UNIVERSITY OF DERBY

A CONCEPTUAL FRAMEWORK FOR COUNTERING SYSTEMIC NOVELTY IN DEFENCE AND SECURITY

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ABBREVIATIONS USED IN THIS THESIS

INDEX	DESCRIPTION
AoK	Areas of Knowledge
CAS	Complex Adaptive Systems
CESN	Countering Emergent Systemic Novelty
CNI	Critical National Infrastructure
CPNI	Centre for the Protection of the National Infrastructure
CS	Collated Statement

DefSy	Defence & Security
ERM	Enterprise Risk Management
ESRC	Economic and Social Research Council
GSG	Government Security Group
HRO	High Reliability Organisations
HMG	Her Majesty's Government
MOD	Ministry of Defence
NAT	Normal Accident Theory
NCSC	National Cyber Security Centre
PAR	Participatory Action Research
RIMS	The Risk and Insurance Management Society
RD	Root Definition
RV	Requisite Variety
SA	Situational Awareness
SD	System Dynamics
SM	Sense-making
SSDM	Soft System Dynamics Methodology
SSM	Soft Systems Methodology
SME	Subject Matter Expert

GLOSSARY OF KEY TERMS

TERM	DESCRIPTION
Coevolution	An evolutionary change in a trait of the individuals in one population in response to a trait of the individuals of a second population, followed by an evolutionary response by the second population to the change in the first (Janzen, 1979).
Complex Adaptive System	A system that changes and reorganises their component parts to adapt themselves to the problems posed by their surroundings (Holland, 2000);

Emergence	The process through which emergent entities (properties or substances) 'arise' out of more fundamental entities and yet are 'novel' or 'irreducible' with respect to them (Stanford University, 2002).
Hazard	A possible source of danger due to the innate properties of an agent (i.e. biological, chemical or physical) to cause harm (Ramsey, 2009) and non-linearity.
Non-Linearity	A consequence of chance events, such as mutation and environmental variation, operating at local levels, the potential for alternative developmental pathways (Levin, 1998) or hazard
Novelty	Something never before embodied (Henle, 1942); a set of features that are not previously observed in the complex system under observation. This novelty is (…) neither predictable nor deducible from lower or micro-level components (Goldstein, 1999).
Problem Space	Describes the setting for this research as – The "state space" of a system is defined by the (state) variables that constitute the system (Walker et al., 2004). It is within this setting that the defence and security sector (DefSy), as a limited set of these variables, can be said to exist.
Risk	'Measurable Uncertainty', or 'Objective Probability' of effect or exposure (accident) – for which there can be Statistical Uncertainty (as knowledge);
Systemic Novelty	The central phenomenon examined through this Practitioner Project: That which emerges between/or across government departments or programmes and for which there is no 'global controller'. Specifically, it is not within the bounds of a department or programme, which would have the control capability.
Uncertainty	'Unmeasurable Uncertainty' Or 'Subjective Probability' of effect or exposure (accident) – for which there can be Total Ignorance (as knowledge).

STATEMENT OF INTELLECTUAL OWNERSHIP

I declare that I, Christopher Sheader, am the sole author of this thesis.

This research project has been ethically approved by the University of Derby and met the ethical research requirements of the UK Ministry of Defence.

ABSTRACT

The Defence and Security sector within Her Majesty's Government (and beyond) undertakes significant development programmes that augment the Critical National Infrastructure. The Critical National Infrastructure is a collective term for those facilities, systems, sites, information, people, networks and processes, necessary for a country to function and upon which daily life depends (CPNI, 2019). Significant programme issues have been observed repeatedly within the study context – perhaps not surprising given the complex adaptive system in which it exists. Upon being commissioned by the organisation to explore and develop an intervention to reduce failures/enhance programme success, the notion of novelty emerged. It is this novelty across systems in the study context that is explored in this thesis

Taking the form of a Participatory Action Research Project, this thesis reviews the key literature and develops a multi-disciplinary Conceptual Framework—Countering Systemic Novelty (*CSN*). *CSN* incorporates across four theoretical areas: (1) The nature of Complex Adaptive Systems; (2) the notion of *Novelty* as an emergent phenomenon; (3) Understanding the Context, (4) and the level of System Response. The thesis then explores whether *CSN* can augment the overall capability of the system to respond to the emergence of *Novelty* and propose a mechanism for the delivery of the intervention into this system.

The investigation is guided theoretically by both holism and pragmatism; it sits within a philosophy that sees actors as being part of the system and is takes a constructivist perspective to the research. Both the encompassing philosophy and the research are supported by the key principles of 'Coevolution' and 'Requisite Variety' that run throughout the evolution of this Practitioner Project.

The research is based on a multi-round study, using the Delphi Technique, which examined the 'Validity and Applicability' of *CSN* with a senior expert panel drawn from the operational context, specifically programme and risk management. The results of the study were assessed using two 'Thesis indicators' and found the expert panel agreed that *CSN* was both valid and applicable. For Validity TI-1 Agreement Tendency achieved 91% and TI-2 Degree of Consensus achieved 86%. For Applicability, TI-1 Agreement Tendency achieved 92% and TI-2 Degree of Consensus achieved 79%.

The study confirms that *CSN* is a valid and applicable approach to help counter emergent *Novelty* in the defence and security sector and, as a result, system capability would improve following its adoption. It also confirms that *CSN* can be used to inform differing interventions, including discrete development programmes; as additions to existing programmes or as targeted intervention in the event of emergent threat.

Key words: Defence & Security; Participatory Action Research; Delphi Technique; Complex Adaptive Systems; Sense-making; Risk Management, Soft Systems Methodology; System Dynamics; Pragmatism.

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To all those work colleagues, who have helped me in the development of CSN. Notably, Catherine and James - your encouragement was invaluable.

Mother, brother, from Torre Drive to here…

Thank you.

CHAPTER 1 ~ PROLOGUE

The purpose of this chapter is to establish the foundation for the research. Beginning with a personal ontology, I will firstly provide a background to the research and the principles that guide my project. I will then place the discussion 'in context', supporting understanding for the conceptualisation of the research. After this, I move to explore the phenomenon under study and the state within which this exists.

1.1. Reality: Personal Ontology

"Whatever answers we come upon will profoundly affect our view of ourselves and our world." – John Holland (1998)

Through my journey within higher education, I have explored many management and organisational research areas. Beginning with administrative management, c.1996, via a Diploma in Higher Education, which introduced what became a passion area — Strategic Management. In 2002, a Post-Graduate Programme, the Diploma in Management Studies focused on organisational choices around Corporate Strategy. At this stage, I began to scrutinise the practical conventions of strategic formulation and execution; specifically, how the environment interfaced with the 'strategic planning' processes. In a subsequent Master of Sciences degree, I found that this (process) was seldom undertaken to an optimal level, as in many cases, given the insufficient consideration of 'feedbacks'. Moving on from strategy, I then reviewed the area of Performance Management, via a Master of Arts programme, and I again found, via my dissertation, that linear and deterministic processes were constraining organisational 'realisation', i.e., actors did not see themselves as part of a greater whole and consciously pursued reductive practices. I viewed these programmes as being extremely useful and foundational in establishing a personal philosophical stance that remains, some 22 years on. Outside of these formal programmes, ongoing reading has included a considerable number of published works around the distinction between the scientific method of reductionism and that of more 'holistic' views of the world and indeed life itself. It is through this lens, paired with a symbiotic interest in the field of Complexity and Chaos, that I view life, study and professional practice.

During the early stages of this research, i.e., at a point when the conceptual framework was beginning to coalesce, I reflected on everyday situations through a lens of complexity and, more explicitly, conceiving operational contexts and organisational abstractions as

characteristics of complex adaptive systems (*CAS*) – a key theme of this project. This process became particularly challenging when seeking to explain (the notion of) systemic hazard and *Novelty* in everyday professional conversations with peers; the interdisciplinary nature of the study (proposed through this project) and the potential implications met with a high degree of scepticism and, of more concern, significant passive and active resistance.

My education and development have provided me with the skills and personal awareness to allow me to critically review historic limited perspectives or perceptions. I recognise that, in gaining this education, I gained a new responsibility, that of sharing this learning within the organisational context in the hope that this will inspire actors to both develop themselves and explore problems at a deeper and richer level.

1.2. Researcher, the Context and Problem Conceptualisation

At this stage I would like to situate myself into this present study; I would also set out my professional context and some of its characteristics. Finally, I will explain the genesis of the Problem Conceptualisation within this setting.

1.2.1. A Personal Professional Overview – What brought me to this study

Professionally, I would describe my career as being varied, however, of most relevance (to this project) is the last ~20 years, where I would broadly define my roles as 'belonging' to the organisational development and improvement field. More recently, I have worked in the field of pan-governmental change programmes relating to the defence and security fields. After four years in a discrete function within the Ministry of Defence (MOD), I currently hold the post of Head of Business Change, Government Security Group within the Cabinet Office (Her Majesty's Government). It is in this role that I bring both the knowledge I have gained through my professional history and education, but more fundamentally the personal ontology that I have referred to above.

1.2.2. The Problem Context – Research Limitations

Stability within the Defence and Security sector is self-evidently important (see Steinbruner [1978] and Trenin [2019]), as are strong systems; therefore, any potential to ameliorate any weakness or to strengthen the system gains immediate significance. The security environment, across all protective security criteria, is becoming more challenging resulting in a significant

increase in organisational and professional development in its broadest sense. This has meant that there has been significant change to manage, particularly as this scale and pace continues, and it presents a challenge across the (already complex) operating system. Major programmes are underway to transform how Her Majesty's Government (HMG) manages government security. While the programme (management structure) is looking to increase capability, it cannot exceed its boundaries of accountability or delegated authorities due to governmental structures. This transformation is destabilising and, arguably, inevitable and impossible to contain. I believe this presents significant risk to the operational context, i.e., the defence and security sector in HMG, or 'the 'Problem Space': I will use this term to connote the meaning as set out by Axelrod & Cohen (2001, p.153) that defines 'Space', as the conceptual location where agents or nodes interact[1].

Working in this professional context brings with it some situational constraints and responsibilities. Owing to the sensitive context, these limitations cannot be set out here, but in the main, they relate to the release of organisational management and personnel information; specifically, the sharing of information that researchers may need for any study. This is well illustrated by the paucity of research that relates to this research problem, which I will set out later in this thesis. When compared to the wider Civil Service, the Government Security Group (GSG) is small, specialised and sensitive, which again provides limits on the available research. However, being a part of GSG, I was able to access those actors and practitioners that could provide me with subjective assessments only they could provide. This has allowed me to add to the limited body of research relating to this area.

1.2.3. The Problem Conceptualisation

On the basis of co-evolution (which forms a central role in my personal philosophy – systems and holism), i.e., "adaptive changes within and between all levels of organizational and environmental interactions" (Lichtenstein, 2000, p.13), I believe that the Problem Space evolves in a series of interactions and self-regulation through the phenomena of 'feedback'. Given this claim, it follows that these interactions will present issues that exist outside the

[1] See also Dunbar (1998, p.5) where the Problem Space is described as consisting of the initial (current) state, the goal state, and all possible states in between.

bounded nature of organisations; it is these interactions, and their effects, that contributed to the genesis of the present research problem, that in turn led to this study.

This study effectively began during a meeting with me and other senior managers when discussing the threats associated with the management of multiple conflicting programmes. The organisation had already experienced issues when endeavouring to implement two complex (pan-government) programmes, however, while the third was of the same in terms of scale, I argued that this would introduce significantly more complexity and risk. I was able to take this view, given my personal ontology, and my (then) awareness of complex systems and complex adaptive systems[2]. In this meeting, I presented a set of documents setting out the situational threat; after which attendees asked for both diagnosis and prognosis of the situation. As the person responsible for the stability of the strategic portfolio, I was able to advise that the level of complexity would increase and with a high probability of threat to the programmes. More importantly, I pointed out that some of the emergent issues may not be predictable so it would be very difficult to prepare any mitigations to these effects. I explained that, when 'systems' interact, then it is likely that this will result in a difference to the overall system that this will result in new information, and this is likely to be a threat to our existing expectation of the 'system'.

It was at that point, that the question arose as to what could be done to (a) address the immediate situation; but more importantly, (b) prevent this situation from re-occurring. I responded that I would explore this and revert via the appropriate channels. In following up on the second action, I discussed some early thoughts regarding a multi-disciplinary approach with key personnel. The Chief People Officer asked if I would undertake a longer-term organisational development study to bring about an increase in risk and change management capability in relation to complex programmes. This became the genesis and the driving case of this doctoral study.

1.2.4. The Problem in Context

In conceptualising the 'Problem Space', and given the complex nature ascribed to it, my ontology supports the belief that there is no separation between the Problem Space and the broader environment. Citing Mitleton-Kelly, Chan (2001, p.1) supports this view pointing out

[2] This distinction is addressed within this Prologue.

the "intricate inter-twining or inter-connectivity of elements (…) between a system and its environment".

In my previous academic pursuits, I have explored certain aspects of the field of Complexity Theory, two of which I introduce in this prologue and will explore further in the literature review. First, I introduce the term Requisite Variety, which means the extent to which systems can respond to changes that affect it. Second, I introduce *Novelty* as the main term and phenomenon of this research, and which refers to the new information that emerges as the result of changes in systems following interaction of inherent information or characteristic variables. This is what I was predicting in my meeting with the senior directors.

In his seminal book 'Leading Change', Kotter (1995) sets out his 'Model for Change' that includes eight critical success factors required for the successful implementation of change initiatives. The lack of any reference to emergence nor complexity in these steps stands out; and this, I do not believe, is due to the timing of the book's release. I draw attention to the slightly earlier work by Stacey (1993, p.12) who outlined in some detail a rich contrast between (the contemporaneous) *"[T]oday's Frame of Reference"* and a *"New Frame of Reference"*. The author was referring to the evolving nature of strategic management and he introduced language relating to complexity, non-linearity and feedback systems. In my own lived experience, the more traditional approach, espoused by Kotter (1995), is an almost normative standard in the management of change[3]; the attempted introduction of practices akin to Stacey (above) has, in the most part, been resisted. In a 2010 paper by the LSE, it is argued that this 'new' approach to change, i.e., emergent versus planned (or linear), is likely to be resisted due to the lack of the "simulacra of security, certainty and stability" (Liebhart & Lorenzo, 2010, p.17) that were prevalent in prior eras. I believe that we need a shift in Weltanschauung[4] (ibid.) away from the linear and toward the emergent in the management of change. Returning to the management of risk, which I argue employs change management to implement preventions or mitigations, what does this proposed shift from planned to linear mean for practice?

3 It is interesting to note that Corum & Burns (2001) argue that there can be no One Best Way for the management of change and a more contingent approach is needed.

4 I note the use of Weltanschauung here which I infer as 'worldview' that could be learned in life (or a posteriori knowledge); this conflicts with the working definition of 'historic a priori condition'.

Within organisations, Risk Management exists as a corporate process to regulate risk through the application of governing mechanisms. While organisational resources can legitimately address *known risk or threats*, which includes external threats (Dafikpaku, 2011, p.6), I am interested in exploring how 'risk management' can address unknown threats, i.e., those arising from *Novelty*. More specifically, and given the 'borderless nature of risk' (Smith & Fischbacher, 2009, p.3), I would argue it is probable that threats can emerge as a result of inter-twining of system variables across the Problem Space and outside departmental and programme bounds, i.e., the space where there is no 'global controller'. It is within these 'accountability interstices' that I conceive of 'Systemic Novelty', and I, therefore, provide the following definition to inform this study:

> *'Systemic Novelty: That which emerges between/or across government departments or programmes and for which there is no 'global controller'. Specifically, it is not within the bounds of a department or programme, which would have the control capability.'*

Signal detection theory itself will be explored briefly within this thesis, but at this stage it is sufficient to note its application as a being "whenever two possible stimulus types must be discriminated" (Stanislaw & Todorov, 1999, p.137). Early discussions also examined the idea of qualia, i.e., "truths about the appearances themselves, about how things seem to us in experience" (Crane, p.180) or the "direct objects of perception" (ibid., p.182), the question posed being ' how would actors, perceive something that is new and novel. What are the characteristics?' Logically, this requires practitioners are actively examining the signal context, the Problem Space, to allow this discrimination: as it is suggested that this is not current practice, it follows that these discriminations may not be made.

1.2.5. Summary Comments

In this section, I have raised questions relating to the context and conceptualisation of my research study. I have introduced the Problem Space as an extra-organisational system, i.e., beyond organisational bounds, and where '*Novelty*' can emerge. Within this Problem Space, I have referred to the 'inter-twinings and inter-connections' that I define as a point where the system or organisation meets the environment – or more precisely where one sub-system interacts with another, *within* a wider system.

Returning to the internal, bounded regulation of *Novelty*, to what extent are traditional risk management models suitable to the challenges that arise? Given that "complexity science has been heralded as a new paradigm in management" (McKelvey, 2012, p.1) to what extent is this influencing or guiding the management of emergent *Novelty*. Accepting that the variety of change (as stimuli) needs to be exceeded by the variety of response (Requisite Variety), to what extent do organisations recognise this phenomenon and to what extent is this used to manage emergent *Novelty*? Finally, and more specifically to this research, to what extent do practitioners in the Problem Space apply regulation to this *Novelty*?

1.3. The Application of my Ontology to the Problem Space

In this thesis, I will argue that the Problem Space presents characteristics ascribed to a complex adaptive system (CAS). While I explore these concepts in some detail in the literature review, the following description helps to explain how I frame associate my ontology with the Problem Space. In describing Complexity, Dodder and Dare (2000, p.9) establish the following characteristics that might frame the study of the Problem Space:

1) Static complexity refers to the structural aspects of a system's complexity. This includes notions of hierarchy, connectivity, detail, intricacy, variety, and levels/strength of interactions; most easily visualised as a network with complex patterns of links and nodes. For the purposes of this study, DefSy would be exemplify Static Complexity. Page (2010, p.25) refers to these systems as 'complex systems' and does not fully define the Problem Space.
2) Dynamic complexity encompasses the ideas of complexity related to behaviour, processes of cause and effect, feedback, fluctuations and stability, cycles and time scales. The focus on CAS is associated with the notion of changes in behaviour over time, which relates to an important aspect of dynamic complexity: evolving complexity. This notion of adaptivity is what differentiates this from the merely complex (ibid.) and therefore I adopt this to describe the Problem Space.

A question arises as a corollary of the above ontological position: within a *CAS,* does the level of interaction increase in line with the number of variables (of links and nodes) because of the adaptive process. While, for this research, I do not require an accurate calculation of this interaction potential, I believe it is enough to state that it is sufficiently complex and leads to a

high potential for an enormous number of 'alternative developmental pathways' (Levin, 1998, p.433). This is positioned as a working definition of 'Hazard' and I believe it follows that the potential for occurrence within the Problem Space is also significant as the "system scans the territory seeking to stabilise/re-stabilise itself" (Nicolis & Prigogine, cited by Mitleton-Kelly, 2003, p.34). Given the collective purpose of the organisations that constitute the Problem Space, e.g., defence and security, is it reasonable to expect an advanced level of maturity and understanding of complexity and *Novelty* from system actors?

