
MPE			0.1		
MAPE			11.56		

As a result of the above suggestions about validation, NHSFRES was compared with a secondary MRA model developed as a control solution.

After comparing the two models i.e. MRA and ANNs, it was pretty clear that the latter model's performance and predictability was much higher than the former. With this in mind the researcher also pursued the second approach of validation stated above. After completing the ANNs model development, the researcher sent the model back to the participants who took part in the data collection exercises. Further details about model validation are provided in the next chapter: chapter ten. In addition further detailed analysis of the ANNs against the MR model are provided in Appendix F of this thesis

9.26 Summary

This chapter has clearly demonstrated that ANNs is a useful technique that can used efficiently to develop business decision models (in this research NHSFRES) that identify, classify, evaluate, measure and predict risk exposure in healthcare FM operations. Strictly speaking, ANNs models can be used as risk evaluation and management systems for improving and benchmarking best business practices in FM services delivery (Boussabaine, 1996). The NHSFRES model developed which utilises ANN intelligence as its model base was used to evaluate the critical FM risk factors that adversely affect healthcare FM operators' business objective in the NHS. These critical risk factors were used as the database or inputs values that can be modelled to provide the facilities manager (decision maker) with a less complex and practical tool for making best value FM decision that continuously improve the delivery of non clinical services in the NHS.

The advantage of using NHSFRES is the fact that FM operators (purchasers and inhouse/external providers) can provide their own risk merit values (point score system) based on their own FM business knowledge (expertise) and corporate objectives for various FM service operations in the NHS. Comparing the ANN model used in the NHSFRES with the MR based model, was undertaken as a way to provide a benchmark for pattern-recognition capabilities and predictive abilities of ANN models. This chapter has shown that there are multivariate and complex risk factors that affect the efficient delivery of high quality non-clinical services by operators in trusts, and if not monitored properly will result in high business risk exposure.

As a result these risks affecting business continuity, healthcare facilities managers have to develop complex models that incorporate all the factors whilst maintaining the meaningful predictive consistency of the model when managing their healthcare FM businesses.

The NHSFRES therefore incorporated only the seven main risk factors that were found to be more significant without compromising the model's forecasting capability. The model performance results also show that FM risk factors faced by helathcare FM operation when delivering customer focused non-clinical service in the NHS can be quantitatively classified and predicted with more accuracy than most traditional approaches commonly used for this purpose. The systematic methodology approach used in this research provides a realistic justification and explanation for the total risk exposure value, which can be used by facilities managers as an early warning sign to show if the FM business process is being maximised or minimised (Economist Intelligence Unit, 1995). These risk warning signs can then be used by decision makers to manage the risk propensity in FM operations. A clear understanding of the risk signals and rating would mean that appropritae management course of action needs to be considered that will improve FM operators' business performance.

CHAPTER TEN

VALIDATION OF THE NHSFRES MODEL

10.1 Introduction

This chapter presents a logical methodology for validating the performance and sensitivity of the developed NHSFRES for healthcare FM operations. It also provides details of testing and analysis results of comparative quantitative methods used to validate NHSFRES. Finally, this chapter will also discuss the practical benefits that non-clinical service managers can gain from using NHSFRES in the strategic management of healthcare FM operations in the NHS.

10.2 Model Performance Validation Approach

Validation is often a prominent and critical stage in most literature/knowledge relating to education, psychology, facilities management, business management systems research experiments and findings. Apparently, although validation has been extensively discussed since the time of the early DSSs such MYCIN (Okoroh and Torrance, 1999), there is no universal definition as to what validation really means, and how it is systematically conducted. Generally, it is understood as relating to user acceptability of developed model, quality of discourse with user, maintainability, and other considerations related to the value (cost/function) and benefits of implementing the final developed model or system. Boussabaine *et al.,* (1999) and Cairn and Beech (1999) define validation as a systematic process of evaluating the practical benefits of any developed decision support system in dealing with real world business problems. This application is viewed as a means by which the developed model complies with functionality requirements or properties very much needed by the developer(s), and future users of the model in solving their domain problems.

To facilities and healthcare managers, economists and other social scientists that frequently use modelling in representing, predicting or solving various service delivery problems and relationships in business, any model developed must be validated. This must be done in order to evaluate whether the model as a decision tool is capable of producing expedient and good quality results that add value to any FM service organisation's decision-making process. Validation shows how a model (i.e. NHSFRES) is going to work and perform in FM practice. Therefore, if validation is used in the context of this research, the definition described above by Boussabaine *et al.,* (1999) may be regarded as appropriate.

However, in FM research where objectivity is sought and variance is to be avoided at all costs, validation also investigates the theoretical basis and possible shortcomings of the model in relation to its core function. In a FM sense, validation as a process shows how the business model was developed and its performance accuracy tested against the users' desired outcomes. In terms of the NHSFRES knowledge refinement, validation methods used can be categorised into two main classes that are informal and formal validation (Okoroh, 1992).

10.3 Informal validation

Informal validation as used in this research involved a long-term feedback process of communication between the researcher being the KE and various healthcare FM experts, and healthcare facilities managers who were regarded as targeted users of NHSFRES. This process has been extensively discussed in chapters four and six respectively. This process was initiated from the start of this research and continued throughout the NHSFRES model development.

10.4 Formal validation

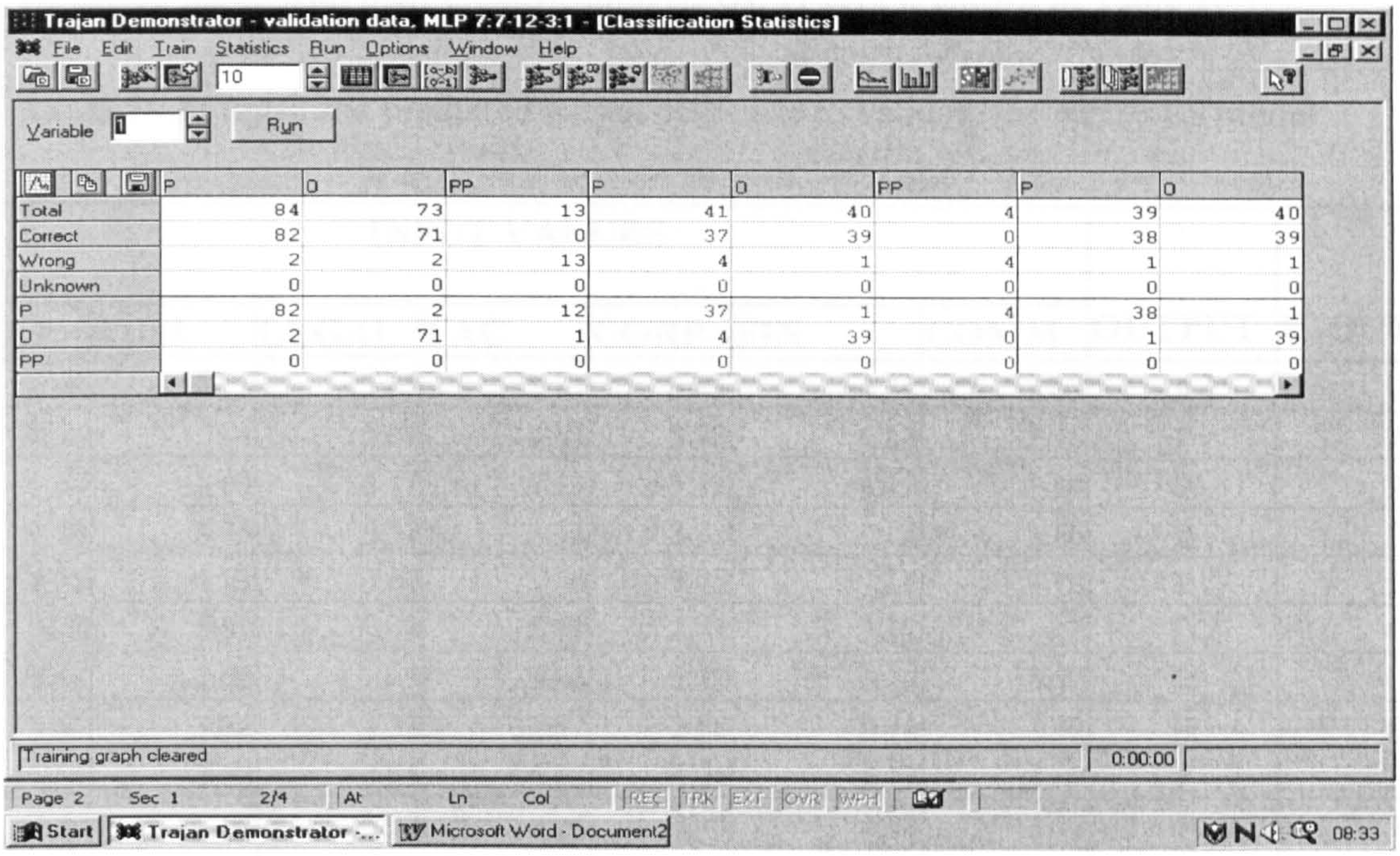
Formal validation usually starts once the proposed model has been fully designed to developers and users' satisfactory requirements. In this research, the NHSFRES was formally validated using independent data provided by 20 (10 purchasers, 5 external and 5 internal provides) healthcare FM operators. This unseen data was also earlier used in the Repertory Grid knowledge solicitation process described in chapters five. Facilities managers managing the 17 common non-clinical services surveyed in the NHS supplied the data used for formal validation. These FM services were established in the pilot study findings in chapter six. On the basis of the above approaches, the term 'validation' also refers to the overall acceptability of both recommendations and reasoning of the NHSFRES model. It should be noted that there are certain general problems associated with validating models using ANNs systems (Boussabaine, 1996; and Boussabaine *et al.*, 1999). Sometimes network models suffer from limitations in their ability to learn and to recall due to over-fitting. Thus, in this research, a comparative study has had to be undertaken to verify the accuracy and possible error elimination of the model developed.

As a result of this, a three-stage procedure was adopted for validating the NHSFRES model. The three-stage formal validation approach is one of the mostly widely used methods to validate decision models in the built environment field (Akinsola, 1997). In light of the above, Akinsola (1997), Boussabaine *et al.,* (1999) and Okoroh and Torrance (1999) developed intelligent decision models that they tested using the formal validation methodology. First, using independent or out-of-sample data, the consistency of the model performance accuracy was tested. This process was mainly undertaken to ensure that the model maintains its predictive accuracy levels on any given new set of data. In most cases if the model is properly trained, its accuracy level of prediction should be always consistent enough to either be accepted or rejected. Secondly, the proposed research hypothesis (stated in chapter three) about the effective management of FM risks in relation to the model's performance was also validated. Finally, sensitivity analysis of the model to changes in risk factors parameters or input data (i.e. between ratings of 1-5) was also carried out. This technique facilitated the use a relative importance index technique in measuring risk factors that were used to justify the predictions. This approach was adopted in order to use the decision support analysis of IF….. .THEN to arrive at various management solutions shown earlier on in Table 9.2 of chapter nine.

10.5 Validity of the NHSFRES model's consistency

As observed in the ANN analysis results in chapter nine, artificial neural network models do learn through a continuous training process undertaken to the training data set. The NHSFRES was formally validated using independent data provided by 20 (10 purchasers, 6 external and 4 internal provides) healthcare FM operators that was used in the Repertory Grid knowledge solicitation process described in chapter five. This data was collected from non-clinical service managers working for FM operators involved in managing the 17 FM services in the NHS. For an overview of the ANN model topology and architecture, chapter nine has explored these aspects in great detail.

Figure 10.1: Validation statistics for 85 FM (shown in black) cases



	P	O	PP	P	O	PP	P	O
Total	84	73	13	41	40	4	39	40
Correct	82	71	0	37	39	0	38	39
Wrong	2	2	13	4	1	4	1	1
Unknown	0	0	0	0	0	0	0	0
P	82	2	12	37	1	4	38	1
O	2	71	1	4	39	0	1	39
PP	0	0	0	0	0	0	0	0

Therefore, by testing the NHSFRES using the split training (unseen 84 cases) data reflected how well FM sub-risk variables are predicted by the proposed decision model. For this purpose, out-of-sample data (unseen data) was used for testing the model. This data had never been introduced to the NHSFRES, hence it was unseen. Figure 10.1 shows that the NHSFRES forecast reliable estimates using independent data of the training set. Furthermore, Figure 10.1 also shows that from a total of 84 FM cases used, 82 (96%) were correctly classified and 2 (2%) cases were wrongly predicted, while only 1(1%) case was omitted.

The main difference in using this approach compared to the methodology used in model development and training session is the time lapse that was allowed for data collection. Unseen data used for validating the NHSFRES was stored separately in a special coded Microsoft Excel file that was used 2 months after the development of the NHSFRES model. This was done to allow for any changes or shift in perception and opinion of non clinical service managers investigated using the relative levels of importance on the surveyed 48 critical risk factors that affected the FM business process in healthcare operations. Further summary of statistics for data set run for 85 cases used for validation is shown in Appendix E.

Furthermore, a small sample of input parameters used for in validating the NHSFRES for the 85 cases with their classification (E.OUTPUT) is shown in Table 10.1.

Table 10.1: Input and predicted output cases use to validate the NHSRES model

INPUT VALUES								
CUST	BUSI	LEGAL	FAC	CORP	FIN	COMM	OUTPUT	E. OUTPUT
4.44	4.13	3.83	3.33	3.38	4.38	3.67	P	P
4.11	4	3.67	3.67	3.38	4.13	3.56	P	P
3.67	3.63	3.17	3.33	3.13	4.13	3.44	P	P
3.78	3.75	3.33	3.33	3.13	4	3.56	P	P
4.22	4.13	3.67	4	3.25	3.5	3.78	P	P
3.78	3.88	3	3.33	2.88	3.13	3	O	O
3.67	3.63	3	3.33	3.13	3.13	3.22	O	O
3.33	3.38	3.33	3.67	2.88	4.13	3.22	O	O
4	3.88	3.5	3.33	3.25	4.13	3.67	P	P
3.89	4	3.33	4	3	4.13	3.78	P	P
4.22	4	3.83	3.67	3.5	2.75	3.78	P	P
3.56	3.63	3.67	3.67	2.63	2.63	2.89	O	O
3.33	3.5	3.33	3.67	2.88	2.88	3	O	O

It is interesting to note that out of the 85 cases tested, the overall classification rate shown in Figure 10.1 and Table 10.1 was 96% indicating a very good classification rate. Table 10.1 shows the actual tested total risk exposure (OUTPUT) compared with the predicted risk exposure (E.OUTPUT) in terms of the correct or wrong classification or learning. The E.OUTPUT is used to evaluate how knowledgeable the tested NHSFRES model has learnt, in predicting and classifying various risk exposure categories for the 85 FM services used in the validation process.

Furthermore the variance between the actual and the NHSFRES' predicted value were also calculated to determine the error associated with individual model predictions. The error range and the mean root square error was established for the whole data set to determine the NHSFRES model's accuracy and its consistency compared to the acceptable level of accuracy in the FM business operations for the model of this nature.

Table 10.2: Validation results of the NHSFRES

FM Case Number	Actual TRE	ANN prediction	Error	PE (%)	APE (%)
1.	0.68	0.328	0.352	19.76471	0.352
2.	0.66	0.596	0.064	-24.303	0.064
3.	0.61	-0.169	0.779	88.70492	0.779
4.	0.62	0.602	0.018	-35.0968	0.018
5.	0.7	0.599	0.101	-15.5714	0.101
6.	0.61	0.565	0.045	-31.623	0.045
7.	0.61	0.568	0.042	-32.1148	0.042
8.	0.56	0.55996	4.00E-05	-43.9929	4E-05
9.	0.59	0.562	0.028	-36.2542	0.028
10.	0.61	-0.2	0.81	93.78689	0.81
11.	0.7	0.457	0.243	4.714286	0.243
12.	0.61	0.474	0.136	-38.8333	0.007
13.	0.68	0.612	0.068	-16.7049	0.136
14.	0.63	0.618	0.012	-22	0.068
15.	0.62	0.597	0.023	-35.0952	0.012
		MPE	-19.51		
		MAPE	0.12		

The summary of the validation results is shown in Table 10.2. In overall, the NHSFRES' model prediction errors were less than 5% indicating that the NHSFRES performance accuracy and results was very good and acceptable. From Table 10.2 more than 95% of the of the FM services' total risk exposure were predicted with an error below 5%. The low prediction error observed in the 85 FM cases tested is a true sign of the ability of ANNs that they have been fully trained or learned in order for their predictions to be within the NHSFRES model's required accuracy. Another sign to show that the NHSFRES model's accuracy was very much acceptable; The NHSFRES model shown in Table 10.2 had an MAPE of –19.51. An MAPE of –19.51 shows that the model was now starting to over-predict due to over-training or overfitting.

This scenario is very normal with ANNs since they can sometime over-fit data sample used for testing (Boussabaine, 1996). This indicates that the NHSFRES model had a high predictive power, thus the need to reduce over-prediction can be reduced by not over-training the model. However, given the NHSFRES model results of the MAPE, according to Akinsola (1997), McCaffer (1975) and Edwards *et al.*, (2000), these results obtained during validation are within acceptable limits.

Therefore these results support the hypothesis that FM service operational risks can be predicted, quantitatively with better accuracy using AI approaches by FM operators in the NHS. To validate the integrity of the NHSFRES model's consistency further, Chi-squared statistical analysis was used. In practice if the TRE on most FM service operations can be predicted with a mean error, as observed, closer to that of the training data (see Table 10.3), then the NHSFRES model can be regarded as having learned the common characteristics of healthcare FM operations in NHS trusts. NHSFRES can then be used confidently to predict and classify various non-clinical services risk exposures faced by service operators. In order to test this proposition, the chi-squared (χ^2) was calculated by using the formula below:

$$\chi^2 = \sum \frac{Pe - Po^2}{Po} \quad \text{Where } P_o = \text{actual TRE, and } P_e = \text{predicted TRE}$$

Using the above stated equation, it can be seen in Table 10.3 that χ^2 is 440.5 and assuming a significant level 0.05 with 8 degree of freedom, χ^2 value (from statistical Table) is 1.344 (Neave, 1978). Since the calculated χ^2 is far much greater than the theoretical or tabulated value which 1.344. It can be confidentially concluded that the model is consistent and does show that there is a strong relationship between risk factors or variable used to develop the NHSFRES model. If properly managed, these multivariate risks become the critical success factors of delivering best value non-clinical service in NHS trusts.

10.6 Validity of the research hypothesis

The main hypothesis of the research was developed and explained stated in chapter three. The main hypothesis was based on the effect (negative, neutral or positive) of FM risks to the FM business process in NHS operations. The null hypothesis was formulated in relation to the research aim as follows:

H0: *Critical risk factors in healthcare FM operations are strongly correlated and therefore their business impact can be evaluated with accuracy using a prediction model.*

H1: Critical risk factors in healthcare FM operations are never correlated as a result; their business impact cannot be evaluated with accuracy using a prediction model.

Table 10.3: Chi-squared test of NHSFRES model' consistency

FM Number	Case Actual TRE	ANN prediction	$P_e - P_o$	$(P_e - P_o)^2$
1.	0.68	0.328	0.352	0.123904
2.	0.66	0.596	0.064	0.004096
3.	0.61	-0.169	0.779	0.606841
4.	0.62	0.602	0.018	0.000324
5.	0.7	0.599	0.101	0.010201
6.	0.61	0.565	0.045	0.002025
7.	0.61	0.568	0.042	0.001764
8.	0.56	0.55996	4.00E-05	1.6E-09
9.	0.59	0.562	0.028	0.000784
10.	0.61	-0.2	0.81	0.6561
11.	0.7	0.457	0.243	0.059049
12.	0.61	0.474	0.136	0.018496
13.	0.68	0.612	0.068	0.004624
14.	0.63	0.618	0.012	0.000144
15.	0.62	0.597	0.023	0.000529
	$\Sigma P_e = 52.5$			$\Sigma P_o = 5.1+6$

The NHSFRES which uses ANN as modelling technique is to a certain extent non statistical in nature, which therefore means that, in order to test the validity of this hypothesis, a Spear-man coefficient of rank correlation (r) is used. The model test results on the validation data set are shown in Table 10.4. In practice, if the NHSFRES model prediction and classification performance are accurate, then the predicted values and the actual values should be significantly correlated, that is more than zero.

Table 10.4: Research hypothesis validity test results

FM Case Number	Actual TRE	Rank	Prediction TRE	Rank	d_i	d_i^2
1.	0.68	15	0.328	11	4	16
2.	0.66	13	0.596	37	-24	576
3.	0.61	8	-0.169	2	6	36
4.	0.62	9	0.602	42	-33	1089
5.	0.7	17	0.599	40	-23	529
6.	0.61	8	0.565	25	-17	289
7.	0.61	8	0.568	27	-19	361
8.	0.56	3	0.559	22	-19	361
9.	0.59	6	0.562	24	-18	324
10.	0.61	8	-0.2	1	7	49
11.	0.7	17	0.457	12	5	25
12.	0.61	8	0.474	13	-5	25
13.	0.68	15	0.612	43	-28	784
14.	0.63	10	0.618	44	-34	1156
15.	0.62	9	0.597	38	-29	841
						d_i^2 45825

Tied (t) = $t^2 - t/85$

As a result of the chi-squared test, the null hypotheses to be tested can be expressed as follows:

Ho: $\mu_d = 0$

Ho: $\mu_d > 0$

The calculation of critical values of the Spearman coefficient of rank correlation test was carried out as follows:

$$r_s = 1 - \frac{6\sum di^2}{n(n^2-1)}$$ where d_i = difference between ranks

n = number of pair of values (85)

As calculated in the last column of Table 10.4, the value of d_i^2 is 45825 (calculated tied value is added to value d_i^2).

Therefore,

r_s= 1- 0.0921 = 0.908

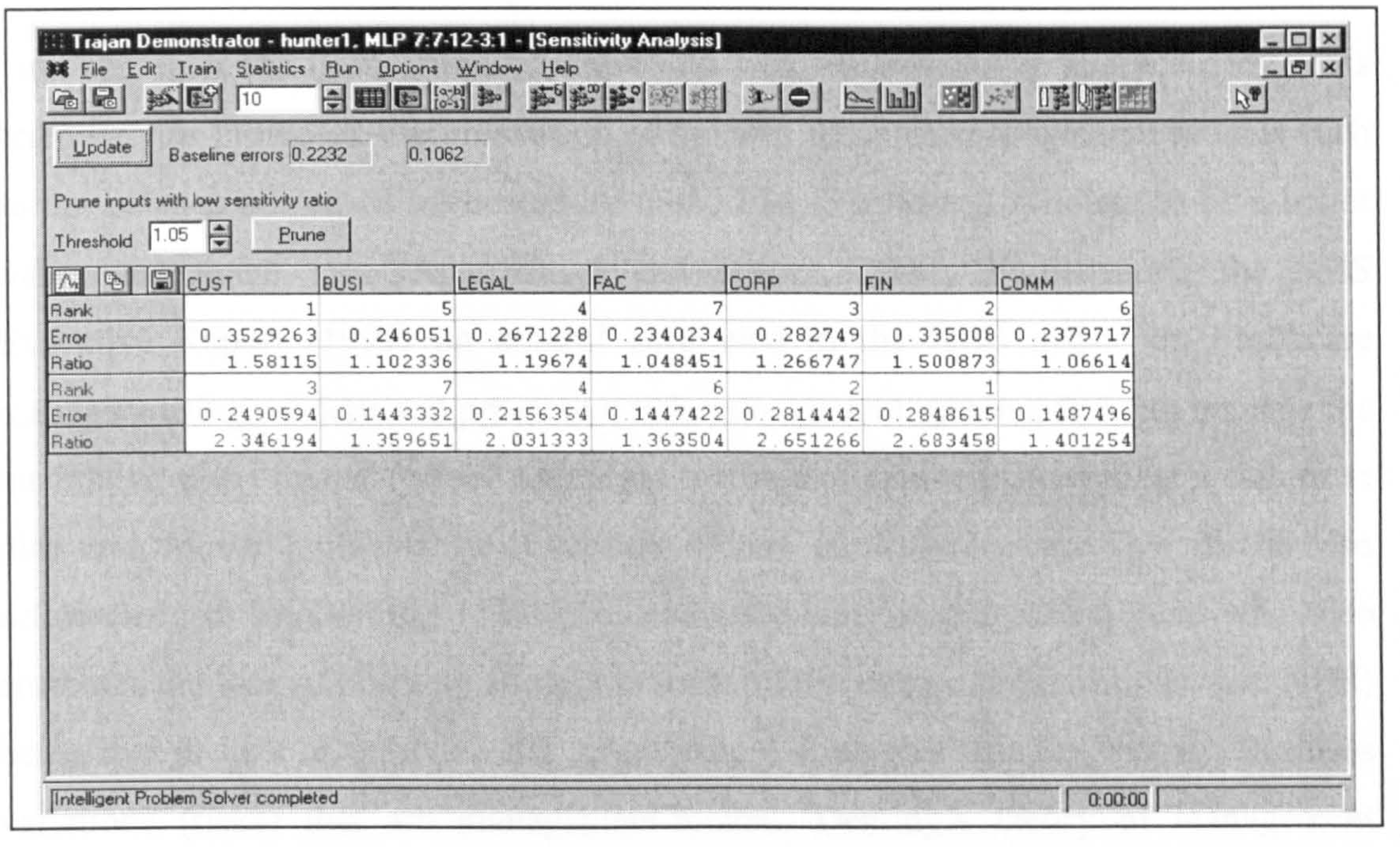
The r_s value indicates a high correlation between the two sets of ranks. To test r_s assuming a 0.05 significant level , the critical values of $r_{0.05}$ for 8 degrees of freedom is 0.382 (Akinsola, 1997). Since the calculated r_s is far much greater than the tabulated 0.382, we reject the Ho and conclude that the NHSFRES can be used as a decision support tool to evaluate total risk exposure in FM services. In addition to using the NHSFRES as decision support tool, the above results validate that the NHSFRES model can be used to predict risk factors healthcare FM operations with high significant accuracy.

10.7 Sensitivity Analysis

In order to investigate the model's response to changes in the risk input factors, a sensitivity analysis was also carried out. As a general principle, a quantitative model as a decision making tool should always be sensitive enough to detect changes in its input parameters, as those changes will determine the variability in the predicted total risk exposure in FM services managed in the NHS. To determine this variability, the first input factor (i.e. customer care risks) shown in Figure 10.2 was varied between its mean +/- 50 times the number of its standard deviation while all other input factors were held constant at their respective means. The model output was computed each time the factor was varied above or below the mean. This process was repeated for each input factors in turn (see Appendix E for the plotted graphs for each input factors showing output(s) over the range of the varied input factor). It is interesting to note that the relationship between the number of input factors and the output factors were non linear. These results go on a long to show why ANNs were used in this research to model linear relationships between input and output variables. Furthermore, using another methodology the variability was calculated by dividing each output standard deviation by the standard deviation of each risk input factor, which was, varied to create the risk exposure output. Figure 10.2 summarises these results. Having determined the standard variability, the values were converted into percentages. Figure 10.2 also shows the summary of the conversion. Figure 10.2 shows the ranking of the seven input risk factors measured and their influence on the output. For example, an error increase of 0.234 in legal risks (ranked as 4) in the FM business process will result in a 0.22 decrease in the total legal risks exposure in non-clinical services operations.

The same can be said about customer care risks that were ranked as number one, an error increase of 0.35 will result in a 0.25 decrease in error to the business process. These results can be transformed into a decision tree to explain or justify the model's predictions in terms of high or low probability of exposure.

Figure 10.2 Model sensitivity analysis



	CUST	BUSI	LEGAL	FAC	CORP	FIN	COMM
Rank	1	5	4	7	3	2	6
Error	0.3529263	0.246051	0.2671228	0.2340234	0.282749	0.335008	0.2379717
Ratio	1.58115	1.102336	1.19674	1.048451	1.266747	1.500873	1.06614
Rank	3	7	4	6	2	1	5
Error	0.2490594	0.1443332	0.2156354	0.1447422	0.2814442	0.2848615	0.1487496
Ratio	2.346194	1.359651	2.031333	1.363504	2.651266	2.683458	1.401254

In overall, Figure 10.2 shows that a continued variability of risk input factors will result in ranking changes and decreasing the error of learning with regards to the developed model. As can be seen in the Figure 10.2 the NHSFRES model is sensitive enough to take into any changes (as shown by figures written in red colours) to the input factors. The conclusion derived from this technique is that the model is accurate and can be used as business DSS for managing FM risks in the NHS.

10.8 Quality of model against traditional practice

The research defines critical FM risks as those management driven factors that have a strategic (i.e. positive, negative or a neutral) and competitive effect towards the effective management of the healthcare FM (non clinical services) business process in NHS trusts.