1.4. Responding to Systemic Novelty

Having both defined the Problem Space and introduced themes that I will explore in the literature review, I now turn to how organisations and practitioners, in current practice, might seek to respond to *Novelty*. Key themes deemed central, and introduced here, include (a) the nature of resilience to hazard, (b) the characteristics of organisations who perform well within similar systems, and (c) observations on current practice within the Problem Space and the defence and security sector (DefSy).

At this point, I bring the relationship between the rates of both stimulus and response, that is Requisite Variety, back to focus. Requisite Variety (Ashby, 1958) refers to the relationship between stimuli and variety and argues that, by virtue of a power-law relationship, for a system to be viable it must match the rate of response (or capability) to the rate of stimuli. In effect, the system must be contingent and organised in such a way that its functions correspond to the nature of the environment that it finds itself in (Lawrence & Lorsch, 1967, p.2). If this is not in balance, i.e., in the event of misaligned variables, then a state of disequilibrium, or 'irresilience', exists within the system that represents 'system hazard'. In the Problem Space, this can result in major adverse effects to DefSy, and, as such, the importance of any developments in this area will be important. The management (or more appropriately regulation) of both hazard and *Novelty* is at the core of this practitioner project and I will explore this within the literature review section.

While the literature is replete with articles on organisational resilience (see Bhamra et al., 2011), it is less so when the research context is limited to DefSy and even lower when this

includes Requisite Variety[5]. Interestingly, when searching on a smaller set, ("Defence" "Security" "Requisite Variety"), the return rate was higher, although the article citation rate might suggest the subject is not that well known. While I would note the concerns questioning the citation rate as an effective indicator (Seglen, 1998), it does support an inference that we, in DefSy, do not sufficiently consider Requisite Variety in managing *Novelty*.

In this research, I argue that the emergence of *Novelty* is a material issue for the management of system performance and variation. This project explores the nature of emergence as hazard, which I distinguish as either latent, defined here as 'pre-existing, but hitherto unknown', or nascent, defined here as 'new and now known'. In distinguishing between latent and nascent hazard, I argue that while the former might be more readily identifiable, both forms represent threats to the stability (or equilibrium) of the Problem Space, given the potential effects of system perturbations. I further argue that while (the adoption of) risk management provides the opportunity of regulating hazard, this is limited in respect of the nascent typology, as by definition it is new and now known and, therefore, without empirical knowledge and understanding.

Given the nature of DefSy, it is my view that it shares some similarities with High Reliability Organisations (HRO), introduced by Weick & Sutcliffe (2007). HRO's operate at the 'edge of chaos' where the ability to effectively respond and deal with significant, and rapid, events is crucial; the authors cite events such as the Challenger Shuttle disaster, wildfires, and battleship operations as examples. In application, HRO demonstrate the following attributes that I have paraphrased within the context of the Problem Space:

1) Preoccupation with failure: To avoid failure we must look for it and be sensitive to its early signs. I am interested in how this might take place in the Problem Space.
2) Reluctance to simplify: Labels and clichés can limit examination of events; mental heuristics can mask non-simple novelties of both latent and nascent hazard typologies. To what extent is this a feature within the Problem Space?
3) Sensitivity to operations: Systems are not static and linear but rather dynamic and nonlinear in nature. A deep, 'plugged-in' connection with operations can help deliver the appropriate response to system variation.

[5] I found this to be the case when undertaking a preliminary review of literature at the early stages if this Practitioner Project. The review took place via the University's library services.

4) Commitment to resilience: The organisation must maintain function during high demand events. How do senior stakeholders ensure this is an active consideration in times of budget constraint?
5) Deference to expertise: In a layered, hierarchical organisational structure, how are the voices of experts heard when risk is immediate? To what extent is this an issue within the Problem Space?

As a researching practitioner, when I conceive of DefSy within a Problem Space, together with its response capacity, I see it as being comparable to the types of organisation that benefit from HRO principles. However, as the Problem Space is an abstract construct, which cuts across multiple organisations and without the capacity for 'global regulation', there are structural differences that I was not able to sufficiently reconcile in order to apply the model. Notwithstanding this key limitation, I contend we can learn lessons from the concept of the HRO as it describes a type of organisation that *can* regulate hazard and *Novelty*, or at least its impact. The frequency, normalcy and 'reasonable expectation' of these novelties is also key to the development of this project, I will explore 'Normal Accident Theory' (Perrow, 1984) within the literature review.

Within the Problem Space, I did observe the application of 'Traditional', 'Enterprise', and 'Programme Risk Management' in normal 'business as usual' activities. However, having reviewed these general approaches with DefSy practitioners, I would contend that these models did not address the central phenomenon of *Novelty*, at least in 'real-life application'. In the government's document '[T]he Orange Book Management of Risk – Principles and Concepts' (HMT, 2004), reference is made to at least two key areas that relate to both nascent *Novelty* and cross-boundary risk. Given this is a government practice document, I was interested in the extent to which I might improve on the adoption of these facets of risk management in DefSy. Perhaps one reason for the perceived lack of awareness is the notion of risk maturity, i.e., the extent to which risk management has been embedded into the 'organisational DNA'. It is logical to infer that Risk Maturity (see RIMS, 2018 as one example) may play a role in this context. This provides a tiered model for organisations to assess their performance in the area of managing risk; some organisations will be relatively low in maturity across the range of characteristics which might provide an insight into the lack of understanding of the central phenomenon. This, in turn, suggests these organisations may not yet be fully capable to respond to *Novelty*. Given the gaps in the requisite knowledge around *Novelty*, I would argue that

DefSy is not totally viable. If this is indeed the *cas*e, I am interested in how practitioners within this space can address this lack of capability through the main contributions of this study.

1.5. Prologue Summary

In this section, I have set out the genesis of this Practitioner Project and the key themes that arose following the initial discussions with senior directors. I have defined the Problem Space as a *CAS* within the DefSy sector and provided an initial description of *Novelty*, both within my personal ontology. Key to the system's response capacity, or Requisite Variety, is the extent to which the Problem Space, through the knowledge and capability of its practitioners, is even cognizant of the central phenomenon. The initial research exercise supported my lived experience, suggests this (knowledge and capability) may be insufficient, and requires intervention, and this is the core aim of this Practitioner Project.

CHAPTER 2 ~ INTRODUCTION TO THE RESEARCH

In this section I will set out my 3-stage approach to this study, before setting out the research problem and the aims and objectives. I will then briefly discuss the relevance and contribution this research will make to both theory and practice before setting out the organisation of this thesis.

2.1 Research Approach

In Figure 1, I capture the key 3 stages of this research project, which I would describe as follows:

Stage 1. In this stage, I include the 'Genesis' of the research, which identified the kernel of the research problem and research opportunity, together with the consequential informal preliminary research.

Stage 2. In this stage, I include the iterative discussion/learning feedback loop that both defined the key themes that I would explore when seeking to develop any solution to the research problem.

Stage 3. This stage defines the Areas of Knowledge that informs the development of the Conceptual Framework, which, in turn, provides the solution as requested in Stage 1. In this stage, I also validate the Conceptual Framework through the research study itself in the form of a multi-round Delphi Study and subsequently present the research findings and the contributions to knowledge and practice. I also include a reference to the emergent opportunities for dissemination that arose during Stage 3, which I refer to within this present study.

2.2 Research Problem, Aims and Objectives

In this section, I establish the background to the study, the identification of the Research Problem and the consequential Research Question. I then set out the Aims & Objectives of the Practitioner Project and I will then provide a summary that will then introduce the research benefits.

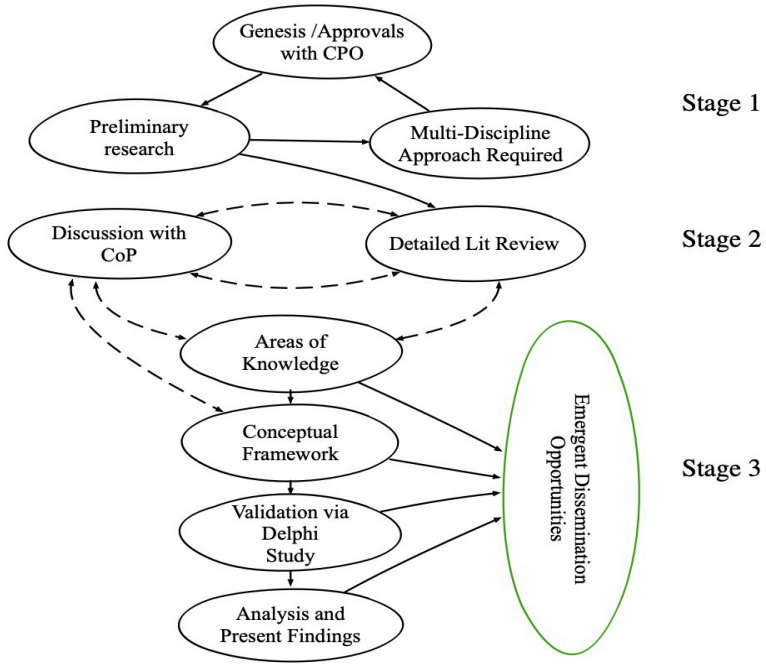


Fig. 1 Depiction of the Research Approach

2.2.1 Emergence of the Research Problem

The Research Problem is an "essential element...that conveys the issues...that gave rise to the study" (McGaghie et al., 2001, p.923); indeed Walliman (2006, p.185) affirms the importance of the Research Problem (to the project) in stating "[A] clear definition of the research problem is an essential ingredient of a proposal; after all, the whole project hinges on this".

In my 'Lived Experience', I have significant familiarity with organisational development projects that appeared to take inadequate account of the external environment. Of specific interest was the state of threat potentiality, or 'Hazard', that arose because of programmes 'co-existing' in this wider environment and indeed why this would be the case. Consequently, and having considered and reflected on prior experiences where hazards led to actual issues that could have been anticipated, and errors had occurred in the absence of 'awareness of these issues'; I am interested in determining how this would occur.

In early observations, risk management appeared to reinforce bounded, 'silo' thinking, as assessments were looking at the organisation within and of itself, i.e., to the exclusion of the wider environment. Whether these organisations, which sat within DefSy, were cognizant of 'emerging systemic novelty' and its effects, or threats, to ecosystem stability was of significant interest. These 'Lived Experiences' led to a desire to understand what was happening within the operating context (or the system under study).

2.2.2 The Research Problem Statement

Given the above brief discussion, I set out the following as the Research Problem Statement:

> "As an organisational function, the management of risk is bounded and cannot control potential 'emergent issues' arising from the interaction of extra-organisational, ecosystem initiatives that are both unknowable and unbounded. This can lead to new and uncontrollable effects on the defence and security sector. As a researching practitioner, I was asked to investigate how the DefSy sector can improve practice in this area and consequently better counter what has been defined as Systemic Novelty (or Novelty)."

2.2.3 The Research Question

In designing the research question (Table 1), this research follows Blaikie (2000, p.67) by first setting out the 'Major Research Question' followed by 'Subsidiary Questions'. In-so-doing, the author incorporates the collective 'key Areas of Knowledge' identified through the preliminary literature review 1) Complexity (Emergence & Feedback); 2) *Novelty*; 3) Understanding; and 4) Response, into the subsidiary question structure.

Table 1 Explication of the Major and Subsidiary Research Questions

MAJOR RESEARCH QUESTION
Can a holistic, multi-disciplinary conceptual framework be deployed as a strategic tool to address the research problem thereby help to maintain the stability of the Defence and Security sector across HMG (known as the Problem Space)?
SUBSIDIARY QUESTIONS
Q.1. What are the discrete Areas of Knowledge relating to the programme threat and its remediation? Q.2. How can these Areas of Knowledge be developed into a method to counter the threats to the Problem Space? Q.3. Can the validity[6] and applicability of the method be verified across a range of Problem Space Practitioners?

6 I adopt Cresswell and Miller's (2000, p.126) definition of validity as applicable to the approach taken in this research, the Constructivist paradigm, wherein a "thick and rich description" is used to build credibility for research participants.

2.2.4 The Aims and Objectives of this Practitioner Project

Having established the Research Problem and the Research Question/s, the next step is to determine the 'Aims and Objectives of the Research' and I explore these here. Interestingly, Blaikie (2000, p.23) posits that while stating the Research Questions are vital to the research project, stating the Research Objectives is not; as their meaning might be drawn from their questions themselves. However, a set of 'Practitioner Project Objectives' are indeed established and are framed by an overall 'Aim of the Practitioner Project'. Blaikie (ibid.) offers a fuller explanation of objectives and distinguishes between 'basic' and 'applied' research. Here both 'basic' and 'applied' research are combined, using 'explore', 'change' and 'assess', in order to answer the Major and Subsidiary Research Questions. These objectives together with the corresponding questions and the method through which these objectives will be achieved are shown in Table 2.

Table 2 Practitioner Project – Aims and Objectives

AIM OF PRACTITIONER PROJECT
To create a conceptual framework that (a) raises awareness of the environmental phenomena affecting programme performance, and (b) provides a logical approach through which these phenomena can be countered.
PRACTITIONER PROJECT OBJECTIVES
• Obj.1. (Basic) To provide a detailed exploration (via the Literature Review) of the characteristics seen to be affecting pan-government programmes performance within the system under study. • Obj.2. (Applied) To develop a Conceptual Framework, based on the literature review, that can be used to address the 'Systemic Novelty'. • Obj.3. (Applied) 3. To provide an assessment of the validity and applicability of the Conceptual Framework by seeking the collective views of senior leaders and practitioners in the Defence and Security sector in HMG, specifically in the area of risk and programme management.

2.3 Relevance and Contribution

Saunders et al., (2009) assert that it is wise to have some idea of the expected outcome of the research before a start is made. Having established the Aims and Objectives above, a key artefact that enables the delivery of these benefits, the four Areas of Knowledge (AoKs), will be a foundational tool from which varying interventions will be constructed. The Conceptual

Framework will comprise four paradigms that help in the answering of the Research Problem by countering Systemic Novelty. I use the word 'paradigm' as it is my firm view that, to optimally address the Research Problem, practitioners need to have a distinct worldview that is informed from these paradigms: hereafter the phrase 'Areas of Knowledge' (AoK) will be used as standard nomenclature.

2.3.1 Relevance of the Conceptual Framework

Following the early meetings that formed the genesis of this Practitioner Project, I formed a virtual 'Community of Practice' or CoP. This group was informal and included interested senior parties across government from the Cabinet Office, Ministry of Defence, Home Office, DEFRA and Foreign and Commonwealth Office. I established this group as a 'critical friend' setting for my evolving participatory action research (PAR) project and test how this can be applied which supports the achievement of the research objectives. One of the key achievements through the group, either in session or through local bilateral meetings, was the final agreement what Areas of Knowledge (AoK) should be included and explored through a theoretical review[7].

The discussion on the AoK took place over numerous sessions with the CoP and begin with a session on the complex and adaptive nature of DefSy. I took the group through some basic facets of Complex Adaptive Systems and how I felt this would affect the operation of the overall DefSy. The group then discussed how we as a community manage risk and the lack of maturity in this extant practice, further meetings touched on this subject, specifically questioning how a mechanical system could respond to a hazard in a Complex Adaptive System. We discussed an early notion of the *qualia* of perception of risk or threat as it is realised, but we felt this was not sufficiently material for any remediation and may not be a practicable element to any response. One of the group members introduced 'Mindfulness' as an alternative theory (to qualia) as to how practitioners can seek to comprehend their operating context and the group supported the central aim of increasing understanding. Finally, a challenging session led to a pointed question from one of the group members – effectively – *"So what?"*. We may have this information, but how can we deploy measures to remediate the

[7] It is worth noting that this final grouping of AoK only in part resembles the starting point; a major route explored was the notion of qualia of the central phenomenon and what skills would be required to perceive these characteristics. This was deemed as being of little practical use and an inefficient use of the programme and set aside.

hazards we become aware of with this increased skill set. I returned to a later set of discussions with methods that sit within the philosophy of complexity and demonstrated how threats can be regulated through these measures.

At this point the subjects of the literature review (the AoK) came into realization: Complexity; Understanding, Hazard (which later became Novelty) and Response. It is also worth pointing out that in addition to *qualia* other potential AoKs were discounted: change management; organisational design; cyber-security; protective security; politics and culture. However, the group, following varying discussions, agreed these aspects were not seen as central to the final AoK set and that any model needed to tie together coherently; hence the Proto-Model was agreed from Version 3 as shown in Figure 2, which is then illustrated for clarity in Figure 3.

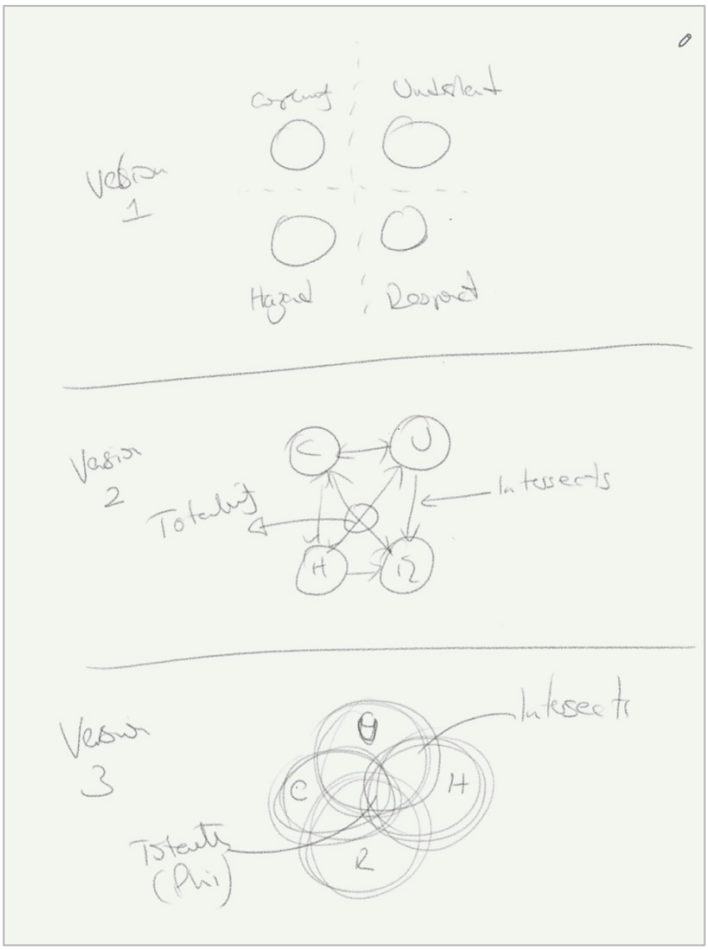


Fig. 2 Recreation of Proto-Model from discussions[8]

[8] This was recreated 'in-session' from a white-wall drawing as photography was not allowed in the building.