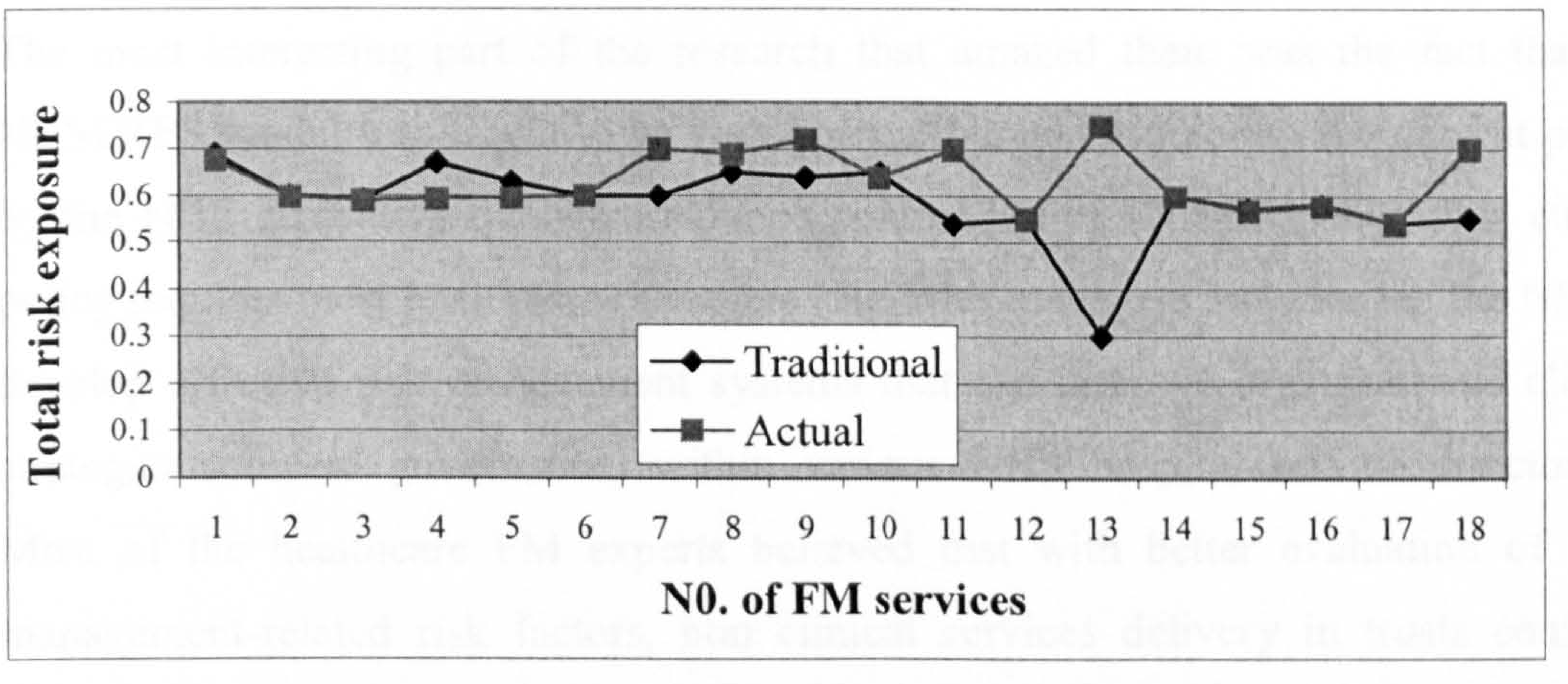
The total resultant business effect of these risk factors on various FM services managed by healthcare operators in this thesis has been defined as total business risk exposure. The traditional practice has been that of not measuring or predicting such factors but concentrated on physical FM risk factors which can be easily quantified and insured against, transferred to a third party or to a guarantor who can carry such risks.

This approach has been criticised due to its lack of consistency and accuracy. This criticism has promoted the innovation of modern business management models such as the balance scorecard advocated by many FM experts and scholars to be a better risk management tool (Amaratunga and Baldry, 2000). Furthermore, the NHS Executive Report (1999) on control assurance in the NHS insists on healthcare managers using modern and pro-active risk management systems that can manage the qualitative non clinical factors which are a result of senior management's failure to plan and deliver high quality of models of non clinical services. This fact is also acknowledged by Deming (1993), a leading quality management guru who also attributes the lack of business success in most public service organisations (i.e. NHS) being due to lack of effective risk management strategies that can manage business variations (risks) that are management-related. Deming's theory of management outlined the causes of management-related risks as being a result of the14 points relating to senior management failures established as part of the 'seven deadly diseases' (Deming, 1986). It is no doubt that that the development and use of a DSS such as the NHSFRES provides a more modern approach to classifying and predicting FM risks that are subjective to measure in the real world of business. In the past as mentioned the traditional practice has been that of ignoring the impact of such business risks completely when measuring key performance indicators that influence the management of non-clinical services effectively in the NHS.

The other approach used in the past has been to allocate a certain percentage financial cover for such risks whose impact on the business process could not be identified or quantified accurately. This approach which is not based on any systematic model or guideline related to the FM business process is flawed, unrealistic, in overall simplistic and arbitrary, and does not have any resemblance to the complexity of various FM businesses in the NHS.

It is normally based on variety of individual FM managers' expert judgement experience that in some cases might not be representative of the various FM risks faced by operators. Furthermore, the traditional approach used by most healthcare FM managers has been based on a lack of strategic and systematic guidelines of measuring such risks resulting in less predictability and accurate classification of these FM risks and their actual business impact (risk exposure). As a result of this, most FM service operators and their organisations have been subjected to a string of unmonitored and controlled business risks that continue to expose them to serious service delivery and business disruptions in the delivery of non-clinical services in trusts. The validity of these findings is the primary interest of this section.

Figure 10.3: Actual total risk exposure against traditional predictions



10.9 Domain FM experts' view of the NHSFRES model

The NHSFRES model was also scrutinised by various domain healthcare facilities managers or FM experts for its practical usage and consistency across all the 17 FM services. The results of this investigation are shown in Figure 10.3. It is interesting to note that the results of the NHSFRES model were discussed with 15 healthcare FM service operators (which consisted of 5 purchasers, 5 in-house and 5 external providers). The healthcare facilities managers who participated in this survey where the same participants who were used to provide validation data described in chapter nine, as well as five (5) well known domain FM experts who are consultants to the NHS.

It is interesting to note that Figure 10.3 shows that out of the 15 healthcare facilities managers surveyed, 13 (87%) agreed with the model's accuracy and found it very practical and interesting to use in evaluating management critical risk factors which if accurately identified or predicted and managed properly would become the critical success factors in most healthcare FM operations in the NHS. Figure 10.3 also shows that NHSFRES had a better prediction rate than the traditional approaches used by 2 (8%) other healthcare facilities managers during the survey. In addition to the 13 who agreed with the NHSFRES model, 5 (20%) FM experts also sided with the model and were also surprised to see that no such research had been undertaken before. Not only were they surprised by the fact that there was a great dearth of knowledge in this area of healthcare FM.

The most interesting part of the research that amazed them was the fact that the NHSFRES model was found to be very compatible and promoting the current policy by the NHS Executive quality assurance control policy (NAO, 1999). This current policy requires most healthcare managers (facilities managers included) in the NHS to develop effective risk management systems that can improve organisational clinical strategies (clinical governance) within various NHS hospital service directorates. Most of the healthcare FM experts believed that with better evaluation of these management-related risk factors, non clinical services delivery in trusts could be performance measured and improved to front the clinical services effectively in the NHS. At least by using the NHSFRES model in healthcare FM, most of the critical risk factors that are very difficult to identify and measure can be assessed and their risk exposure known with a view of controlling or mitigating them. Once these business risks have been identified and evaluated accurately in the pre- and post FM operational stages, healthcare facilities service operators can then use effective risk management strategies that are aimed at improving the responsiveness of non-clinical services to customers thereby reducing a service crisis in trusts. As for the other 5 (20%) FM operators who were sceptical about the model, they were surprised by the level of accuracy of the model but remained doubtful whether knowing the total risk exposure would improve the business process performance of non-clinical services in the NHS without costing all these risks. It is clear that all these healthcare facilities managers placed cost as the most important or traditional aspect of evaluating business failure in the healthcare FM operations.

However, they were in general agreement that with adequate risk management strategies FM risks can be minimised or mitigated to improve the level of business failure or exposure in various FM service operations (Alexander, 1993; and Gombera and Okoroh, 2000). Thus, Okoroh *et al.,* (2001) noted also similar results through the DRI case study they analysed earlier on at the beginning of this research. Okoroh *et al.*, noticed that if critical FM risks that influenced the non clinical business process in the NHS were properly managed, they would lead to an improve FM services delivery situation that can enhance the clinical services so demanded by NHS customers. Furthermore, in managing effectively the FM business process risk factors that affect the delivery of responsive and seamless non clinical service, healthcare facilities managers will be complying with the requirements by NHS Executive that requires every healthcare manager to implement service quality and risk management strategies across all the trust directorates in the NHS. The reservations as to the NHSFRES model's applicability however remained in those 5 FM service operators who were in disagreement about the NHSFRES.

10.10 Application of the model

The ultimate rationale for developing the NHSFRES was to develop an effective business risk management system for managing non-clinical services in the NHS.
In addition, NHSFRES can be used by non-clinical service operators to strategically manage business exposure levels of these critical FM risk factors that affect the effective delivery of non-clinical services in NHS trust hospitals. The development of the NHSFRES involved the identification of a multivariate of management-related risk factors encountered by FM service operators in the NHS using various healthcare FM qualitative data collection methods. The data collected was transformed into quantitative data by first, statistical normalisation and processing it in artificial neural networks. This process is fully described in chapter nine, section 9.3. After normalisation and processing of the critical FM risk factors, they were then modelled using an artificial intelligence tool (i.e. ANNs) to predict their business exposure levels. The development, use and properties of the ANN model to achieve the main research objectives of this thesis have already been described extensively in chapter nine.

10.11 Summary

The main research objective of developing the NHSFRES model in chapter nine was to provide healthcare FM operators with a risk management tool (NHSFRES). The NHSFRES can be used practically by healthcare FM operators to manage 'hard' and 'soft' FM services' risk exposure effectively with a view of providing best value for money on non clinical services that front the delivery of care services in the NHS. Thus, NHSFRES can assist FM service operators in establishing an acceptable the risk management process (i.e. FM risks identification, classification, measurement and control). The model can also be used in developing key decision management protocols that can be used in most healthcare FM operations that are complex, very uncertain and if uncontrolled can lead to service disruptions in the NHS. In validating the model, three very important criteria were used:

1) to test the classification and consistency of the NHSFRES model, whether it can maintain its prediction accuracy in uncertain business situations and environment such as the healthcare. This ability is very essential if the NHSFRES model is to meet the development objective.

2) to test the validity of the research hypothesis which was entirely based on the overall aim of the research.
3) sensitivity analysis of the NHSFRES model to study the relative influences of the NHSFRES model input parameters on the model prediction. This is very important for justification of the degree of business risk exposure.

The validation and test results of these criteria have proved that artificial neural network models such as the NHSFRES have a higher degree of prediction and classification accuracy in managing FM business process risks. In conclusion it an be confidently said from this research that artificial neural networks are better risk management tools compared to the traditional approaches, and therefore can be used as business decision support systems in the NHS.

CHAPTER ELEVEN

CONCLUSION AND RECOMMENDATIONS

11.1 Introduction

This chapter describes the main findings of the research. In addition, this chapter also outlines how the main research aim and objectives have been achieved throughout the development process of this thesis. In overall, this chapter describes the dynamic research methodology adopted for this research. In conclusion, this chapter highlights the main limitations of this thesis and proposes some recommendations for further research.

11.2 Research aim and objectives

The research described in this thesis set to identify, analyse and develop a risk management system that can be used by healthcare FM operators to manage effectively non-clinical services in the NHS. The overall business intelligence used in this research was that, the provision of customer-focused non-clinical service solutions will continuously add value to the delivery of seamless and responsive healthcare services in the NHS. Hence, if these services are provided on the basis of NHS customers' healthcare needs using an effective business and risk management approach stated above, these risk factors and their sub-attributes can be identified, evaluated and be best managed. Furthermore, if these critical risks were modelled to represent the full FM service development, they can then be predicted with significant accuracy and managed to become the critical success factors for delivering best value non-clinical services and allowing for business continuity. As a result of this approach, business objectives in trust hospitals can be enhanced through FM service performance. Hence, many business and healthcare facility-related risk factors that might have a potential to adversely affect, or even negate attempts of delivering best value clinical services are minimised. In healthcare business terms, effective service management in trusts by benchmarking best practices in FM will lead to an uninterrupted supply of non clinical services that front the core (clinical) business objective in NHS trusts. In the end, this business strategy will result in minimising risks associated with business disruption and the NHS corporate image of delivering cost-effective healthcare.

In hindsight, if these non-clinical risks were not managed effectively, they would have serious business process consequences on service delivery levels of support services in NHS trust hospitals. Thus, affecting the total healthcare delivery system using integrated pathways of care fronted by these support services. It was with this realisation that the research sort to contribute to the existing limited knowledge on how best to develop an effective risk management system that can be used to improve the continuous delivery of healthcare in the NHS, as proposed by many White Papers and commercial business reports (DoH, 1989; DoH, 1997; CFM, 1993; HFN 17, 1997; and HFN 18, 1998). In view of this main objective, the research has achieved successfully the following sub-objectives:

i) investigated key risk factors faced by FM service operators (purchasers, in-house and, or external providers) when providing best value FM services that underpin the delivery of responsive and seamless clinical services in NHS trust hospitals;

ii) developed a DSS that provides a systematic and objective approach to risk management of healthcare FM operations;

iii) established an acceptable risk action plan for managing effectively healthcare FM operations.

11.3 Research methodology

The approach developed in this research focused mainly on the control and reduction of potential business failures/risks arising from the strategic management healthcare FM operations. In hindsight, the research started with a detailed review of primary and secondary literature to establish the business scope of healthcare facilities and risk management in the NHS. In addition, the researcher conducted several meetings and interviews. These meetings and interviews were held with domain FM experts working within the FM and NHS sectors, both nationally and internationally. To build on more FM knowledge to the research, a best practice case study involving one of the UK's top performing NHS hospitals; the DRI hospital was chosen.

The DRI hospital, now part of the Southern Derbyshire Acute NHS Trust is currently practising an integrated FM approach. Hence, it was chosen as one of the best practice models for FM contracts delivery in the NHS. The DRI case study analysis involved the investigation of innovative service delivery approaches that had been introduced by senior management of this healthcare FM partnering contract. In addition to evaluating the innovative service practices, the DRI contract was also used for evaluating the pertinent business process risks faced by both the FM provider and the DRI hospital. The identified FM risks from the DRI case study were then used as the best practice model for benchmarking FM excellence in the NHS, for the conceptual framework and research methodology. The rest of the research was then divided into five main stages. In addition, these five stages were fully developed and discussed in chapter five, as part of the main research methodology and framework. Therefore, the five main stages used to formulate the research methodology process are listed below;

(i) extensive review of body of current knowledge in NHS FM
(ii) domain FM expert interviews
(iii) pilot and major study analysis
(iv) repertory grid knowledge analysis
(v) model development and validation

The section below will now describe these five research stages in relation to the relevant chapters of the thesis.

11.4 Chapter two – Literature review

Chapter two has provided a critical review of literature relating to the business scope and strategic relevance of managing non-clinical services in the NHS. As a result, it was identified that the non-core business objective for NHS trusts is to provide modern and comfortable healing environments for customers, as well as flexible (virtual) workplaces that front the delivery of responsive and seamless clinical services. In this chapter, it was discovered that there are various approaches used in the NHS to manage support services.

In overall, this chapter has established that an integration of management and control of support services has fast become an effective business model for delivering value for money services by healthcare executives. The use of such a business model also revealed that, it is the sole responsibility of FM executives to make strategic decisions that can reduce the rate of support and clinical services failure in most NHS hospitals. This chapter also highlighted the fact that most business models used in the NHS to deliver FM services were designed and managed around key FM stakeholders. The key players identified were, purchasers, in-house and external providers and customers (patients, staff and visitors). In overall, the delivery of non-clinical services in the NHS has been highly influenced by various government reforms such as market testing, best value for money and strategic partnership (i.e. PPP and PFI). These reforms such as strategic partnering and PPP have promoted the transferring and sharing of business risks fairly between purchasers and external providers.

11.5 Chapter three – Literature review

Chapter three examined the concept of risk management and its potential application to effective decision making in healthcare FM in the NHS. In particular, this chapter identified that the concept of risk management is a recent advent in the NHS. In addition, this chapter has identified that there are multivariate sources of FM risks that can affect the effective delivery of healthcare operations in the NHS. This chapter also explored various techniques used for risk analysis and decision making in the NHS. It was intriguing to discover in this chapter that that healthcare facilities manager used a variety of risk assessment techniques that attempt to balance the elements of risk and reward across healthcare FM operations in Trusts. In addition, examples were also used to provide support for the adoption of a FM risk management process as well as to understand the approaches used in managing FM business processes in the NHS.

11.6 Chapter four – Literature review

Chapter four provided a critical review of literature related to decision support systems (DSSs) and their potential application(s) in solving strategic and competitive non-clinical service decisions in healthcare operations. This chapter also examined the process of knowledge acquisition, implementation and development of DSSs in the NHS. Also in this chapter it was clear that DSSs have a wider application in healthcare FM operations. In particular, they can be used as aids for developing effective business and risk management strategies.

11.7 Chapter five – Research methodology

Chapter five discussed the research methodology, the scope and methods of data collection. The methodology used for this research consisted of five integrated phases already described above in section 11.3.

11.8 Chapter six – Pilot survey analysis

Chapter six discussed the results of the pilot survey analysis conducted on NHS trust hospitals in the UK that practiced an integrated FM approach. The pilot survey identified that there were problems in precisely defining what really constitutes FM in the NHS due to the overlap between clinical and non-clinical functions. In this chapter, at least 24 non-clinical services were identified as the main functions that are managed in most FM directorates in the NHS. These non-clinical services were managed using various procurement routes namely: outsourcing, insourcing and out-tasking. The pilot study results revealed that healthcare FM service operations are now considered at strategic level in most Trusts. In addition the decision making process in FM is now carried out by a multi-disciplinary team of senior healthcare managers (i.e. CEs, Estates and FM Directors) working across all NHS hospital service departments.

The pilot study also identified that some non-clinical services (e.g. estates, hotel, site and catering services) were more developed in terms of management and control than others were in the NHS. The results obtained in this chapter formed the background information to the major survey that followed in chapter seven.

11.9 Chapter seven – Major survey analysis

Chapter seven presented the results of the major questionnaire survey analysis conducted on senior facilities executives working for FM purchasers, in-house and external providers in the NHS. This chapter identified that FM purchasers and providers have different business objective in the NHS. For example, the main business objective for FM purchasers in this survey was found to be the need to deliver customer satisfaction and enhance service quality delivered. While that of commercial providers was to improve profitability and shareholder value. As for in-house providers, their objectives were similar to those of the purchasers. Hence, these FM service operators employed various risk management techniques that reflected the nature of their business operations. The major survey also identified forty-eight (48) common risk constructs faced by both providers and purchasers that had a significant (i.e. negative, positive or neutral) effect towards the effective management and delivery of FM services in the NHS.

11.10 Chapter eight – Repertory grid analysis

Chapter eight presented results of the Repertory Grid analysis of FM purchasers, in-house and external providers in the NHS. In this chapter, it was seen that FM service operators (purchasers, in-house and external providers) applied similar criteria when managing business risks associated with the delivery of effective non-clinical services that front the delivery of clinical services in the NHS. Also from the Grid Analysis, it was possible to identify the most important and least important constructs that non-clinical service managers considered when managing FM risks in healthcare operations.

The combined grids formed by aligning FM operators' grids suggested the existence of conceptual relationships between constructs used for decision-making. The relevance of construct relationships derived from combined grids is not only that they highlighted the existence of conceptual relationships between the service operators' constructs, the constructs were also found to complement each other rather than contradicting each other and thereby providing a broader insight into FM operators' decision-making processes. There was a high level of agreement between NHS facilities executives regarding the relative degree of importance attached to these criteria. The results of the PCA identified the key criteria that influence the decision making process when managing FM and business risks in healthcare operations. This chapter also brought to light the fact that, the proposed risk management model for healthcare operators based on the purchasers and providers' ideal and least preferred risk factors may be formulated by combining the groups' respective value judgements, thereby encompassing a broad based risk management process approach. This would facilitate a structured systematic, and rationale approach to the strategic management of healthcare FM business risks and decision-making system used by purchasers and providers. This chapter also confirmed that healthcare operators use similar constructs when managing business risk associated with the effective provision of high quality non-clinical services that underpin the delivery effective healthcare service in the NHS.

11.11 Chapter nine – Model development

Chapter nine described the risk management system: NHSFRES that was developed using FM data collected from the pilot survey, major survey and Repertory Grid interviews. This data was modelled using ANNs. The NHSFRES model developed utilises artificial intelligence as its model base to evaluate the critical FM risk factors that adversely affect healthcare FM operators' business objective in the NHS. This chapter clearly demonstrated that ANNs is a useful technique that can be used efficiently to develop business decision models to identify, classify, evaluate, measure and predict risk exposure in healthcare FM operations.

Thus, in healthcare management terms, ANNs models can be used as risk evaluation and management systems for improving and benchmarking best business practices in FM services delivery. These critical risk factors were used as the database or inputs values that can be modelled to provide the facilities manager (decision maker) with a less complex and practical tool for making best value FM decision that continuously improve the delivery of non clinical services in the NHS.

11.12 Chapter ten – Model validation

Chapter ten described the procedure adopted for validating the NHSFRES. The validation and test results proved that artificial neural network models such as the NHSFRES have a higher degree of prediction and classification accuracy in managing FM business process risks. This chapter also confirmed the hypothesis set out earlier in chapter three about the predictability of risks using DSSs. Therefore, it can be confidently said from this research that artificial neural networks are better risk management tools compared to the traditional approaches, and therefore can be used as business decision support systems in the NHS.

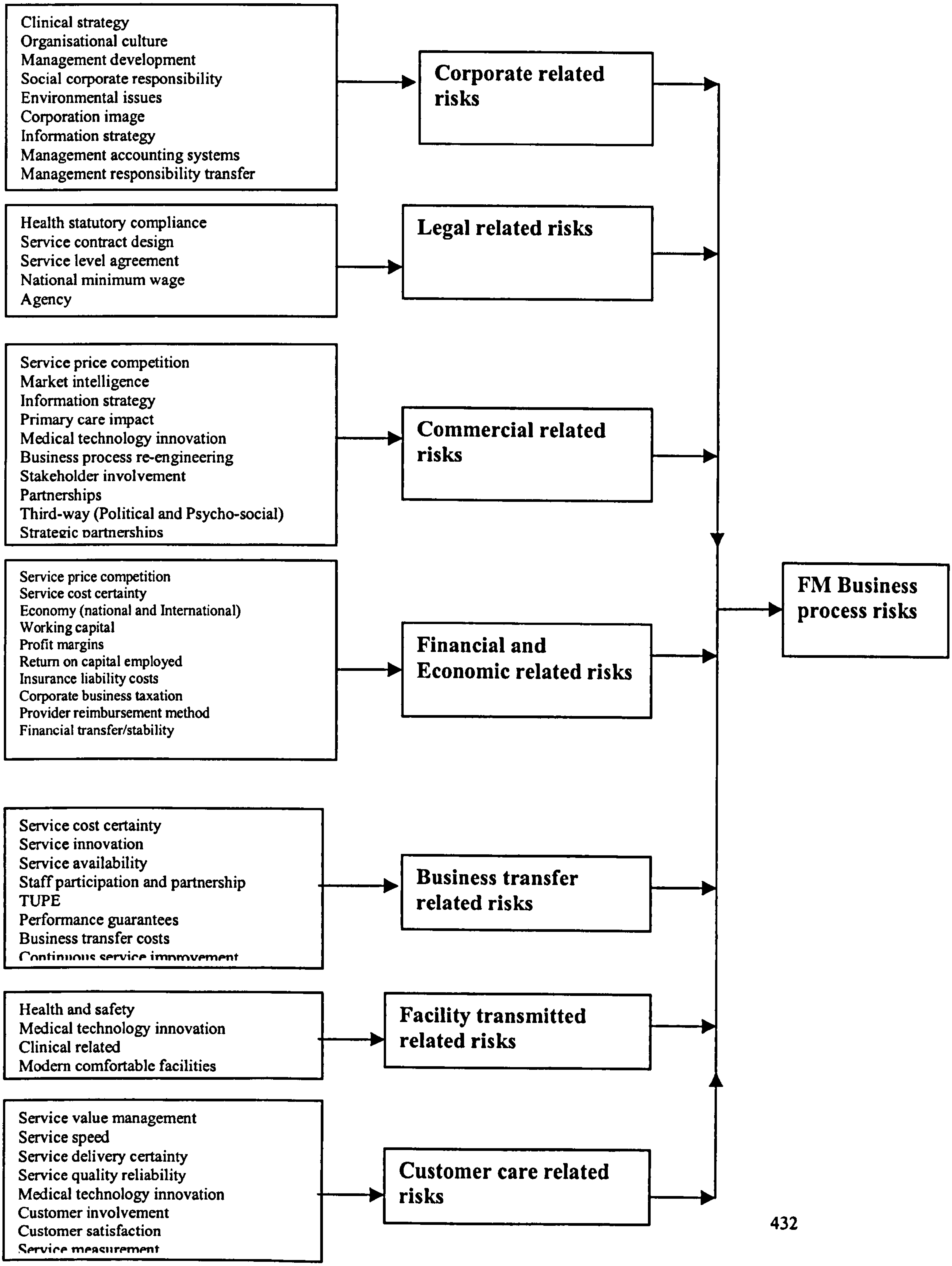
11.13 Chapter eleven – Conclusion

Chapter eleven provided the conclusion and summarises the main findings of this research. This chapter also outlines proposals for further research.

11.4 Findings of the research

This research has established that in managing healthcare operations in NHS trust hospitals; FM operators: purchasers, in-house and external providers commonly faced forty-eight (48) sub-risks which can be classified using the PCFA into seven (7) main risk factors. The seven common strategic and competitive risk factors and their sub-attributes identified to be critical in healthcare FM operations are shown in Figure 11.1, and are also briefly described below starting with;

Figure 11.1: Domain FM operations risks in NHS trust Hospitals



Customer care risks

Customer care risks in healthcare FM operations are those related to the provision of high quality healthcare service outcomes to satisfy customers' clinical needs and allow for repeat business. These risks are faced by FM service operators (providers and purchasers) in the NHS as a result of the ever changing and competitive environment in which non-clinical services are provided – FM servicescape. The FM servicecape in the NHS has necessitated that in order for FM operators to survive or be best in class, they need to deliver high quality non-clinical services solutions that deliver to customers a better value and quality/cost . In this process of delivering high quality FM service solutions to NHS customers, FM operators have had to face risks related to satisfying their customers and delivering non-clinical service strategies that enhance customer satisfaction and achieving best value money models or goals. In this research, the sub-risks that were highly rated by FM operators and classified as part of customer care risks were; *Customer satisfaction, Service delivery certainty, Customer involvement, Service quality reliability, Service value management (Best value), Service speed and Service measurement*

Legal risks

This relates to risks arising due to FM contractual liabilities and, or service operation performance relationship between providers and purchasers. The relationship ensures that a legal challenge is dealt with perfectly or may follow any non-performance or breakdown in relationship. It is therefore imperative in non-clinical service operations to have adequately designed and defined FM purchaser's service requirements that include all the service provision parameters and the contractual arrangements to be used in delivering healthcare service operations. In overall, legal risks in healthcare FM operations relate to the transfer effect of business risks related to contractual and service obligations between purchasers and providers, in order to avoid operational and contractual pitfalls.