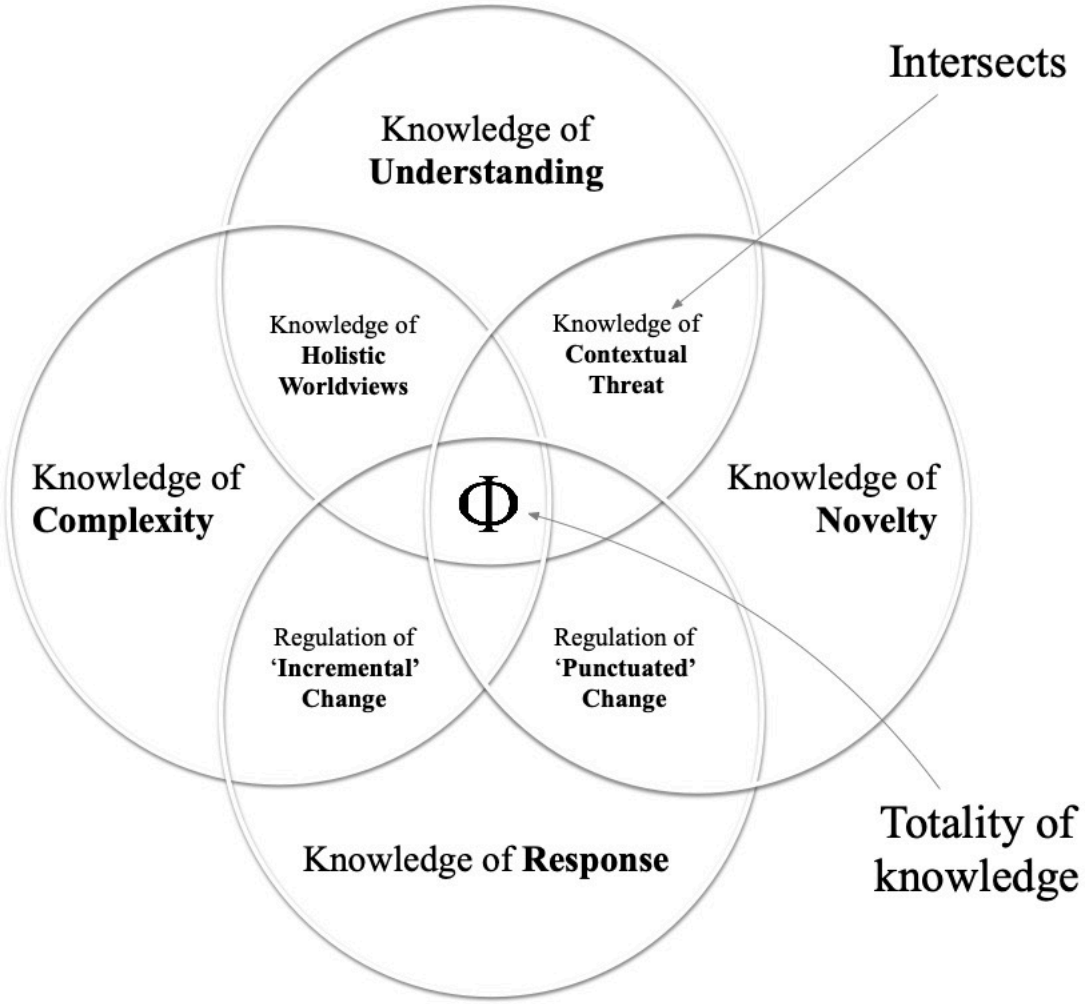


Figure 3 Illustration of Conceptual Framework (Collapsed)

2.3.2 Early Interest in the Proto-Model

Given the level of interest in this project, from its genesis, through the CoP group, and other associated discussions, the project has gained significant momentum during the last 2 years. These opportunities range from: (a) using the Conceptual Framework as a development method for those advising on security matters, as (b) a model through which targeted intervention teams can be deployed, (c) contributing to National Leader Development Programmes (CEO and leading Directors-General), (d) offering revisions to existing development of Major Programmes Leadership activity and finally (e) advising Board level risk management decisions. Given this level of demand, I was somewhat surprised, at this early stage, that a model was not already in existence and implemented internally that positioned the AoK as a multi-disciplinary approach with the DefSy community. The level of interest, I assumed, resulted from the evident gaps in both knowledge and practice, and indeed this proved to be the case in ongoing discussions.

Key to the progression of the above initiatives is the verification of the 'Validity and Applicability' of the Conceptual Framework. In making this determination, I have been guided by Creswell & Poth (2017) and offered 'thick and rich descriptions of the research', 'peer review' and, arguably 'prolonged engagement'. While this has proven to be extremely time-consuming, especially given contextual constraints, I have also found it to be equally, if not more, valuable in building credibility. Once I have obtained this verification, through the research study, and concluded this programme I will launch a programme of development activity to explore these opportunities.

2.3.3 Anticipated Contributions Arising from this Study

In Chapter 8.2 I will provide a detailed review of contributions arising from this study; however, it is worth pointing out that, at the formative stages of this study, and I had identified gaps in the areas shown below. It is important to stress that as the context for this study is the DefSy sector in HMG, the use of a similar PAR approach, with an expert group, would be naturally scarce due to access restrictions.

2.3.3.1 From a Theoretical Perspective

I found the search for relevant prior study challenging given the apparently limited body of literature when some of the areas of interest are searched in combination, i.e., a keyword string. I illustrate this with some observations on keywords (see Figure 3).

Table 3 Keywords used for this Practitioner Project

KEYWORDS
Defence & Security; Participatory Action Research; Delphi Technique; Complex Adaptive Systems; Sense-making; Risk Management, Soft Systems Methodology; System Dynamics; Pragmatism.

Beginning with the first three keyword criteria and using Google Scholar as an indicator (that I had linked to the University Library Catalogues) and EthOS, I was only able to find one article as a result of the search criteria; the search result was a doctoral thesis (PhD) that I reviewed during my literature review. When I added a further search criterion, Sense-making, this reduced the result to zero; this applied to most other search criteria also. I had elected the first three criteria as these (a) defined the industry within which the research was taking place, (b) the research method and finally (c) one of my philosophical principles, against these keywords I found limited existing research. Of course, there is a significant body of literature

in the discrete criteria, but not in combination: I did use other terms that more closely reflected the sensitive nature of the Problem Space, but this did not yield additional literature. Perhaps the strongest, and theoretically proximal, is a review of major accidents in the oil industry (Rosness et al., 2004); while this explores some of the AoKs (or perspectives) it does not present a Conceptual Framework as a practical tool for countering threat and *Novelty*.

2.3.3.2 From a Practitioner perspective

The nature of a research commission was to improve performance in a discrete functional area and address a specific issue, that of emergent threat or *Novelty*. As the commissioner, and sponsor for the project, was the Chief People Officer, responsible for training and development programmes, it was apparent that no existing model addressed the problem. On wider examination, the gap seemed widespread, this was not surprising as the nature of the problem had not been fully developed at that early stage.

The Major Programmes Leadership Academy (MPLA) is a development programme ran by Said Business School, University of Oxford: MPLA participants are Senior Responsible Owners and Project Directors from the Government Major Projects Portfolio. Having explored the matter, it was clear that while MPLA addressed risk, it did not address[9] its inherent non-linearity. Consideration of models for targeted intervention seem unexplored within DefSy; discussions with practitioners highlighted the norm to appoint external consultants as required, which they saw as being sub-optimal along time, cost and quality measures.

The accepted norm of obtaining agreement to proposed courses of action was through the formation of working groups and workshops. Prior to this research, the Delphi Technique had not been used to achieve consensus on strategy forming, forecasting or information gathering in any sense. While I found Delphi to be my chosen data collection method a natural fit, I was also interested to assess the level of acceptance as a new approach.

2.4 Organisation

I conducted this research as part of a Professional Practice Doctorate that develops both theory and practice, in fact, the latter was the main attraction for this programme. It is of personal

[9] One of the MPLA's senior participants (with whom I worked closely and had sat on the early CoP) brought this to my attention.

satisfaction to describe myself as a 'researching professional' and as someone that can bring the strengths gained through personal growth to the benefit of the environment in which I work. The knowledge amassed through this journey is considerable and has proven to be beneficial in many professional quarters. I set out my journey and my final presentation of the learning and development as follows:

I have structured this thesis as follows: having provided the Prologue to the study in Chapter 1, in Chapter 2 I have introduced this project, the Research Problem and the Aims & Objectives of the study. Chapter 3 will explore the literature around the defined Areas of Knowledge before providing a commentary on the implications for this Practitioner Project in Chapter 4. In Chapter 5, I will set out a detailed explication of the Conceptual Framework that I have based on the findings of the theoretical literature review. Chapter 6 sets out the applied research methodology, a Delphi Technique, including the composition and sample size, data collection, and results analysis. Sections 7 reviews the data, the themes identified from the analysis and the proposed contributions to existing knowledge. Chapter 8 sets out my personal reflections of this Practitioner Project journey before Chapter 9 concludes and summarises the Practitioner Project.

2.5 Chapter Summary

The purpose of this chapter was to establish my overall approach to the research study within this Practitioner Project. The main thrust of this section has been to establish my personal worldview that drives its progression, i.e., a holistic and pragmatic philosophy. Having now set out the Research Problem and the intended strategy, to answer the related Aims and Objectives, I now commence this strategy, the first element of which is to undertake a review of the relevant literature.

CHAPTER 3 ~ THEORETICAL BACKGROUND

As a researcher-practitioner, the importance of undertaking a review of the available literature was significant in the development of the conceptual framework. Hart (1998, p.13) defines the literature review as:

> "[T]he selection of available documents (both published and unpublished) on the topic, which contains information, ideas, data and evidence written from a particular standpoint to fulfil certain aims or express certain views on the nature of the topic and how it is to be investigated, and the effective evaluation of these documents in relation to the research being produced".

I examined the following key areas of knowledge to obtain "a broad perspective on a topic[s]" (Cook et al, 1997, p.3). Saunders et al., (2009) underline the importance of a critical review of the literature to develop a thorough understanding of the previous relevant and up-to-date research of the topic area. Hart (2018, p.31) in discussing the literature review, sets a "range of purposes" that are all equal importance when undertaking such an exercise, although the author contends this is not a complete list and they are of equal importance. In order to avoid the risk of "producing mind-numbing lists of citations and findings that resemble a phonebook-impressive case, lots of numbers, but not much plot" (Webster & Watson, 2002, p.2), the following structure applies to this chapter. The chapter begins with an outline of the approach to this literature review, in 3.2 I discuss the key theories relating to Complex Adaptive Systems (CAS), specifically those of 'Feedback' and 'Emergence', which is followed by an examination of the theories relating the management of *Novelty* in Chapter 3.3, including risk and uncertainty and existing risk management protocols in the Problem Space. Chapter 3.4 explores the theories relating to Sense-making and Situation Awareness and how they can increase 'understanding', which I follow with a review of both Soft Systems Methodology and System Dynamics in Chapter 3.5 as methods to address and counter the emergence of *Novelty.* Chapter 3.6 then reviews each area of knowledge and the implications these each has for this Practitioner Project before Chapter 3.7 provides a range of summary observations following the theoretical review. Chapter 8 both summarises and concludes this main section of the Practitioner Project.

3.1 Review Method

As we shall see, this project is exploratory and takes a pragmatic, abductive approach methodologically; the literature review is consistent with this paradigm. In choosing the form of the review, Cook et al., (1997) distinguishes between the Systematic Review and the Narrative Review; given the broad-range and inter-disciplinary nature of this research, i.e., the four AoK, it is argued that the presented literature review is Narrative in nature as it falls within the following (consistently pragmatic) definition:

> "[M]ost narrative review articles deal with a broad range of issues related to a given topic rather than addressing a particular issue in depth… Thus, narrative reviews may be most useful for obtaining a broad perspective on a topic; they are less often useful in furnishing quantitative answers to specific … questions." (Cook et al, 1997, p.3).

It is worth noting that while this approach enables a broad understanding (of the AoK), I felt, conversely, it restricts the depth to which the review can explore, especially given the word count constraint.

This chapter builds on the review of the literature undertaken for the discussions with the 'Community of Practice' and delves deeper into each Area of Knowledge (AoK) and I intend to provide the following outcomes. First, it will inform the development and advancement of the Delphi Panel; providing the initial framing for Delphi 1 and help to guide subsequent panels (2 & 3). Second, it will support and inform the development of the Conceptual Framework as an active intervention in the management of *Novelty* (in practice) and a potential Development Programme for practitioners in DefSy.

I see two themes as essential in helping to address the 'Research Problem' – first, the theme of (the) Problem Space and second that of the Problem Space Response. Each theme has two AoK and it is these discrete areas that are the subject of this Literature Review. These AoK emerged during the preliminary literature review and iteratively validated during a preliminary PAR exercise with informed parties (some of which will continue to support this project in taking part in the Delphi Panels) these AoK as set out in Table 4.

Table 4 Research Project Areas of Knowledge

PROBLEM SPACE
• **AoK 1. Complexity (Feedbacks & Emergence)** – acknowledges the context (Problem Space) is not 'ordered' or homogeneous, rather its 'complexity' and heterogeneity is a critical factor that leads to emergent properties through the existence of positive feedbacks.
• **AoK 2. Novelty –** acknowledges that Novelty, or threats, exist and/or emerge within this complex Problem Space, the extent to which this can be managed is a critical area.
PROBLEM SPACE RESPONSE
• **AoK 3. Understanding (the Problem Space) –** acknowledging that Novelty is largely unknowable, holding a deep understanding of the Problem Space is essential in making sense of the potential future states.
• **AoK 4. Response –** acknowledges that, once 'Understanding' has been developed, being able to deploy measures (mitigations and contingencies), is essential in countering and regulating Novelty.

3.2 Complex Adaptive Systems (Feedback and Emergence)

> "[C]omplexity is … associated with the intricate inter-twining or inter-connectivity of elements within a system and between a system and its environment". Chan, 2001, p.1.

3.2.1 The Problem Space as a Complex Adaptive System

Levin (1998, p.2) observes that the defining of a CAS is more difficult than discussing its characteristics, as to define it "will somehow limit a concept that is meant to apply to everything". Holland describes these CAS as systems that "change and reorganize their component parts to adapt themselves to the problems posed by their surroundings. This is the main reason that systems are difficult to understand and control—they constitute a "moving target." (Holland, 2000, p.18).

I have referred to the emergence of *Novelty* in the Problem Space and this can be a result of the inter-twining of these agents. Within the Problem Space, then, what agents or schemas exist and what patterns of interaction can arise and in turn lead to 'emergence of *Novelty*' or 'non-

linear behaviour'? As CAS operate and interact with the environmental agents, both exogenous and endogenous (Dovers & Handmer, 1992; Choi et al, 2001), the following are a preliminary set of collections (of these agents) existing in the Problem Space.

- Problem Space Organisations (defined here as those organisations that interact directly or indirectly) that are deemed to relate to the Critical National Infrastructure (CNI); this will to a greater or lesser extent include all Her Majesty's Government (HMG) 45 Ministerial and non-Ministerial Departments (gov.uk, 2018).
- CNI Programmes that are seeking to implement HMG policy, for example, the Strategic Defence and Security Review 2015 and National Security Capability Review 2018.

The above collections contain several non-static individual agents (Eidelson, 1997, p.3), or nodes (Choi et al., 2001, p.4) that constitute sizeable, and complex, systems. Within this construct, the network of nodes and the density of both actual connections and potential connections would be extremely high.

The collections of agents discussed above take the form of both organisational constructs and programmes that operate either within the bounds of these organisations or indeed across them. When conceiving these (organisations and programmes) as agents or nodes, it follows that there will be a significant number of 'states' that these agents can find themselves in, given variation in the system. These variables may be those described by the Office of Government Commerce in project management literature, for example Prince2 or MSP, such as Timescales, Cost, Quality, Scope, Benefits and Risk (BIS, 2010); there may be organisational variables, for example (in the Problem Space) mission performance, headcount, demand/supply ratios, financial performance, and so forth. In both areas, these variables, apply across a range of potential states. These states can be the products of the active, or indeed nil, response to prevailing stimuli, thereby demonstrating the scale of system variety. The full range of these system variables, and therefore potential states, is known as the Phase Space (Holling, 1973, p.19) and it is within this space that I conceive of the central phenomenon of *Novelty*.

In my experience I have seen how programmes negatively impact on other programmes that were directly and, more relevantly, indirectly related. I believe this was evidence of the inter-twining and interaction of system resulting in the emergence of alternative developmental pathways (Levin, 1998, p.3), or *Novelty*. I suggest that there are continuing and immeasurable

opportunities for emergence due to the large number of connections between active agents within the Problem Space.

I have proposed the Problem Space as being a complex system, within which the central phenomenon of *Novelty* manifests; I have provisionally described the system and have established some of the key characteristics. Within the complex system, I have identified two characteristics as being core to the Problem Space; (a) 'emergence of perpetual *Novelty* (Holland, 1995, p.31) driven by (b) 'non-linear behaviour'. I argue that this emergence of perpetual *Novelty* aptly describes the central phenomenon of *Novelty* within the Problem Space and I ask the following, how do practitioners respond to this emergence?

I have defined the Problem Space (within which *Novelty* exists) as a Complex Adaptive System (CAS). Here, I note Levin's (1998, p.2) description of the study of *CAS*, if not providing a definition, as being "how complicated structures and patterns of interaction can arise from disorder through simple but powerful rules that guide change." (ibid.). Definitions of *CAS* do exist that demonstrate one key facet that I view as important for this research, and this relates to the interconnections within the system, for example, Shaw refers to large numbers of agents (1998, p.3) & Eidelson refers to the collection of diverse parts, (1997, p.2). Similarly, and while agreeing there is no universal definition of *CAS*, Anderson (1999, p.4) details key themes that help to explain the concept of *CAS* that includes "agents with schemata"; but also "recombination & system evolution". Brownlee (2007, p.2) also refers to these characteristics and introduces another key concept to the study namely, non-linear interaction. Chan (2001, p.1) provides an effective definition in pronouncing "[C]omplexity is … associated with the intricate inter-twining or inter-connectivity of elements within a system and between a system and its environment". Finally, Smith & Stacey (1997, p.3), arguing from a Human Systems perspective (groups, organisations or nations), state that *CAS* share several attributes, which includes "consisting of large numbers of agents interrelated in a nonlinear way"…"they interact with an environment consisting of other complex adaptive systems"… "they use feedback". Arthur et al., (1997, p.2) discusses CAS from the field of economics and develops two attributes "continual adaptation" and "perpetual *Novelty*." Rammel et al., (2007, p.2) argue that organisations themselves, as socio-economic systems, share the characteristics of CAS, specifically, the "emergence of *Novelty*", "which is the creative foundation of sustainable development" and "non-linear behaviour that is far from equilibrium".

In an exploration of organisations as CAS, Schneider & Somers (2006, p.352) stress that variables "characterize dynamic systems"; the full range of system variables, have been described as the State (or Phase) Space (Holling, 1973, p.19). The descriptions of *CAS*, together with the number of variables highlight the potential difficulty in fully comprehending the Problem Space which Winter et al., (2006, p.6) underscore in describing as "the indefinite levels and kinds of description of the terrain [Problem Space] itself". Goldstein (1994, p.61) describes an emergent state, that is a consequence of the interaction of 'system characteristics or variables', as an 'attractor'. More precisely, these environmental factors are known as 'initial conditions', a sensitivity to which is one of the core tenets in Complexity Theory (see Schneider & Somers, 2006; Sole & Goodwin, 2000, as examples). Initial conditions form the constraints associated with another key term in complexity theory, that of 'Basins of Attraction': Walker et al (2004, p.3) in discussing stability in socio-ecological systems (another example of *CAS*), define these basins as:

> "a region in state space in which the system tends to remain. For systems that tend toward an equilibrium, the equilibrium state is defined as an "attractor," and the basin of attraction constitutes all initial conditions that will tend toward that equilibrium state. … Therefore, we think of SESs as moving about within a particular basin of attraction, rather than tending directly toward an attractor".

Goldstein's (2011, p.6) provides a more accessible definition as "[B]asins … can be likened to an actual basin or bowl of a sink with a drain at the bottom. The drain at the bottom of the sink is analogous to the fixed-point attractor in the centre of the phase space diagram".

3.2.2 Feedback in Complex Adaptive System

> "It is hard to underestimate the power of the feedback view. Indeed, almost nothing is exogenous." Sterman, (2002, p.505).

In 2.3.1, I introduced 'Feedback' as being a core attribute of *CAS*. Feedback, in this context, refers to the regulation of a machine/organism through the use of governing devices known as 'feedback loops'. Stacey, (1995, p.4) argues that feedback loops drive human systems and are fundamental to organisation life to achieve a steady-state. Relating this to the Problem Space, in the evolution of *CAS* both Norbert Wiener (1894-1964) and Ludwig Von Bertalanffy (1901-1972) played important roles; Wiener with the development of Cybernetics (1948) and

Bertalanffy with General Systems Theory (1968). While 'negative feedback' attenuates[10] a system's variables to maintain equilibrium, which organisational theorist Stafford Beer (cited by Kandjani et al., 2013, p.4) defines as the "constancy of some critical variable (output)", 'positive feedback' or amplification can (be used to) move the system to a new 'desirable stability'. For example, Dooley (1997, p.91) contends that following the formation of a shared vision, feedback can address the 'state gap' and motivate (and demotivate) individual performance. Beer (1926-2002), in his work on management system control, extended the notion of regulation into his theory of 'Management Cybernetics' and the Viable System Model (VSM). Core to the development of VSM is the role of regulation in the management of variety (Beer, 1985) through attenuation (negative feedback) and amplification (positive feedback) which constitutes an element of System 1. Sterman, a key contributor to System Dynamics, (2000, p.6) explains that complexity arises since systems (and their environment) are:

- Constantly changing: Heraclitus said, "All is change." What appears to be unchanging is, over a longer time horizon, seen to vary. Change in systems occurs at many time scales, and these different scales sometimes interact.
- Tightly coupled: The practitioners in the system interact strongly with one another and with the natural world. Everything is connected to everything else.
- Governed by feedback: Because of the tight couplings among practitioners, our actions feed back on themselves. Our decisions alter the state of the world, causing changes in nature and triggering others to act, thus giving rise to a new situation which then influences our next decisions. Dynamics arise from these feedbacks.
- Nonlinear: Effect is rarely proportional to cause, and what happens locally in a system (near the current operating point) often does not apply in distant regions (other states of the system). Non-linearity often arises from the basic physics of systems: Insufficient inventory may cause you to boost production, but production can never fall below zero no matter how much excess inventory you have.

[10] Organisational theorist, Stafford Beer (1926-2002) in his work on organisational and management system regulation, extended the notion of regulation into his core works 'Management Cybernetics', which resulted in the Viable System Model (VSM). Core to the development of VSM is the role of regulation in the management of residual variety (Espejo, 2002, p.9) through attenuation (negative feedback) and amplification (positive feedback).

- History-dependent: Taking one road often precludes taking others and determines where you end up (path dependence). Many actions are irreversible: You can't unscramble an egg (the second law of thermodynamics). Stocks and flows (accumulations) and long time delays often mean doing and undoing have fundamentally different time constants.
- Self-organizing: The dynamics of systems arise spontaneously from their internal structure. Often, small, random perturbations are amplified and moulded by the feedback structure, generating patterns in space and time.
- Adaptive: The capabilities and decision rules of the agents in complex systems change over time. Evolution leads to selection and proliferation of some agents while others become extinct.
- Characterized by trade-offs: Time delays in feedback channels mean the long-run response of a system to intervention is often different from its short-run response.
- Counterintuitive: In complex systems, cause and effect are distant in time and space while we tend to look for causes near the events we seek to explain. Our attention is drawn to the symptoms of difficulty rather than the underlying cause. High leverage policies are often not obvious.
- Policy resistant: The complexity of the systems in which we are embedded overwhelms our ability to understand them. The result: Many seemingly obvious solutions fail or actually worsen the problem.

Forrester describes the strength of System Dynamics in that it "recognizes all systems as having the same fundamental structure of levels and rates (accumulations and flows) structured into feedback loops that cause all changes through time." (1992, p.10). Forrester and his later proponents embrace the centrality of feedback (in controlling systems) though they use the terms 'Reinforcing' to denote positive and 'Balancing' to denote negative (feedback loops). Mitleton-Kelly (2003, p.16) defines Positive, or Reinforcing feedback, as "processes [that] underlie … transformation and they provide a starting point for understanding the constant movement between change and stability in complex systems." Citing Arthur, Mitleton-Kelly (2003, p.17) also defines Negative (or Balancing) Feedback as leading "to diminishing returns, which in turn lead to (predictable) equilibrium outcomes".

3.2.3 Emergence in Complex Adaptive Systems

The literature around the theory of Emergence is both broad and deep; from language (Beckner et al., 2009), supply networks (Choi & Dooley, 2001), organisations (Boisot & Child, 1999) and ecology (Folke, 2006) the literature is not short of exploration and application. While these references suggest the idea of emergence as arising over relatively recent times, Corning (2002) adopts a much longer timeframe and describes this recent interest as the 're-emergence of emergence' (ibid., p1). Corning states that recent authors are merely following comments made by "Aristotle had made more than 2000 years earlier" who wrote "[T]he whole is something over and above its parts, and not just the sum of them all..." (ibid., p.3). Corning cites the reason in the submergence of the theory was an interest in reductionism and Darwinism (ibid., p.3-5), the nascent interest in the field of biology led to a renewed interest (in emergence) notably from the biologist Ludwig Von Bertalanffy (1901-1972), who subsequently wrote General System Theory (1968), which Corning suggests led to the development of the field of Complexity Theory. In discussing the precursors of the post-modern 'emergent concept' Clayton & Davies (2006) refer to Aristotelian theories relating to the transition from 'Potential to Actual' (ibid. p.5) and Plotinus theories of 'Emanation' in the 3rd century CE (ibid). More recently the phenomenon of 'Emergence' has been situated as a property of CAS (see Schneider & Somers, 2009; Holland, 2002; Anderson, 1999; Rammel et al., 2007; Van Bilsen et al., 2010, p.40). In a detailed paper discussing and describing the concept of Emergence, Corning (2007, p.19) states that the term 'Emergence' originated in the work of pioneer psychologist G. H. Lewes (1874-1879). Lewes, Corning asserts, like other theorists (of the time), was arguing against the accepted Darwinian notions of resultant evolution and was instead arguing for emergent evolution:

> "Every resultant is either a sum or a difference of the cooperant forces; their sum, when their directions are the same — their difference, when their directions are contrary. Further, every resultant is clearly traceable in its components, because these are homogeneous and commensurable... It is otherwise with emergents, when, instead of adding measurable motion to measurable motion, or things of one kind to other individuals of their kind, there is a cooperation of things of unlike kind". (ibid.)

O'Connor (1994, p.3) echoed this understanding and differentiated emergents from resultants and provides the example of a table as having emergent macro-properties, such as shape, and

less 'higher level' such as mass as resultant micro-properties. Stephan (1992) having reviewed the key contributions in the field, cites the following varying (abbreviated) characteristics or "versions of emergence" (ibid., p.26):

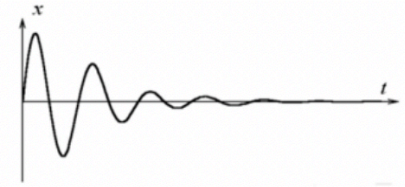
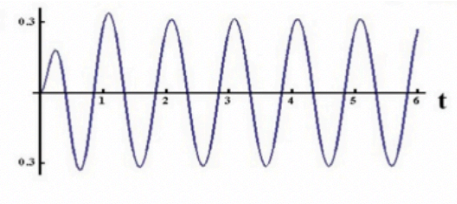
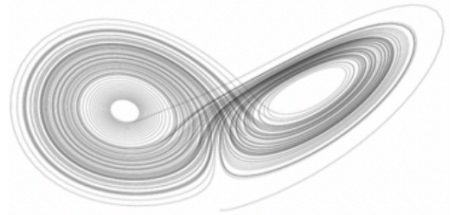
- **Emergence as non-additivity:** English philosophers, John Stuart Mills (1806-1873) and George Henry Lewes (1817-1878), "[T]he emergent is unlike its components in so far as these are incommensurable, and it cannot be reduced either to their sum or their difference";
- **Emergence as novelty**: Argentinian philosopher Mario Bunge (1919-) argues that 'levels of emergence' result in a whole of a certain property 'for the first time' and "an emergent thing is one that has properties that none of its components has";
- **Emergence as non-predictability**: Karl Popper (1902-1994) uses emergence, firstly, to describe the absolute unpredictability of events and secondly to describe the non-deductibility of properties.
- **Emergence as non-deducibility**: Epistemologist CD Broad (1887-1971) develops away from non-predictability towards non-deductibility while the behaviour of the system is determined by the behaviour of its components, the microstructure, it cannot be deduced from it.

Finally, and more succinctly, Clayton & Davies (2006) provide the following characteristics for Emergence:

- Ontological physicalism: All that exists in the space-time world are the basic particles recognized by physics and their aggregates.
- Property emergence: When aggregates of material particles attain an appropriate level of organizational complexity, genuinely novel properties emerge in these complex systems.
- Their reducibility of the emergence: Emergent properties are irreducible to, and unpredictable from, the lower-level phenomena from which they emerge.

Henle (cited by Goldstein, 2009, p.78) describing the doctrine of emergence as a "generally accepted view", importantly, Henle also described 'novelties' as those qualities that were "never before embodied" (ibid., p.79). At this ontological level, it is worth returning that the concept of attractors in relation to the *Novelty* for a brief discussion. In Table 5, I identify three types of attractor that legitimise the use of the term by providing a supporting scientific framework.

Table 5 Consideration of the Problem Space as Attractors

ATTRACTOR	DESCRIPTION	COMMENT
Stable or Fixed Point 	The most basic attractor is the point attractor. This attractor can be described as operating in a phase space that moves towards a highly equilibrium state. They "lure systems to a stable position of rest" (Gilstrap, 2005, p.59). *Example: A dampened pendulum, a dropped book.*	Highly regulated by the environment; what might be described as 'deep basin walls'. I would argue that this(attractor) does not meet the intended definition of the *Novelty*; as there is a likelihood toward equilibrium and, therefore, a controlled state.
Periodic or Limit Cycle 	This type of attractor is one that usually moves in a linear or orbital pattern toward and away from a set point a given number of times. It is driven towards a stable equilibrium state, as it follows the same path repeatedly until it eventually comes to rest (Goldstein, 2011, p.7). *Example: A pushed pendulum, planetary orbits.*	Like the Stable/Fixed Point attractor, it is regulated by the environment within a stable basin of attraction. Within the basin of attraction, I would suggest the attractor is oscillating up and down the basin walls repeatedly. While there might be disturbance, the system is stable with its limits. Again, I do not believe that this represents *Novelty*.
Strange or Chaotic Attractor 	Strange attractors are reflected in patterns of behaviour, that is, shapes in space or movements over time, which are never exactly repeated but are always similar to each other – the chaotic system cannot be predicted. *Example: A weather system evolving in a dynamical environment.*	Given the unpredictable, or unknowable, nature of the attractor, I view this as highly representative of *Novelty,* i.e., it is emergent and driven by non-linear behaviour.

These attractors are situated within the Problem Space and describe how they may meet the working definition of the central phenomenon within this ontological level, i.e. emergence as *Novelty*. In the field of CAS, random and non-linear behaviour are key features; the point at which these behaviours occur is known as the 'bifurcation' point. Eidelson (1997), in a rich description of bifurcation, refers to the external or internal forces (perturbations) that can result in a "transformational pattern shift from one qualitative state to another" (ibid., p.50). Citing Prigogine and Stengers, Eidelson (ibid., p.51) describes bifurcation as "a delicate interplay between chance and necessity, between fluctuations and deterministic laws". Returning to previously mentioned "intricate inter-twining or inter-connectivity of elements within a system and between a system and its environment" (Chan, 2001, p.1), I would posit that the opportunity for bifurcation of variables within the Problem Space is high.

3.3 Novelty in Complex Adaptive Systems

Having established the nature of CAS, and that of emergence and feedback, in this section I define risk and risk management conventions within the Problem Space. I will then discuss the second Area of Knowledge in the Problem Space – *Novelty* (as Risk and Uncertainty).

3.3.1 Novelty as Risk and Uncertainty

While in this study, I do not undertake a detailed exposition of emergence, I have demonstrated that it is at this level that the phenomenon of *Novelty* is conceptualised. In order to understand this worldview, Goldstein (1999, p.2) provides the following description (for *Novelty*):

> "Emergents have features that are not previously observed in the complex system under observation… In other words, radically novel emergents are not able to be anticipated in their full richness before they actually show themselves."

Given the ontological-level view of emergence as *Novelty*, it follows there would be an absence of a priori knowledge, or certainty, of the central phenomenon: a question, therefore, arises – how practitioners fully understand emergence? Walker et al., (2003, p.8), in discussing uncertainty in relation to knowledge, proposes a spectrum between 'determinism and total ignorance' (see Figure 4).

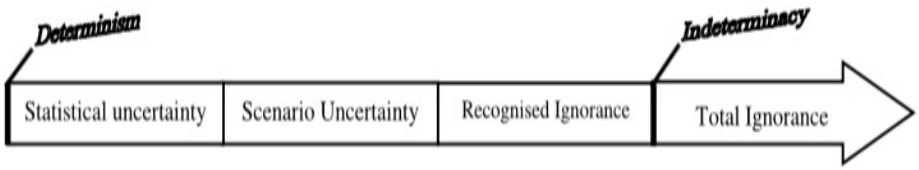


Fig. 4 The progressive transition between determinism & total ignorance. Walker et al., (2003, p.8)

Of particular interest is the area of 'Total Ignorance' which is defined as "the other extreme from determinism on the scale of uncertainty, which implies a deep level of uncertainty, to the extent that we do not even know that we do not know" (ibid.). Making a bridge to the assertion around *CAS*, the authors also describe this level of uncertainty as potentially irreducible, thereby underscoring its macro-level ontological characteristic.

Building on the work of Walker et al., (2003) in a review of the key concepts relating to the management of hazard, Ramsey (2009) discusses the terminology relating to the uncertainty in the assessment of hazard. In this paper, while acknowledging that definitions (for hazard) vary across disciplines, Ramsey (ibid., p.7) posits a definition for hazard "as a possible source of danger due to the innate properties of an agent (i.e. biological, chemical or physical) to cause harm". In summarising the gaps in understanding what constitutes 'Total Ignorance', as shown in Figure 7, Ramsey (ibid., p.11) identifies the following characteristics (here contextualised for this project):

- A limitation in the availability of basic measurements of environmental variables;
- A lack of knowledge of the environmental processes affecting novelty in the system;
- An inability to predict the effects of the intertwining of environmental variables. In many cases of novelty there are multiple rather than single novelties;
- The aetiology (cause or causes) of system perturbation. Even when it is possible to make accurate estimates of the exposure to one novelty, the mechanisms by which this exposure translates into system variation are often not known;
- Impact assessment, the assessment of hazard, exposure, risk and hazard incidence are all limited by economic factors.

Ramsey (2009, p.12) concludes with a recommendation that in order to develop and resolve the problems discussed above, there is a need to explore practices from other disciplines and apply them to the area of hazard assessment. Of interest is the work undertaken as a result of the Challenger Space Shuttle disaster and the resulting evolution of Normal Accident Theory

(Perrow, 1984) as it provides an interesting prism through which the *Novelty* can be viewed.[11] In developing Normal Accident Theory (NAT) Perrow argued that in complex organisations, accidents, or failures, are inevitable (Viller, Bowers & Roden, 1997, p.18) and likely environments will include the following four characteristics.

1) Signals only noticed in retrospect;
2) Multiple design and equipment failures;
3) Some type of operator error which is not considered error until the accident is understood;
4) "Negative synergy" where the sum of equipment, design, and operator errors is far greater than the consequences of each singly.

In his seminal work on 'Normal Accidents: Living with High-Risk Technologies' Perrow (1984, p.70) defines a 'normal accident' as those "involving unanticipated interaction of multiple failures in systems with high-risk technologies". Proposing a four-box grid, (Figure 5) Perrow places industries along two axes (a) Interactions – Linear to Complex and (b) Coupling – Loose to Tight. Perrow essentially argues in systems of 'interactive complexity' and 'tight coupling' that their very nature is likely to produce system accidents and that they are inevitable, or normal, in those systems. Of interest is that 'normal accidents' require "the interaction of multiple failures that are not in a direct operational sequence." (ibid., p.23); of specific note is that "normal accidents have a significant degree of incomprehensibility" (ibid.). This points to (a) the complex nature of the required environment within which these accidents occur, and (b) that they are unknowable a priori, which is in accordance with the present conception of *Novelty*.

Perrow's views (on the normalcy of accidents) are not without criticism. For example, Leveson et al., dispute some of Perrow's specific findings around the holistic classification of accidents stating – "the theory of NAT is incomplete and leads to more pessimism…in designing and operating in complex high-risk systems" (2009, p.239). The authors do, however, acknowledge Perrow's general contribution to the field of complexity and culture in the area of safety theory. Similarly, Hopkins (1999) who introduces Perrow's work as a "classic of organisational

11 While NAT offers an insight into the types of failures that can occur under some circumstances, I distinguish these accidents from the central phenomenon of novelty. NAT relates to the contextual characteristics of any 'singular' organisation (or node), whereas novelty occurs as a result of intertwining of multiple nodes. It is noted with interest, that a normal accident - while significant to the host organisation - could (and will) lead to novelty across the wider system. However, novelty is not always caused by a normal accident.

sociology" (ibid., p.1) argues that it "does not contribute to our understanding of accidents" (ibid., p.10), but that it did provoke the development of 'high-reliability theory' (reviewed herein), "which really has contributed to our understanding of how disasters can be avoided" (ibid.). Hopkins was addressing Perrow's initial work, but also his updated perspectives, wherein Perrow noted that the level of interaction and coupling is largely irrelevant as all organisation will experience failure.

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Fig. 5 Perrow's Interaction Coupling chart (1999, p.327)

Although this research is interested in the phenomenon of *Novelty* as it exists in DefSy, it would be remiss not to mention the work on organisational accidents by psychology Professor James T. Reason (1938-present). Though Reason's work focuses on human and organisational accidents, there are some broad-based theories that apply to this research project, namely Reason (1997, p.1) proposes some clear definitions for accidents:

- **Individual Accidents** – In which a specific person or group is often both the agent and the victim of the accident. They are larger in number than Organisational Accidents.
- **Organisational Accidents** – Have multiple causes involving many people operating at different levels of their respective companies. They are fewer in number but are more catastrophic and occur in complex systems.

In a prior paper, Reason (1990, p.2) in an analysis of human errors differentiates two types of errors, as:

- **Active failures:** those errors and violations having an immediate adverse effect. These are generally associated with the activities of 'front-line' operators: control room personnel, ships' crews, train drivers, signalmen, pilots, air traffic controllers, etc.
- **Latent failures:** these are decisions or actions, the damaging consequences of which may lie dormant for a long time, only becoming evident when they combine with local triggering factors (that is, active failures, technical faults, atypical system conditions, etc.) to breach the system's defences. Their defining feature is that they were present within the system well before the onset of a recognizable accident sequence. They are most likely to be spawned by those whose activities are removed in both time and space from the direct human-machine interface: designers, high-level decision-makers, regulators, managers and maintenance staff.