These may include statues, risk transfer strategies, clinical governance and best practices, regulations and codes of conduct between the FM provider and purchaser. These legal aspects can be at a localised level (i.e. within hospital settings and the SHA) or at national level (i.e. NHS and Government) and also at an international level (i.e. EC) and the UN. As a result of the above, the sub-risks that were highly rated by FM operators and classified as part of legal risks were; *health statutory compliance, service contract design, service level agreement, national minimum wage and Agency.*

Facilities transmitted risks

These are risks associated with poor hospital facilities design and management standards. These hazards are mainly to do with the general standard of hygiene, cleanliness and safe use of internal hospital space for healthcare business operations by staff, patients and visitors (customers). It is therefore apparent that in the business of healthcare, excellent hospital facilities will provide customers with a comfortable, pleasing and healing environment. In hindsight, modern healthcare facilities will also contribute to the delivery of healthcare service excellence by being safe and virtual places to work in, while also allowing for future environmental sustainability. Thus, this will be seen to be reducing risks associated with the use of a hospital by NHS customers. Since then, FM purchasers and providers have become increasingly informed that a safe environment (the estate), clean surroundings, an appropriate diet (hotel services) and happy support services staff are all integral parts in the delivery of high quality healthcare (diagnosis, treatment and recovery) to customers. Therefore, the provision of a desirable environment that fosters the provision of healthcare is seen by customers as part of reducing hospital acquired infections (HAI) risks associated with the trust hospital facilities. Safe and clean facilities will help in providing customers with a comfortable environment while being flexible in use to customers' individual necessities when receiving healthcare in the NHS. In this class, the sub-risks identified as constituting facilities transmitted risks were; *Health and safety, Medical technology innovation, environmental issues, clinical related and modern comfortable facilities*

Commercial risks

These are business risks emanating from the execution of various strategic and competitive FM procurement options, transactional costs and the day-to-day management of healthcare facilities within and outside the hospital Trust environment. These risks are necessitated by the need for FM services to be delivered using business approaches that are focused at providing high quality FM solutions through market competition. FM service operators in the NHS competing for business markets are obliged, for survival and will need business intelligence about various non-clinical services performance of their competitors. This can either be done by benchmarking best FM practices or by providing healthcare service excellence to patients, staff and visitors. In so doing, this approach exposes FM service operators to various business and customer service management risks that are determined by the laws of demand and supply in the NHS. Since, the NHS now operates an internal market that requires non-clinical services to be delivered at best value, FM service operators working in NHS Trusts are now vying for a larger loyal customer base and market share, and are also willing to procure and deliver FM services competitively. As a consequence of this, FM service operators will no doubt encounter commercial risks whilst trying to define their strategic direction, fighting business competition and operational plans. The ideal service strategies that must be implemented should commercially match the customer and market demand for healthcare with the available non-clinical resources – human, financial and physical assets. Usually FM services have to be competitively procured and delivered at best value to the customer at a commercial risk premium. Hence, the sub-risks that were highly rated by FM purchasers, in-house and external providers in healthcare operations as part of commercial risks were; *service price competition, market intelligence, information strategy, primary care impact, medical technology innovation, business process re-engineering, stakeholder involvement, partnerships, third-way (Political and Psycho-social) and strategic partnerships.*

Financial and Economic risks

This relates to risks arising from economies of scale through the investment of finance or working capital tied into the management of healthcare facilities by either the FM provider or the purchaser to meet the clinical business objectives. The increasing role of business approaches that are being pursued to manage clinical and non-clinical service outcomes in the NHS and UK economy require huge capital outlay and cashflow for them to be carried out efficiently. Therefore, FM service operators' financial performance measures define the long/short term objectives of FM businesses and indicate whether the strategy, implementation and execution are contributing to bottom-line improvement. The management of resources especially in healthcare FM operations represents a substantial financial investment for trust hospitals in managing of modern comfortable and healing environs. These need to be serviced at all business times in order for them to support the core business (i.e. to provide responsive healthcare services) objectives of the purchaser or else risk service disruption and failures in the NHS. In view of the current situation in the NHS regarding the effective modernisation (privatisation and public management) of healthcare FM operations, a good cashflow outlay to finance such capital-intensive operations is essential on the part of purchasers. Hence, financial stability of both the purchaser and provider is an essential element of effective healthcare FM businesses and ensuring that the business of delivering non-clinical services by providers on behalf of the purchaser does not fail (business continuity/success).

Given that the NHS is heavily under-funded for major technological and capital intensive projects, trust hospitals have found themselves with no financial resources option except to bring in private sector participation using three pathways; the first directed to estates, site services and hotel investment decisions, the second to the management of property assets, and the third to the management of facility operating costs, all within the context of the property market, which tends to be the most illiquid vehicle for investment.

Under this class, the sub-risks identified by FM operators to constitute financial and economic risks were; *service price competition, service cost certainty, economy (national and International), working capital, profit margins, return on capital employed, insurance liability costs, corporate business taxation, provider reimbursement method and financial transfer/stability*

Business transfer risks

This relates to business risks arising from the transfer in management of part, or all (integrated) non-clinical services by the FM purchaser to service operators (external and in-house) through market competition and partnerships. This is normally due to perceived advantages to the transferred organisation and staff in form of business process re-engineering and healthcare service delivery enhancement that is associated with entering the commercial market to achieve best value for money. In light of the above, commercial providers are of course accustomed to facing new business challenges posed by legislation and regulation in the NHS. Business transfer risks are thus also associated with the transfer of support service resources - FM staff, physical and financial assets to the new service provider who will no doubt be affected by TUPE. In light of the above, the sub-risks identified that were highly rated by FM operators and classified as part of business transfer risks were; *service cost certainty, service innovation, service availability, Staff participation and partnership, TUPE, performance guarantees, business transfer costs and continuous service improvement.*

Corporate risks

These are strategic and competitive risks associated with FM operators meeting their core (clinical) business objectives. These business objectives can either be short-term or on a long-term basis. These risks also encompass corporate and clinical governance, statutory services, the service organisational culture, the operating environment, vision, values, beliefs and the welfare of its staff and customers in meeting the clinical business objectives.

Under this class, the sub-risks identified as part of this class were; *clinical strategy, organisational culture, management development, social corporate responsibility, environmental issues, corporation image, information strategy, management accounting systems and management responsibility transfer.*

Further evaluation of the key seven risk factors and forty-eight sub-risks faced by FM operators investigated in this research demonstrated that they had different levels of relative importance to the FM business process in the NHS. As part of development a DSS, the level of importance for each risk factor and their sub-risks were transformed in terms of business consequences (as either being negative, neutral or positive) to FM operations in the NHS. Furthermore, the key risk factors were also modelled using ANNs to develop NHSFRES (see Figure 11.1). As was fully described in chapter nine of this thesis, NHSFRES is a best practice model for managing key FM risks faced by FM service operators in the NHS. These FM risks identified in this study were regarded as critical as they can adversely affect the surveyed NHS hospitals' ability to achieve their core business objectives of providing healthcare services at best value in the UK. Furthermore, if these critical risk factors were continuously managed effectively they would become the critical success factors that would enable FM NHS hospitals to execute their clinical service strategies successfully. On the other hand, if these business risks were unmanaged systematically, they would expose the entire NHS hospital service organisation to serious FM business consequences and customer service disruptions in the NHS. The NHSFRES also developed as a DSS improves both the consistency and objectivity of controlling and predicting such qualitative risk factors in order for healthcare facilities managers to make effective business decisions that enhance service delivery levels and agility. By using linguistic variables that are converted to symbolic expressions, healthcare facilities managers as decision makers can assess the business impact of those FM risks faced in managing non-clinical services effectively. This is particularly important in healthcare FM operations where such linguistic and symbolic expressions can be used to provide simple management solutions, as well as in other hospital departments.

In addition, the management solutions obtained using NHSFRES are the result of social interaction between experienced healthcare facilities managers (multiple healthcare FM experts) who are able to use their expertise to implement a common risk management strategy used in the NHS. In such a situation, NHSFRES ensures that business decisions relating the effective delivery of seamless and responsive non-clinical services in the NHS are made effectively using this systematic approach. Therefore, NHSFRES developed in this research functions as a business management tool that can be used by FM operators to manage and enhance FM operations effectively in the NHS.

11.15 Conclusion

The non-core business objective for trust hospitals in the UK is to provide modern and comfortable healing environments through their FM directorates to NHS customers requiring clinical services. In addition to providing integrated FM support services, NHS hospitals also provide flexible (virtual) workplace environment to NHS staff and other service providers that manage the provision of responsive and seamless clinical services. The need to achieve the above stated goals (manage FM services) economically has meant that healthcare FM operations now have a strategic value in the business planning and delivery of clinical services in the NHS. This is in comparison to the past where they were considered as "backroom" services with no corporate or strategic value. The strategic worth attached to non-clinical services today in the NHS has meant that, there is a clear need for FM service operators to identify and or, effectively manage key performance risks associated with the management of such complex service transactions using an integrated FM services approach.

It has become apparent through extensive literature review in this research that FM service operators are now focused heavily on providing customer-focused facilities solutions that add value to the healthcare service process chain. Furthermore, today where healthcare services are provided 24-hours a day in the UK, the management of FM operations involve highly qualitative and subjective management risk factors.

Quite often healthcare facilities managers as decision-makers tend to use multivariate factors and sub-attributes/constructs to evaluate the total influence of such factors on the FM service delivery process. Hence, precise prediction of how each key risk factor will affect the NHS trust's FM service delivery (business process) strategy by means of an absolute value without a high quality business management system is too fuzzy and complicated.

The research has also evidently demonstrated through extensive literature, detailed surveys analysis of healthcare FM operations and through personal interviews with facilities managers and experts working in the NHS, that FM service delivery processes are influenced by a multivariate of classical management/qualitative-related risk factors. As a result of such service delivery scenario in the NHS, FM services operators continuously and commonly face forty-eight (48) key business risks that can be classified into seven main risk classes. These FM risk factors are usually very complex to manage or mitigate as they are highly qualitative (based on FM managers' opinions) and subjective. Hence, these key FM business risks more often than usual, have an adverse effect on support services delivered and business continuity in the NHS. As identified in chapters one and two respectively of this thesis, the non-core business objective of NHS trust hospitals is to provide responsive and seamless support service to customers through out the UK. Using an integrated business management approach proposed in this research to develop a FM service excellence model, it can be concluded that, effective risk management of non-clinical services can be achieved in NHS trusts by benchmarking best practices in healthcare operations. This process if managed effectively will further lead to an uninterrupted provision of non-clinical services that support the core (clinical) business objective in NHS trusts. Furthermore, this strategy as demonstrated in chapters two and three respectively, can result in minimising critical risks associated with clinical business disruption and the NHS corporate image of delivering cost-effective FM services.

Therefore, in order to manage effectively healthcare FM services in NHS trust hospitals, FM operators can develop a strategic and competitive model of managing FM risks by investigating the following quintessential issues identified below in various chapters of this thesis;

(i) a clear understanding of the business scope (strategic intent) of FM in healthcare service operations in the NHS trust hospitals: – as described in chapters two, three and six;

(ii) a comprehensive knowledge of the sources and nature of critical business risk factors in healthcare operations that causes service level (performance) variations in delivering value adding non-clinical services in the NHS:- chapters three and seven;

(iii) a clear understanding of the complex relationship and measurement of critical risk factors that affect the healthcare FM operations using business information tools that can be used as a DSS:- chapter four, seven and eight;

(iv) a proper classification of these FM risks into their respective membership classes and; a quantification model for evaluating the perceived importance (impact) of the identified critical FM risk factors: - chapters three and eight, and

(v) an analysis and management of the effects of these risks towards the effective delivery of clinical (core) services and business decision making in the NHS using domain FM experts' knowledge:– chapter eight.

Chapters nine and ten respectively, have fully described the development and testing of NHSFRES; a novel risk management system for managing strategic and competitive healthcare FM risks in the NHS.

Furthermore, NHSFRES provides an integrated decision support evaluation and risk management system for predicting and managing the pertinent FM business risks faced by FM service operators and their business risk exposure levels. The NHSFRES model therefore improves both consistency and objectivity of controlling and predicting such qualitative management-related risk factors in order for healthcare facilities managers to usher effective FM business decisions that enhance service delivery levels and agility. This process ensures that NHS FM decisions relating the effective delivery of seamless and responsive non-clinical services in the NHS are made using a systematic approach as opposed to an ad hoc manner identified in the research to be the norm. Decision-making relating to healthcare FM operations reached in an ad-hoc has been noted in this study to lack precise service level specification and often results in poor service response times as well as business risk exposure in a highly politically sensitive sector such as the healthcare. The NHSFRES functions as a practical and strategic business decision management tool that can be utilised by healthcare FM operators to evaluate the total risk exposure levels in a single or multi-FM service process that front clinical (core) services in NHS trusts. This evaluation is facilitated by non-clinical services managers using everyday qualitative (simple linguistic and symbolic) expressions to measure and value strategic FM risks, thereby providing best value management solutions processed via an intelligent (neural network) system. The developed NHSFRES model therefore explicitly clarifies thinking about healthcare FM decision-making and the management of uncertainty in healthcare support services operations. In particular, it focuses attention on the principal risk factors and sub-risks correlations influencing the management of the FM business process in healthcare operations.

As a result of the validation process performed on the NHSFRES model, it can be confidently concluded that, NHSFRES can be used as a business DSS. Furthermore, since it is the only intelligent risk management system of its kind ever to be developed in healthcare FM operations, it is therefore a novel business improvement tool for modelling FM decisions that improve the delivery of high quality support services to customers in the NHS. In overall, NHSFRES provides several novel and valued benefits to FM service operators (purchasers and providers).

These benefits can be listed as follows:

i) It provides both an objective and consistent decision making process that can be used to competitively and efficiently aid healthcare facilities managers to make best value decisions regarding the management of the FM business in the NHS;

ii) It integrates varied sources of information and knowledge from various healthcare FM stakeholders (domain FM experts, customers, providers and purchasers) who are involved in the demand and supply chain, to manage the critical and common risks faced when providing non-clinical services in the NHS;

iii) The NHSFRES functions as a performance management system providing FM service operators with those key performance indicators (critical risk factors) and their relationships that, if managed effectively in their business healthcare processes would become the critical success factors;

iv) This approach also allows FM operators to have contingency business or recovery plans in cases of service delivery failures in order to improve customer care or repeat business;

v) It also allows FM operators to establish an acceptable risk strategy and levels of exposure that are acceptable for the measurement, monitoring, evaluation and reporting of performance risks in healthcare FM operations;

vi) Using artificial neural networks as a business modelling tool, NHSFRES facilitates FM service operators to accurately identify, classify, predict, prioritise and manage critical FM risks faced in the managing different healthcare FM operations with varying business complexity;

vii) ANN modelling also facilitates for a complete and holistic decision making process for managing FM risks in NHS trusts using acceptable risk management strategies (i.e. probabilistic) familiar to most healthcare and facilities managers and further enhancing them with novel knowledge based on artificial reasoning (i.e. IF ....THEN approach); and

viii) By using NHSFRES, FM service operators are capable of simplifying complex service delivery problems using popular and practical qualitative business approaches (postal surveys and repertory grid interviews) that can be transformed by use of a quantitative approach (artificial neural networks) to provide appropriate service solutions.

11.16 Further research

Hindsight is wise, with the knowledge and experience gained from completing this thesis it probably would not be undertaken in exactly the same way if it were to be planned today. Over the years it has taken to complete the research, the business scope and the strategic management of FM in healthcare service operations has continued to change with new knowledge on macro business environmental factors concerning central government policy and legislation (contractual arrangements) that have been introduced in the UK NHS. These new procurement/contractual regimes have tended to favour the transfer and management risk fairly and squarely among all the FM stakeholders (Okoroh *et al.,* 1998). For instance, the current modernisation reforms introduced in the NHS such as MPCs as well as the Best Value Concept, immediately followed by the PFI and PPP are all new business models still in their infancy stage of use. These service provision models will continue to affect and bring business uncertainty in the delivery of healthcare services in the NHS. In this context, further research will have to be carried out to investigate the new set of risk factors regarding the financial management of such contractual arrangements. As these strategic service delivery options present new business transactional costs and supply chain relationships in healthcare FM directorates, further research will also have to be considered in relation to outsourcing of healthcare FM operations to third parties (TUPE) in the NHS.

Whilst on the same point, the new Construction Act (2000) ought to be investigated in relation to how it affects healthcare FM operations and the management of business risks in the NHS. This Act has introduced new set of guidelines and legislation regarding the outsourcing of construction and FM operations. In addition, the UK healthcare FM sector continues to develop considerably from its embryonic state. Understandably, this research does not and ought not end with the writing of this thesis. Many research objectives raised in this thesis have been explored and answered by the investigation presented in this thesis. Furthermore, there is still an on-going problem relating to the lack of research information on some clinical operations risks that have a major influence on the FM business process. This research has only identified critical FM risks without the consideration key operational risk factors and the overlap between clinical and non-clinical functions that can occur when using a MPCs approach for delivering healthcare services in the NHS.

Clinical risks that have an influence on the effective management of support services in this research although indirectly investigated are beyond the scope of this study. Therefore, further research to identify in detail all the clinical risks faced by FM service operators in the NHS will need to be undertaken. The following suggestions for further research are not exhaustive, but do represent some ideas that immediately present themselves. Further research is still needed to uncover in more depth and with greater clarity the environmental behaviour and decision-making process of FM service operators in relation to the management of business risks in the NHS. There is still more to learn and understand about how and why FM service operators manage business risks and make their decision protocols in the way they do in the NHS. The research presented in this thesis contributes an understanding, but this is not finite. To begin with, there is a need for further research to identify FM risks using other comparative quantitative or traditional techniques in order to evaluate the quality of the results for this research. In this research, questionnaire surveys and the RGT were primarily used to gather risk knowledge from senior non-clinical managers (domain NHS FM experts) working in the NHS.

Since the risk knowledge collected for the research was qualitative data that is often very subjective, it had to be transformed into quantitative or statistical data that can be easily analysed and modelled. Respecting the contribution a qualitative investigation can make in the understanding of the FM risk factor relationships, there is also a considerable need for improvement in the measurement and collation of quantitative healthcare FM risk factors to develop a better predicting risk management system that can be validated with scientific accuracy. The aspect of accuracy is very important when considering that there might be further need to compare and contrast, and repeat research results obtained in future. It would be interesting to see how these factors can be measured using a quantitative tool that uses financial values or loss (i.e. attaching a cost benefit) incurred as a result of the effective management of the common seventeen FM services in the NHS. This approach would suit those FM experts evaluated earlier on in chapter ten as part of the validation process. These FM experts stated that the developed FM model could have been improved by using the financial utility theory to represent the monetary value (profit or loss) of business exposure levels. The comments above do indicate that further research needs to be done on risk costing. Finally, further research, which could be conducted in relation to the development of an integrated DSS, can be identified as follows:

i) NHSFRES needs further development using other quantitative techniques (listed in section 4.9) using a much larger sample of FM service operators (providers and purchasers) and testing on a number of case study data.

ii) NHSFRES model needs to be fully integrated with the knowledge base and further developed into a more user-friendly software (with a professional user interface/environment i.e. JAVA, Prolog, C++, Visual basic and other Windows programme environments).

iii) Further analysis of research findings can be made in comparison to other sectors such the UK private healthcare hospitals and public sectors such as the HMSO Prisons.

This will be done with a view of benchmarking the best practice of managing healthcare support service operations in the NHS.

The nature of this research reported in this thesis is said to be analytical and can serve as a proposition or hypotheses on issues raised above, to be tested for future research. However, although exhaustive the research has satisfied the main aims and objectives for which it was meant to investigate.

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APPENDIX A

PILOT SURVEY QUESTIONNAIRE

Please tick ☑ as appropriate *Thank you.*

1. ***What is your job title?:**..*

2. ***How many years of experience do you have in healthcare services management?***

   0-2 ☐ 2-5 ☐ 5-10 ☐ 10-20 ☐ above 20 years ☐

3. ***What are the core or main clinical services offered by your hospital trust***

Type of clinical services provided	
Acute services	☐
Acute and Community services	☐
Teaching hospital services	☐
Community/Mental hospital services	☐
Integrated Acute services	☐
Others; Please state	

5. ***Which department in your organisation is responsible for the procurement and management of building and support/non clinical services?***

Name of Directorate	
Facilities Management	☐
Support Services Management	☐
Non-Core Services Management	☐
Hotel Services Management	☐
Estates Management	☐
Others: Please State	☐

6. ***Who in your organisation is the most senior manager responsible for the procurement and management of building and support/non-clinical services? Please state below, and if possible please provide your organisation chart to reflect his position.***

....

....

7. ***What is the annual operating budget for your organisation? Please state below:***

£ 250,000 – 500,000	☐
£ 500,000 – 1,500,000	☐
£ 1,500,000 – 2,500,000	☐
£ 2,500,000 – 5,000,000	☐
£ 5,000,000 +	☐
Other Please state below:	

8. ***What is the annual operating budget for the department you ticked in question 5, above?***

£ 250,000 – 500,000 ☐
£ 500,000 – 1,500,000 ☐
£ 1,500,000 – 2,500,000 ☐
£ 2,500,000 – 5,000,000 ☐
£ 5,000,000 + ☐
Other Please state below:

9. ***Please state the type of service provision arrangement that your organisation uses to manage the following support services. Please provide percentages for those services***

FM Function	***Outsourced Percentage %***	***In-house Percentage %***
Gardens and Grounds		
Estate Management		
Hotel & catering		
Mechanical & Elect		
Domestic		
Risk Management		
Building Services		
Waste management		
Total FM		
Energy management		
Car parking		
Healthy and Safety		
Reprographic		
IT & Telcomms		
Cleaning		
Portering & security		
Pathology & X-ray services		
EBME & medical equipment		
Courier and lock smith		
Low dependency patient care		
Patient transport		
Specialist support		
Police force		
Others: Please state below		

12. What type of contractual procurement system is used by your organisation to manage the service stated above in 11?

Type of procurement route	***Please tick***
Traditional contracting	❑
Partnering	❑
CCT	❑
Joint ventures	❑
Partnerships	❑
Private Finance Initiative	❑
Service Level Agreements	❑
Other, Please state	

If you believe that any key issues have been inadequately covered by this questionnaire, please specify so, in the space provided:

....

....

....

Thank you for taking the time in completing the questionnaire. Please send once completed in the stamped, addressed envelope provided to:

Mr Peter Gombera
Doctoral Researcher,
Built Environment Research Group
School of Engineering and the Built Environment,
University of Derby.,
Keddleston Road Street,
Derby
DE22 1GB.

Tel: 01332 622798 (switch board)

01332 591796 (direct line)

fax: 01332 622739

APPENDIX B

FM PURCHASERS, IN-HOUSE AND EXTERNAL PROVIDERS' QUESTIONNAIRES

Risk Management in Healthcare Facilities Management Partnerships

1998 FM Service Purchasers Risk Management Survey

All responses will be treated in strict confidence

This study is being conducted by

DR. MI OKOROH &

PETER GOMBERA, to

develop a business decision support and risk management system for healthcare FM operations

Risk Management in Healthcare Facilities Management Partnerships

1998 FM Service External Providers' Risk Management Survey

All responses will be treated in strict confidence

This study is being conducted by

DR. MI OKOROH &

PETER GOMBERA, to

develop a business decision support and risk management system for healthcare FM partnerships

Risk Management in Healthcare Facilities Management Partnerships

1998 FM Service In-house Providers' Risk Management Survey

All responses will be treated in strict confidence

This study is being conducted by

DR. MI OKOROH &

PETER GOMBERA, to

develop a business decision support and risk management system for healthcare FM partnerships

UNIVERSITY of DERBY

APPENDIX C

FM GRID RESULTS ANALYSIS

```
GRIDSCAL - A Package for Analysing Multiple Repertory
Grid Data.

          written by Richard C. Bell
          School of Behavioural Science
          University of Melbourne, Parkville, Victoria
          3052 Australia.

          phone :    61 (0)3 9344 6364
          fax   :    61 (0)3 9347 6618
          e-mail: rcbell@rubens.its.unimelb.edu.au


          Version 1.0   August 1998

     Title for this run: PURCHASERGRID ANALYSIS

     Data Read in from file: C:\PETER_~1\PUR2.TXT
     under format: *

     Grid  Constructs Elements
      ~~~~~~~~~~~~~~~~~~~~~~~~~
        1       30       17
        2       30       17
        3       30       17
        4       30       17
        5       30       17
        6       30       17
        7       30       17
        8       30       17
        9       30       17
       10       30       17
 ** dimensions of first 10 grids only listed **

      Max Dimensions: Grids  Constructs  Elements
                        18        48          17

 ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
 ~~~~~~~~~~~~~
  Individual Differences Multidimensional Scaling based on
  the Schonemann (1972) algorithm for the Horan (1969)
 Model.

  Ref: Schonemann, James & Carter (1979) Ch 33 in Lingoes,
  Roskam, & Borg (Eds) Geometric representations of
 Relational Data.Ann Arbor MI: Mathesis Press

     Analysis Options:
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      Scaling of Constructs
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Replicated across Elements
Weighted by Grids

Measures of Association: Euclidean Distances
Re-Scaling of Association Matrices: No Re-Scaling

Heading : PURCHASERGRID2

Average Grid
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Mean Ratings [Rows are Constructs, Cols are Elements]

	1	2	3	4	5	6	7	8	9	10
1	3.89	3.89	3.22	2.44	2.56	2.89	3.11	3.89	3.33	2.89
2	5.22	5.00	4.56	4.17	4.06	3.50	3.22	4.89	4.56	4.22
3	4.44	4.56	4.00	4.11	4.11	3.00	3.00	5.00	3.56	4.44
4	4.28	4.44	4.44	3.44	3.44	3.89	3.44	5.00	3.44	5.00
5	5.00	5.00	4.56	4.44	4.00	4.56	4.00	5.00	4.11	4.56
6	4.56	4.56	4.11	4.56	4.00	4.00	3.56	4.67	4.17	4.00
7	4.44	4.44	4.61	4.00	4.11	4.11	3.44	4.17	4.00	4.44
8	4.44	4.56	4.33	3.56	3.72	3.61	3.56	4.00	4.00	4.56
9	3.83	4.00	3.67	3.44	3.44	3.17	3.22	4.00	4.00	4.00
10	3.56	3.56	3.44	3.44	3.44	3.17	3.00	3.56	3.56	3.44
11	3.89	3.89	3.72	3.28	3.28	3.11	3.11	3.89	3.44	3.28
12	5.00	4.89	5.00	4.44	4.33	4.22	4.22	5.00	4.44	4.44
13	4.33	4.28	4.33	4.22	4.06	3.89	4.22	4.44	4.33	4.56
14	3.22	3.39	3.00	3.06	3.06	3.06	3.56	3.50	3.22	3.56
15	3.44	3.44	3.11	3.00	3.00	3.44	3.44	3.61	3.44	3.00
16	4.44	4.44	4.44	3.44	3.44	4.00	4.00	4.44	4.44	3.89
17	4.78	4.33	4.22	3.89	3.89	3.44	3.56	4.22	4.44	4.89
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18	4.22	3.67	3.39	3.39	3.39	2.83	3.00	3.50	3.83	3.94
19	3.56	3.56	3.39	3.00	3.00	3.00	3.00	3.56	3.56	3.00
20	3.11	2.78	2.89	3.00	2.89	2.89	3.00	2.78	3.00	3.00
21	3.61	3.11	3.28	3.44	3.28	2.83	3.00	3.56	3.44	3.00
22	4.44	4.44	4.00	4.00	4.00	3.44	3.44	5.00	4.44	3.89
23	4.56	4.67	4.00	3.89	3.44	3.56	3.56	4.56	4.11	4.00
24	3.67	3.83	3.56	3.39	2.72	2.89	2.89	3.56	3.00	2.83
25	4.06	3.61	3.44	3.44	2.83	2.83	2.83	3.89	3.44	3.44
	4.11	3.56	3.56	3.56	3.00	3.00	3.00	4.11	3.56	3.56
27	2.67	2.56	2.56	2.56	2.67	2.56	2.56	2.78	2.56	2.56
28	3.50	3.33	3.33	2.44	2.61	2.00	2.00	3.22	2.44	2.44
29	4.56	4.56	4.56	3.00	3.44	2.89	3.33	4.00	3.44	3.44
30	3.56	3.56	3.00	2.44	3.11	3.11	4.11	3.56	3.11	3.00

	11	12	13	14	15	16	17
1	3.00	3.11	3.00	2.89	3.11	3.00	3.22
2	4.17	4.39	4.22	3.89	4.39	4.11	4.72
3	4.00	3.78	4.11	3.78	3.78	3.78	4.33
4	4.11	3.78	4.33	3.78	3.78	3.78	3.78
5	4.28	4.67	4.56	4.56	4.56	4.67	4.56
6	4.17	4.28	4.11	4.00	4.00	4.17	4.11
7	4.00	4.06	4.22	3.89	3.89	3.89	4.22
8	4.00	3.67	4.11	3.56	3.67	3.56	4.11
9	4.00	3.33	3.00	3.00	3.33	3.00	3.11
10	3.33	3.78	3.11	3.11	3.67	3.11	3.28
11	3.11	3.89	3.56	3.56	3.56	3.56	3.56
12	4.44	4.67	4.11	4.11	4.11	4.11	4.11
13	4.44	3.89	4.11	4.11	3.89	3.89	3.89
14	3.28	3.11	3.44	3.33	3.22	3.22	3.22
15	2.83	2.94	2.94	2.78	3.11	3.11	3.11
16	3.89	3.33	3.33	3.33	3.33	3.33	3.44
17	4.00	3.56	3.56	3.56	3.56	3.56	3.89
18	2.83	3.00	3.00	3.00	3.00	3.00	3.56
19	3.00	3.00	3.00	3.00	3.00	3.00	3.00
20	2.78	3.00	3.11	3.00	3.11	3.11	3.11
21	2.67	3.00	3.56	3.22	3.44	3.56	3.67
22	3.89	3.17	4.22	3.67	3.89	4.22	4.39

23	4.00	3.67	4.11	4.11	3.56	4.11	4.00
24	2.72	3.17	3.00	3.00	3.00	3.00	2.83
25	2.83	3.00	3.00	3.00	3.17	3.00	3.00
26	3.00	2.78	2.89	2.89	3.44	2.89	2.89
27	2.11	2.33	2.67	2.78	2.56	2.89	2.67
28	1.89	2.00	2.56	2.56	2.22	2.72	2.56
29	3.44	3.22	3.22	2.67	2.67	2.67	3.22
30	3.11	3.00	3.11	3.11	3.00	3.11	3.00

Construct Statistics
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[Across both Elements & Grids]

Construct No.	Mean	Std Dev	Label
1	3.1	1.25	construct 1
2	4.3	0.77	construct 2
3	4.0	0.77	construct 3
4	4.0	0.83	construct 4
5	4.5	0.50	construct 5
6	4.2	0.44	construct 6
7	4.1	0.50	construct 7
8	3.9	0.72	construct 8
9	3.5	0.55	construct 9
10	3.4	0.66	construct 10
11	3.5	0.91	construct 11
12	4.5	0.59	construct 12
13	4.2	0.96	construct 13
14	3.3	0.79	construct 14
15	3.2	0.56	construct 15
16	3.8	0.72	construct 16
17	4.0	0.83	construct 17
18	3.3	0.70	construct 18
19	3.2	0.36	construct 19
20	3.0	0.36	construct 20
21	3.3	0.75	construct 21
22	4.0	0.74	construct 22
23	4.0	0.85	construct 23
24	3.1	0.52	construct 24
25	3.2	0.61	construct 25
26	3.3	0.66	construct 26
27	2.6	0.63	construct 27
28	2.6	1.04	construct 28
29	3.4	0.95	construct 29
30	3.2	1.02	construct 30
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Grid Statistics
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[Across both Elements & Constructs]

Grid No.	Mean	Std Dev	Label
1	3.6	0.85	Provider 1
2	3.6	0.86	Provider 2
3	3.6	0.86	Provider 3
4	3.6	0.85	Provider 4
5	3.6	0.85	Provider 5
6	3.6	0.85	Provider 6
7	3.5	1.03	Provider 7
8	3.5	1.03	Provider 8
9	3.5	1.01	Provider 9
10	3.6	0.88	Provider 10
11	3.6	0.88	Provider 11
12	3.6	0.85	Provider 12
13	3.6	0.85	Provider 13
14	3.5	1.01	Provider 14
15	3.6	0.88	Provider 15
16	3.6	0.85	Provider 16
17	3.6	0.85	Provider 17
18	3.5	1.01	Provider 18

ANOVA Table
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Source	Sums of Squares	Mean Square	df	F-ratio	Sig.
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Main Effects					
Elements	558.12	34.88	16	416.91	0.000
Constructs	2468.42	85.12	29	18.06	0.000
Grids	37.10	2.18	17		
Interactions					
Elem*Const	671.10	1.45	464	7.60	0.000
Elem*Grid	22.76	0.08	272		
Grid*Const	2323.87	4.71	493		
Residual					
Grd*El*Con	1500.61	0.19	7888		

Total

7581.98 9179

Maxwell & Pilliner (1968) Coefficents

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1. Av. Agreement between grids, over all constructs,
   for these elements = 0.995

2. Av. Agreement within grids, over all constructs,
   for these elements = 0.906

3. Av. Agreement within grids, per construct,
   for these elements = 0.615

4. Av. Agreement between these grids,
   and another sample, over all constructs, for these
elements = 0.998

5. Av. Agreement between one of these grids,
   and another grid, over all constructs, for these
elements = 0.959

6. Av. Agreement between one of these grids, and another
grid,
   per construct, for these elements = 0.210

7. Av. Agreement between these grids, and another
sample, over all elements,
   for these constructs = 0.945

8. Av. Agreement between grids, per element,
   for these constructs= 0.928

9. Av. Agreement within grids, per element,
   for these constructs= 0.503

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End GRIDSCAL Analyses

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Title for this run : PURCHASERGRID

Data Read in from file: C:\PETER_~1\PURCH.TXT
under format: *
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Grid	Constructs	Elements
1	48	17
2	48	17
3	48	17
4	48	17
5	48	17
6	48	17
7	48	17
8	48	17
9	48	17
10	48	17

** dimensions of first 10 grids only listed **

Max Dimensions:	Grids	Constructs	Elements
	20	48	17

Individual Differences Multidimensional Scaling based on the Schonemann (1972) algorithm for the Horan (1969) Model.