Given Reason's above comments, Latent Failures or "Resident Pathogens" (ibid., p.477) offer considerable probable threat (to system equilibrium) and reinforce the posited notion of *Novelty*. One of Reason's main contributions to accident theory is what became known as the 'Swiss-Cheese Model' or SCM. In this model, inputs (or novelties) evolve as they follow, as Reason argues (ibid., p.481), a "trajectory of opportunity" through system defences – the better the defences, the lower the chance of the exposure (or accident). However, the defences may have inherent weaknesses – 'holes' – which on occasion will align, thereby increasing the possibility of exposure. Perneger (2005) argues that Reason's SCM is not universally supported however; in a study of healthcare quality professionals, the authors found that there was a considerable variation in the interpretation of the model. They argue that this is due to lack of understanding of some of the terms, but also that as the model was difficult to interpret, that it would be difficult to communicate[12]. This has not prevented SCM being used as a basis for further, and indeed more recent work; in a study proposing the expanded use of the model, Seshia et al., (2017) acknowledge the criticisms of the model, but argue that Reason intended

[12] This is a point I will monitor through the research study itself.

for the model to "a generic tool meant to be custom-tailored to specific situations" (ibid., p.189).

3.3.2 Hazard Management Conventions

Having introduced 'emergent *Novelty*' as constituting a 'threat' to the stability of the Problem Space (as a complex system) – should circumstances allow. The Swiss Cheese Model (Reason, 2006), as a conceptual model illustrates how *Novelty* can lead to potential accidents when gaps in defences align. I have referred to observations made (through lived experience) during the application of regulatory practices where I noted that these tools did not address the (then embryonic) concept of *Novelty*, indeed it was clear from discussions (with practitioners) that some were not fully aware of the notions, or qualities, of (a) 'hazard' (as a source) for (b) '*Novelty*'. I now consider the approaches available to practitioners to respond to the threats raised by *Novelty*, and a consequential question arises – are these models capable of countering the central phenomenon? But first, I begin with a brief definition of 'risk'.

3.3.2.1 Defining Risk

Holton (2004), in reviewing the historical derivation of risk as a term, draws from the work of American economist Frank Knight, who had distinguished between the 'measurable uncertainty' or 'objective probability' and 'unmeasurable uncertainty' or 'subjective probability' of accidents – the former being a priori and based on statistical probabilities, and the latter based on opinion. Holton adopts Knight's "most famous definition of the term" of risk as:

> "[T]o preserve the distinction . . . between the measurable uncertainty and an unmeasurable one we may use the term "risk" to designate the former and the term "uncertainty" for the latter." (ibid., p.2).

However, Kaplan & Garrick (1981), while highlighting that risk-based terminology, e.g., probability, had been the subject of dispute for some "200 years, since the time of Laplace and Bayes" (ibid., p.17), suggest alternate definitions of risk. While Holton (and Knight) adopt 'measurable uncertainty' as the definition, Kaplan & Garrick add that risk needs to incorporate damage, therefore must be negative (or 'downside' risk) and offer the following equation: *Risk = Uncertainty + Damage.* While the author's support the assertion of hazard 'as source' of risk (ibid., p.2) and the importance of the use of defences in the management of risk (which they

term as "safeguards"), they contend that other facets must be taken into consideration: each assessment of risk must include likelihood and consequence. Moreover, the authors criticise the standard of using simplistic, multiplicative calculation such as probability x consequence to quantify risk level, stating "[W]e have argued that a single number is not a big enough concept to communicate risk. It takes a whole curve, or actually a family of curves, to communicate the idea of risk." (ibid., p.15). The is in accord with a recurrent theme of this present research, i.e., that we cannot simplify complexity, it is irreducible. Going forward, and to continue the development of the conceptual model, I acknowledge and adopt the Knightian definitions of both Risk and Uncertainty[13], (blended with Walker's (2003) descriptions of knowledge) as follows:

- Risk – 'Measurable Uncertainty', or 'Objective Probability' of effect or exposure (accident) – for which there can be Statistical Uncertainty (as knowledge);
- Uncertainty – 'Unmeasurable Uncertainty' Or 'Subjective Probability' of effect or exposure (accident) – for which there can be Total Ignorance (as knowledge).

As this project is interested in systemic *Novelty*, i.e., that which does not necessarily correlate to organisational boundaries, I was interested to note the following contribution to the field. Writing in the Journal of z, Smith & Fischbacher (2009) argue that, given the its complex nature, risks are borderless – and:

> "are also trans-boundary because they do not have a single root cause for the nature of the threat and also involve multiple causal agents and pathways for transmission. As such, they do not 'fit' neatly into the conceptual mind-sets that we often have for categorizing threats and the causes of risk." (ibid., p.6).

I now review 'Risk Management' practices from this perspective and the question of whether risk (or uncertainty) could, in fact, be 'fully managed' in any meaningful sense.

3.3.2.2 Overview of Risk Management in the Problem Space

While I have contended that the nature of the Problem Space is borderless and therefore difficult to define or indeed reduce, it is possible to view it as existing within the context of

13 The definition of uncertainty is also adopted given the (emergence as novelty) ontological level.

Her Majesty's Government (HMG). In 2002, HMG, published 'Risk: Improving government's capability to handle risk and uncertainty'; the purpose of which was, according to (then) Prime Minister Tony Blair, to get "the right balance between innovation and change on the one hand, and avoidance of shocks and crises on the other" and that this was "now central to the business of good government" (HMG, 2002, p.2). From this, arguably, foundational document, HMG developed its general approach to the management of 'risk' and 'uncertainty' (using their own definitions, not those adopted during this project); it is worth observing that these key words are used synonymously in this document (this is not unique – see Perminova et al., 2008; Alaszewski & Coxon, 2009; Cleden, 2017); though it is possible that as an early document it was somewhat immature in its thinking. Consider, for example, the following passage – "[G]overnments have always faced risks and dangers of their own – unforeseen events, programmes going wrong, projects going awry. Such uncertainty is not new" (HMG, 2002, p.4), given that this adopted distinction may lead to different responses, I view this foundational position as inconsistent and potentially misleading.

The government's document '[T]he Orange Book Management of Risk – Principles and Concepts' (HMG, 2004), the purpose of which is "to provide broad based general guidance on the principles of risk management" (ibid., p.7), builds on the aforementioned 2002 document. While the document intends to incorporate "lessons we have all been learning about risk management through the experience of the last few years" (ibid.), it does not appear to recognise the distinction between risk and uncertainty identified during this project. The overall approach centres on the quantification of (known) risk and therefore omits reference to 'uncertainty' as defined (by Knight & Walker) – this perhaps exemplifies the 'Total Ignorance' category as established by Walker (2003). Of note is the depiction of a Risk Management Model, see Figure 6 (HMG, 2004, p.13), which includes a consideration of the 'Risk Environment / Context'.

This depiction suggests a boundary between the 'organisation' or 'enterprise' and the wider environment; however, this would be at odds with the boundary-less nature of the Problem Space. My attention was drawn to the section relating to 'Identifying risks', which supports the concerns related to this model, as "[I]n order to manage risk, an organisation needs to know what risks it faces, and to evaluate them. Identifying risks is the first step in building the organisation's risk profile" (ibid., p.15). There is no single right way to document an organisation's risk profile, but "documentation is critical to the effective management of risk."

(ibid.). While this is positive in terms of the management of 'risk', as defined as 'measurable uncertainty', it was not possible to draw any guidance on how to address uncertainty, i.e., 'unmeasurable uncertainty' from this document. In an updated version of this document Management of Risk in Government (HMG, 2017), the assumption that risk is identifiable remains, although the language seems to adopt a more dynamic and holistic tone.

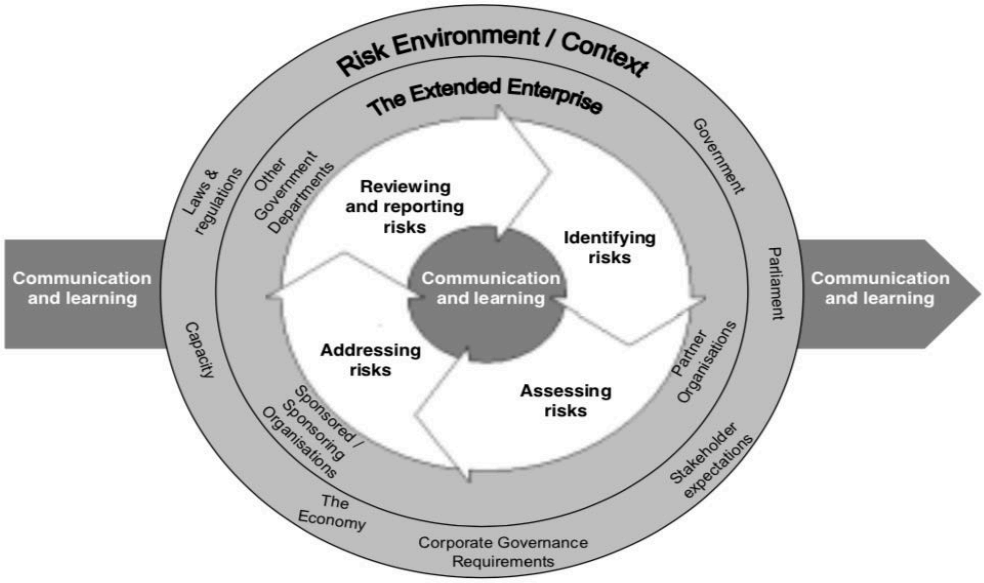

Fig. 6 Illustration of basic Conceptual Framework Risk Management Model HMG, (2004, p.13) Crown Copyright - http://www.nationalarchives.gov.uk/doc/open-government-licence/version/1/open-government-licence.htm

3.3.2.3 Risk Management Standards

In the early discussions with the sponsors and community of practice (CoP), and addressing the potential issues leading the research problem, a number of comments were made around the maturity of the Problem Space, the current practices around risk management (as referenced in Table 6 below) and the need for a model that would represent its individual characteristics. This is one of the drivers for this research. In a broad-based comparison of available risk management standards, Rehacek (2017), compares the following standards that are available within a project management space: PMI, PRINCE2, IPMA, ISO 31000 and IEC 62198. Within the review the author presents the following definitions for 'risk':

- PMI: Project risk is an uncertain event or condition that, if it occurs, has a positive or a negative effect on projects objectives such as scope, schedule, cost, and quality.
- PRINCE2: A risk is an uncertain event or set of events that, should it occur, will have an

effect on the achievement of objectives. It consists of a combination of the probability of a perceived threat or opportunity occurring, and the magnitude of its impact on objectives.

- IPMA/ISO/IEC: Precarious event or condition which if it occurs impacts the attainment of the project objective negatively. Risk is effect of uncertainty on objectives.

As this project is concerned as to why existing practices may not be effective to mitigate the problem of emergent systemic threat, it is worth noting Rehacek's observation that shows 'risk identification' is a feature of all the examined standards and that the various and structured risk responses are similar in nature (ibid., p.12). In reviewing the risk management process of 'Establishing the Context' Rehacek observes that "[T]he external context is the … environment in which the organization seeks to define and achieve its objectives." (ibid., p.9), and as Hillson (2006, p.62) suggests, "this [process] may not result in a full scope of possible risks", this highlights a weakness in the processes. I would propose that, given this weakness, i.e., it is unrealistic to provide a full analysis of the breadth of uncertainty—given both the work of Walker (2003) and Ramsey (2009) above—no standard can ever fully mitigate threats and hazards, even were the organisations to be operating at a high level of maturity.

Away from the project management context, Enterprise Risk Management (ERM) is a "process by which organizations in all industries assess, control, exploit, finance and monitor risks from all sources for the purpose of increasing the organization's short and long term value to its stakeholders." (D'Arcy & Brogan, 2001, p.2). Introduced as a means for bringing forms of an enterprise's risk management activity together (ibid, p.) in order to "to maximize the productive efficiency of the enterprise." (Mehr & Hedges, 2001, p.3). This focus on the aggregated risk has helped organisations to "continuously improve" in the face of "the rapid development of technology and management" (Idris & Abdullah, 2015, p.246). Organisations such as the Committee of Sponsoring Organizations of the Treadway Commission define ERM as:

> "… a process, effected by an entity's board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives." (LLP PWC & COSO, 2004, p.4)

The COSO framework provides a method through which an organisation can manage its risk; notably its 'Event Identification' examines "Internal and external events affecting achievement

of an entity's objectives must be identified, distinguishing between risks and opportunities. Opportunities are channeled back to management's strategy or objective-setting processes."(ibid, p.4)

COSO is not the only ERM model; the alternative ISO 31000 avoids the criticisms of traditional risk management practices, for example, relying on a "probabilistic approach", "technical and scientific rationality" (Lalonde & Boiral, 2012, p.280) and takes a different approach. Working with an arguably simple definition of risk as "effect of uncertainty on objectives" ISO 31000 combines both internal and external assessments in the first phase of the process – 'Establishing the Context' (Purdy, 2010, p2). This process is focussed on uncertainty at the start of the risk assessment process, but importantly maintains this holistic perspective as an ongoing activity. It does not, however, take into account the specific issue of 'emerging risk', which is defined under the newly proposed ISO 31050–Guidance for Managing Emerging Risks to Enhance Resilience[14]—as "new and/or increasing" risks [that] can be related to different areas of activities, such as new processes, new technologies, new types of workplace, or social or organizational change" (ISO, 2020). I would argue that this represents a clear move forward as it takes a more systemic view of contextual risk, however, at this point in development it cannot be known whether the definition of emergence, which is used in this thesis, is taken into account in the proposed standard. Because of this, the need for a contingent and specific approach for DefSy, as expressed by the commissioning group, remains valid.

3.3.2.4 Risk Management in the Wider Context

Within the broader Problem Space, i.e., outside government but within the related national infrastructure, organisations are evolving their own approaches to the management of both risk and uncertainty; two important organisations are the Centre for the Protection of the National Infrastructure (CPNI) and the National Cyber Security Centre (NCSC). While it is not possible to analyse internal policy documents, having reviewed publicly available information, I make the following observations. The government established CPNI to strengthen DefSy and its direction is guided by the following government documents (CPNI, 2018), (a) National Security Strategy (and Strategic Defence and Security Review), (b) National Risk Register,

[14] Scheduled for publication in 2021.

and (c) Counter-Terrorism Strategy. Naturally, these documents refer to predefined nation-level risks and governmental policy approaches in the main, however, there are discrete references to 'in practice' protocols. For example, the Counter-Terrorism Strategy (CONTEST) provides the following diagram (Figure 7) to illustrate the approach to address risk.

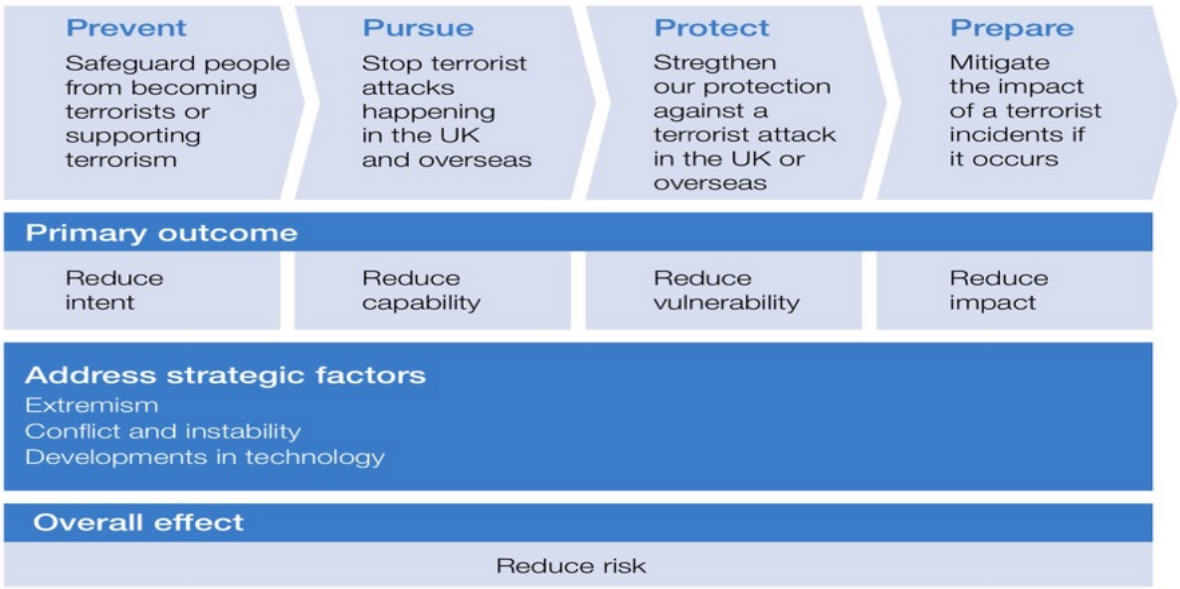

Fig. 7 HMG, (2004, p.13) CONTEST's Risk Reduction Model, CPNI (2018) Crown Copyright - http://www.nationalarchives.gov.uk/doc/open-government-licence/version/1/open-government-licence.htm

One of the core functions provided by CPNI is an advisory role. Within this portfolio is the 'Passport to Good Security' service[15]; a core element of which includes risk management through prevention (CPNI, 2018). The guidance is broad in scope, identifies areas where risk might arise, and the steps organisations can take to improve their overall performance. However, it is noted that (a) this focus may miss the broader systemic risks and uncertainties, and (b) that the delineation into themes might be seen as reductive and miss risks that fall between these themes or across them (when viewed as 'hierarchically lower' node interactions).

Within NCSC the approach is markedly different, the information relating to risk management is more closely related to the definition of uncertainty as adopted in this project, i.e., unmeasurable uncertainty. In an online guidance "[O]utcomes over process: how risk management is changing in government" (NCSC, 2016) the organisation acknowledges a more contingent, pragmatic approach needs to be taken around risk management where

15 CPNI - https://www.cpni.gov.uk/managing-my-asset/leadership-in-security/board-security-passport

"[C]ompliance with the risk management process should not become more important than a true understanding of risk." (ibid.). Reflecting this more advanced paradigm, the organisation has produced "A critical appraisal of risk methods and frameworks" (Table 6) that identifies a range of limitations – having set out the available risk management standards in 3.3.2.3 above this goes someway to explain the need for a more localised or context specific approach.