Ref: Schonemann, James & Carter (1979) Ch 33 in Lingoes, Roskam, & Borg (Eds) Geometric representations of Relational Data.Ann Arbor MI: Mathesis Press

Analysis Options:

Scaling of Constructs
Replicated across Elements
Weighted by Grids

Measures of Association: Euclidean Distances
Re-Scaling of Association Matrices: No Re-Scaling

Heading : INHOUSEGRID

Element Statistics

[Across both Constructs & Grids]

Element No.	Mean	Std Dev	Label
1	4.0	0.89	Hotel Catering
2	3.9	0.94	Portering
3	3.9	0.92	Security
4	3.4	1.00	Building Serv
5	3.3	0.94	Mech and Elec
6	3.3	0.91	Ground Garden

7	3.3	0.87	Reprographic
8	3.8	0.99	HS
9	3.5	0.90	WM
10	3.6	0.95	ITM
11	3.5	0.98	EBME
12	3.4	0.92	PT
13	3.4	0.89	CarP
14	3.4	0.83	DOMESTIC
15	3.4	0.84	EMANAG
16	3.4	0.84	LPC
17	3.5	0.91	CLEANING

Grid Statistics
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[Across both Elements & Constructs]

Grid No.	Mean	Std Dev	Label
1	3.7	0.92	Provider 1
2	3.7	0.92	Provider 2
3	3.4	0.94	Provider 3
4	3.7	0.92	Provider 4
5	3.4	0.94	Provider 5
6	3.7	0.92	Provider 6
7	3.4	0.94	Provider 7
8	3.7	0.92	Provider 8
9	3.4	0.94	Provider 9
10	3.7	0.92	Provider 10
11	3.4	0.94	Provider 11
12	3.7	0.92	Provider 12
13	3.4	0.94	Provider 13
14	3.7	0.92	Provider 14
15	3.4	0.94	Provider 15
16	3.7	0.92	Provider 16
17	3.4	0.94	Provider 17
18	3.7	0.92	Provider 18
19	3.4	0.94	Provider 19
20	3.4	0.94	Provider 20

Construct Statistics
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[Across both Elements & Grids]

Construct No.	Mean	Std Dev	Label
1	4.5	1.13	construct 1
2	4.0	0.49	construct 2
3	3.5	0.70	construct 3
4	4.7	0.46	construct 4
5	4.7	0.84	construct 5
6	3.9	0.24	construct 6
7	4.4	0.48	construct 7

8	3.7	0.73	construct 8
9	3.9	0.64	construct 9
10	3.0	0.00	construct 10
11	4.3	0.46	construct 11
12	5.0	0.00	construct 12
13	4.0	0.00	construct 13
14	3.0	0.00	construct 14
15	3.2	0.42	construct 15
16	4.1	0.58	construct 16
17	3.1	0.77	construct 17
18	3.3	0.46	construct 18
19	3.0	0.00	construct 19
20	3.0	0.00	construct 20
21	3.7	0.61	construct 21
22	4.6	0.49	construct 22
23	3.3	0.46	construct 23
24	4.0	1.02	construct 24
25	3.6	0.69	construct 25
26	3.5	0.85	construct 26
27	4.6	0.80	construct 27
28	3.1	1.20	construct 28
29	3.8	0.63	construct 29
30	2.2	0.42	construct 30
31	4.0	0.00	construct 31
32	3.4	0.73	construct 32
33	4.0	0.30	construct 33
34	2.1	0.61	construct 34
35	3.5	0.76	construct 35
36	2.7	0.61	construct 36
37	2.6	0.49	construct 37
38	3.9	1.13	construct 38
39	2.9	0.51	construct 39
40	3.4	0.59	construct 40
41	3.4	1.68	construct 41
42	2.2	0.70	construct 42
43	3.1	0.32	construct 43
44	4.1	0.00	construct 44
45	3.6	0.60	construct 45
46	3.6	1.50	construct 46
47	4.1	0.51	construct 47
48	3.5	0.70	construct 48

Average Grid
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Mean Ratings [Rows are Constructs, Cols are Elements]

	1	2	3	4	5	6	7	8	9	10
1	5.00	5.00	5.00	4.00	3.00	4.00	4.00	5.00	5.00	4.00
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2	4.00	4.00	4.00	4.00	4.00	3.00	3.00	5.00	4.00	4.00
3	4.00	4.00	4.00	3.00	3.00	3.00	3.00	5.00	3.00	5.00
4	5.00	5.00	5.00	4.00	4.00	5.00	4.00	5.00	4.00	5.00
5	4.00	4.00	4.00	5.00	4.00	4.00	4.00	5.00	4.00	4.00
6	4.00	4.00	4.00	4.00	4.00	4.00	3.00	4.00	4.00	4.00
7	5.00	5.00	5.00	4.00	4.00	4.00	4.00	4.00	4.00	5.00
8	5.00	5.00	5.00	4.00	3.00	3.00	3.00	4.00	4.00	4.00
9	4.50	4.50	4.50	4.50	4.50	4.50	4.00	4.00	4.00	4.00
10	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
11	5.00	5.00	5.00	4.00	4.00	4.00	4.00	5.00	4.00	4.00
12	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
13	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
14	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
15	3.50	3.50	3.50	3.00	3.00	3.50	3.50	3.50	4.00	3.00
16	4.00	4.00	4.00	3.00	3.00	4.00	4.00	5.00	5.00	5.00
17	4.00	3.50	3.00	3.50	4.00	3.00	3.00	3.00	3.50	3.50
18	4.00	4.00	4.00	3.00	3.00	3.00	3.00	4.00	4.00	3.00
19	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
20	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
21	4.00	4.00	4.00	4.00	4.00	3.00	3.00	5.00	4.00	3.00
22	5.00	5.00	4.00	4.00	4.00	4.00	4.00	5.00	5.00	5.00
23	4.00	4.00	4.00	4.00	3.00	3.00	3.00	4.00	3.00	3.00
24	5.00	5.00	5.00	5.00	4.00	3.00	3.00	4.00	4.00	4.00
25	5.00	4.00	4.00	4.00	3.00	3.00	3.00	5.00	4.00	4.00
26	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00

27	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
28	5.00	5.00	5.00	3.00	3.00	2.00	2.00	4.00	3.00	3.00
29	3.50	3.00	3.50	3.00	3.00	3.50	5.00	4.00	4.00	4.00
30	3.00	3.00	2.00	2.00	2.00	2.00	3.00	3.00	2.00	2.00
31	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
32	3.50	3.50	3.50	4.00	4.00	3.00	3.00	3.00	3.00	3.50
33	4.00	4.00	4.00	3.50	4.00	4.00	4.00	4.00	4.00	4.00
34	3.00	3.00	3.00	1.00	1.00	2.00	2.00	1.50	2.00	2.00
35	4.50	5.00	5.00	3.00	3.00	3.00	2.00	4.00	3.00	4.00
36	3.50	3.50	3.50	2.00	2.00	2.00	3.00	2.00	3.00	3.00
37	3.00	3.00	3.00	2.00	2.00	2.00	2.00	3.00	3.00	2.00
38	5.00	5.00	5.00	2.00	2.00	2.00	2.00	4.00	4.00	5.00
39	4.00	2.50	3.00	3.00	3.00	3.00	2.50	3.00	2.00	3.00
40	3.00	3.00	4.00	4.00	4.00	4.00	3.00	3.00	3.00	3.00
41	3.00	3.00	3.00	3.50	3.50	3.00	3.50	3.50	3.00	3.50
42	4.00	3.00	3.00	1.00	1.00	2.00	2.00	3.00	3.00	2.00
43	4.00	4.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
44	4.50	4.00	4.50	3.50	4.00	4.00	3.50	3.50	3.50	4.00
45	3.50	2.50	4.00	3.00	4.00	4.00	4.00	4.00	3.00	4.00
46	4.00	4.00	5.00	3.50	3.50	3.50	3.50	3.50	3.50	3.50
47	5.00	5.00	5.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
48	4.00	4.00	4.00	3.00	4.00	4.00	4.00	4.00	4.00	4.00

	11	12	13	14	15	16	17
1	4.00	5.00	4.00	4.00	5.00	4.00	5.00
2	4.00	4.00	4.00	4.00	4.00	4.00	5.00
3	4.00	3.00	4.00	3.00	3.00	3.00	3.00
4	4.00	5.00	5.00	5.00	5.00	5.00	5.00
5	4.00	4.00	4.00	4.00	4.00	4.00	4.00

6	4.00	4.00	4.00	4.00	4.00	4.00	4.00
7	4.00	4.00	5.00	4.00	4.00	4.00	5.00
8	4.00	3.00	3.00	3.00	3.00	3.00	3.00
9	4.00	4.00	3.00	3.00	4.00	3.00	3.00
10	3.00	3.00	3.00	3.00	3.00	3.00	3.00
11	4.00	5.00	4.00	4.00	4.00	4.00	4.00
12	5.00	5.00	5.00	5.00	5.00	5.00	5.00
13	4.00	4.00	4.00	4.00	4.00	4.00	4.00
14	3.00	3.00	3.00	3.00	3.00	3.00	3.00
15	3.00	3.00	3.00	3.00	3.00	3.00	3.00
16	5.00	4.00	4.00	4.00	4.00	4.00	4.00
17	2.50	3.00	2.50	3.00	3.00	2.50	3.00
18	3.00	3.00	3.00	3.00	3.00	3.00	3.00
19	3.00	3.00	3.00	3.00	3.00	3.00	3.00
20	3.00	3.00	3.00	3.00	3.00	3.00	3.00
21	3.00	3.00	4.50	3.00	4.00	4.00	4.00
22	5.00	4.00	5.00	5.00	4.00	5.00	5.00
23	3.00	3.00	3.00	3.00	3.00	3.00	3.00
24	4.00	4.00	4.00	3.00	3.00	4.00	4.00
25	3.00	3.00	3.00	3.00	4.00	3.00	3.00
26	3.00	3.00	3.00	3.00	3.00	3.00	3.00
27	1.00	1.00	2.00	2.00	2.00	2.00	2.00
28	3.00	3.00	3.00	2.00	2.00	2.00	3.00
29	4.00	4.00	4.00	4.00	4.00	4.00	4.00
30	2.00	2.00	2.00	2.00	2.00	2.00	2.00
31	4.00	4.00	4.00	4.00	4.00	4.00	4.00
32	3.50	3.00	3.50	3.50	3.50	3.50	3.50
33	4.00	4.00	4.00	4.00	4.00	4.00	4.00
34	2.00	2.00	2.00	2.00	3.00	2.00	2.00
35	4.00	3.00	3.00	3.00	4.00	3.00	3.00
36	3.00	2.00	2.00	3.00	3.00	3.00	3.00
37	2.00	3.00	3.00	3.00	2.00	3.00	3.00
38	5.00	4.00	4.00	4.00	4.00	4.00	5.00
39	2.50	3.00	3.00	3.00	3.00	3.00	3.00
40	5.00	3.00	3.00	3.00	3.00	3.00	3.00
41	3.50	3.50	3.50	3.50	3.50	3.50	3.50
42	2.00	2.00	2.00	2.00	2.00	2.00	2.00
43	3.00	3.00	3.00	3.00	3.00	3.00	3.00
44	4.00	4.00	4.00	4.00	4.00	4.00	4.00
45	4.00	4.00	3.00	4.00	3.00	4.00	3.00
46	3.00	3.50	3.50	3.50	3.50	3.50	3.50
47	3.50	3.00	4.00	4.00	4.00	4.00	4.00
48	4.00	4.00	4.00	4.00	4.00	3.50	4.00

The first 10 factors of the following will be used subsequently.

	Root	Percent of Trace	Cum. Percent
1	126.745	87.260	87.260

2	6.973	4.801	92.061
3	3.297	2.270	94.330
4	2.782	1.915	96.245
5	1.492	1.027	97.273
6	1.248	0.859	98.132
7	0.961	0.662	98.794
8	0.696	0.479	99.273
9	0.269	0.185	99.458
10	0.236	0.162	99.620
11	0.199	0.137	99.757
12	0.135	0.093	99.850
13	0.122	0.084	99.934
14	0.079	0.054	99.988
15	0.017	0.012	100.000

Factor loadings

	1	2	3
1	-2.714	-1.381	-0.157
2	-2.859	-0.966	0.532
3	-2.144	-1.513	-0.150
4	-2.786	-0.099	0.003
5	-2.522	-0.098	0.859
6	-3.040	-0.095	0.601
7	-2.896	0.541	0.163
8	-3.034	0.118	-0.711
9	-3.275	0.330	-0.184
10	-2.769	-0.132	-1.008
11	-2.899	0.553	-0.190
12	-2.637	0.514	0.150
13	-2.613	0.276	-0.214
14	-2.527	0.466	0.207
15	-2.527	0.466	0.207
16	-2.430	0.295	-0.228
17	-2.527	0.466	0.207

Average Grid Coordinate Matrix Correlations

	Label		1	2	3
1	construct 1		-0.66	-0.31	
0.10	0.13	-0.30			
2	construct 2		-0.34	-0.08	
0.77	0.09	-0.25			
3	construct 3		-0.60	0.03	
0.13	-0.27	-0.38			
4	construct 4		-0.37	-0.50	
0.29	0.08	0.09			

```
   5   construct  5                            -0.08   0.69
0.35   0.34  -0.41
   6   construct  6                            -0.24   0.04
0.74  -0.33   0.10
   7   construct  7                            -0.62  -0.28
0.15  -0.13   0.37
   8   construct  8                            -0.88   0.30  -
0.06  -0.25   0.00
   9   construct  9                            -0.26   0.54  -
0.50  -0.28  -0.36
  10   construct 10                             0.00   0.00
0.00   0.00   0.00
  11   construct 11                            -0.77   0.09  -
0.05  -0.02  -0.22
  12   construct 12                             0.00   0.00
0.00   0.00   0.00
  13   construct 13                             0.00   0.00
0.00   0.00   0.00
  14   construct 14                             0.00   0.00
0.00   0.00   0.00
  15   construct 15                            -0.58   0.09  -
0.56   0.28  -0.25
  16   construct 16                            -0.27  -0.43  -
0.01  -0.28  -0.66
  17   construct 17                            -0.66   0.41  -
0.02  -0.10   0.06
  18   construct 18                            -0.88   0.09  -
0.07   0.16  -0.23
  19   construct 19                             0.00   0.00
0.00   0.00   0.00
  20   construct 20                             0.00   0.00
0.00   0.00   0.00
  21   construct 21                            -0.48   0.24
0.46   0.52  -0.12
  22   construct 22                            -0.39  -0.45
0.39  -0.02  -0.04
  23   construct 23                            -0.77   0.53
0.07   0.15  -0.01
  24   construct 24                            -0.68   0.43
0.31  -0.16   0.23
  25   construct 25                            -0.80   0.32
0.05   0.17  -0.24
  26   construct 26                             0.00   0.00
0.00   0.00   0.00
  27   construct 27                            -0.19   0.06
0.00   0.67   0.31
  28   construct 28                            -0.90   0.20
0.06  -0.14   0.02
  29   construct 29                             0.06  -0.55  -
0.70   0.14  -0.19
```

```
  30   construct 30                              -0.59    0.08   -
0.46   0.40   -0.18
  31   construct 31                               0.00    0.00
0.00   0.00    0.00
  32   construct 32                               0.00    0.00
0.00   0.00    0.00
  33   construct 33                              -0.60    0.07   -
0.24   0.01    0.39
  34   construct 34                              -0.69   -0.48   -
0.24  -0.08    0.06
  35   construct 35                              -0.86    0.05
0.07  -0.37    0.05
  36   construct 36                              -0.67   -0.30   -
0.26  -0.16    0.32
  37   construct 37                              -0.52   -0.43
0.38   0.29   -0.01
  38   construct 38                              -0.64   -0.53
0.33  -0.39   -0.04
  39   construct 39                              -0.60    0.07   -
0.24   0.01    0.39
  40   construct 40                               0.22    0.51   -
0.07  -0.63    0.03
  41   construct 41                               0.00    0.00
0.00   0.00    0.00
  42   construct 42                              -0.88   -0.28   -
0.20   0.07   -0.14
  43   construct 43                              -0.76    0.00   -
0.22   0.04    0.37
  44   construct 44                               0.00    0.00
0.00   0.00    0.00
  45   construct 45                               0.14    0.48   -
0.26  -0.26   -0.06
  46   construct 46                               0.00    0.00
0.00   0.00    0.00
  47   construct 47                              -0.76    0.10   -
0.19   0.02    0.39
  48   construct 48                              -0.23   -0.47   -
0.37  -0.23   -0.31


 ANOVA Table
 ~~~~~~~~~~~

              Sums of        Mean               F-
  Source      Squares        Square      df     ratio
Sig.
  ~~~~~~      ~~~~~~~        ~~~~~~      ~~     ~~~~~
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 Main Effects
```

Elements	766.03	47.88	16	1332.61	0.000
Constructs	7450.11	158.51	47	64.80	0.000
Grids	326.92	17.21	19		
Interactions					
Elem*Const	3287.53	4.37	752	163.27	0.000
Elem*Grid	10.92	0.04	304		
Grid*Const	2184.58	2.45	893		
Residual					
Grd*El*Con	382.58	0.03	****		
Total					
	14408.67		****		

Maxwell & Pilliner (1968) Coefficents

1. Av. Agreement between grids, over all constructs, for these elements = 0.999

2. Av. Agreement within grids, over all constructs, for these elements = 0.989

3. Av. Agreement within grids, per construct, for these elements = 0.863

4. Av. Agreement between these grids, and another sample, over all constructs, for these elements = 0.999

5. Av. Agreement between one of these grids, and another grid, over all constructs, for these elements = 0.985

6. Av. Agreement between one of these grids, and another grid, per construct, for these elements = 0.696

7. Av. Agreement between these grids, and another sample, over all elements, for these constructs = 0.985

8. Av. Agreement between grids, per element, for these constructs= 0.987

9. Av. Agreement within grids, per element,
   for these constructs= 1.078

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End GRIDSCAL Analyses.

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Title for this run : EXTERNALPROVIDERS GRID

Data Read in from file: C:\PETER_~1\EXTPROV.TXT
under format: *

Grid	Constructs	Elements
1	48	17
2	48	17
3	48	17
4	48	17
5	48	17
6	48	17
7	48	17
8	48	17
9	48	17
10	48	17

** dimensions of first 10 grids only listed **

Max Dimensions:	Grids	Constructs	Elements
	20	48	17

~~~~~~

Individual Differences Multidimensional Scaling based on the Schonemann (1972) algorithm for the Horan (1969) Model.

Ref: Schonemann, James & Carter (1979) Ch 33 in Lingoes, Roskam, & Borg (Eds) Geometric representations of Relational Data.Ann Arbor MI: Mathesis Press

Analysis Options:
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Scaling of Constructs
Replicated across Elements
Weighted by Grids

Measures of Association: Euclidean Distances
Re-Scaling of Association Matrices: No Re-Scaling

Heading : EXTERNALPROVIDERSGRID

Element Statistics
~~~~~~~~~~~~~~~~~~

[Across both Constructs & Grids]

Element No.	Mean	Std Dev	Label
1	4.1	0.89	Hotel Catering
2	3.9	0.94	Portering
3	3.9	0.92	Security
4	3.4	1.00	Building Serv
5	3.3	0.94	Mech and Elec
6	3.3	0.91	Ground Garden
7	3.3	0.87	Reprographic
8	3.8	0.99	HS
9	3.5	0.90	WM
10	3.6	0.95	ITM
11	3.5	0.98	EBME
12	3.4	0.92	PT
13	3.4	0.89	CarP
14	3.4	0.83	DOMESTIC
15	3.4	0.84	EMANAG
16	3.4	0.84	LPC
17	3.5	0.91	CLEANING

Grid Statistics
~~~~~~~~~~~~~~~

[Across both Elements & Constructs]

Grid No.	Mean	Std Dev	Label
1	3.7	0.92	Provider 1
2	3.7	0.92	Provider 2
3	3.4	0.94	Provider 3
4	3.7	0.92	Provider 4
5	3.4	0.94	Provider 5
6	3.7	0.92	Provider 6
7	3.4	0.94	Provider 7
8	3.7	0.92	Provider 8
9	3.4	0.94	Provider 9
10	3.7	0.92	Provider 10
11	3.4	0.94	Provider 11
12	3.7	0.92	Provider 12
13	3.4	0.94	Provider 13
~~~~~~~~~~~~~~~

14	3.7	0.92	Provider 14
15	3.4	0.94	Provider 15
16	3.7	0.92	Provider 16
17	3.4	0.94	Provider 17
18	3.7	0.92	Provider 18
19	3.4	0.94	Provider 19
20	3.4	0.94	Provider 20

Construct Statistics
~~~~~~~~~~~~~~~~~~~~

[Across both Elements & Grids]

Construct No.	Mean	Std Dev	Label
1	4.1	1.13	construct 1
2	4.5	1.04	construct 2
3	3.0	1.02	construct 3
4	4.0	0.85	construct 4
5	4.7	0.84	construct 5
6	3.9	0.24	construct 6
7	4.4	0.48	construct 7
8	3.7	0.73	construct 8
9	3.9	0.64	construct 9
10	3.0	0.00	construct 10
11	4.3	0.46	construct 11
12	5.0	0.00	construct 12
13	4.0	0.00	construct 13
14	3.0	0.00	construct 14
15	3.2	0.42	construct 15
16	4.1	0.58	construct 16
17	3.1	0.77	construct 17
18	3.3	0.46	construct 18
19	3.0	0.00	construct 19
20	3.0	0.00	construct 20
21	3.7	0.61	construct 21
22	4.6	0.49	construct 22
23	3.3	0.46	construct 23
24	4.0	1.02	construct 24
25	3.6	0.69	construct 25
26	3.5	0.85	construct 26
27	4.6	0.80	construct 27
28	3.1	1.20	construct 28
29	3.8	0.63	construct 29
30	2.2	0.42	construct 30
31	4.0	0.00	construct 31
32	3.4	0.73	construct 32
33	4.0	0.30	construct 33
34	2.1	0.61	construct 34
35	3.5	0.76	construct 35
36	2.7	0.61	construct 36
37	2.6	0.49	construct 37
~~~~~~~~~~~~~~~~~~~~

38	3.9	1.13	construct 38
39	2.9	0.51	construct 39
40	3.4	0.59	construct 40
41	3.4	1.68	construct 41
42	2.2	0.70	construct 42
43	3.1	0.32	construct 43
44	4.1	0.00	construct 44
45	3.6	0.60	construct 45
46	3.6	1.50	construct 46
47	4.1	0.51	construct 47
48	3.5	0.70	construct 48

Average Grid

Mean Ratings [Rows are Constructs, Cols are Elements]

	1	2	3	4	5	6	7	8	9	10
1	5.00	5.00	5.00	4.00	3.00	4.00	4.00	5.00	5.00	4.00
2	4.00	4.00	4.00	4.00	4.00	3.00	3.00	5.00	4.00	4.00
3	4.00	4.00	4.00	3.00	3.00	3.00	3.00	5.00	3.00	5.00
4	5.00	5.00	5.00	4.00	4.00	5.00	4.00	5.00	4.00	5.00
5	4.00	4.00	4.00	5.00	4.00	4.00	4.00	5.00	4.00	4.00
6	4.00	4.00	4.00	4.00	4.00	4.00	3.00	4.00	4.00	4.00
7	5.00	5.00	5.00	4.00	4.00	4.00	4.00	4.00	4.00	5.00
8	5.00	5.00	5.00	4.00	3.00	3.00	3.00	4.00	4.00	4.00
9	4.50	4.50	4.50	4.50	4.50	4.50	4.00	4.00	4.00	4.00
10	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
11	5.00	5.00	5.00	4.00	4.00	4.00	4.00	5.00	4.00	4.00
12	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
13	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
14	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
15	3.50	3.50	3.50	3.00	3.00	3.50	3.50	3.50	4.00	3.00
16	4.00	4.00	4.00	3.00	3.00	4.00	4.00	5.00	5.00	5.00

17	4.00	3.50	3.00	3.50	4.00	3.00	3.00	3.00	3.50	3.50
18	4.00	4.00	4.00	3.00	3.00	3.00	3.00	4.00	4.00	3.00
19	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
20	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
21	4.00	4.00	4.00	4.00	4.00	3.00	3.00	5.00	4.00	3.00
22	5.00	5.00	4.00	4.00	4.00	4.00	4.00	5.00	5.00	5.00
23	4.00	4.00	4.00	4.00	3.00	3.00	3.00	4.00	3.00	3.00
24	5.00	5.00	5.00	5.00	4.00	3.00	3.00	4.00	4.00	4.00
25	5.00	4.00	4.00	4.00	3.00	3.00	3.00	5.00	4.00	4.00
26	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
27	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
28	5.00	5.00	5.00	3.00	3.00	2.00	2.00	4.00	3.00	3.00
29	3.50	3.00	3.50	3.00	3.00	3.50	5.00	4.00	4.00	4.00
30	3.00	3.00	2.00	2.00	2.00	2.00	3.00	3.00	2.00	2.00
31	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
32	3.50	3.50	3.50	4.00	4.00	3.00	3.00	3.00	3.00	3.50
33	4.00	4.00	4.00	3.50	4.00	4.00	4.00	4.00	4.00	4.00
34	3.00	3.00	3.00	1.00	1.00	2.00	2.00	1.50	2.00	2.00
35	4.50	5.00	5.00	3.00	3.00	3.00	2.00	4.00	3.00	4.00
36	3.50	3.50	3.50	2.00	2.00	2.00	3.00	2.00	3.00	3.00
37	3.00	3.00	3.00	2.00	2.00	2.00	2.00	3.00	3.00	2.00
38	5.00	5.00	5.00	2.00	2.00	2.00	2.00	4.00	4.00	5.00
39	4.00	2.50	3.00	3.00	3.00	3.00	2.50	3.00	2.00	3.00
40	3.00	3.00	4.00	4.00	4.00	4.00	3.00	3.00	3.00	3.00
41	3.00	3.00	3.00	3.50	3.50	3.00	3.50	3.50	3.00	3.50

42	4.00	3.00	3.00	1.00	1.00	2.00	2.00	3.00	3.00	2.00
43	4.00	4.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
44	4.50	4.00	4.50	3.50	4.00	4.00	3.50	3.50	3.50	4.00
45	3.50	2.50	4.00	3.00	4.00	4.00	4.00	4.00	3.00	4.00
46	4.00	4.00	5.00	3.50	3.50	3.50	3.50	3.50	3.50	3.50
47	5.00	5.00	5.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
48	4.00	4.00	4.00	3.00	4.00	4.00	4.00	4.00	4.00	4.00

	11	12	13	14	15	16	17
1	4.00	5.00	4.00	4.00	5.00	4.00	5.00
2	4.00	4.00	4.00	4.00	4.00	4.00	5.00
3	4.00	3.00	4.00	3.00	3.00	3.00	3.00
4	4.00	5.00	5.00	5.00	5.00	5.00	5.00
5	4.00	4.00	4.00	4.00	4.00	4.00	4.00
6	4.00	4.00	4.00	4.00	4.00	4.00	4.00
7	4.00	4.00	5.00	4.00	4.00	4.00	5.00
8	4.00	3.00	3.00	3.00	3.00	3.00	3.00
9	4.00	4.00	3.00	3.00	4.00	3.00	3.00
10	3.00	3.00	3.00	3.00	3.00	3.00	3.00
11	4.00	5.00	4.00	4.00	4.00	4.00	4.00
12	5.00	5.00	5.00	5.00	5.00	5.00	5.00
13	4.00	4.00	4.00	4.00	4.00	4.00	4.00
14	3.00	3.00	3.00	3.00	3.00	3.00	3.00
15	3.00	3.00	3.00	3.00	3.00	3.00	3.00
16	5.00	4.00	4.00	4.00	4.00	4.00	4.00
17	2.50	3.00	2.50	3.00	3.00	2.50	3.00
18	3.00	3.00	3.00	3.00	3.00	3.00	3.00
19	3.00	3.00	3.00	3.00	3.00	3.00	3.00
20	3.00	3.00	3.00	3.00	3.00	3.00	3.00
21	3.00	3.00	4.50	3.00	4.00	4.00	4.00
22	5.00	4.00	5.00	5.00	4.00	5.00	5.00
23	3.00	3.00	3.00	3.00	3.00	3.00	3.00
24	4.00	4.00	4.00	3.00	3.00	4.00	4.00
25	3.00	3.00	3.00	3.00	4.00	3.00	3.00
26	3.00	3.00	3.00	3.00	3.00	3.00	3.00
27	1.00	1.00	2.00	2.00	2.00	2.00	2.00
28	3.00	3.00	3.00	2.00	2.00	2.00	3.00
29	4.00	4.00	4.00	4.00	4.00	4.00	4.00
30	2.00	2.00	2.00	2.00	2.00	2.00	2.00
31	4.00	4.00	4.00	4.00	4.00	4.00	4.00
32	3.50	3.00	3.50	3.50	3.50	3.50	3.50
33	4.00	4.00	4.00	4.00	4.00	4.00	4.00
34	2.00	2.00	2.00	2.00	3.00	2.00	2.00
35	4.00	3.00	3.00	3.00	4.00	3.00	3.00

36	3.00	2.00	2.00	3.00	3.00	3.00	3.00
37	2.00	3.00	3.00	3.00	2.00	3.00	3.00
38	5.00	4.00	4.00	4.00	4.00	4.00	5.00
39	2.50	3.00	3.00	3.00	3.00	3.00	3.00
40	5.00	3.00	3.00	3.00	3.00	3.00	3.00
41	3.50	3.50	3.50	3.50	3.50	3.50	3.50
42	2.00	2.00	2.00	2.00	2.00	2.00	2.00
43	3.00	3.00	3.00	3.00	3.00	3.00	3.00
44	4.00	4.00	4.00	4.00	4.00	4.00	4.00
45	4.00	4.00	3.00	4.00	3.00	4.00	3.00
46	3.00	3.50	3.50	3.50	3.50	3.50	3.50
47	3.50	3.00	4.00	4.00	4.00	4.00	4.00
48	4.00	4.00	4.00	4.00	4.00	3.50	4.00

The first 10 factors of the following will be used subsequently.

	Root	Percent of Trace	Cum. Percent
1	126.745	87.260	87.260
2	6.973	4.801	92.061
3	3.297	2.270	94.330
4	2.782	1.915	96.245
5	1.492	1.027	97.273
6	1.248	0.859	98.132
7	0.961	0.662	98.794
8	0.696	0.479	99.273
9	0.269	0.185	99.458
10	0.236	0.162	99.620
11	0.199	0.137	99.757
12	0.135	0.093	99.850
13	0.122	0.084	99.934
14	0.079	0.054	99.988
15	0.017	0.012	100.000

Factor loadings

	1	2	3
1	-2.714	-1.381	-0.157
2	-2.859	-0.966	0.532
3	-2.144	-1.513	-0.150
4	-2.786	-0.099	0.003
5	-2.522	-0.098	0.859
6	-3.040	-0.095	0.601
7	-2.896	0.541	0.163
8	-3.034	0.118	-0.711
9	-3.275	0.330	-0.184
10	-2.769	-0.132	-1.008
11	-2.899	0.553	-0.190

12	-2.637	0.514	0.150
13	-2.613	0.276	-0.214
14	-2.527	0.466	0.207
15	-2.527	0.466	0.207
16	-2.430	0.295	-0.228
17	-2.527	0.466	0.207

Average Grid Coordinate Matrix Correlations

	Label		1	2	3
1	construct 1		-0.66	-0.31	
0.10	0.13	-0.30			
2	construct 2		-0.34	-0.08	
0.77	0.09	-0.25			
3	construct 3		-0.60	0.03	
0.13	-0.27	-0.38			
4	construct 4		-0.37	-0.50	
0.29	0.08	0.09			
5	construct 5		-0.08	0.69	
0.35	0.34	-0.41			
6	construct 6		-0.24	0.04	
0.74	-0.33	0.10			
7	construct 7		-0.62	-0.28	
0.15	-0.13	0.37			
8	construct 8		-0.88	0.30	-
0.06	-0.25	0.00			
9	construct 9		-0.26	0.54	-
0.50	-0.28	-0.36			
10	construct 10		0.00	0.00	
0.00	0.00	0.00			
11	construct 11		-0.77	0.09	-
0.05	-0.02	-0.22			
12	construct 12		0.00	0.00	
0.00	0.00	0.00			
13	construct 13		0.00	0.00	
0.00	0.00	0.00			
14	construct 14		0.00	0.00	
0.00	0.00	0.00			
15	construct 15		-0.58	0.09	-
0.56	0.28	-0.25			
16	construct 16		-0.27	-0.43	-
0.01	-0.28	-0.66			
17	construct 17		-0.66	0.41	-
0.02	-0.10	0.06			
18	construct 18		-0.88	0.09	-
0.07	0.16	-0.23			
19	construct 19		0.00	0.00	
0.00	0.00	0.00			

20	construct 20	0.00	0.00		
0.00	0.00	0.00			
21	construct 21	-0.48	0.24		
0.46	0.52	-0.12			
22	construct 22	-0.39	-0.45		
0.39	-0.02	-0.04			
23	construct 23	-0.77	0.53		
0.07	0.15	-0.01			
24	construct 24	-0.68	0.43		
0.31	-0.16	0.23			
25	construct 25	-0.80	0.32		
0.05	0.17	-0.24			
26	construct 26	0.00	0.00		
0.00	0.00	0.00			
27	construct 27	-0.19	0.06		
0.00	0.67	0.31			
28	construct 28	-0.90	0.20		
0.06	-0.14	0.02			
29	construct 29	0.06	-0.55	-	
0.70	0.14	-0.19			
30	construct 30	-0.59	0.08	-	
0.46	0.40	-0.18			
31	construct 31	0.00	0.00		
0.00	0.00	0.00			
32	construct 32	0.00	0.00		
0.00	0.00	0.00			
33	construct 33	-0.60	0.07	-	
0.24	0.01	0.39			
34	construct 34	-0.69	-0.48	-	
0.24	-0.08	0.06			
35	construct 35	-0.86	0.05		
0.07	-0.37	0.05			
36	construct 36	-0.67	-0.30	-	
0.26	-0.16	0.32			
37	construct 37	-0.52	-0.43		
0.38	0.29	-0.01			
38	construct 38	-0.64	-0.53		
0.33	-0.39	-0.04			
39	construct 39	-0.60	0.07	-	
0.24	0.01	0.39			
40	construct 40	0.22	0.51	-	
0.07	-0.63	0.03			
41	construct 41	0.00	0.00		
0.00	0.00	0.00			
42	construct 42	-0.88	-0.28	-	
0.20	0.07	-0.14			
43	construct 43	-0.76	0.00	-	
0.22	0.04	0.37			
44	construct 44	0.00	0.00		
0.00	0.00	0.00			

```
  45    construct 45                              0.14    0.48   -
0.26  -0.26  -0.06
  46    construct 46                              0.00    0.00
0.00   0.00   0.00
  47    construct 47                             -0.76    0.10   -
0.19   0.02   0.39
  48    construct 48                             -0.23   -0.47   -
0.37  -0.23  -0.31
```

ANOVA Table
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Source	Sums of Squares	Mean Square	df	F-ratio	Sig.
~~	~~~~~~~	~~~~~~	~~	~~~~~	~~~~
Main Effects					
Elements	766.03	47.88	16	1332.61	0.000
Constructs	7450.11	158.51	47	64.80	0.000
Grids	326.92	17.21	19		
Interactions					
Elem*Const	3287.53	4.37	752	163.27	0.000
Elem*Grid	10.92	0.04	304		
Grid*Const	2184.58	2.45	893		
Residual					
Grd*El*Con	382.58	0.03	****		
Total	14408.67		****		

Maxwell & Pilliner (1968) Coefficents
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1. Av. Agreement between grids, over all constructs, for these elements = 0.999

2. Av. Agreement within grids, over all constructs, for these elements = 0.989

3. Av. Agreement within grids, per construct,
for these elements = 0.863

4. Av. Agreement between these grids,
and another sample, over all constructs, for these elements = 0.999

5. Av. Agreement between one of these grids,
and another grid, over all constructs, for these elements = 0.985

6. Av. Agreement between one of these grids, and another grid,
per construct, for these elements = 0.696

7. Av. Agreement between these grids, and another sample, over all elements,
for these constructs = 0.985

8. Av. Agreement between grids, per element,
for these constructs= 0.987

9. Av. Agreement within grids, per element,
for these constructs= 1.078

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End GRIDSCAL Analyses.

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APPENDIX D
NHSFRES TRAINNING DATA

CUST	BUSI	LEGAL	FAC	CORP	FIN	COMM	OUTPUT
4.22	4.13	4.17	3.67	3.88	4.5	4.22	P
4.22	4	4	3.67	3.63	4.25	4.11	P
4.22	4	3.67	4	3.5	4.38	4.11	P
3.56	3.5	3.67	3.67	2.88	4.13	3.11	O
3.33	3.38	3.33	3.67	2.88	4.13	3.22	O
3.56	3.5	3.17	3.67	2.88	4.25	3.22	P
3.33	3.5	3.33	3.33	2.75	4.38	3.22	O
4.44	4.13	3.83	3.33	3.38	4.38	3.67	P
4	3.88	3.5	3.33	3.25	4.13	3.67	P
4.11	4	3.67	3.67	3.38	4.13	3.56	P
3.89	4	3.33	4	3	4.13	3.78	P
3.78	3.88	3.33	3.33	2.88	4.13	3.22	P
3.78	3.63	3.5	3.67	3.13	4	3.44	P
3.67	3.63	3.17	3.33	3.13	4.13	3.44	O
3.78	3.63	3.33	3.33	3.13	4	3.56	P
3.56	3.63	3.33	3.33	3.13	4.13	3.44	P
3.89	3.75	3.5	3.67	3.13	4	3.67	P
4.22	4.13	4.17	3.67	3.88	4.5	4.22	P
4.22	4	4	3.67	3.63	4.25	4.11	P
4.22	4	3.83	4	3.5	4.38	4.11	P
3.56	3.5	3.67	3.67	2.88	4.13	3.11	P
3.33	3.38	3.33	3.67	2.88	4.13	3.22	O
3.56	3.5	3.17	3.67	2.88	4.25	3.22	O
3.33	3.5	3.33	3.33	2.75	4.38	3.22	O
4.44	4.13	3.83	3.33	3.38	4.38	3.67	P
4	3.88	3.5	3.33	3.25	4.13	3.67	P
4.11	4	3.67	3.67	3.38	4.13	3.56	P
3.89	4	3.33	4	3	4.13	3.78	P
3.78	3.88	3.33	3.33	2.88	4.13	3.22	P
3.78	3.63	3.5	3.67	3.13	4	3.44	P
3.67	3.63	3.17	3.33	3.13	4.13	3.44	P
3.78	3.75	3.33	3.33	3.13	4	3.56	P
3.67	3.63	3.33	3.33	3.13	4.13	3.44	P
3.89	3.75	3.5	3.67	3.13	4	3.67	P
4.22	4.25	4	3.67	3.25	3	3.89	P
4.22	4	3.83	3.67	3.5	2.75	3.78	P
4.22	4.13	3.67	4	3.25	3.5	3.78	P
3.56	3.63	3.67	3.67	2.63	2.63	2.89	O
3.33	3.5	3.33	3.67	2.88	2.88	3	O
3.56	3.63	2.83	3.67	2.88	2.88	3	O
3.33	3.38	3	3.33	2.75	3.13	3	PP
4.44	4.13	3.5	3.33	3	3.13	3.44	P
4	3.63	3.17	3.33	3.13	2.88	3.44	O
4.11	4	3.5	3.67	3	3.13	3.33	P

3.89	3.88	3.17	4	2.88	3	3.44	P
3.78	3.88	3	3.33	2.88	3.13	3	O
3.78	3.63	3.33	3.67	3	3	3.33	O
3.67	3.63	3	3.33	3.13	3.13	3.22	O
3.78	3.75	3.17	3.33	3.13	3	3.33	O
3.67	3.63	3.17	3.33	3	3.13	3.33	O
3.89	3.75	3.33	3.67	3.13	3	3.44	P
4.22	4.13	4.17	3.67	3.88	4.5	4.22	P
4.22	4	4	3.67	3.63	4.25	4.11	P
4.22	4	3.83	4	3.5	4.38	4.11	P
3.56	3.5	3.67	3.67	2.88	4.13	3.11	P
3.33	3.38	3.33	3.67	2.88	4.13	3.22	O
3.56	3.5	3.17	3.67	2.88	4.25	3.22	O
3.33	3.5	3.33	3.33	2.75	4.38	3.22	O
4.44	4.13	3.83	3.33	3.38	4.38	3.67	P
4	3.88	3.5	3.33	3.25	4.13	3.67	P
4.11	4	3.67	3.67	3.38	4.13	3.56	P
3.89	4	3.33	4	3	4.13	3.78	P
3.78	3.88	3.33	3.33	2.88	4.13	3.22	P
3.78	3.63	3.5	3.67	3.13	4	3.44	P
3.67	3.63	3.17	3.33	3.13	4.13	3.44	P
3.78	3.75	3.33	3.33	3.13	4	3.56	P
3.67	3.63	3.33	3.33	3.13	4.13	3.44	P
3.89	3.75	3.5	3.67	3.13	4	3.67	P
4.22	4.25	4	3.67	3.25	3	3.89	P
4.22	4	3.83	3.67	3.5	2.75	3.78	P
4.22	4.13	3.67	4	3.25	3.5	3.78	P
3.56	3.63	3.67	3.67	2.63	2.63	2.89	O
3.33	3.5	3.33	3.67	2.88	2.88	3	O
3.56	3.63	2.83	3.67	2.88	2.88	3	O
3.33	3.38	3	3.33	2.75	3.13	3	O
4.44	4.13	3.5	3.33	3	3.13	3.44	P
4	3.63	3.17	3.33	3.13	2.88	3.44	O
4.11	4	3.5	3.67	3	3.13	3.33	P
3.89	3.88	3.17	4	2.88	3	3.44	O
3.78	3.88	3	3.33	2.88	3.13	3	O
3.78	3.63	3.33	3.67	3	3	3.33	O
3.67	3.63	3	3.33	3.13	3.13	3.22	O
3.78	3.75	3.17	3.33	3.13	3	3.33	O
3.67	3.63	3.17	3.33	3	3.13	3.33	O
3.89	3.75	3.33	3.67	3.13	3	3.44	P
4.22	4.13	4.17	3.67	3.88	4.5	4.22	P
4.11	3.88	4	3.67	3.63	4.25	4.11	P
4.22	4	3.83	4	3.5	4.38	4.11	P
3.56	3.5	3.67	3.67	2.88	4.13	3.11	P

3.33	3.38	3.33	3.67	2.88	4.13	3.22	O
3.56	3.5	3.17	3.67	2.88	4.25	3.22	O
3.33	3.5	3.33	3.33	2.75	4.38	3.22	O
4.44	4.13	3.83	3.33	3.38	4.38	3.67	PP
4	3.88	3.5	3.33	3.25	4.13	3.67	PP
4.11	4	3.67	3.67	3.38	4.13	3.56	P
3.89	4	3.33	4	3	4.13	3.78	P
3.78	3.88	3.33	3.33	2.88	4.13	3.22	P
3.78	3.63	3.5	3.67	3.13	4	3.44	P
3.67	3.63	3.17	3.33	3.13	4.13	3.44	P
3.78	3.75	3.33	3.33	3.13	4	3.56	P
3.67	3.63	3.33	3.33	3.13	4.13	3.44	P
3.89	3.75	3.5	3.67	3.13	4	3.67	P
4.22	4.25	4	3.67	3.25	3	3.89	P
4.22	4	3.83	3.67	3.5	2.75	3.78	P
4.22	4.13	3.67	4	3.25	3.5	3.78	P
3.56	3.63	3.67	3.67	2.63	2.63	2.89	O
3.33	3.5	3.33	3.67	2.88	2.88	3	O
3.56	3.63	2.83	3.67	2.88	2.88	3	O
3.33	3.38	3	3.33	2.75	3.13	3	O
4.44	4.13	3.5	3.33	3	3.13	3.44	PP
4	3.63	3.17	3.33	3.13	2.88	3.44	O
4.11	4	3.5	3.67	3	3.13	3.33	PP
3.89	3.88	3.17	4	2.88	3	3.44	O
3.78	3.88	3	3.33	2.88	3.13	3	O
3.78	3.63	3.33	3.67	3	3	3.33	O
3.67	3.63	3	3.33	3.13	3.13	3.22	O
3.78	3.75	3.17	3.33	3.13	3	3.33	O
3.67	3.63	3.17	3.33	3	3.13	3.33	O
3.89	3.75	3.33	3.67	3.13	3	3.44	O
4.22	4.13	4.17	3.67	3.88	4.5	4.22	PP
4.22	4	4	3.67	3.63	4.25	4.11	PP
4.22	4	3.83	4	3.5	4.38	4.11	P
3.56	3.5	3.67	3.67	2.88	4.13	3.11	P
3.33	3.38	3.33	3.67	2.88	4.13	3.22	O
3.56	3.5	3.17	3.67	2.88	4.25	3.22	O
3.33	3.5	3.33	3.33	2.75	4.38	3.22	O
4.44	4.13	3.83	3.33	3.38	4.38	3.67	P
4	3.88	3.5	3.33	3.25	4.13	3.67	P
4.11	4	3.67	3.67	3.38	4.13	3.56	P
3.89	4	3.33	4	3	4.13	3.78	P
3.78	3.88	3.33	3.33	2.88	4.13	3.22	P
3.78	3.63	3.5	3.67	3.13	4	3.44	P
3.67	3.63	3.17	3.33	3.13	4.13	3.44	P
3.78	3.75	3.33	3.33	3.13	4	3.56	P

3.67	3.63	3.33	3.33	3.13	4.13	3.44	P
3.89	3.75	3.5	3.67	3.13	4	3.67	P
4.22	4.25	4	3.67	3.25	3	3.89	P
4.22	4	3.83	3.67	3.5	2.75	3.78	P
4.22	4.13	3.67	4	3.25	3.5	3.78	P
3.56	3.63	3.67	3.67	2.63	2.63	2.89	O
3.33	3.5	3.33	3.67	2.88	2.88	3	O
3.56	3.63	2.83	3.67	2.88	2.88	3	O
3.33	3.38	3	3.33	2.75	3.13	3	O
4.44	4.13	3.5	3.33	3	3.13	3.44	P
4	3.63	3.17	3.33	3.13	2.88	3.44	O
4.11	4	3.5	3.67	3	3.13	3.33	PP
3.89	3.88	3.17	4	2.88	3	3.44	O
3.78	3.88	3	3.33	2.88	3.13	3	O
3.78	3.63	3.33	3.67	3	3	3.33	O
3.67	3.63	3	3.33	3.13	3.13	3.22	O
3.78	3.75	3.17	3.33	3.13	3	3.33	O
3.67	3.63	3.17	3.33	3	3.13	3.33	O
3.89	3.75	3.33	3.67	3.13	3	3.44	O
4.22	4.13	4.17	3.67	3.88	4.5	4.22	PP
4.22	4	4	3.67	3.63	4.25	4.11	PP
4.22	4	3.83	4	3.5	4.38	4.11	P
3.56	3.5	3.67	3.67	2.88	4.13	3.11	O
3.33	3.38	3.33	3.67	2.88	4.13	3.22	O
3.56	3.5	3.17	3.67	2.88	4.25	3.22	O
3.33	3.5	3.33	3.33	2.75	4.38	3.22	O
4.44	4.13	3.83	3.33	3.38	4.38	3.67	PP
4	3.88	3.5	3.33	3.25	4.13	3.67	PP
4.11	4	3.67	3.67	3.38	4.13	3.56	P
3.89	4	3.33	4	3	4.13	3.78	P
3.78	3.88	3.33	3.33	2.88	4.13	3.22	P
3.78	3.63	3.5	3.67	3.13	4	3.44	P
3.67	3.63	3.17	3.33	3.13	4.13	3.44	P
3.78	3.75	3.33	3.33	3.13	4	3.56	P
3.67	3.63	3.33	3.33	3.13	4.13	3.44	P
3.89	3.75	3.5	3.67	3.13	4	3.67	P
4.22	4.25	4	3.67	3.25	3	3.89	P
4.22	4	3.83	3.67	3.5	2.75	3.78	P
4.22	4.13	3.67	4	3.25	3.5	3.78	P
3.56	3.63	3.67	3.67	2.63	2.63	2.89	O
3.33	3.5	3.33	3.67	2.88	2.88	3	O
3.56	3.63	2.83	3.67	2.88	2.88	3	O
3.33	3.38	3	3.33	2.75	3.13	3	O
4.44	4.13	3.5	3.33	3	3.13	3.44	PP
4	3.63	3.17	3.33	3.13	2.88	3.44	O

4.11	4	3.5	3.67	3	3.13	3.33	PP
3.89	3.88	3.17	4	2.88	3	3.44	O
3.78	3.88	3	3.33	2.88	3.13	3	O
3.78	3.63	3.33	3.67	3	3	3.33	O
3.67	3.63	3	3.33	3.13	3.13	3.22	O
3.78	3.75	3.17	3.33	3.13	3	3.33	O
3.67	3.63	3.17	3.33	3	3.13	3.33	O
3.89	3.75	3.33	3.67	3.13	3	3.44	O
4.22	4.13	4.17	3.67	3.88	4.5	4.22	PP
4.22	4	4	3.67	3.63	4.25	4.11	PP
4.22	4	3.83	4	3.5	4.38	4.11	P
3.56	3.5	3.67	3.67	2.88	4.13	3.11	P
3.33	3.38	3.33	3.67	2.88	4.13	3.22	O
3.56	3.5	3.17	3.67	2.88	4.25	3.22	O
3.33	3.5	3.33	3.33	2.75	4.38	3.22	O
4.44	4.13	3.83	3.33	3.38	4.38	3.67	PP
4	3.88	3.5	3.33	3.25	4.13	3.67	PP
4.11	4	3.67	3.67	3.38	4.13	3.56	P
3.89	4	3.33	4	3	4.13	3.78	P
3.78	3.88	3.33	3.33	2.88	4.13	3.22	P
3.78	3.63	3.5	3.67	3.13	4	3.44	P
3.67	3.63	3.17	3.33	3.13	4.13	3.44	P
3.78	3.75	3.33	3.33	3.13	4	3.56	P
3.67	3.63	3.33	3.33	3.13	4.13	3.44	P
3.89	3.75	3.5	3.67	3.13	4	3.67	P
4.22	4.25	4	3.67	3.25	3	3.89	P
4.22	4	3.83	3.67	3.5	2.75	3.78	P
4.22	4.13	3.67	4	3.25	3.5	3.78	P
3.56	3.63	3.67	3.67	2.63	2.63	2.89	O
3.33	3.5	3.33	3.67	2.88	2.88	3	O
3.56	3.63	2.83	3.67	2.88	2.88	3	O
3.33	3.38	3	3.33	2.75	3.13	3	O
4.44	4.13	3.5	3.33	3	3.13	3.44	PP
4	3.63	3.17	3.33	3.13	2.88	3.44	O
4.11	4	3.5	3.67	3	3.13	3.33	PP
3.89	3.88	3.17	4	2.88	3	3.44	O
3.78	3.88	3	3.33	2.88	3.13	3	O
3.78	3.63	3.33	3.67	3	3	3.33	O
3.67	3.63	3	3.33	3.13	3.13	3.22	O
3.78	3.75	3.17	3.33	3.13	3	3.33	O
3.67	3.63	3.17	3.33	3	3.13	3.33	O
3.89	3.75	3.33	3.67	3.13	3	3.44	O
4.22	4.13	4.17	3.67	3.88	4.5	4.22	PP
4.22	4	4	3.67	3.63	4.25	4.11	PP
4.22	4	3.83	4	3.5	4.38	4.11	P