Table 6 NCSC Limitations of Risk Methods and Frameworks

GENERAL LIMITATIONS OF RISK METHODS & FRAMEWORKS	SPECIFIC LIMITATIONS OF RISK METHODS & FRAMEWORKS
Limits of a 'reductionist' approach	Abstraction through labelling
Lack of variety	The limits of using matrices
Limits of a 'fixed state' approach	Limits in the way uncertainty is presented
Lack of feedback and control	The effect risk relationships have on impact
Losing risk signals in the 'security noise'	The adverse effect of an intervention
System operation	Impacts are not limited to the scope of assessment
Information opacity	The effect of time on risk
Assumed determinability	

Source: NCSC (2016) Crown Copyright - http://www.nationalarchives.gov.uk/doc/open-government-licence/version/1/open-government-licence.htm

While acknowledging the advancements made above, and perhaps reflecting the evolving nature of risk management (across the Problem Space), NCSC offered until November 2018 a document entitled "Technical Risk Assessment and Risk Treatment" further into the NCSC website that might be seen as *reinforcing* the reductive approach criticised in the same organisation. It is interesting to note that the document outlined a 'Six-Step Process' (NCSC, withdrawn documents) is entirely focused on the known risks, the 'measurable uncertainty', rather than suggesting methods for addressing the 'unmeasurable uncertainty'. One potential reason is the notion of risk maturity, i.e., the extent to which risk management is embedded in the 'organisational DNA'. It is logical to infer that, given Risk Maturity Modelling (see RIMS[16], 2018 as one example) provides a tiered model for organisations to assess their performance in this area, some organisations will be relatively low in maturity across the range

16 RIMS – available at *https*://www.riskmaturitymodel.org

of characteristics, and this might also provide an insight into the apparent lack of understanding of the phenomenon of *Novelty* more broadly.

In this thesis, I have highlighted the need to explore practices from other disciplines (Ramsey, 2009, p.12). In pursuance of this, I refer to the work of Haddon (1970) who, writing in the field of ecology and public health, outlined ten strategies for reducing losses associated with biological hazards (ibid., p.2-4). These (strategies) are summarised below:

- To prevent the initial marshalling of the form of energy;
- To reduce the amount of energy marshalled;
- To prevent the release of the energy;
- To modify the rate of spatial distribution of release of energy from its source;
- To separate in space or time the energy being released from the susceptible structure;
- To separate the energy being released from the susceptible structure by the interposition of a material barrier;
- To modify the contact surface, subsurface, or basic structure which can be impacted;
- To strengthen the structure which might be damaged by the energy transfer;
- To move rapidly in detection and evaluation of damage and to counter its continuation and extension;
- Rehabilitation of the damaged object.

What is evident from this approach is the prevention focus at the start and the immediately subsequent focus on 'regulation' of any release of energy; this can be seen as focussing on both *Risk* as 'Measurable Uncertainty'/'Objective Probability, or *Uncertainty* as 'Unmeasurable Uncertainty'/'Subjective Probability'.

3.4 Understanding the Problem Space

One of the objectives of this project is to develop a practical framework that enables practitioners to respond to *Novelty*. In pursuit of 'Understanding', I examine the following: the nature of knowledge, critical thinking and bias, a review of sense-making and finally situation awareness. I have commented on the degree to which we can understand systemic *Novelty* and whether this can ever "yield to conventional forms of risk management" (Smith

& Fishbacher, 2009, p.2). In this regard, I am interested in exploring how developing a deeper understanding of respective contexts can help to counter and mitigate the effects of *Novelty*.

3.4.1 On Knowledge

Given the complexity of the Problem Space, I explore the importance of developing knowledge in this section. In this context, *'knowledge'* is distinguished from Situation Awareness, which is "about the knowledge state that's achieved—either knowledge of current data elements, or inferences drawn from these data, or predictions that can be made using these inferences." (Klein et al., 2006, p.71). In this project, I do not seek to advance the philosophical work relating to 'the theory or definition of knowledge 'in and of itself'. Bolisani & Bratianu suggest this 'definitional journey' may be a fruitless one given knowledge "has no clear definition so far" (2018, p.2), indeed "the whole subject of knowledge is so "slippery" that it is impossible to get a firm grasp of it" (Penrose, cited by tlu.ee, n.d.). Understanding the 'nature of knowledge' is seen as vital, however, and a range of definitions that are applicable to this project are presented below:

- Knowledge is what I know, information is what we know (Foskett, 1997).
- Knowledge originates and resides in people's minds (Davenport and Prusak, 1998, p.24).
- Knowledge is organised information in people's heads (Stonier, 1990).
- Knowledge is the meaningful links people make in their minds between information and its application in action in a specific setting (Dixon, 2000).
- Knowledge is the accumulation of everything an organisation knows and uses in the carrying out of its business (Smith & Webster, 2000).
- Knowledge is experience. Everything else is just information, Einstein (1879-1955).
- Knowledge is information in action (O'Dell and Grayson, 1998).
- Knowledge is 'information given meaning and integrated with other contents of understanding' (Bates, 2005).

Source: Institute of Information Studies, TLE, (2014)

The importance of knowledge is clear, as Zack (1999, p.128) argues:

> "knowledge can be considered the most important strategic resource, and the ability to acquire, integrate, store, share, and apply it the most important capability for building and sustaining … advantage" and "[K]nowledge, especially context-specific, tacit knowledge embedded in complex organizational routines and developed from experience—tends to be unique and difficult to imitate."

In outlining how key practitioners should address the gathering and retention of knowledge, Zack (ibid., p.143) provides the following process to defining a Knowledge Strategy (Table 7).

Table 7 Process for Developing a Knowledge Strategy

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Citing Drucker (1968), Nonaka states we live in a 'knowledge society', where "the increasing importance of knowledge in contemporary society calls for a shift in our thinking concerning innovation in large business organizations" (1994, p.1). In this well-cited paper, the author distinguishes between *Explicit* and *Tacit* knowledge as follows:

Explicit Knowledge – "knowledge that is transmittable informal, systematic language." Nonaka (ibid., p.16). "Explicit knowledge is discrete or "digital." It is captured in records of

the past such as libraries, archives, and databases and is assessed on a sequential basis." (ibid., p.17)

Tacit Knowledge – Nonaka argues that "[O]n the other hand, "tacit" knowledge has a personal quality, which makes it hard to formalize and communicate. Tacit knowledge is deeply rooted in action, commitment, and involvement in a specific context. In Polanyi's words,

> "it indwells in a comprehensive cognizance of the human mind and body…is representative of mental models" (ibid., p.16). Tacit knowledge is further distinguished into Cognitive and Technical as: Cognitive elements which enable mental models, inform paradigms that enable 'individuals to perceive and define their worlds" (ibid.)

In contrast, the technical "element of tacit knowledge covers concrete know-how, crafts, and skills that apply to specific contexts." Nonaka (ibid.). "Tacit knowledge is a continuous activity of knowing and embodies what Bateson (1973) has referred to as an "analogue" quality, (ibid.). In a taxonomy of knowledge, Zack (1999, p.132) breaks down explicit knowledge into three categories (tle.ee, 2018):

- **Declarative knowledge,** or 'knowledge about' or 'know what', refers to the labels, concepts, categories and things that are important to the organisation. It is the ability to recognize and classify concepts, things and states of the world, routine knowledge about which the expert is conscious. It is shallow knowledge that can be readily recalled since it consists of simple and uncomplicated information. This type of knowledge often resides in short/term memory.
- **Procedural knowledge,** or 'knowledge how', represents the understanding of how to carry out a specific procedure. It includes organisational routines and rituals and refers to the ability to perform a particular set of actions.
- **Causal knowledge,** or 'knowledge why', refers to an understanding of why something occurs. It is a description of causal links among a set of factors; organisational stories, which provides a means for organisations to develop consensus about why particular actions should be taken or how best to achieve some goal.

The role of ***Relational Knowledge*** *is* perhaps one of the more important facets of Zack's taxonomy in that it refers to the "understanding of the relationships among or between these types of knowledge. Learning and innovation is often the result of creating or modifying

relationships among existing and seemingly disparate concepts and ideas." (ibid.). I observe from this that the development of relational knowledge (of the Problem Space) would be significantly advantageous in countering *Novelty*.

Zack (1999, p.133) argues that "knowledge can be classified according to whether it is core, advanced, or innovative…" and this provides a structure for the remediation toolset that is an objective of this research project. Zack provides the following brief descriptions for these categories:

- **Core knowledge** is that minimum scope and level of knowledge required just to "play the game."
- **Advanced knowledge** enables a firm to be competitively viable. The firm may have generally the same level, scope, or quality of knowledge as its competitors although the specific knowledge content will often vary among competitors, enabling knowledge differentiation.
- **Innovative knowledge** is that knowledge that enables a firm to lead its industry and competitors and to significantly differentiate itself from its competitors. Innovative knowledge often enables a firm to change the rules of the game itself.

Alavi & Leidner, in a broad discussion of the nature of knowledge taxonomies, argue that "[A]n understanding of the concept of knowledge and knowledge taxonomies, is important because theoretical developments in the knowledge management area are influenced by the distinction among the different types of knowledge." (2001, p.112). In this paper, the authors set out the different types of knowledge with respective definitions in Table 8 (ibid., p.113), and argue how they apply to the management of systems; hence they see the awareness of the nature of knowledge as integral to the development of any remediating model.

Table 8 Knowledge Taxonomies and Examples

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3.4.2 Critical Thinking

During the CoP sessions (with practitioners), it appeared to me that the logical flow of understanding of risk was flawed. One key observation was that so-called mitigations (or defences as discussed above), did not act as such, i.e., they did not relate to the causal event or risk, and there was no evidence to support any of the narratives in the risk analysis process. Contemporaneous discussions/observations demonstrated a range of biases in the knowledge-seeking, 'rationalisation' process, for example, significant errors in the definition of the risk event whereby I observed multiple occasions of logical fallacy in the attribution of risk. In a discussion on the role of cognitive bias and risk assessment (through scoring mechanisms), Hubbard & Evans (2010, p.3) include the following as directly skewing the understanding and scoring of risk:

- **The availability heuristic –** where memories are skewed based on "by the ease with which instances or associations come to mind" (Tversky & Kahneman, cited in Schwartz et al, 1991, p.195)
- **Optimism bias** – overestimation of the likelihood of positive events (Sharot, 2010, p.1)

- **Confirmation bias** – seeking or interpreting of evidence in ways that are partial to existing beliefs, expectations, or a hypothesis in hand (Nickerson, 1998, p.176)

As Hubbard & Evans conclude, "caution should be exercised before continually using scoring methods to make critical risk assessments" (2010, p.9). From these observations, the nature of the human condition relating to perception, rational, and indeed, critical thinking seemed to have an influence on the management of risk. It is to this general area the research now turns.

In his seminal paper, discussing rational choice, Simon, (1955, p.102) argues that… "[B]ecause of the psychological limits of the organism (particularly with respect to computational and predictive ability), actual human rationality-striving can at best be an extremely crude". Of key importance to this project is the conclusion of Simon's paper where he argues that a paradox exists between the economic theory of the firm (i.e., rational) and the evident simplified and global rationality. As Simon asserts, this paradox:

> "disappears…when we substitute for "economic man" or "administrative man" a choosing organism of limited knowledge and ability. This organism's simplifications of the real world for purposes of choice introduce discrepancies between the simplified model and the reality; and these discrepancies, in turn, serve to explain many of the phenomena of organizational behaviour." (ibid., p.16).

In relation to the financial crisis of 2008, Ariely (2009) claimed that the financial crisis "shattered two articles of faith in standard economic theory" one being "that human beings make rational decisions" (ibid., p.80). Introducing 'behavioural economics' Ariely (ibid., p.80) describes the concept as being "founded on the premise that human beings are fundamentally irrational and motivated by unconscious cognitive biases", perhaps echoing Simon, as mentioned above.

As we have seen, when undertaking decision-making processes it is possible to introduce bias into strategic assumptions (Schwenk, 1988), due to this, interest around strategic cognition has grown (ibid., p.53); Critical Thinking seeks to reduce the degree to which cognitive bias negatively affects decision making. In a discussion on his 'Personal Reflections' Ennis (2011, p.9, citing Smith) evolves his mentor's definition of "both determining the meaning of statements and assessing these statements" and incorporates the notion of 'correctness' into the statement, thus, his first definition is "the correct assessing of statements" (ibid.). Ennis later develops this further definition as "[C]ritical thinking is reasonable reflective thinking focused

on deciding what to believe or do." (ibid., p.10), which, given its action orientation, is the purpose of this research.

In their broad-ranging review of the definitions of critical thinking, Sanders & Moulenbelt (2011, p.1) contend that, "a widely accepted, cross-disciplinary definition for critical thinking still does not exist", but this is possibly a prevailing facet of the field; as Halonen (cited in Dunn et al., 2008, p.150) claimed – if you "ask 12 psychology faculty members to define the term critical thinking, you may receive 12 overlapping but distinct definitions". For the purposes of this review, however, and notwithstanding the evidence from the above, I adopt Ennis' second definition. Being alive to confirmation bias, I note Kahneman & Egan (2011) who propose a two-system construct to enable decision making (Figure 8). In System 1 the cognitive processes are faster, intuitive and instinctive, in System 2 processes are more reflective and requires deeper thinking; all decisions that require conscious thought is taken by System 2, as an executive function.

Fig. 8 Process and Content in Two Cognitive Systems (Kahnemann, 2003, p.1451)

Other scientific disciplines also appear to support Kahneman's work; indeed, I have referred to learning from other fields already in this project. In a neuro-biological study involving fMRI scanning of the human brain and to examine the 'Framing Bias', De Martino et al., (2006) argue that one of the central tenets in rational decision making is logical consistency across decisions – 'extensionality' or 'invariance' (ibid., p.1). However, they add that indeed human decisions do not hold these properties arguing "when taking decisions under conditions when available information is incomplete or overly complex, subjects rely on a number of

simplifying heuristics, or efficient rules of thumb, rather than extensive algorithmic processing." This is of interest to this research as, in supporting Kahneman's work, it underscores that stress or urgency, i.e., those circumstances in System 1, can lead to inconsistent decision making. In turn, this has implications for management within the system; in the event of rushed decisions, perhaps under uncertainty, then there is an increased likelihood of error in the form of individual accident. This is further supported by Tversky & Kahnemann (1974) in reviewing how decisions are made under uncertainty, which is of specific importance to this research, find that "three heuristics that are employed in making judgments under uncertainty: (i) representativeness, which is usually employed when people are asked to judge the probability that an object or event A belongs to class or process B; (ii) availability of instances or scenarios, which is often employed when people are asked to assess the frequency of a class or the plausibility of a particular development; and (iii) adjustment from an anchor, which is usually employed in numerical prediction when a relevant value is available." (ibid., p.8). The authors add that these "heuristics are highly economical and usually effective, but they lead to systematic and predictable errors." (ibid.).

3.4.3 Sense-making

In order to understand the Problem Space, and the prevailing conditions, or characteristics, I first introduce Sense-making (SM), followed by observations on two approaches – retrospective sense-making and prospective sense-making. The size of the field of research around SM is considerable and much of the work in the area of can be seen as referencing the work of Karl Weick, indeed (Gephart et al, 2010) distinguishes the field between so-called "Weickian and post-Weickian" forms (ibid., p.277). The authors go on to argue that the Weickian approach is retrospective and where "attention and meaning creation are directed backwards from a specific point in time" … and SM is … "what is discovered when people glance backwards" (Weick, cited in ibid.). Weick has been found to be a key contributor to the field of SM and it is perhaps fitting that one of the important facets (of SM) falls from one of his definitions. In his seminal publication, Sensemaking in Organisations, Weick (1995) defines SM as "[S]ensemaking is understood as a process that is (1) grounded in identity construction, (2) retrospective, (3) enactive of sensible environments, (4) social, (5) ongoing,

(6) focused on and by extracted cues, (7) driven by plausibility rather than accuracy.[17]" (ibid., p. 17).

In a detailed, exhaustive paper Maitlis & Christianson (2014) consider a wide range of facets relating to SM. In what be described as a meta literature review, the authors consider the multiple definitions, specific forms and discrete constructs of SM from a large range of sources. The authors argue that "[T]he roots of SM in the organizational literature can be traced back to the beginning of the twentieth century…but SM did not begin to emerge as a distinct topic of study until the late 1960s" (2014, p.60): "[T]he first published mention of Sensemaking in the organizational context is in Weick's (1969) book, The Social Psychology of Organizing." (ibid.) The authors describe SM as "the process through which individuals work to understand novel, unexpected, or confusing events", adding that SM "goes beyond [this] interpretation and involves the active authoring of events and frameworks for understanding, as people play a role in constructing the very situations they attempt to comprehend" (ibid., p2). In a more realistic assessment of the field Brown at al., (2105) argue that "[T]here is no single agreed definition of 'Sensemaking. There is, though, an emergent consensus that SM refers generally to those processes by which people seek plausibly to understand ambiguous, equivocal or confusing issues or events" (ibid., p. 4). I would point to the potential benefits of understanding (and indeed countering) *Novelty*, and of particular interest is the definition of SM provided by Klein et al., (2006) – "[S]ensemaking is a motivated, continuous effort to understand connections[18] (which can be among people, places, and events) in order to anticipate their trajectories and act effectively." (ibid., p.71). Klein et al., (ibid., p.3) go onto describe SM with the following attributes:

1) It satisfies a need or drive to comprehend.
2) It helps us test and improve the plausibility of our explanations and explain apparent anomalies. Whether an explanation makes sense depends on the person who's doing the Sense-making. The property of "being an explanation" isn't a property of statements but an interaction of people, situations, and knowledge.
3) It's often a retrospective analysis of events. It clarifies the past but doesn't make it transparent (that is, completely understood).

[17] This abductive approach is consistent with my worldview and indeed is reflected in this project through the research methodology.
[18] Given the inherent nature of the Problem Space, I find this focus on connections relevant.

4) It anticipates the future. This makes action possible, though uncertain. It helps us muster resources, anticipate difficulties, notice problems, and realize concerns.
5) It isn't the choice of an explanation but a process of deliberating over alternative plausible explanations.
6) It guides the exploration of information.
7) It's often a social activity that promotes the achievement of common ground. It isn't just an individual activity.

3.4.3.1 An Observation of Retrospective Sense-making (SM)

As we have seen, a key contributor to the field of SM has been Karl Weick, who has focused on a retrospective form. We can see from his definition however that this is not a fixed position, it evolves over time – the inclusion of the wording 'retrospective' & 'ongoing' points to a forward-moving, ever developing, rich picture of the existing context and how this develops. Two key questions (for this research), arise from this position: First, how can organisations ensure that knowledge is amassed or retained given organisational churn, i.e., loss of staff through natural wastage or promotion? And second, how can this knowledge help to counter *Novelty*, given its 'unknowable' nature, especially given that "categorizing an emerging issue as either a threat or an opportunity is dependent upon sense made from past experiences" (Eckel & Kezar,2003, p.3)? For example, in accident management practice, Reason et al., (2006, p.13) argue "…when analysing events and conditions in an accident evolution, the Swiss Cheese Model makes it tempting to draw a line from an outcome to a set of 'latent conditions'. This invites 'hindsight bias'."[19] A classic case study that perhaps demonstrates this limitation is Weick's (1993) analysis of the 'Mann Gulch Forest Fire' of 1949. Here Weick examined the responses of the personnel involved and how they sought to respond to the fast-moving situation using frames and narratives that were based on their retrospective views. Weick concluded that a "less stringent commitment to frames and tools may have enabled the firefighters to shift their thinking and to adapt and improvise in real-time." If due to bias, the

19 Hindsight bias is defined as the belief that an event is more predictable after it becomes known than it was before it became known. Hindsight bias involves the inability to recapture the feeling of uncertainty that preceded an event. When there is a need to understand past events as they were experienced in situ, hindsight bias thwarts sound appraisal. Sometimes termed the "knew it all along effect," hindsight bias involves the inability to recapture the feeling of uncertainty that preceded an event. When there is a need to understand past events as they were experienced in situ, hindsight bias thwarts sound appraisal. (Roese & Vohs, 2012, p.411)

understanding of past events is misinterpreted, it is argued that this skews any anticipation the trajectory of future events as Klein et al., assert (2006, p.71).