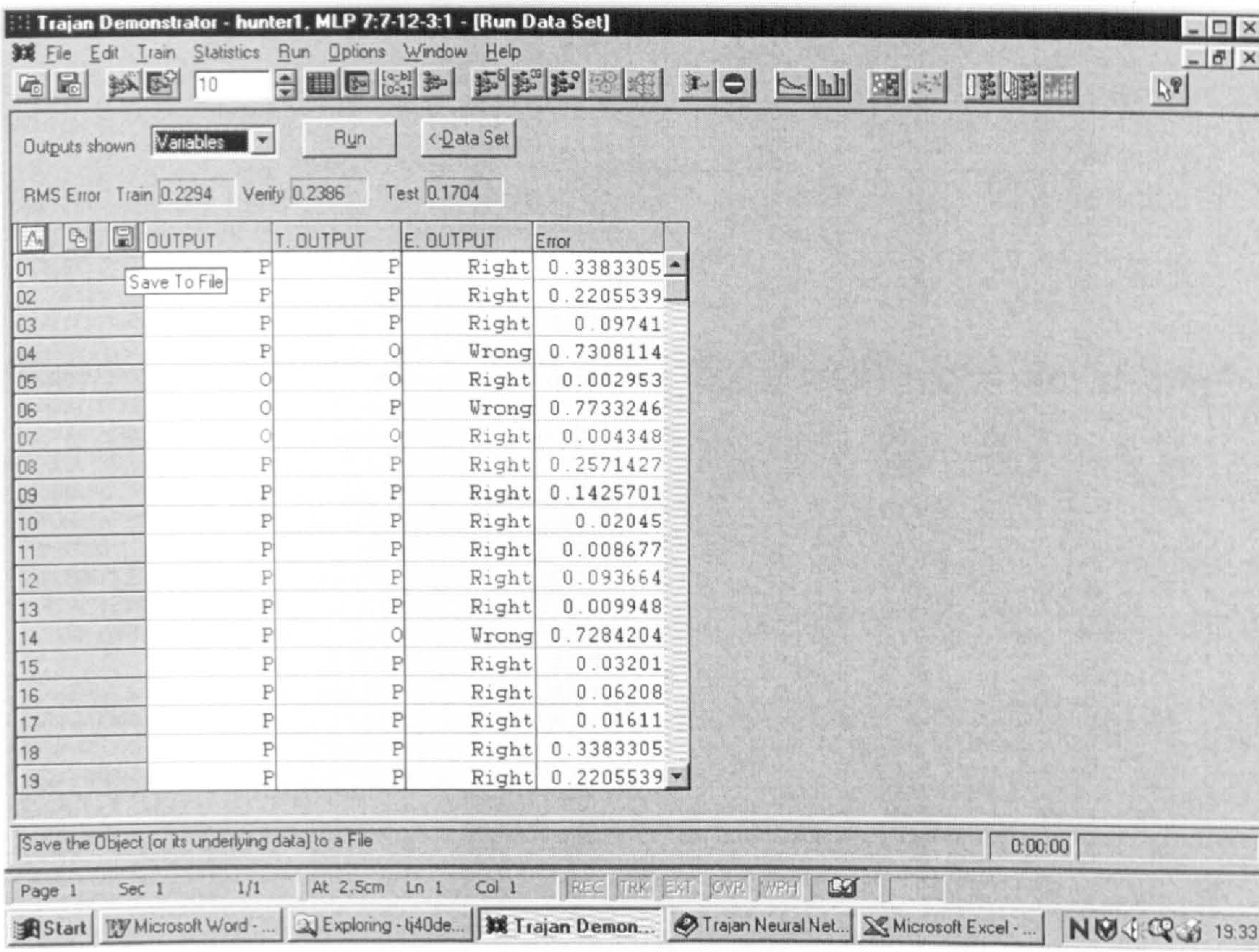
3.56	3.5	3.67	3.67	2.88	4.13	3.11	P
3.33	3.38	3.33	3.67	2.88	4.13	3.22	O
3.56	3.5	3.17	3.67	2.88	4.25	3.22	O
3.33	3.5	3.33	3.33	2.75	4.38	3.22	O
4.44	4.13	3.83	3.33	3.38	4.38	3.67	P
4	3.88	3.5	3.33	3.25	4.13	3.67	P
4.11	4	3.67	3.67	3.38	4.13	3.56	P
3.89	4	3.33	4	3	4.13	3.78	P
3.78	3.88	3.33	3.33	2.88	4.13	3.22	P
3.78	3.63	3.5	3.67	3.13	4	3.44	P
3.67	3.63	3.17	3.33	3.13	4.13	3.44	P
3.78	3.75	3.33	3.33	3.13	4	3.56	P
3.67	3.63	3.33	3.33	3.13	4.13	3.44	P
3.89	3.75	3.5	3.67	3.13	4	3.67	P
4.22	3.88	4.33	3.67	3.38	3	3.22	P
4.22	3.88	4.17	3.67	3.25	3.13	3.33	P
4.22	4.13	4.33	3.67	3.63	4.5	4.22	P
3.56	3.75	4	3.33	3.38	3.88	4.11	P
3.33	3.75	3.67	3.67	3.63	3.88	4.11	P
3.56	3.5	3.5	3.67	2.88	3.88	3	O
3.33	3.38	3.5	3.67	2.75	3.88	3.11	O
4.44	3.75	4	3.67	2.88	4	3.44	P
4	3.5	3.83	3.33	2.88	4	3.33	P
4.11	3.75	4	3.67	3.25	3.88	3.44	P
3.89	3.75	3.5	3.33	3.13	3.63	3.56	P
3.78	3.88	3.5	3.33	3.13	3.88	3.56	P
3.78	3.63	3.83	4.33	3.13	3.88	4	P
3.67	3.5	3.5	3.33	3.25	3.88	3.22	P
3.78	3.63	3.67	3.33	3.13	3.75	3.44	P
3.67	3.5	3.67	3.33	3.13	3.88	3.56	P
3.89	3.5	3.83	3.67	3.38	3.75	3.56	P
3.33	3.88	3.67	3.33	4	4.13	3.89	P
3	3.63	3.83	3.67	4	4.13	3.56	P
3.22	3.88	3.83	3.67	4.13	4	3.67	O
2.44	2.88	3.17	2.67	3.5	3.75	3.33	O
2.44	3.13	3.17	3	3.5	3.38	3.22	O
2.44	3.25	3	3	3.63	3.25	3.22	O
2.56	3.13	3.17	3.33	3.63	3.38	3.11	O
2.67	3.88	3.83	3.33	3.88	4	3.89	PP
2.56	3.63	3.5	3.67	3.63	3.63	3.44	O
2.67	3.75	3.83	3.33	3.5	3.75	3.44	O
2.78	3.5	3.67	3.33	3.38	3.63	3.11	O
2.44	3.38	3.17	3	3.63	3.75	3.11	O
2.67	3.13	3.33	3	3.5	3.75	3.33	O
2.56	3.25	3.33	3.33	3.5	3.5	3.22	O

2.67	3.25	3.33	3.33	3.5	3.5	3.44	O
2.56	3.25	3.33	3.33	3.5	3.63	3.33	O
2.67	3.13	3.5	3.33	3.5	3.88	3.33	O
3.67	4	4.17	4.33	4.38	4.63	3.89	P
3.56	3.75	4	4	4.38	4.63	3.67	P
3.56	3.75	4	4	4.25	4.5	3.67	P
2.78	3.13	3.33	3	4.13	4.13	3.33	O
2.89	3.25	3.17	3	4.13	3.75	3.22	O
3	3.38	3	3	4.13	3.75	3.22	O
3.11	3.13	3.17	3.33	4.13	3.75	3.22	O
3.33	3.63	3.83	3.33	4.38	4.38	3.89	P
3.11	3.5	3.5	3.67	4.25	4.13	3.67	P
3	3.38	3.83	3.33	4.13	4.13	3.44	P
3.11	3.38	3.67	3.33	4.13	4	3.33	P
2.89	3.38	3.17	3	4.25	4.13	3.11	O
3	3	3.33	3	4.13	4.13	3.44	O
2.89	3.25	3.33	3.33	4.13	3.88	3.22	O
3	3.25	3.33	3.33	4.13	3.88	3.44	O
2.89	3.13	3.33	3.33	4	4	3.33	O
3	3.13	3.5	3.33	4.13	4.25	3.33	P
3.33	3.88	3.67	3.33	4	4.13	3.89	P
3	3.63	3.83	3.67	4	4.13	3.56	P
3.22	3.88	3.83	3.67	4.13	4	3.67	P
2.44	2.88	3.17	2.67	3.5	3.75	3.33	O
2.44	3.13	3.17	3	3.5	3.38	3.22	O
2.44	3.25	3	3	3.63	3.25	3.22	O
2.56	3.13	3.17	3.33	3.63	3.38	3.11	P
2.67	3.88	3.83	3.33	3.88	4	3.89	P
2.56	3.63	3.5	3.67	3.63	3.63	3.44	O
2.67	3.75	3.83	3.33	3.5	3.75	3.44	O
2.78	3.5	3.67	3.33	3.38	3.63	3.11	O
2.44	3.38	3.17	3	3.63	3.75	3.11	O
2.67	3.13	3.33	3	3.5	3.75	3.33	O
2.56	3.25	3.33	3.33	3.5	3.5	3.22	O
2.67	3.25	3.33	3.33	3.5	3.5	3.44	O
2.56	3.25	3.33	3.33	3.5	3.63	3.33	O
2.67	3.13	3.5	3.33	3.5	3.88	3.33	O
3.67	4	4.17	4.33	4.38	4.63	3.89	P
3.56	3.75	4	4	4.38	4.63	3.67	P
3.56	3.75	4	4	4.25	4.5	3.67	P
2.78	3.13	3.33	3	4.13	4.13	3.33	O
2.89	3.25	3.17	3	4.13	3.75	3.22	O
3	3.38	3	3	4.13	3.75	3.22	O
3.11	3.13	3.17	3.33	4.13	3.75	3.22	O
3.33	3.63	3.83	3.33	4.38	4.38	3.89	P

3.11	3.5	3.5	3.67	4.25	4.13	3.67	P
3	3.38	3.83	3.33	4.13	4.13	3.44	P
3.11	3.38	3.67	3.33	4.13	4	3.33	P
2.89	3.38	3.17	3	4.25	4.13	3.11	O
3	3	3.33	3	4.13	4.13	3.44	O
2.89	3.25	3.33	3.33	4.13	3.88	3.22	O
3	3.25	3.33	3.33	4.13	3.88	3.44	O
2.89	3.13	3.33	3.33	4	4	3.33	O
3	3.13	3.5	3.33	4.13	4.25	3.33	P
3.33	3.75	3.67	3.33	3.88	4.13	3.89	P
3	3.63	3.83	3.67	3.88	4.13	3.56	P
3.22	3.75	3.83	3.67	4	4	3.67	P
2.44	2.88	3.17	2.67	3.5	3.75	3.33	O
2.44	3.25	3.17	3	3.5	3.38	3.22	O
2.44	3.38	3	3	3.5	3.25	3.22	O
2.56	3.13	3.17	3.33	3.5	3.38	3.11	O
2.67	3.63	3.83	3.33	3.75	4	3.89	P
2.56	3.5	3.5	3.67	3.63	3.63	3.44	O
2.67	3.38	3.83	3.33	3.5	3.75	3.44	O
2.78	3.38	3.67	3.33	3.38	3.63	3.11	O
2.44	3.38	3.17	3	3.63	3.75	3.11	O
2.67	3	3.33	3	3.5	3.75	3.44	O
2.56	3.25	3.33	3.33	3.5	3.5	3.22	O
2.67	3.25	3.33	3.33	3.5	3.5	3.44	O
2.56	3.13	3.33	3.33	3.5	3.63	3.33	O
2.67	3.13	3.5	3.33	3.5	3.88	3.33	O

APPENDIX E

NHSFFRES MODEL PERFORMANCE ANALYSIS


Trajan Demonstrator - hunter1, MLP 7:7-12-3:1 - [Run Data Set]
File Edit Train Statistics Run Options Window Help
Outputs shown Variables
Run
<Data Set
RMS Error Train 0.2294 Verify 0.2386 Test 0.1704
OUTPUT T. OUTPUT E. OUTPUT Error
Save To File
01 P P Right 0.3383305
02 P P Right 0.2205539
03 P P Right 0.09741
04 P O Wrong 0.7308114
05 O O Right 0.002953
06 O P Wrong 0.7733246
07 O O Right 0.004348
08 P P Right 0.2571427
09 P P Right 0.1425701
10 P P Right 0.02045
11 P P Right 0.008677
12 P P Right 0.093664
13 P P Right 0.009948
14 P O Wrong 0.7284204
15 P P Right 0.03201
16 P P Right 0.06208
17 P P Right 0.01611
18 P P Right 0.3383305
19 P P Right 0.2205539
Save the Object (or its underlying data) to a File
0:00:00
Page 1 Sec 1 1/1 At 2.5cm Ln 1 Col 1 REC TRK EXT OVR WPH
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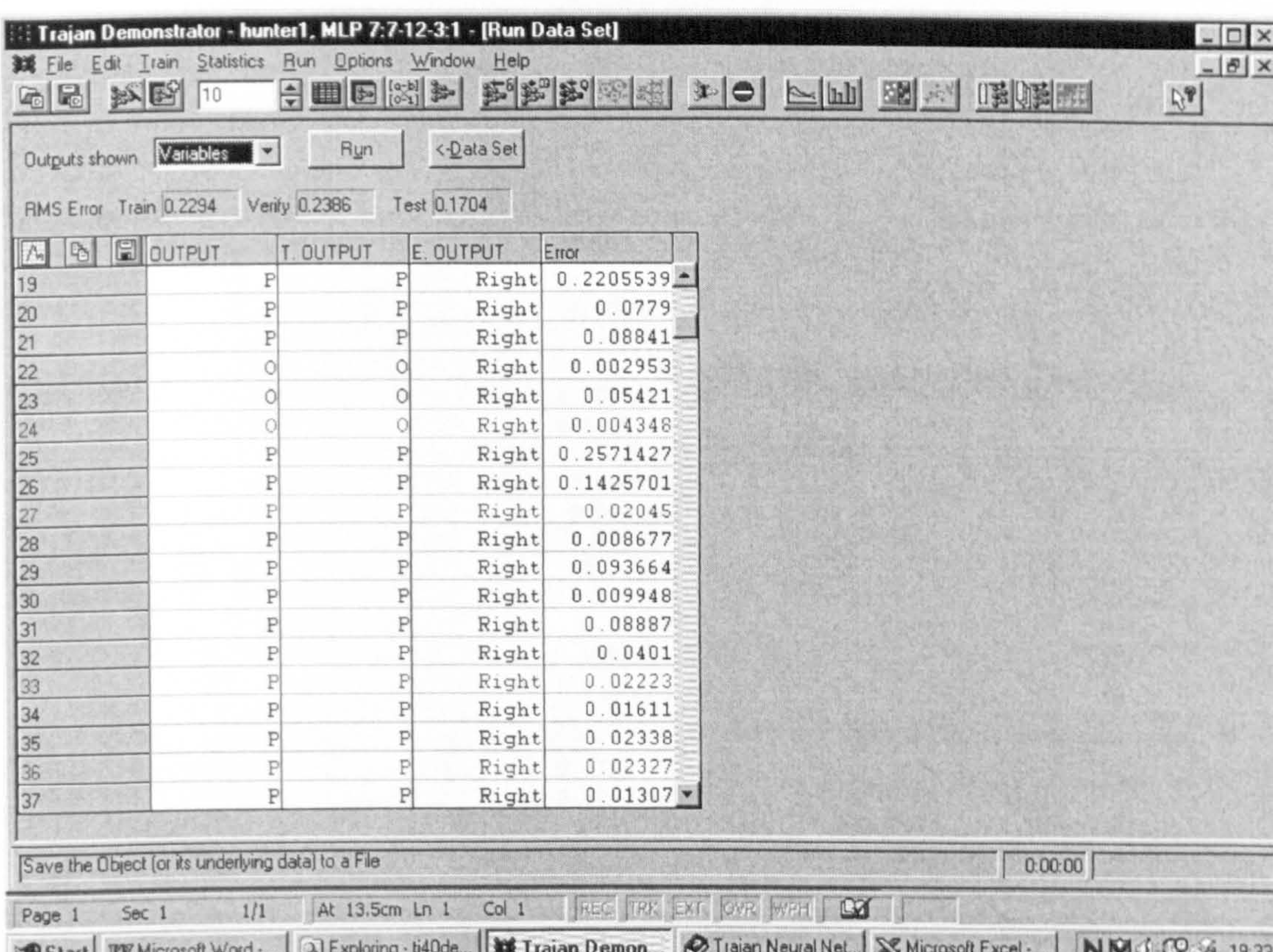
Trajan Demonstrator - hunter1, MLP 7:7-12-3:1 - [Run Data Set]
File Edit Train Statistics Run Options Window Help
Outputs shown Variables
Run
<Data Set
RMS Error Train 0.2294 Verify 0.2386 Test 0.1704
OUTPUT T. OUTPUT E. OUTPUT Error
19 P P Right 0.2205539
20 P P Right 0.0779
21 P P Right 0.08841
22 O O Right 0.002953
23 O O Right 0.05421
24 O O Right 0.004348
25 P P Right 0.2571427
26 P P Right 0.1425701
27 P P Right 0.02045
28 P P Right 0.008677
29 P P Right 0.093664
30 P P Right 0.009948
31 P P Right 0.08887
32 P P Right 0.0401
33 P P Right 0.02223
34 P P Right 0.01611
35 P P Right 0.02338
36 P P Right 0.02327
37 P P Right 0.01307
Save the Object (or its underlying data) to a File
0:00:00
Page 1 Sec 1 1/1 At 13.5cm Ln 1 Col 1 REC TRK EXT OVR WPH
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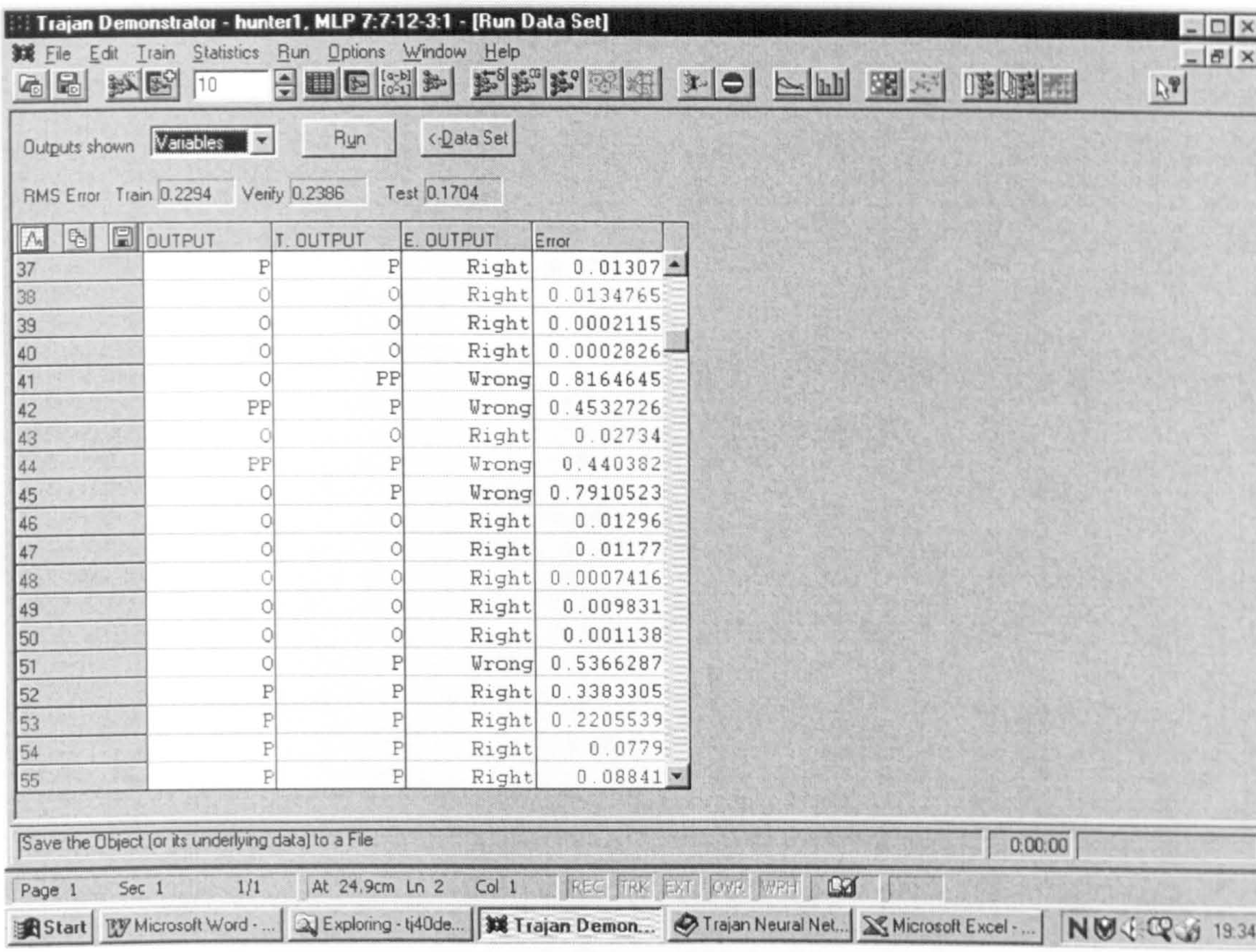
Trajan Demonstrator - hunter1, MLP 7:7-12-3:1 - [Run Data Set]
File Edit Train Statistics Run Options Window Help
10
Outputs shown Variables
Run
<-Data Set
RMS Error Train 0.2294 Verify 0.2386 Test 0.1704
OUTPUT T. OUTPUT E. OUTPUT Error
37 P P Right 0.01307
38 O O Right 0.0134765
39 O O Right 0.0002115
40 O O Right 0.0002826
41 O PP Wrong 0.8164645
42 PP P Wrong 0.4532726
43 O O Right 0.02734
44 PP P Wrong 0.440382
45 O P Wrong 0.7910523
46 O O Right 0.01296
47 O O Right 0.01177
48 O O Right 0.0007416
49 O O Right 0.009831
50 O O Right 0.001138
51 O P Wrong 0.5366287
52 P P Right 0.3383305
53 P P Right 0.2205539
54 P P Right 0.0779
55 P P Right 0.08841
Save the Object (or its underlying data) to a File
0:00:00
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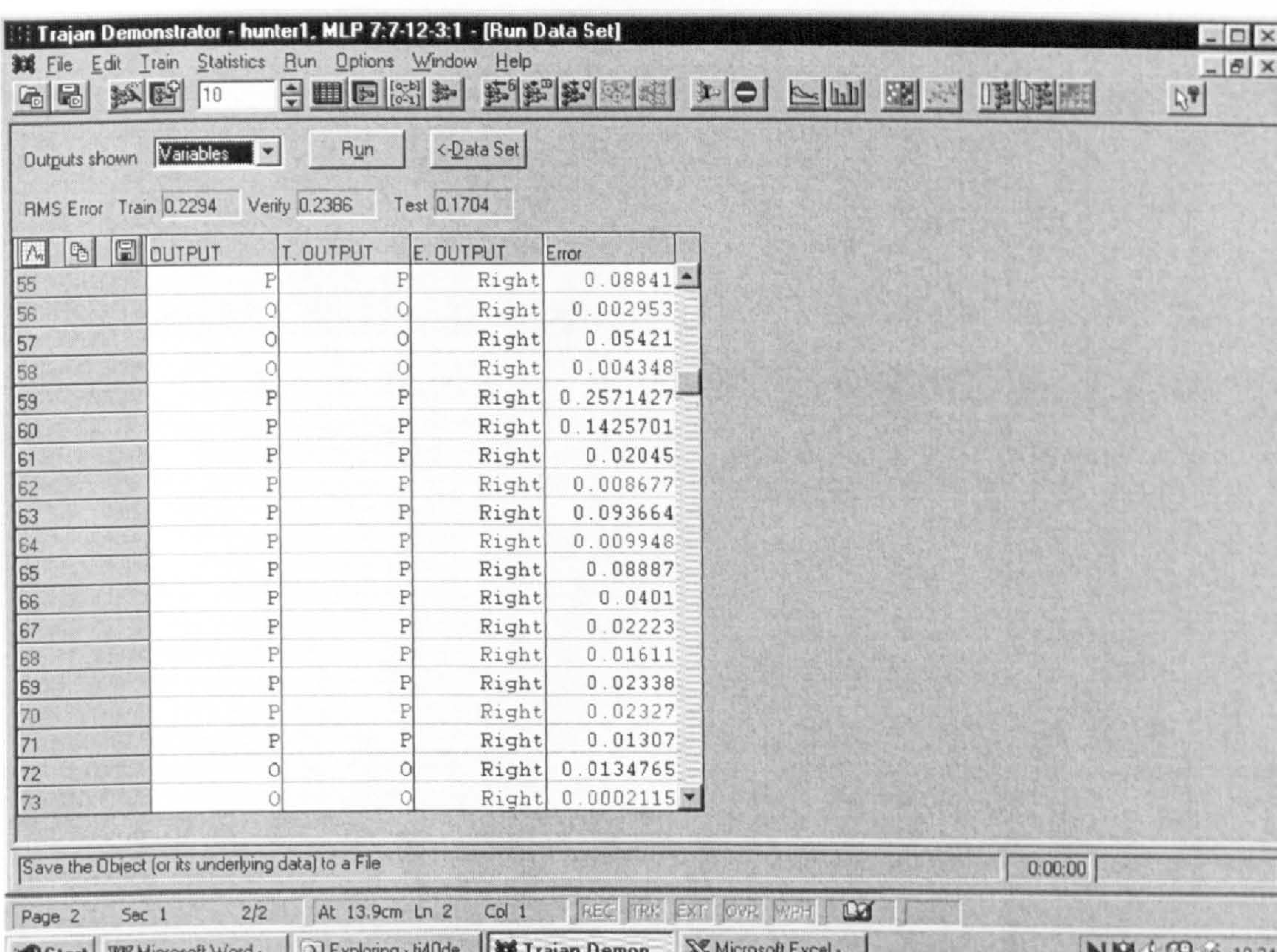
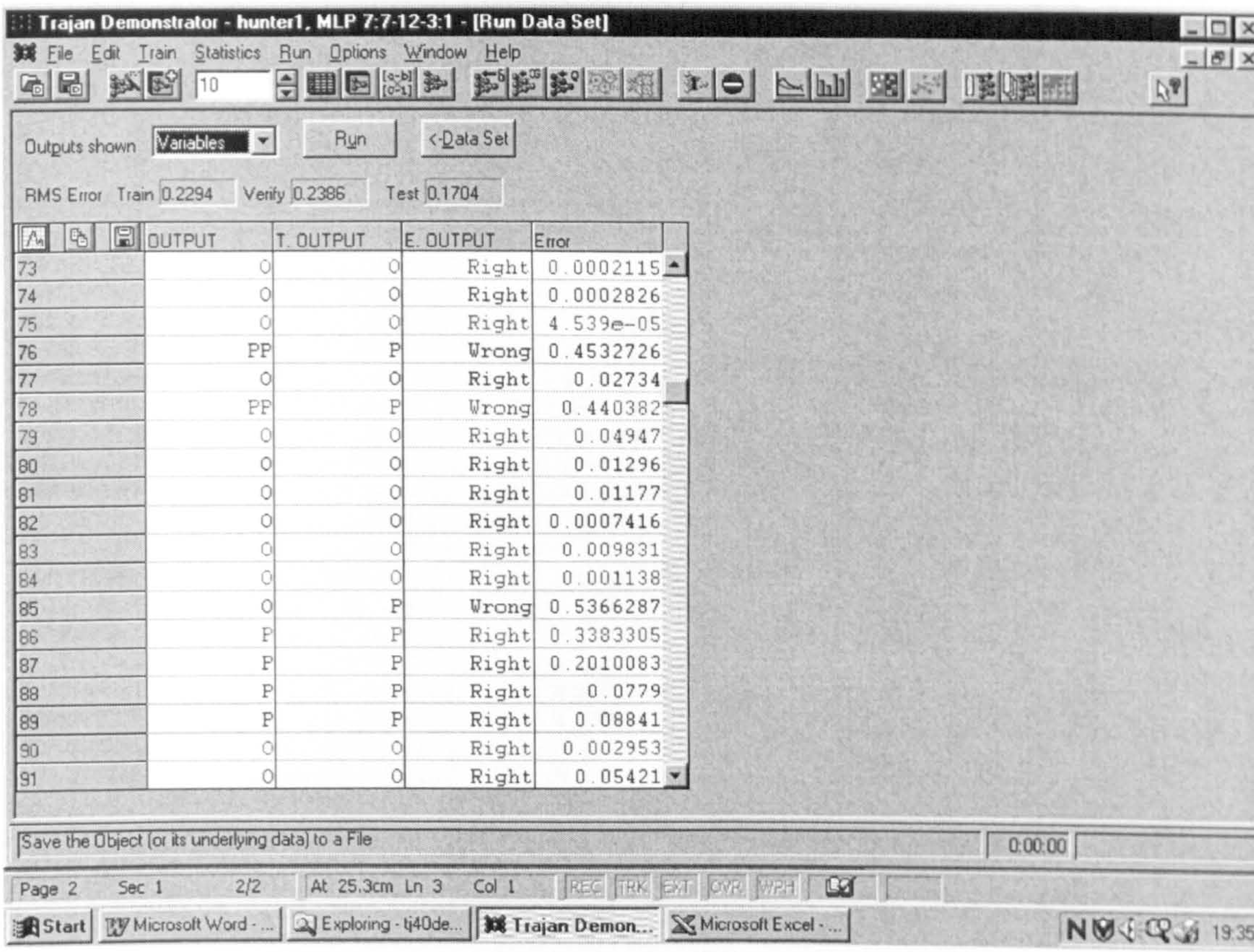
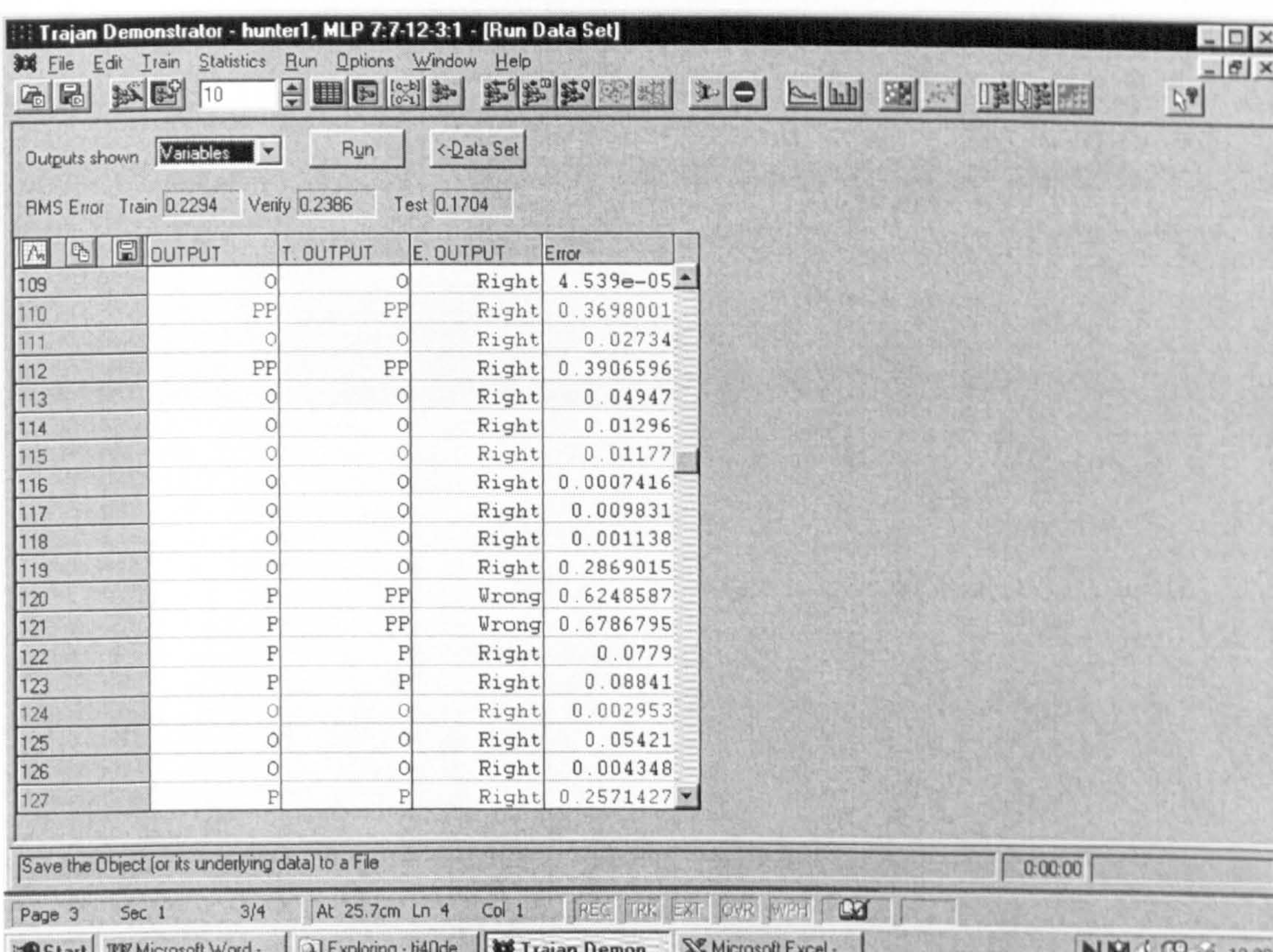
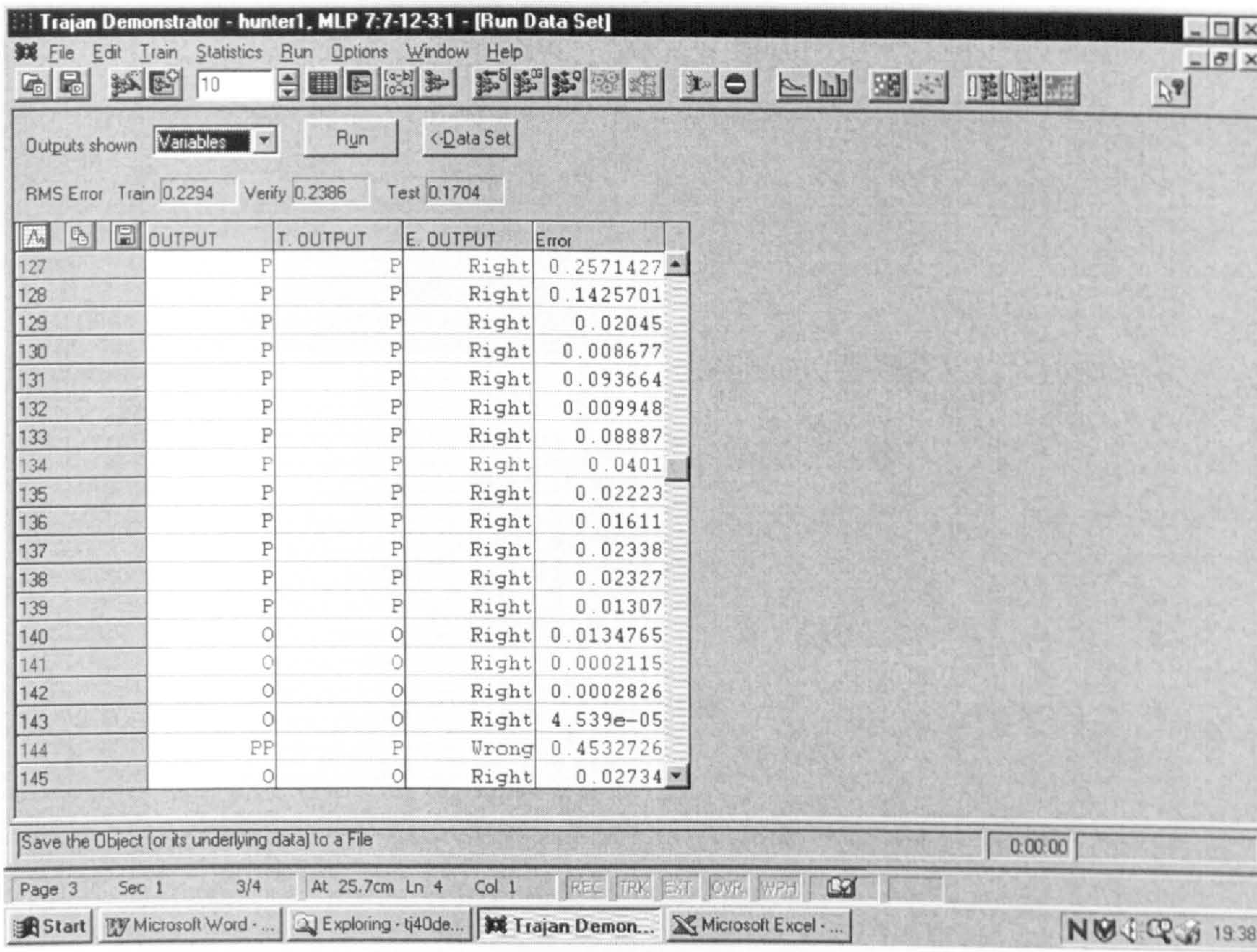

Trajan Demonstrator - hunter1, MLP 7:7-12-3:1 - [Run Data Set]
File Edit Train Statistics Run Options Window Help
10
Outputs shown Variables
Run
<-Data Set
RMS Error Train 0.2294 Verify 0.2386 Test 0.1704
OUTPUT T. OUTPUT E. OUTPUT Error
55 P P Right 0.08841
56 O O Right 0.002953
57 O O Right 0.05421
58 O O Right 0.004348
59 P P Right 0.2571427
60 P P Right 0.1425701
61 P P Right 0.02045
62 P P Right 0.008677
63 P P Right 0.093664
64 P P Right 0.009948
65 P P Right 0.08887
66 P P Right 0.0401
67 P P Right 0.02223
68 P P Right 0.01611
69 P P Right 0.02338
70 P P Right 0.02327
71 P P Right 0.01307
72 O O Right 0.0134765
73 O O Right 0.0002115
Save the Object (or its underlying data) to a File
0:00:00
Page 2 Sec 1 2/2 At 13.9cm Ln 2 Col 1 REC TRK EXT OVR WPH
Start Microsoft Word - ... Exploring - tj40de... Trajan Demon... Microsoft Excel - ... 19:34

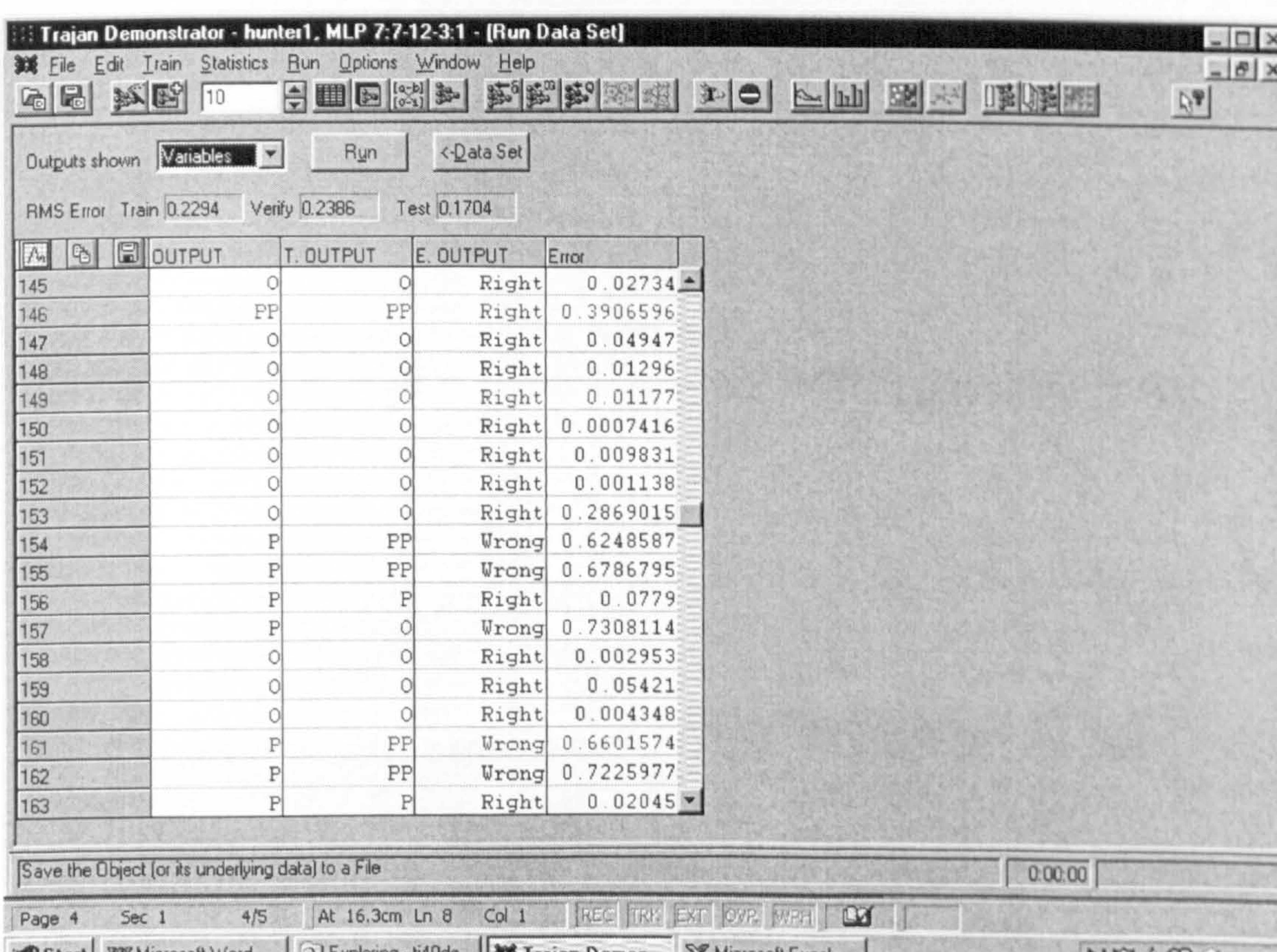


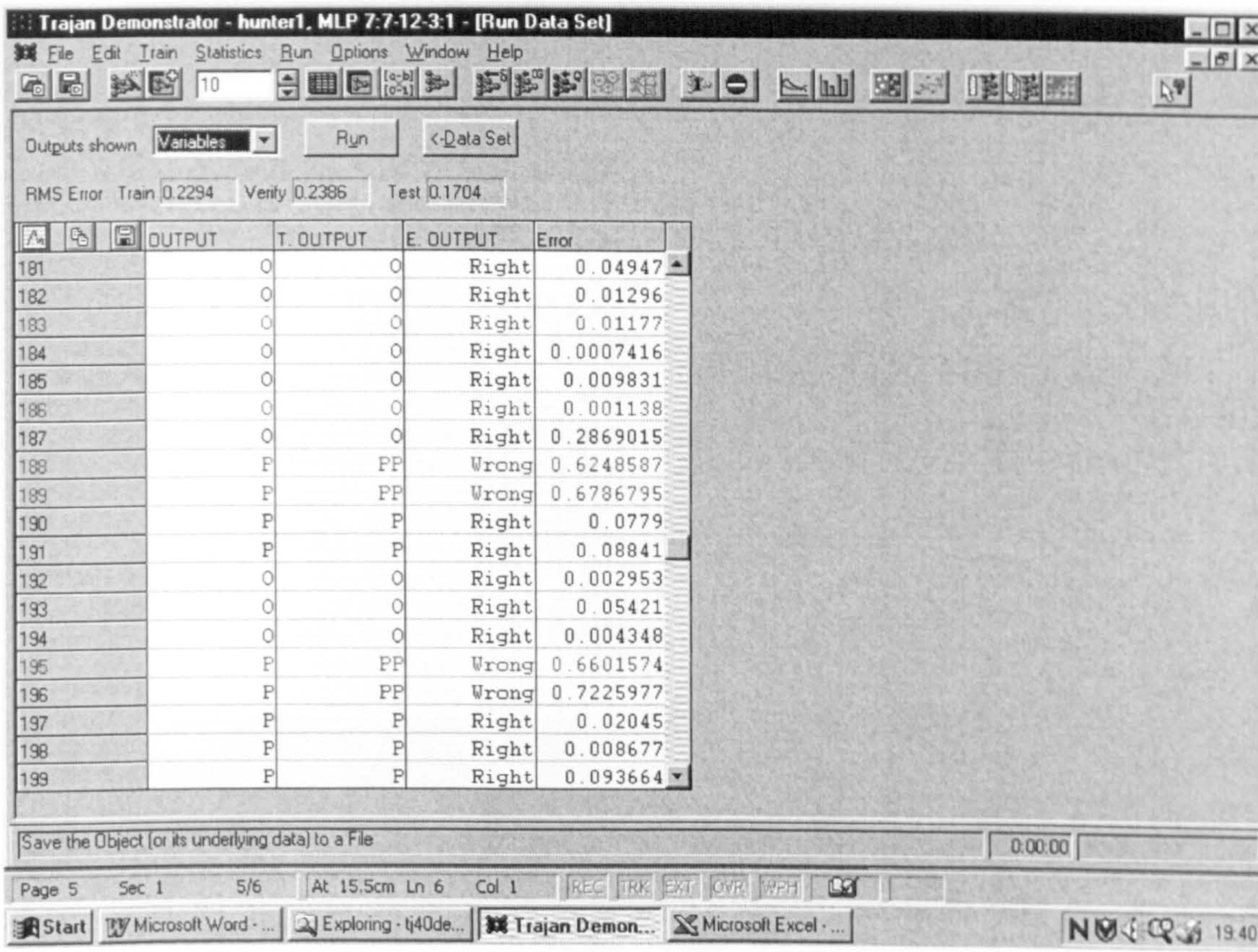
	OUTPUT	T. OUTPUT	E. OUTPUT	Error
73	O	O	Right	0.0002115
74	O	O	Right	0.0002826
75	O	O	Right	4.539e-05
76	PP	P	Wrong	0.4532726
77	O	O	Right	0.02734
78	PP	P	Wrong	0.440382
79	O	O	Right	0.04947
80	O	O	Right	0.01296
81	O	O	Right	0.01177
82	O	O	Right	0.0007416
83	O	O	Right	0.009831
84	O	O	Right	0.001138
85	O	P	Wrong	0.5366287
86	P	P	Right	0.3383305
87	P	P	Right	0.2010083
88	P	P	Right	0.0779
89	P	P	Right	0.08841
90	O	O	Right	0.002953
91	O	O	Right	0.05421



	OUTPUT	T. OUTPUT	E. OUTPUT	Error
109	O	O	Right	4.539e-05
110	PP	PP	Right	0.3698001
111	O	O	Right	0.02734
112	PP	PP	Right	0.3906596
113	O	O	Right	0.04947
114	O	O	Right	0.01296
115	O	O	Right	0.01177
116	O	O	Right	0.0007416
117	O	O	Right	0.009831
118	O	O	Right	0.001138
119	O	O	Right	0.2869015
120	P	PP	Wrong	0.6248587
121	P	PP	Wrong	0.6786795
122	P	P	Right	0.0779
123	P	P	Right	0.08841
124	O	O	Right	0.002953
125	O	O	Right	0.05421
126	O	O	Right	0.004348
127	P	P	Right	0.2571427


Trajan Demonstrator - hunter1, MLP 7:7-12-3:1 - [Run Data Set]
File Edit Train Statistics Run Options Window Help
Outputs shown Variables Run <-Data Set
RMS Error Train 0.2294 Verify 0.2386 Test 0.1704
OUTPUT T. OUTPUT E. OUTPUT Error
127 P P Right 0.2571427
128 P P Right 0.1425701
129 P P Right 0.02045
130 P P Right 0.008677
131 P P Right 0.093664
132 P P Right 0.009948
133 P P Right 0.08887
134 P P Right 0.0401
135 P P Right 0.02223
136 P P Right 0.01611
137 P P Right 0.02338
138 P P Right 0.02327
139 P P Right 0.01307
140 O O Right 0.0134765
141 O O Right 0.0002115
142 O O Right 0.0002826
143 O O Right 4.539e-05
144 PP P Wrong 0.4532726
145 O O Right 0.02734
Save the Object (or its underlying data) to a File
0:00:00
Page 3 Sec 1 3/4 At 25.7cm Ln 4 Col 1
Start Microsoft Word - ... Exploring - tj40de... Trajan Demon... Microsoft Excel - ...
19:38


Trajan Demonstrator - hunter1, MLP 7:7-12-3:1 - [Run Data Set]
File Edit Train Statistics Run Options Window Help
Outputs shown Variables Run <-Data Set
RMS Error Train 0.2294 Verify 0.2386 Test 0.1704
OUTPUT T. OUTPUT E. OUTPUT Error
145 O O Right 0.02734
146 PP PP Right 0.3906596
147 O O Right 0.04947
148 O O Right 0.01296
149 O O Right 0.01177
150 O O Right 0.0007416
151 O O Right 0.009831
152 O O Right 0.001138
153 O O Right 0.2869015
154 P PP Wrong 0.6248587
155 P PP Wrong 0.6786795
156 P P Right 0.0779
157 P O Wrong 0.7308114
158 O O Right 0.002953
159 O O Right 0.05421
160 O O Right 0.004348
161 P PP Wrong 0.6601574
162 P PP Wrong 0.7225977
163 P P Right 0.02045
Save the Object (or its underlying data) to a File
0:00:00
Page 4 Sec 1 4/5 At 16.3cm Ln 8 Col 1
Start Microsoft Word - ... Exploring - tj40de... Trajan Demon... Microsoft Excel - ...
19:39



	OUTPUT	T. OUTPUT	E. OUTPUT	Error
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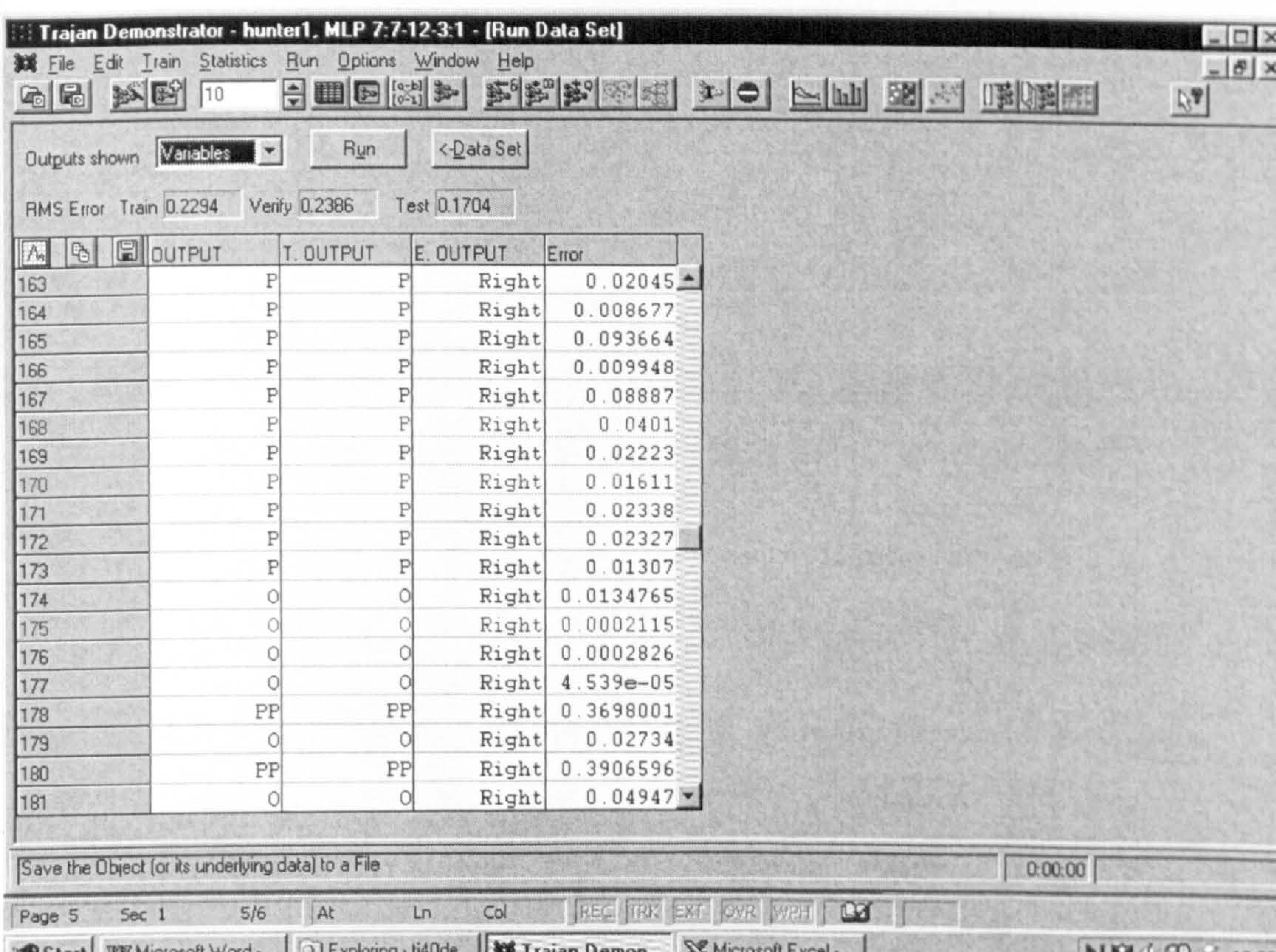
182	O	O	Right	0.01296
183	O	O	Right	0.01177
184	O	O	Right	0.0007416
185	O	O	Right	0.009831
186	O	O	Right	0.001138
187	O	O	Right	0.2869015
188	P	PP	Wrong	0.6248587
189	P	PP	Wrong	0.6786795
190	P	P	Right	0.0779
191	P	P	Right	0.08841
192	O	O	Right	0.002953
193	O	O	Right	0.05421
194	O	O	Right	0.004348
195	P	PP	Wrong	0.6601574
196	P	PP	Wrong	0.7225977
197	P	P	Right	0.02045
198	P	P	Right	0.008677
199	P	P	Right	0.093664



	OUTPUT	T. OUTPUT	E. OUTPUT	Error
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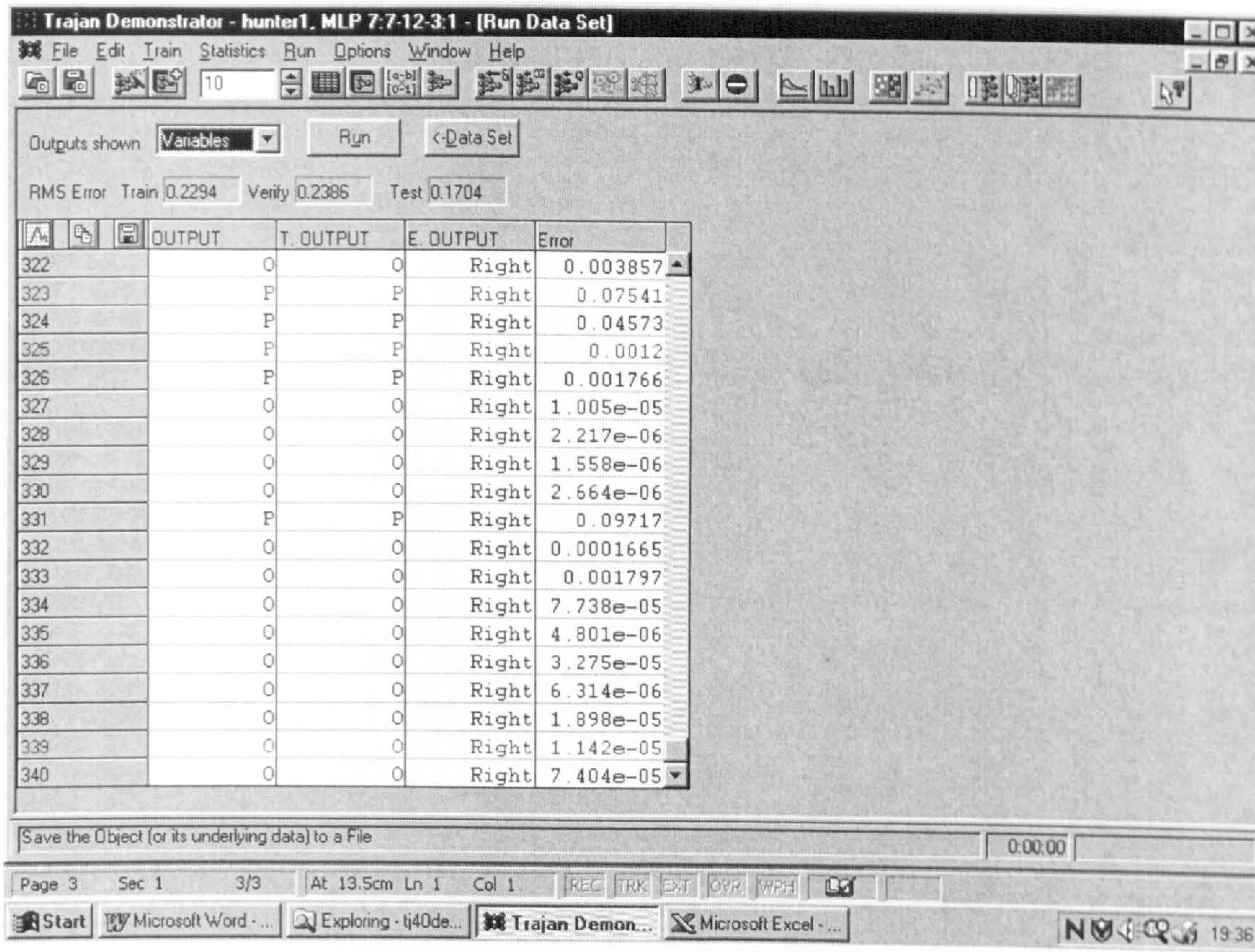
164	P	P	Right	0.008677
165	P	P	Right	0.093664
166	P	P	Right	0.009948
167	P	P	Right	0.08887
168	P	P	Right	0.0401
169	P	P	Right	0.02223
170	P	P	Right	0.01611
171	P	P	Right	0.02338
172	P	P	Right	0.02327
173	P	P	Right	0.01307
174	O	O	Right	0.0134765
175	O	O	Right	0.0002115
176	O	O	Right	0.0002826
177	O	O	Right	4.539e-05
178	PP	PP	Right	0.3698001
179	O	O	Right	0.02734
180	PP	PP	Right	0.3906596
181	O	O	Right	0.04947



	OUTPUT	T. OUTPUT	E. OUTPUT	Error
322	O	O	Right	0.003857
323	P	P	Right	0.07541
324	P	P	Right	0.04573
325	P	P	Right	0.0012
326	P	P	Right	0.001766
327	O	O	Right	1.005e-05
328	O	O	Right	2.217e-06
329	O	O	Right	1.558e-06
330	O	O	Right	2.664e-06
331	P	P	Right	0.09717
332	O	O	Right	0.0001665
333	O	O	Right	0.001797
334	O	O	Right	7.738e-05
335	O	O	Right	4.801e-06
336	O	O	Right	3.275e-05
337	O	O	Right	6.314e-06
338	O	O	Right	1.898e-05
339	O	O	Right	1.142e-05
340	O	O	Right	7.404e-05

APPENDIX F
MODEL VALIDATION RESULTS

1.16 Multiple regression Model

As this research is the only one of its kind to be undertaken in healthcare FM operations management, the absence of previous quantitative tools to compare and test the usefulness of the ANN model was considered as an important issue worth examining fully in this research. Therefore, the researcher had to choose another traditional modeling technique to compare the performance of the ANN model which was developed for the NHSFRES. According to Lam *et al.*, (2000) and Boussabaine *et al.*, (1999) several modeling techniques have now been developed in FM that can be used to compare their performance with that of ANNs models. These models are numerous and can either be:

i) Statistical models
ii) Traditional models
iii) Life cycle costing
iv) Resource-based – PERT
v) Artificial intelligence
vi) Risk analysis techniques

All the above stated modeling techniques were explained in chapter four of this thesis, and do rely to some extent on assumptions, whether explicit or implicit. In order to assess the viability of a model using any of the above techniques, the user needs to have an understanding of the assumptions, which contribute to it. Unfortunately, where the assumptions are built in, it is difficult to assess and evaluate the model in question. A key issue that should always be noted by facilities managers or NHSFRES users in the case of the research problem for this survey is that, the concept of measuring or evaluating business risks will always be uncertain. Therefore, the user must distinguish between those methods that include a formal measure of uncertainty (stochastic methods) and those that do not (deterministic). In this research, the selection of a comparable model was based on the main attributes outlined by Boussabaine *et al.*, (1999) as being essential when comparing models:

i) the characteristics of data to be employed must be quantitative, qualitative, large not small;

ii) general knowledge of the problem to be modeled;

iii) general knowledge about the boundary conditions of the model;

iv) errors that the model can generate;

v) input and output targets and possible consequences;

vi) understanding of accuracy, reliability, validity, confidence and sensitivity of the model to be selected; and

vii) understanding the parameters that define the problem to be modelled.

After an extensive evaluation of various modeling techniques, the researcher selected to use the MRA. The MRA was used because it is a method commonly used by healthcare and facilities managers to compare and make estimates for key variables using collected FM knowledge from healthcare facilities managers working in the NHS. Furthermore, this method of modelling has been widely used in by most in facilities management research (Ilozor and Oluwoye, 1999; Ilozor and Oluwoye, 1998; Bussabaine *et al.*, 1999; Edwards *et al.*, 2000; and Bean and Holden, 1994). Therefore, multiple regression analysis is a method for quantifying the relationship between a dependent factor/variable/ criterion and one or more independent factor(s)/ variable(s)/criterion.