3.4.3.2 An Observation of Prospective Sense-making (SM)

The above has focused on the use of retrospective SM, which can offer a rich understanding of 'the current', based on previous experiences and occurrences and allow for a degree of anticipation. In the Weickian world (of SM) "even the future is understood retrospectively through future perfect thinking" (Kaplan & Orlikowski, 2013, p.969). However, in endeavouring to counter *Novelty*, I question the ability of retrospective SM and the paradigm, therefore, shifts from retrospective to prospective SM. In first naming 'prospective SM' Gioia et al., (1994) the authors were highlighting "a phenomenon that had an anticipatory character about it: the conscious and intentional consideration of the probable future impact of certain actions, and especially non-actions, on the meaning construction processes of themselves and others." (ibid., p.378).

Brenda Dervin, following a 30 year study of communication, established the 'Sense-making Approach' to research; here Derwin argues that, given "SM is central to all communicating situations, (whether they be intra-personal, interpersonal, mass, cross-cultural, societal, or international) the SM approach is seen as having wide applicability" (Dervin, 1983, p.3). The core premises, Dervin argues, are (abridged as):

- Reality is neither complete nor constant but rather filled with fundamental and pervasive discontinuities or gaps.
- Information is not a thing that exists independent of and external to human beings but rather is a product of human observing.
- All information is subjective.

The final point is of importance to the SM approach and appears to contradict the previous assertions around cognitive bias. Dervin rejects the use of the term 'biased', as it assumes there is some external standard against which they are made; also rejected is the use of the term 'limited' as this is to suggest that observings are trapped and this would impede human advancement (ibid., p.5). Dervin also introduces the idea constraints on human observations as follows:

- The limitations on human physiology. As a species, we appear at this point in our collective history, at least to be unable to make some observations of which other species are capable.
- The limitation of present time-space. Since it is assumed that we are all bound in time-space, what we can observe at a given moment is constrained by where we are.
- The limitation of past time-space. We come from different histories and our observations today rest, at least in part, on our pasts. In one sense, our historical differences account for our great species variety and enable us, via communicating, to achieve fuller pictures of the "circle of reality" enriched by wider spectrums of observations.
- The limitation of future time-space. We are going to different places and our observations today rest, at least in part on where we focus in the future. In addition, the general discontinuity principle suggests that our observations today apply only to today and not to tomorrow.

Key to the "core assumption [of sense-making] is that of discontinuity; there are gaps between entities, time, and spaces." (Spurgin, 2006, p.1). As Dervin herself asserts, "a person moves from time-space moment to time-space moment, gap-bridging is seen as both potentially responsive and potentially impervious to changing conditions." (Dervin, 2005, p.27).

In order to provide an overview of the SM methodology, Dervin "conceptualizes messages not as things to be gotten, but as constructions that are tied to the specific times, places and perspectives of their creators" (Foreman-Wernet, cited by Agarwal, 2012, p.7). In order to demonstrate the SM approach visually, Agarwal (Dervin, Foreman-Wernet with Lauterbach, cited in ibid.) offers Figure 9 under the banner of "What is Sense-making".:

The second element in Figure 9 relates to the actionable stages of SM and this is illustrated in Figure 10 and is commonly known as the Sense-Making Metaphor. This image reflects the forward-looking perspective of Dervin's model and which Naumer & Fisher with Dervin (2008, p.2) encapsulate as:

> "a person is seen as embedded in a context-laden situation, bounded in time-space. The person pictured as crossing a bridge is used to metaphorically describe the way that humans are mandated by the human condition to bridge gaps in an always evolving and ever-gappy reality."

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Fig. 9 What is Sense-making? Dervin, Foreman-Wernet with Lauterbach (2003)

Reflecting my own worldview/paradigm, this approach might be seen as 'pragmatic' given that "SM has been defined as a 'methodology between the cracks' because it is informed by numerous research traditions, some of which are considered oppositional to each other – e.g. qualitative and quantitative, critical and administrative, American and European" (Dervin, 2007, cited in ibid., p.3).

I have touched upon the limits of retrospective SM, specifically regarding existing frames and the adverse effect of bias. Brown et al., (2015, p.17) expresses broader concerns and, citing Sandberg and Tsoukas (2014), argue that key terms such as 'process' and 'sense' are under-explained (in the literature). Also, that the personal nature of SM can ignore what else is happening in the context (or Problem Space) – hence "all perspectives are partial" (ibid.) and finally and perhaps more of concern "'every way of seeing is a way of not seeing'." (Burke, cited in ibid.) In order to allow for a wider perspective, I now review the role of Situation Awareness.

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Fig. 10 Sense-Making Metaphor (Dervin, 1999, in Naumer et al., 2008, p.2)

3.4.4 Situation Awareness (SA)

In the preliminary PAR phase of this project, the question of perception (of the central phenomenon) was a key discussion point; when asked '[H]ow would practitioners first perceive what became '*Novelty*' there was scant understanding (from practitioners). I have already discussed both retrospective and prospective SM, but a related concept of a practitioners' Situation Awareness is also an important area. Klein at al. (2006) argues that (when considering SA) "[P]sychology's focus has been on achieving a state, some sort of memory representation that constitutes … explanation" and compares SM with SA:

> "Endsley's work on SA is about the knowledge state that's achieved—either knowledge of current data elements, or inferences drawn from these data, or predictions that can be made using these inferences. In contrast, SM is about the process of achieving these kinds of outcomes, the strategies, and the barriers encountered." (ibid., p.71)

In this sense then, SA is a goal for the practitioners, who might utilise SM for goal achievement. This is not a straightforward, delineated process however and attention is drawn to the three (arguably conflicting) definitions for SA; here SM and SA might be used interchangeably to a degree (Stanton et al, 2001, p.191-192); after examination of these models, Endsley's work is adopted as most fitting to this research given the focus on Perception, Comprehension and Projection.

3.4.4.1 Definitions of Situation Awareness (Potentially Conflicting)

- Situational awareness is the conscious dynamic reflection on the situation by an individual. It provides dynamic orientation to the situation, the opportunity to reflect not only the past, present and future but the potential features of the situation. The dynamic reflection contains logical-conceptual, imaginative, conscious and unconscious components which enable individuals to develop mental models of external events (Bedny & Meister, 1999)
- Situational awareness is the invariant in the agent-environment system that generates the momentary knowledge and behaviour required to attain the goals specified by an arbiter of performance in the environment (Smith & Hancock, 1995).
- Situational awareness is the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning and a projection of their status in the near future (Endsley, 1988).

3.4.4.2 Origins of Situation Awareness (SA) and Endsley's Model.

Endsley herself stated that her work on SA began within the fields of Human Factors and Information (#HFES2018 Bonus Interview with Mica Endsley, 2018). The work then moved to focus on aviation and specifically the skills used by pilots given they "need to pay attention to a large amount of data from a variety of sources inside and outside their cockpit" (Sartor & Woods, 1991, p.47). Indeed the "earliest discussions of SA undoubtedly derive from the pilot community, going back as far as World War I" (Press, cited by Endsley, 2000, p.5) and Spick provides a fascinating fighter pilot's view of the importance of SA in combat aircraft." (cited in Endsley, 2000, p.5). But SA has moved beyond the aviation industry and uses have been found in other domains, larger driven by the advent of technology (ibid., p.6): Endsley's Model for Situation Awareness is depicted in Figure 11.

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Fig. 11 Endsley's Model for Situation Awareness (Stanton et al., 2001)

Endsley's Model for Situation Awareness and Dynamic Decision Making establishes three levels of SA that "show an increasing degree of awareness as the information is processed at the higher levels." (Stanton et al, 2001, p.195), these are:

- Level 1 SA (Perception): First, the perception of cues (Level 1 SA) is fundamental. Without a basic perception of important information, the odds of forming an incorrect picture of the situation increase dramatically. Jones and Endsley (1996) found that 76% of SA errors in pilots could be traced to problems in the perception of needed information (due to either failures or shortcomings in the system or problems with cognitive processes).
- Level 2 SA (Comprehension): SA as a construct goes beyond mere perception, however. It also encompasses how people combine, interpret, store, and retain information. Thus, it includes more than perceiving or attending to information, but also the integration of multiple pieces of information and a determination of their relevance to the person's goals (Level 2 SA). This is analogous to having a high level of reading comprehension as compared to just reading words. Twenty per cent of SA errors were found to involve problems with Level 2 SA (Jones & Endsley, 1996).
- Level 3 SA (Projection): At the highest level of SA, the ability to forecast future situation events and dynamics (Level 3 SA) marks operators who have the highest level of understanding of the situation. This ability to project from current events and dynamics to

> anticipate future events (and their implications) allows for timely decision making. In almost every field I have studied (aircraft, air traffic control, power plant operations, maintenance, medicine), I have found that experienced operators rely on future projections heavily. It is the mark of a skilled expert.

Woods (cited in Stanton et al., 2001, p.190) argues practitioners "need to track the development of events as they gradually unfold"…"that incidents evolve by the propagation of disturbances over time. These problems become exacerbated if human controllers fail to adapt to new events." It is argued that a practitioner's awareness (of events) will diverge from the actual events unless they continue to broaden their skills and knowledge. Indeed Endsley (2015), in addressing so-called SA Fallacies, points to the importance of long-term memory in supporting limited working memory and augmenting SA (ibid., p.15): it is argued that subject matter experts (SMEs), with longitudinal domain knowledge, will have a greater capability to enable SA. While the origins of SA have been attributed to aviation, Stanton argues (2001, p.190) that in essence, any task that requires people to keep track of events is a potential candidate for situational assessment research and application. This suggests the applicability of SA for understanding *Novelty* (when considering bifurcation).

3.4.4.3 Perspectives on Situation Awareness (SA)

In a special edition of Journal of Cognitive Engineering and Decision Making (March 2015) focussing on SA, several criticisms of the Endsley Model (Endsley, 1995, p.35) are made that are of interest to this project. While some points may be technical and are in fact dealt with in Endsley's final paper, one specific observation is of particular relevance to this present research – that is the contribution by Stanton et al., (2015). In this paper, Stanton et al., argue that the Endsley model is no longer relevant when taking a 'systems thinking' worldview, and this is for two reasons. First, the authors argue (that) "the linear approach to the model is inconsistent with systems thinking" (ibid., p.47) and second that "the focus needs to be on the environmental factors as opposed to what is in the mind of the actor" (ibid.) and "should be on the links rather than the nodes" (ibid., p.45). In responding, Endsley does not deal specifically with the first point but on the second point, she emphatically rejects the argument stating Stanton et al., are adopting a 'Skinneristic' approach "that has long been rejected by psychologists" (Endsley, 2015, p.106). While this indeed may be true, I would observe that as the Problem Space is a distributed system, we need to consider the emergent "hive mind of the system" (Seeley et al., cited in Stanton et al., 2015, p.47), while focusing on practitioners discrete SA.

3.4.4.4 Signal Detection and Situation Awareness

In the examination of the environmental elements, through which SA can be improved, practitioners are trying to distinguish between two or more signals. Signal Detection Theory (SDT) provides a way in which these signals can be calculated and discriminated. SDT has its origins in the field of psychology as far back as 1860 with Fechner's introduction of the two-alternative forced-choice (2AFC) task model in 'Elements of Psychophysics' (Wixted, 2020, p.2). Fechner proposed a model that allowed for a discrimination of sensations that are expressed in a physical sense; this was later developed by Thurstone (1927) to include discriminations that are outside the physical domain (ibid. p.3). SDT gained additional traction in the 1950's with the work of John Swets, who evolved SDT to a point where it now has applications across many fields that might be described as risk management in a broader sense. For example, Paraskevas & Altinay (2013) refer to SDT in their review of crisis management (in tourism), however, one assumption, which the authors borrow from Mitroff (1988) is that before an occurrence, a crisis sends out repeated and persistent warnings – this may not been the case for emergent *Novelty*. Abdelhamid et al., (2007) apply SDT (allied with the Rasmussen Causation Model) into the field of construction safety where they seek to explore the boundaries beyond which personnel are less exposed to risk. Interestingly, the authors set out a number of stages that resonate with this present research: (a) identify which zone they are working in; (b) identify hazards; (c) prevent hazard release and (d) recovery when hazards are released. Other applications include Sah & Stiglitz (1985) who use SDT to examine decision making within organisations, comparing structures within both polyarchies and hierarchies. In summary, SDT offers a method through which signals can be detected, when discriminating from the noise, but that it is an active process requiring a prospective posture.

3.5 System Response

> "It's a wonderful sign of the breadth and vitality of our field that one can write a thousand-page textbook and still only scratch the surface." J Sterman, MIT Professor of Management on System Dynamics.

At its core, this study is interested in exploring the extent to which personal development (by practitioners) can improve the response capability within the Problem Space and as a corollary what knowledge would help in this pursuit. I am interested in how the adoption of a systems view, from both a philosophical sense and from a practical & current sense, can help to counter

Novelty. First, I explore how systems interact within a wider environment, first through the idea of resilience and second through co-evolution, next I examine another central tent of complexity and cybernetics, i.e., Requisite Variety to understand the potential of systems to respond to change and disturbance. I then move onto two mechanisms that can be used to address hazard and counter *Novelty*; first Soft Systems Methodology followed by System Dynamics.

3.5.1 Resilience Management

The general theme of this research might be described as an aspiration to protect the capability, or stability, of the operational context. Whether this is viewed as maintaining Problem Space variables within a 'basin of attraction' (as described in section 3.2.1 above) or indeed shifting the variables to another basin, this can also be described as managing the *resilience* of the space. In introducing resilience, I begin with an important definition before highlighting some key concepts.

Referencing Holling's 1973 seminal paper, Holling & Walker (2003, p.1) offer the following descriptions for resilience:

- The amount of change the system can undergo and still retain the same controls on function and structure (still be in the same state - within the same domain of attraction)
- The degree to which the system is capable of self-organization
- The ability to build and increase the capacity for learning and adaptation

From the above, a question arises relating to what processes, or strategies, would enable a system to remain resilient. In his 1973 paper, Holling (p.21) concludes that a management approach based on resilience should operate at this system-wide, rather than local level, and emphasise heterogeneity of practice, rather than homogeneity. Folke et al., (2010, p.1) agree with this 'systemic' application and develop the principle of resilience into two discrete forms, general and specified (ibid., p.3) which they define as follows:

- **General resilience:** The resilience of any and all parts of a system to all kinds of shocks, including novel ones. It is about coping with uncertainty in all ways.
- **Specific resilience:** The resilience "of what, to what"; resilience of some particular part of a system, related to a particular control variable, to one or more identified kinds of shocks.

In a review of a "system of systems approach to building disaster resilience" Cavello & Ireland (2015, p.16) follow a similar analysis of general and specified resilience, providing the following descriptions (and for which they provide discrete characteristics in Table 9):

- **General resilience:** refers to the ability to face unknown shocks. Approaches to build general resilience need to be bottom-up and top-down at the same time. The complexity of these capabilities requires that these approaches follow an abductive logic, that is to say, that "hypotheses guide actions, [... and these approaches] are simultaneously tested through those same actions". Risks are typically interdependent and complex to assess. Network approaches are encouraged.
- **Specific resilience:** refers to known risks, whose consequences have already been observed in the world. Action plans are normally reductionist, that is, risks are broken down into more manageable components that are addressed individually. Top-down thinking and management are usually applied to building specified resilience. Risks are addressed as 'systems of subsystems', because we assume that the sum of action plans composed makes the community more resilient.

Table 9 Characteristics of Specified and General Resilience

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Source: Cavello & Ireland (2015, p.16)

In a general discussion on the application of resilience in the management space, Walker et al., (2015) argue that planning on the basis of forecasts and scenarios may be suboptimal as this "cannot account for all possible eventualities, and hence the importance of maintaining general

resilience" (ibid., p.12). The authors go on to echo Perrow (1984), discussed in Chapter 3.2, arguing that any strategic planning approach should “expect that unexpected things will happen and that it is necessary to have the flexibility and options for even radical changes in resource use patterns, to build general resilience” (2015, p.12). This approach is in accord with Holling (1973, p.21) who asserts that the prevailing view should not be an "assumption that future events are expected, but that they will be unexpected".

In Chapter 3.3.1 in this present paper, I introduced the concept of Socio-Ecological Systems (SES) as a form of CAS, within which the definition (of resilience) evolves to add ‘adaptive capacity’, that is defined as “the capacity to perceive stimuli and to send signals for adaptive change, i.e. to respond to balancing feedback (Rammel et al., 2007, p.13). In this field, Walker et al., argue the role of “resilience management is to prevent an SES from moving into undesirable configurations. It depends on the system being able to cope with external shocks in the face of irreducible uncertainty” (2002, p.3) and that the twin aims of resilience management is (a) to prevent the system from moving to undesired system configurations in the face of external stresses and disturbance and (b) to nurture and preserve the elements that enable the system to renew and reorganize itself following a massive change (ibid., p.7).

Similarly, Bhamra et al., states that adaptive capacity “reflects the ability of the system to respond to changes in its external environment, and to recover from damage to internal structures within the system that affect the ability to achieve its purpose” (2011, p.5387). Engle observes that concept—of resilience—refers to the “ability of a system to fluctuate within a domain [or basin] of attraction without being push over the boundary” (2011, p.649) and that ‘adaptive capacity’ is the “capacity of actors in the system to manage and influence resilience” and that “the more adaptive capacity within a system, the greater the likelihood that the system will… maintain the system state” (ibid,. p.650) or “end up in a desirable state” (ibid., p.651). Dalziell & McManus define adaptive capacity as “the ability of the system to respond to changes in its external environment, and to recover from damage to internal structures within the system that affect its ability to achieve its purpose” (2004, p.6). These references to the external environment is instructive and lead to a brief discussion on the Problem Space being situated within, and part of, a wider system and how this adaptive capacity may be viewed as another concept from the field of complexity sciences, that of Requisite Variety.

3.5.2 Adaptation: Coevolution & Requisite Variety

In a study of coevolution in natural resource management, Rammel et al., (2007) argue that we can use coevolution as a heuristic to understand the context and thereafter improve upon system performance. According to the authors, the use of the term 'coevolution' has changed since its first introduction (by Ehrlich & Raven in 1964); the terms were initially used to describe how one species evolved through the interaction with another (ibid., p.11). The meaning has since evolved to encompass other contexts, such as technology with industrial structures (ibid.) and, for the purposes of this research, human behaviours and institutions. Here the authors quote Kauffman when he stated "[I]n a coevolutionary process, [...], the adaptive landscape of one actor heaves and deforms as the other actor make their own adaptive moves" (ibid., p.12), where coevolution is defined as "occurring among species each of which is itself adapting" (Kaufmann, 1991, p.467). In a very brief paper, Janzen defines coevolution[20] as follows… "[C]oevolution may be usefully defined as an evolutionary change in a trait of the *variables* in one population in response to a trait of the *variables* of a second population, followed by an evolutionary response by the second population to the change in the first" (1979, p.611).