Multiple regression analysis involves using more than one independent variable to estimate the dependent variable (Venugopal and Baets, 1994). However, whatever relationship is found it will be a linear one, while in general facilities managers tend to deal with nonlinear relationships. Multiple regression analysis as used in this research served two purposes: firstly, it provided a benchmark against which ANN results can be measured; secondly, it enabled a more careful selection of the variables that will enter the ANN. In developing a MR model, the independent (FM risk factors/input) variables are regressed upon the dependent (risk exposure/output) variable. The regression model is represented as an equation based on the linear (or non-linear) relationship between the dependent variable and two or more independent variables plus an error term. The MRA equation is constructed from simultaneous assessment of the influence of the independent variables upon the independent. MRA calls for determining the quantitative relationship with the following explanatory variables for determining risk factor classification and analysis by healthcare facilities managers:

$$Y = a+b_1X_1+b_2X_2+\ldots\ldots\ldots\ldots+b_kX_k+e$$

where, Y= dependent variable;

a = intercept on y-axis; Xs = independent variables; and

b_k = regression coefficient for k independent variables;

e = The error term

The estimated regression coefficient, b_k was used to measure the amount of changes in Y due to the influence of changes in X_k (Tabachnick and Fidell, 1993; Akinsola, 1997; and Edwards *et al.*, 2000).

1.17 Forecasting results using the MR model

The software used to develop and analyse the MR model was Statistical Package for the Social Scientist (SPSS - version 8.1). As a prerequisite for using MRA, the risk factor variables used as input data were tested for various MR model assumptions. These assumptions were used to check that the FM operators' critical risk factors used to develop the model are multivariate, normally distributed and the covariance matrices of each group used are identical. As a result were not violated (Edwards *et al.*, 2000). In the UK NHS trust hospitals, data pertaining to FM operators' critical risk factors characteristics does violate the normality condition, as it is collected from a wide range of healthcare facilities managers with different perceptions and values about the healthcare business process. Violation of the normality condition affects the predictive accuracy of the analysis (Lippman, 1987). These assumptions needed to be checked for, to avoid developing and using a poor performance-predicting model. Before giving a detailed explanation of how the MR model was developed and tested in this research, it is important first of all to discuss some of the main problems associated with developing MR models and their general analysis (Venugopal and Baets, 1994).

1.18 Difficulties in Regression

The main difficulty in using regression analysis is the requirement of a priori knowledge of the functional form. As above, to formulate the equation, the healthcare facilities manager/decision maker should know a priori the form of the equation that the available information represents. Under normal circumstances, a priori knowledge of the form of the equation is difficult. Otherwise, facilities managers can try several functional forms and finally choose the one that best fits the data. Even in this worst case, facilities managers face the problem of deciding which functional form to consider for the problem under consideration. Often, facilities managers make simplifying assumptions of linearity in the data structure, which has the advantage that models can be built more easily. But linear models are extremely bad at picking up turning-points or changes in the available information. As decision-makers healthcare facilities managers will always have to deal with a multivariate of business risk factors and performance data. This data series is bound to have turning-point trends and non-linearity. Sometimes, the data series may be also chaotic (Thall, 1992). Besides these issues, several methodological problems such as multicollinearity and heteroscedasticity are involved in the regression analysis. For instance, in this research problem, the critical FM risk factors identified for FM purchasers, in-house and external providers are correlated and can lead to multicollinearity problems. The conventional multiple regression analysis can deal with only one dependent variable at a time. In this research problem, suppose NHS facilities managers are interested in predicting the level of risk exposure in various FM cases (services/elements) as well as the overall FM business exposure of all the integrated/total FM services. Then, these two problems are to be treated separately. When multiple factors are to be predicted, statistical analysis such as canonical correlation can help. But it is onerous to interpret the results of such an analysis and the methodology does not lend itself readily to making predictions (Proctor, 1992) Facilities managers may wonder if there is a methodology (i.e. ANNs) that can take all this into account and serve as a tool for accurate risk management forecasts.

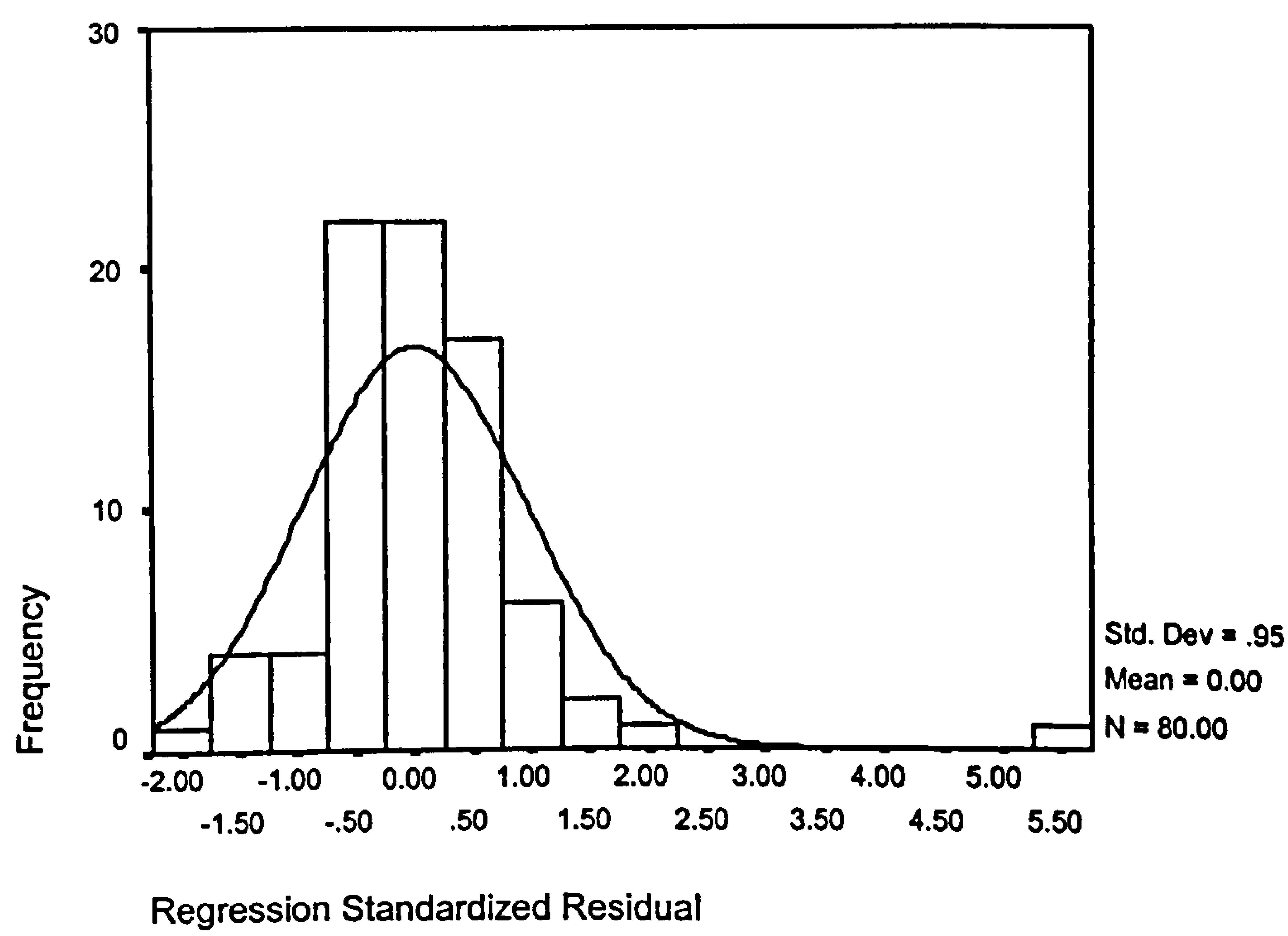
1.19 Checking for violation of MR model assumptions

In order to prove model appropriateness, that is, checking for violation of model assumptions (for example, non-constant variance and multicollinearity), output of the MR analysis was analysed (see Figure 1.9). In order to investigate for sample distribution and normality, the **Kolmogorov-Smirnov test** was used for testing the distribution of normality or goodness-of-fit. Figure 1.9 shows that the results of the test executed on the training data confirmed that the sample was normally distributed, thus allowing the appropriate transformation to meet the normality assumptions of the regression modelling technique.

1.20 Multicollinearity

Multicollinearity (i.e. correlation amongst predictor (X) variables) is problematic in that it can produce model instability (Lapin, 1993). To determine the presence (or absence) of collinearity, the results of several diagnostic tests were examined.

Figure 1.9: Histogram of residuals for MR model



1.21 Tolerance

In essence, tolerance is the proportion of variability of each independent variable that is not explained by its linear relationship with other independent variables in the model. Since tolerance is a proportion, its values range from 0 (low) and 0.5 (medium) to 1 (high). When the tolerance is low, multiple correlation is high and hence there is a possibility of multicollinearity (Bryman and Cramer, 1997).

With low tolerances of 0.32; 0.12; 0.23; 0.33; 0.35; 0.29 and 0.12 for legal risks; corporation risks; business transfer risks; facility transmitted risks; financial and economic risks; customer care risks and commercial risks respectively, the likelihood of multicollinearity is low as it is below the average of 0.5.

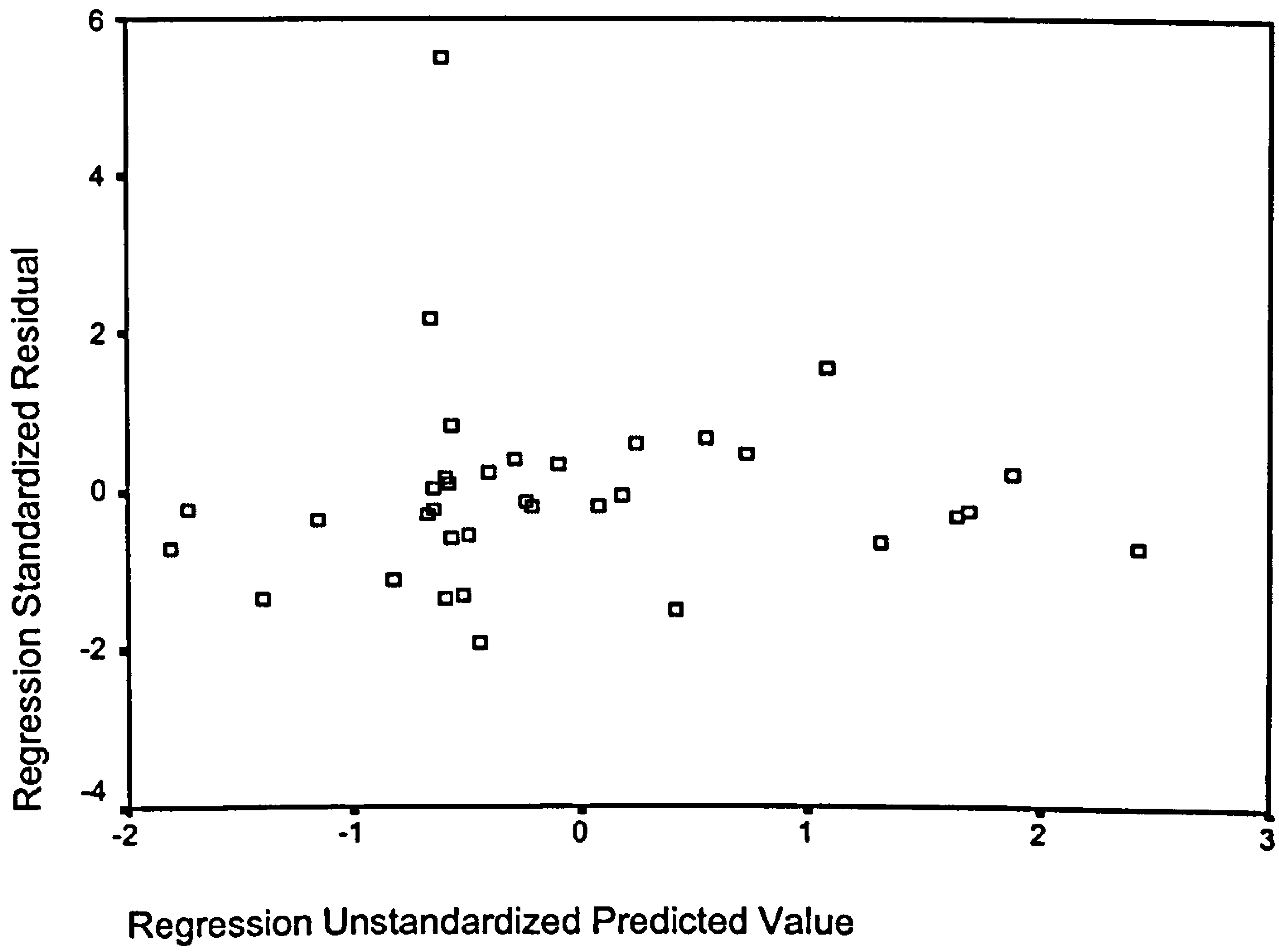
1.22 Variance inflation factor (VIF)

VIF and tolerance are closely related in that VIF is the reciprocal of tolerance (Norusĭis, 1993). Consequently, VIFs for the seven independent variables (legal risks; corporation risks; business transfer risks; facility transmitted risks; financial and economic risks; customer care risks and commercial risks are all low at 3.1; 8.2; 4.2; 2.9; 2.7; 3.3; and 9.2. Again this would point to the likelihood of multicollinearity being low.

1.23 Equality of variance and normality

The assumption of constant variance of Y for all values of X can be checked for violations by plotting the residuals against the predicted values (see Figure 1.7), where residuals are the difference between the actual and predicted risk exposure (output) (Rees, 1996). As residuals remain constant with the magnitude of the predicted output values it is suggested that the equality of variance assumption appears to be proven (Edwards *et al.*, 2000). In order to determine the correctness of this assumption of normality, a histogram of the residuals for the dependent variable risk exposure was plotted in Figure 1.10. Although subjective, the plot of standardised residuals reveals an apparently normal distribution.

Figure 1.10: Scatterplot for equality of variance



As a result of this several analytical trials were conducted on the sample data set. Overall, results of the analysis were good with a high coefficient of determination (R-square) value of 0.996 – see also Table 1.4 below. The MR model of the total risk exposure for FM operators was developed and tested using the same data set (340 FM service cases) earlier used in the training (85 cases) and testing (85 cases) of the ANN model described above. The initial model included 48 factors that were later decomposed in to the seven main risk factors (see Figure 1.2). Using the stepwise procedure, at the 5% level of significance, four variables were identified as key FM risk factors: legal risks, corporation risks and facility-transmitted risks were identified. The stepwise procedure uses probability of F-value to determine key risk predictor factors that influenced most the independent variable (total risk exposure). Based on this procedure, a number of models were developed and the best-fit model was selected. The "goodness of fit", was then used to verify how best the model fitted. In order to determine the goodness of fit for each of the models, the coefficient of multiple determination, R^2 and the adjusted coefficient of multiple determination, R^2_a both of which measure the proportional reduction variability, were calculated and examined.

Based on these criteria, the best-fit model selected included all the seven key risk factors with the probability F-value of 0.05. These key predictor variables are shown in Table 1.5. Since Table 1.5 shows the summary of parameters used and the coefficients and the t-values for the selected model, the best fit model for predicting risk level exposure in various FM services when managing healthcare operations can be expressed as:

TRE = 0.044973 (constant) + 0.044973 (LEGAL)+ 0.031591 (CORPO)+ 0.035039 (BUSTRANS) + 0.026237(FACILITY) + 0.027488 (FIN) + 0.026671(CUSTOMER)+0.013308 (COMMERC)

Where InTRE = Natural log of the total FM risk exposure

LEGAL	= legal risks
CORPO	= Corporation risks
BUSTRANS	= Business transfer risks
FACILITY	= Facilities transmitted risks
FINANCIAL	= Financial and Economic risks
CUSTOMER	= Customer care risks
COMMERC	= Commercial risks

In the above TRE expression, only Legal risks (76%); Corporate risks (12.%); and Business transfer risks (8.4%); and Facility transmitted risks (1.3%); were the four most significant variables. The other three Financial and Economic risks (1.1%); Customer care risks (0.1%); and Commercial risks (0.3%) are used as dummy variables, and add to the constant coefficient. For example, if the FM operator is managing efficiently commercial risks, an extra +0.013 would be added to the 0.004497 constant. The equation comprises of the sum of partial regression coefficients multiplied by their respective predictor variables. The constant "intercept" (a) at 0.044973 requires some further explanation. In regression analysis (a) should equal (y) when all independent variables are zero. Under these circumstances a positive FM risk exposure for this model (i.e. 0.044973) would result.

However, such a proposition is unrealistic, since minimum values of the independent variables cannot be zero and hence, predicted risk exposure values are always positive despite the constant.

To determine how well the model fitted the data, an analysis of variance and the associated F test was conducted to test the null hypothesis $B_i = B_2 = B_n = 0$ (Siegel and Morgan, 1996). As F = 2627.745 and the observed significance level (signif. *F*) is 0.0000, the null hypothesis could be rejected and a conclusion can be drawn that, a linear relationship exists between the dependent variable (y = FM total FM service/business risk exposure) and the independent variables in the equation. From the original 48 FM risk constructs identified from literature review, questionnaire surveys and the Repertory Grids provided by healthcare facilities managers, only seven main risk categories as shown in the ANN primary model in Figure 1.7 were qualitatively adopted for use in developing the final MR model. These seven factors were used starting the one with the largest contribution. This included "*Legal* risks" (76.4%); *Corporate* risks" (12.1%); "*Business transfer* risks" (8.4%); "*Facility transmitted* risks" (1.3%); "*Customer care* risks (1%) and *Commercial* risks (0.3%). The seven factors accounted for more than 86% of the total risk exposure in healthcare FM services. The predictive performance of the MR model was also measured by further examination of the residual as shown in Table 1.5. This quantitative examination was initially conducted using two prediction performance measures namely: mean percentage error (MPE) and the mean absolute percentage error (MAPE). As shown in Table 1.5, the MPE and MAPE of the MR model is 0.21 and 0.10, signifying that the predictive performance of the MR model is fairly accurate and can be relied upon for comparative purposes.

Table 1.5: SPSS output of MR model statistics

Multiple R	0.998					
R square	0.996					
Adjusted R square	0.996					
Standard error	0.00316					
Analysis of variance	DF	Sum of squares	Mean square			
Regression	7	0.184	0.002628			
Residual	72	0.0007201	0.00001			
F = 2627.745	Signif. F = 0.00					
	Variables in the equation					
Variable	B	Std. Error	Beta	Tolerance	VIF	T
CONSTANT	0.004497	.009				4.918
LEGAL	0.003159	.002	.230	.321	3.116	17.675
CORPO	0.003504	.002	.307	.121	8.275	14.483
BUSTRANS	0.002624	.003	.147	.234	4.268	9.699
FACILITY	0.002749	.002	.209	.334	2.993	16.404
FIN	0.002667	.002	.179	.359	2.783	14.612
CUSTOMER	0.001331	.002	.110	.298	3.353	8.134
COMMERC	0.003054	.004	.168	.122	8.229	7.972
Sig = 0.00						
	95% Sig					
CONSTANT	.027					
LEGAL	.027					
CORPO	.030					
BUSTRANS	.021					
FACILITY	.024					
FIN	.023					
CUSTOMER	.010					
COMMERC	.023					

Table 1.6: MR model performance results

FM Number	Case Total risk exposure	MR Prediction	Error	PE	APE
1	.82	.8227	-.00229381	-0.13333	0.0027
2	.78	.7844	-.00103995	-0.28673	0.0044
3	.80	.7963	-.00229381	-0.10891	0.0037
6	.67	.6740	-.00072972	-0.66817	0.004
10	.72	.7256	-.00481081	0.259775	0.0056
11	.72	.7172	.00187038	-0.08993	0.0028
27	.71	.7091	-6.3850E-04	0.079397	0.0009
28	.68	.6763	5.399E-04	-0.17603	0.0037
29	.65	.6495	-1.1442E-03	-0.14181	0.0005
43	.67	.6732	-.00095015	-0.10492	0.0032
97	.70	.7008	.00101994	-0.27973	0.0008
98	.82	.8227	-.00229381	0.648941	0.0027
105	.76	.7573	.00493195	-0.14181	0.0027
336	.68	.6734	.00693851	2.522291*	0.0066
337	.69	.6758	.01740381	-0.63067	*0.0142
338	.67	.6764	-.00422550	-0.89743*	0.0064
339	.68	.6838	-.00610255	-0.62009	0.0038
340	.68	.6802	-.00421658	-0.62009	*0.0002
MPE			0.21		
MAPE			0.10		

1.24 Comparison between MR and ANN models

In order to facilitate a comparison between MR and ANN results, each of the measures of prediction performance was scrutinised and discussed.

MPE - Analysis of prediction performance using the MPE resulted in the derivation of 0.12 percent and 11.56 percent for ANN, while the MR models had 0.21 and 10.00 respectively. The MPE therefore indicated that both models tend to accurately predict total risk exposure but in overall the ANN model seems more accurate.

MAPE - Scrutiny of MAPE output at 2.19 percent and 2.4 percent for ANN and MR models respectively, revealed that both models tend to perform well, although the ANN model appears slightly more accurate.

This may seem an unusual assumption considering that using the MPE method, the MR model curiously yielded a more accurate prediction than the ANN model. However, the utilisation of both MPE and MAPE performance measures are problematic in this instance for two reasons. First, the mean value taken suffers severely from extreme outlier observations (e.g. cases 6; 157; 162; 211; 258; 264; 271; and 303) that tend to pull the average value away from the cluster of the most frequent occurring residual values. Secondly, this methodology does not work well on comparatively low risk exposure (low FM cases) observations. The model's predictive capabilities were further tested using independent out of sample data that was split automatically during network selection process using the data set editor in Trajan 4.0 This sample is shown in Trajan 4.0 with a blue colour. To illustrate this, some of the results of the two models forecasting total risk exposure for test data set aside are summarised in Table 1.7 below.

Table 1.7: Comparative results of ANN and MR models performance

FM Number	CaseTotal exposure	riskMR %	ANN%	Improvement
1	.82	0.0027	0.2027	18.93798
2	.78	0.0044	0.2027559	18.10549
3	.80	0.0037	0.1675772	14.54978
6	.67	0.004	0.1488536	12.19816
10	.72	0.0056	0.8024555	79.54769
11	.72	0.0028	0.047	-1.25745
27	.71	0.0009	0.01	-8
28	.68	0.0037	0.0086	-42.1633
335	.70	0.0008	4.801E-06	-16.6632
336	.68	0.0066	3.275E-05	-201.527
337	.69	*0.0142	6.314E-06	-22.4897
338	.67	0.0064	1.898E-05	-33.7197
339	.68	0.0038	1.142E-05	-33.275
340	.68	*0.0002	7.404E-05	-270.117

RMS improvement = 4.3%

$$\text{Improvement} = \left(\frac{MR - ANN}{MR}\right)100$$

To reinforce this conclusion, a summary statistical analysis (mean, median, range and variance) was conducted on the residual observations for both models. Examination of test results revealed that, both models have exactly the same range between minimum and maximum residual observations; mean and median values for the ANN model are within close proximity of each other at 0.006 and 0.017 respectively. Conversely, the MR model exhibits a widening of distance between mean and median values at 0.00 and 0.705 respectively, signifying slight evidence of a non-parametric (positively skewed distribution). Nonetheless, the MR model seems more accurate; and variability of residual observations around the mean value for the ANN model is less than those for the MR model. This is exhibited graphically using a few selected FM cases in Table 1.8. However, since summary statistical analysis can be influenced by the presence of extreme observations, the minimum and maximum residual observations were deleted (e.g. FM case 9 and 12).

Table 1.8: ANN and MR models test results

FM Case Number	Total risk exposure	MR %	ANN%	Improvement
4	.82	0.008	0.7308	-9134.2
5	.78	1.196	0.0029	119.3575
7	.80	0.368	0.0434	25.00652
8	.67	0.13	0.2571	-184.769
9	.72	0.34	0.1425	-7.91176
12	.72	0.386	0.09948	12.82798
MAPE		0.3	0.16	
Mean improvement = -25.1				

Summary statistical analysis was then re-conducted on the remaining 85 observations. These results are shown as Appendix E. Test results revealed that, the range of residual observations is far greater for the MR model at 13.51 than the ANN model at 8.02. Furthermore, the ANN model has less variability than the MR model; and the MR model exhibits a lower median and mean value but the distance between these values is greater than the distance between the median and mean values of the ANN model.

1.25 Results and discussion

The low MAPE values obtained in (i.e. <10%) obtained in the MR and ANN models shown in Table 1.5 clearly demonstrate that FM risk factors can be utilised by facilities managers as realistic inputs for modelling (i.e. classifying) best practice business processes in healthcare FM operations. These revelations provide adequate justification for this research's initial premise or problem and knowledge of other research studies undertaken on FM risk and performance measurement (Alexander, 1992; Gombera and Okoroh, 2000; and McFedzean, 1993). All these studies agree that critical risks factors of the FM business process if managed effectively by providers and purchasers become the critical success factors in delivering bets value support services to customers. Furthermore, as earlier observed in this thesis' main hypothesis, that according to Wagstaff (1997) the correct modeling and balancing of critical FM business factors such human resources and physical assets will lead to an unbeatable corporate image delivering cost-effective health care. It is clear that in the past, facilities managers especially those in NHS hospitals have mostly concentrated their non clinical business planning process on managing cost at the expense of risk, cost, quality and quantity and without applying a balance scorecard approach (Kaplan and Norton, 1995).

The balance scorecard emphasises the need to view the FM business process as having complex factor relationship at play such customer focus, service innovation, financial and internal process re-engineering (Amaratunga and Baldry, 2001). The current added and most important dimension to the effective skills of managing the 24-hour business process is the NHS is risk which may be composed of a multivariate of factors such commercial, clinical, political, physical or financial. There is a fine balance between acceptable risk and perceived service quality. Professional judgment, based on sound information, is an essential element in interpreting the data in an infrastructure for effective health-care delivery. Taking a closer look at Table 1.5, it can be observed that the ANN model generated about 50% of the prediction error compared to the MR model. This difference or comparison can be made by merely looking at the MAPE for both models.

According to Table 1.5 the MAPE for the ANN model was 0.16 while that of the MR model was 0.3. Such a difference can be attributed to the way ANN models are designed as earlier discussed in chapter 4 of this thesis under properties of ANNs models. As a result of this, ANNs are designed to capture and learn complex or non linear relationships between inputs and output variable factors rather that using a presumed linearity to fit global equation to the data in the case of MR models. Since the service delivery effectiveness of any healthcare FM operations is greatly influenced by the critical risk factors which if not managed properly can cause the FM operator's business objective to fail or may cause great service disruptions to non clinical services that front the delivery of high quality care services in the NHS (Gombera and Okoroh, 2000). Therefore the adoption of a non-linear representation of the critical FM risk factors that affect healthcare operation in NHS trusts should well be a more realistic one rather than an assumption.

However, from the results shown in tabulated in Table 1.8, they show that MR modeling is still the most popular method of modeling complex or simple relationships that are linear in nature, as it can produce better performance results in some cases (Hinks and McNay, 1999; Featherstone and Baldry, 2000). It must also be said that MR modeling still has more traditional advantages when modeling linear relationships (i.e. allow dependent and independent variables to be analysed). As opposed to MR models, an argument often heard against a neural network is that it is a "black box" model, finding dependencies between input and output that are hard to identify and for which the theoretical support may be lacking (Wezel and Baets, 1995). But recent developments in the neural computation has led to the development of few network simulation packages (such as Trajan 4.0 used in this research) that can perform casual analysis. Comparing the two models' predictive capability with present conventional arbitrary approaches to risk exposure forecast earlier described above which are employed in the FM industry shows that the model performance results of the ANN model support the criticism of the conventional approach (Wezel and Baets, 1995). According to Gombera and Okoroh (2000) the approach of measuring FM risks using the traditional approach is simply too fuzzy and in some cases unreliable due to the qualitative nature of management risk variables used.

The traditional approach of measuring risk exposure in most cases lacks credibility, and a formal methodology that may enable a much more realistic approach to determine the input and output factors to be transformed into quantitative parameters using AI techniques (i.e. ANNs). As established in the main surveys and data analysis of this research, only 48 risk factors were identified as the most critical success factors that were vital in adding value to healthcare business operations in UK NHS trust hospitals. After the researcher had carried out some sensitivity analysis on the sample of data using the MR and ANN modeling, these two tests showed that there was need for the 48 risk factors to be decomposed into manageable and main risk classes. The 48 factors were the further regressed into seven main classes to comply with the conceptual model earlier developed in chapter 6 using a similar approach. The decomposition process resulted in seven main risk factor classes that represented all the 48 factors. These seven factors as earlier described above in this thesis were tested and found to be significantly relevant (critical) to the modeling of total risk exposure in various FM services provided by operators in trusts. These risk factors were: *Legal, corporate, financial and economics, commercial, facility related and customer care* risks.