Coevolution implies a clear dependence between one entity's variables to another's (or more likely multiple others). For a system, in its broadest sense, to adapt to its environment it requires general resilience discussed above. Fath et al., (2015, p.1) describes resilience as the "capacity to successfully navigate ALL stages of the complex adaptive cycle", these being: "capacity to grow; capacity to develop; capacity to survive; capacity to renew" (ibid., p.2). Remembering Sterman's admonition that "almost nothing is exogenous" (2002, p.505) then this overall capacity requires the notion of co-evolution as everything is inter-twined—although this might be viewed as 'evolution', as we would only be referring to a single system.

In the middle of the last century, the nascent field of cybernetics searched for a standard language to manage the "the science of control and communication, in the animal and the machine" (Ashby, 1957, p.1): translated from the Greek for 'steersmanship', cybernetics focusses on the regulation of change. Within this larger philosophy, cybernetician W. Ross Ashby (1903-1972) developed the 'Law of Requisite Variety', that states, somewhat enigmatically, "an adaptive system survives to the extent that the variety it generates matches

20 Within this quotation I have replaced the term 'individuals' with 'variables. This does not change the meaning of the quotation but makes the meaning fit the context of the research.

that of the environment it finds itself in" (Ashby, 1956, cited in Boisot & McKelvey, 2011, p.281), or as Ashby himself put it "[O]nly variety can destroy variety" (1956, p.107). Drazin & Van de Ven (1985, p.517) placed Requisite Variety into an organisational setting describing the theorem as, "in which organizational adaptability is enhanced when the degree of complexity present in the environment is reflected in the structure of the organization". Given the passage of time between Ashby's paper and that of Boisot & McKelvey, this notion of "coevolution" between an entity and its environment is one of the most enduring ideas in the field. In building on Ashby's original law, Boisot & McKelvey introduce the notion of 'the Ashby Space' (Figure 12) suggesting that power-law relationships exist between the variety of stimuli[21] and the variety of responses

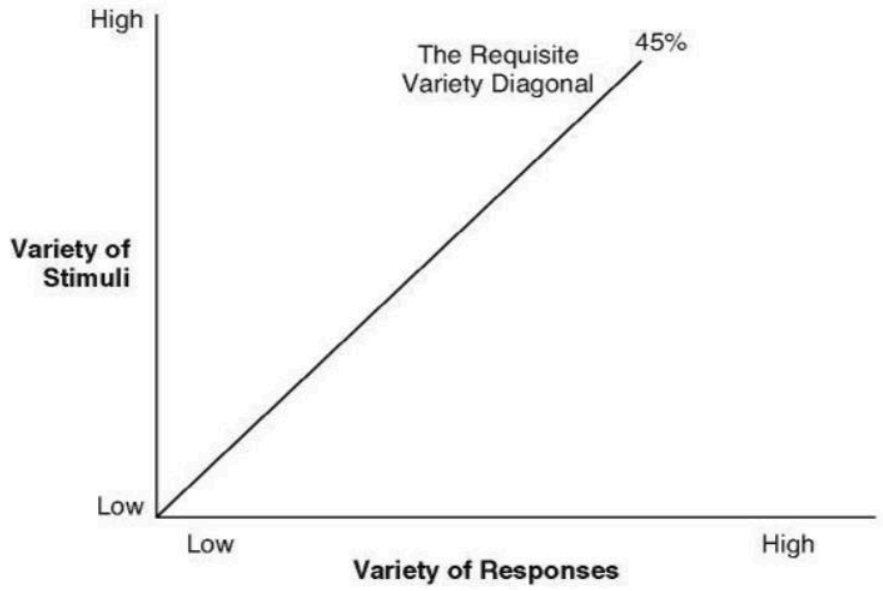

Fig. 12 The Ashby Space (Boisot & McKelvey, (2011, p.284))

Returning to the management of *Novelty*, and other system perturbations, I am interested in the extent to which organisations recognise the Requisite Variety relationship mentioned above and to what extent is this used to manage *Novelty*. It is through the lens of Requisite Variety that I now consider how practitioners can respond to the central phenomenon of *Novelty*.

21 For the purposes of this research, Novelty meets the description of stimuli.

3.5.3 Soft Systems Methodology (SSM)

I view SSM, which came to light through the work of Peter Checkland in 'Systems Thinking, Systems Practice' (1981), as an accessible approach to understanding systems, and one that fits within my personal research paradigm. Brian Wilson, who followed Checkland's work with 'Systems: Concepts, Methodologies and Applications' (1984), differentiates their two approaches thusly – Checkland's model (see Figure 13):

> "described SSM within the context of the history of rational thought, i.e. what the subject of SSM was. Mine was an attempt to describe 'how to do it' within the context of problem-solving in general" (Wilson, 2001, p.xi).

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Fig. 13 Checkland Methodology (Wilson, 2001, p.243)

Wilson argues SSM offers a way through which practitioners can undertake organisational (or system) analysis; however, and importantly to this project,

> "[W]e are not seeking to describe the organisation (or organisation unit) as part of the real world. Such an attempted description would have to be in terms of 'how' the organisation unit is doing 'what' it is doing. What we are trying to do, however, is to build a concept which will map onto the organisation unit. The concept will be in the language of 'what' and not 'how'." (Wilson, 2001, p.xiv).

The notion of the organisation is replete within the SSM literature, and this leads to a question on the relevance to this research project, given its focus on an extra-organisational Problem Space. One important characteristic (within the literature) helps to confirm the appropriateness of SSM, and this relates to the distinction between 'primary-task' and 'issue-based' systems. While understanding that "[P]rimary-task systems…would be expected to map onto some organisation unit" (ibid., p.43) would offer some relevance to the Research Problem, as it helps practitioners understand the system mechanics, it is argued that taking an 'issue-based approach' may be more helpful as it relates to the exploration of systems that may have temporary relevance (ibid.) across the domain. To support this view, Mingers & Taylor (1992), in a study of the application of SSM found that, of a population of 170 respondents, 29.4% stated they chose SSM to 'Ease a Problem Situation'; 51.2% to 'Develop Understanding' and 19.4% for other reasons; in effect, approximately 80% of the population chose reasons similar to those that would aid the objectives of this project. Interestingly, the analysis of the respondent's uses of SSM (Table 10) incorporated those that might be included in the theoretical scope of this project, of specific note, are the following: understanding *CAS*; initial problem clarification; monitoring and organisation (of the system); project management and risk management methodology.

Table 10 Uses of Soft Systems Methodology

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Source: Mingers & Taylor, (1992, p.325)

The authors found that of the respondents only 6% rated the success of the intervention as 'poor/very poor'; 41% rated the intervention as 'reasonable', and 53% rated the intervention

as ‘good/very good’. It is clear then that practitioners can successfully use SSM in a range of professional areas.

From a practical perspective, SSM incorporates two elements (see Figure 14), the Root Definition (RD) and the Conceptual Model (CM). Checkland argues that identifying the RD “must take place if the purpose of the system is to be achieved” (Checkland, 2001, preamble); RDs have been described as being:

> “constructed around an expression of a purposeful activity as a transformation process – T. Any purposeful activity can be expressed in this form, in which an entity, the input to the transforming process, is changed into a different state or form, so becoming the output of the process.” (Checkland, 2000, p.27).

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Fig. 14 Soft Systems Methodology Key Components (Mingers & Taylor, 1992, p.325)

Bergvall-Kåreborn et al., argue that “SSM’s strength lies in its tools for explaining different perspectives, their underlying assumptions and logical consequences; one of the most well-known techniques to derive the root is CATWOE.” (2003, p.1). While this may suggest CATWOE is used as a tool to identify the RD, Wilson argues that CATWOE is a tool “to check the formulation of the RD” (Wilson, 2001, p.22). The mnemonic stands for (here ordered with the mandatory elements first):

1) [T]ransformation process (described either as an input-output conversion or the process itself)
2) [W]eltanschauung (practically interpreted as the statement of belief within the RD)
3) [C]ustomer (the recipient of the output of the transformation process, either the victim or the beneficiary)

4) [A]ctors (those individuals who would do the activities in the resultant conceptual model if they were to map onto reality)
5) [O]wner (a wider-system decision taker with authority over the system defined, with a concern for the performance of the system)
6) [E]nvironmental constraints (those features external to the system defined, which are taken to be significant)

The second element of SSM is the modelling of 'purposeful activity' through the Conceptual Model (CM), which Checkland himself describes as "what the system must do to be the one defined" (Checkland, 2001, preamble). The CMs exist to illustrate the logical dependence on activities and show the flow of human activity to deliver the RD. An important facet (in fact a methodological rule) is the use of arrows, where the activity 'attached to the arrowhead' is entirely dependent on the preceding activity. The development of a Human Activity System, in fact, has a set of principles (Wilson, 20019, p.27); these principles are shown as 'Appendices 11.1 – 11.3', which I summarise as:

> 'A situation can be characterised by multiple perspectives from system practitioners. The situation is messy and unclear, the representation should not reflect this confusion. The situation is captured (in a Human Activity System) in two elements, the Root Definition and the Conceptual Model, that reflects a 'being-doing' relationship and finally, the language used should be specific to the problem and avoid generic terms, for example, corporate verbs/nouns.'

Underneath these principles, both Root Definitions and Conceptual Models have established rules which "govern the structure and construction of the basic intellectual construct." (Wilson, 2001, p.27-28). These rules are summarised as:

- **The Root Definition** captures the transformation in one sentence using one major verb; the mnemonic CATWOE is used as a temporary development aid and then discarded. The elements T and W must be identifiable in every RD. Thus, they are mandatory. The elements C, A, O and E are included or excluded on the basis of the analysts' judgement. A well-structured RD should only have one transformation process. Qualifying words/phrases may be used in the RD; words are not used in the RD without tying back to CATWOE elements.
- **The Conceptual Model** is constructed from the words in the RD but does not refer to the specific situation; as it is likely to be used to expand into further detail, the transformation

process should be explicitly stated. The CM needs to be defensible against the FSM and should include monitor and control structures. Arrows are used to represent information flows and dependencies from one activity to another.

What is clear from reviewing SSM is the theme of control and regulation of the system variables or feedbacks. In order to explore this specific area from a different systems perspective, I now turn to a review of the related field of System Dynamics.

3.5.4 System Dynamics

> "There are no separate systems. The world is a continuum. Where to draw a boundary around a system depends on the purpose of the discussion." Meadows, 2008, p.97.

I previously have introduced the field of System Dynamics into this project and I now explore this further and from both philosophical and practical response perspectives. Sterman argues that System Dynamics (Figure 15) is "a practical tool that policymakers can use to help solve important problems" (2002, p.503), but that it "is also a worldview, a paradigm in the sense of Thomas Kuhn. Like all powerful paradigms, it shapes every aspect of the way I experience the world" (ibid.).

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Fig. 15 System Dynamics Steps from Problem Symptoms to Improvement (Forrester, p.4)

MIT Professor Donella Meadows argued that "the bounded rationality of each actor in a system may not lead to decisions that further the welfare of the system as a whole" (2008, p.191). Akkermans & Oorschot (2002, p.4) argue that this bounded rationality is a feature of "cognitive limitations to knowledge, abilities to process information, and limits of time"; biases have been discussed herein as to the negative effects this might have on decision making and system welfare (performance). Lyneis et al., (2001, p.2) argue that these cognitive limitations are a major reason why projects experience problems, as while "projects are fundamentally complex

dynamic systems, most project management concepts and tools either (1) view a project statically or (2) take a partial, narrow view in order to allow managers to cope mentally with the complexity". Sterman, more poetically, states that "[A]s wonderful as the human mind is, the complexity of the world dwarfs our understanding" (Sterman, 2000, p.5).

It is from this perspective that this Area of Knowledge takes form; the philosophy driven in this research is that 'of the whole' and the system's inherent complexity, it argues that "[T]raditional tools and mental models are inadequate for dealing with the dynamic complexity of projects' (Lyneis et al., 2001,p.2) given their inherent reductive nature. It is also argued that increasing one's domain knowledge, in this case, that of the Problem Space, and embracing an awareness that one's domain knowledge is limited, is a powerful goal for system practitioners. Indeed, one of the most effective ways in which to intervene in a systems performance by shifting prevailing paradigms, addressing "[t]he mind-set out of which the system—its goals, structure, rules, delays, parameters—arises" (Meadows, 2008, p.194) and moving towards a systems view.

One of the core tenets of System Dynamics is the recognition that all models are wrong (Sterman, 2002): in a lengthy discussion on System Dynamics, Sterman argues many important points, key to which is "[O]ne of the goals of System Dynamics is to expand the boundaries of our mental models, to lengthen the time horizon we consider so we can see the patterns of behaviour created by the underlying feedback structure, not only the most recent events." (ibid., p. 511). I would add that in addition to extending the time horizon within the mental models, the scope and space should also be maximised, to the extent that open loops become closed (in as much as is practically possible to conceive), to wit Sterman (MIT, 2014, 07:56) argues that Open-Loop Thinking "describes; [an] assumption of beginning, middle and end" (Figure 16) and that this linear assumption is invalid.

Fig. 16 Open-Loop Thinking (Open-Loop Thinking MIT OpenCourseWare (2014, 07:51)

In a literature review of the existing definitions of 'Mental Models', Doyle & Ford (1996) argue that the field is to date somewhat imprecise and presents problems for those in the System Dynamics field. Citing Forrester (1994) the authors argue that the ability of "even a skilled

investigator is quite unreliable in anticipating the dynamic behavior of a simple information-feedback system of perhaps five or six variables" (Doyle & Ford, 1996, p.6). They observe that (the working definition of Mental Models) "are deeply ingrained assumptions, generalizations, or even pictures or images that influence how we understand the world and how we take action. Very often, we are not consciously aware of our mental models or the effects they have on our behavior (Senge, cited in ibid., p.7). In asserting that "in System Dynamics, the term "mental models" is currently ill-defined and means too many different things to different people to be useful in research and practice" (ibid., p.9) the authors instead propose a definition for a mental model as follows:

> "We propose that a mental model of a dynamic system is a relatively enduring and accessible, but limited, internal conceptual representation of an external system whose structure maintains the perceived structure of that system." (ibid., p.19).

Returning to the discussion on process, rather than adopting an approach that takes this open, or linear, 'process', System Dynamics (Sterman, 2014) offers an alternative 'metaphor' which depicts continuous adjustment within the dynamic system (Figure 17).

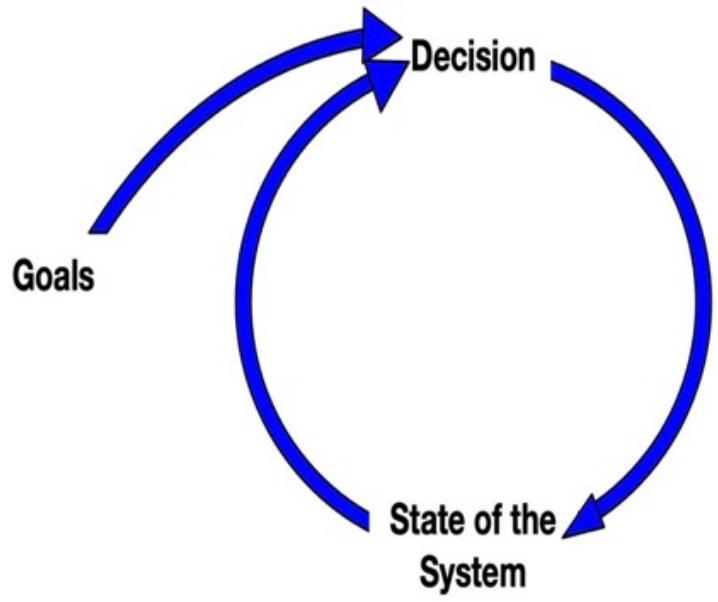

Fig. 17 Simple Feedback Loop Based on Sterman, (2014, 10:30-12:35)

The starting point for a decision (to act) is defining the goal, followed by the decision on what action to take, and indeed to take it, which changes the 'state of the system'. Importantly this process then repeats through a cycle of adjustment that changes the state of the system. But the

practice of System Dynamics notes that this is a simplified depiction; Figure 18 shows how an initial feedback loop links with a secondary loop, tertiary loop (and so on). In fact, this model could extend significantly to the full entirety of the system.

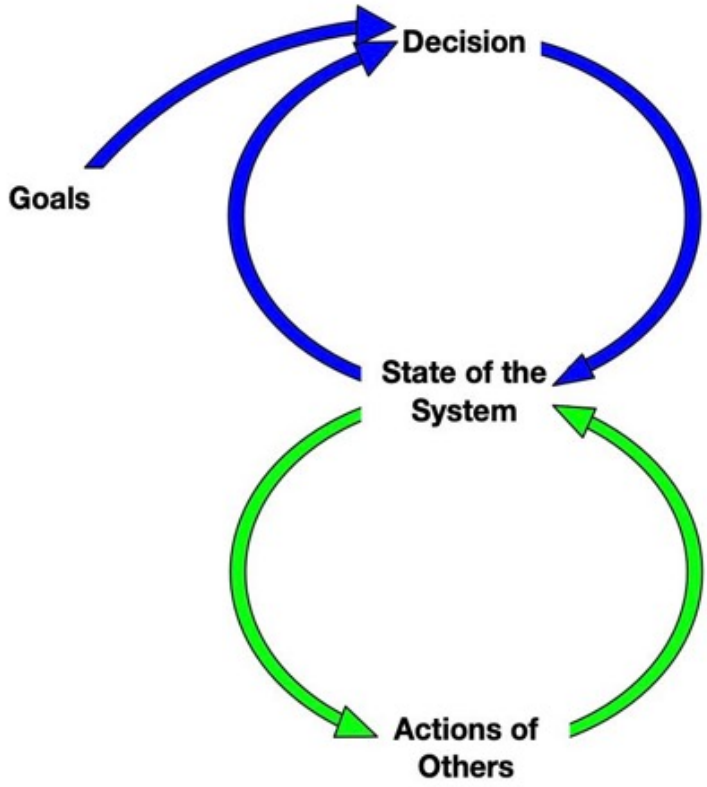

Fig. 18 Simple Feedback Loop Secondary Loop Influence Based on Sterman, (2014, 10:30-12:35)

Given its complexity, and adopting a linear paradigm, it might be reasonable to expect action (in the loops) to occur sequentially; first-level loop, second-level loop and so forth, however, it System Dynamics argues that there is no sequentially in the system, it "…happens all at once. They are connected not just in one direction, but in many directions simultaneously" (Meadows, 2008, p.5). There may be "delays, lags, buffers, ballast, and sources of momentum in a system" (ibid., p.23), but the flow of information is always enacted.

Demonstrating the linkages across the AoK, I return to (the notion of) the phenomenon of *Novelty* that emerges from the interaction and intertwining of state variables. During the preliminary research phase, one actor/practitioner stated that there are always side-effects in projects, which at that time informed the development of the research problem. An important point for this project is the System Dynamics practitioner view that there are no such things as 'side-effects'; Sterman asserts "[T]here are no side effects—only effects. Those we thought of in advance, the ones we like, we call the main, or intended, effects, and take credit for them.

The ones we didn't anticipate, the ones that came around and bit us in the rear—those are the ''side effects''." (2002, p.505). This failure to anticipate is seen as a product of limited mental models; Sterman (2002) argues that all mental models are by definition wrong, as they cannot fully replicate reality and, as we have seen, are subject to bias and heuristics. Figure 19 illustrates how these side-effects might occur, and at this stage, I would liken this with an occurrence of *Novelty*. As mentioned above, the sense of quantum of *Novelty* is perhaps appreciable, given the level of dynamic interaction across the Problem Space.

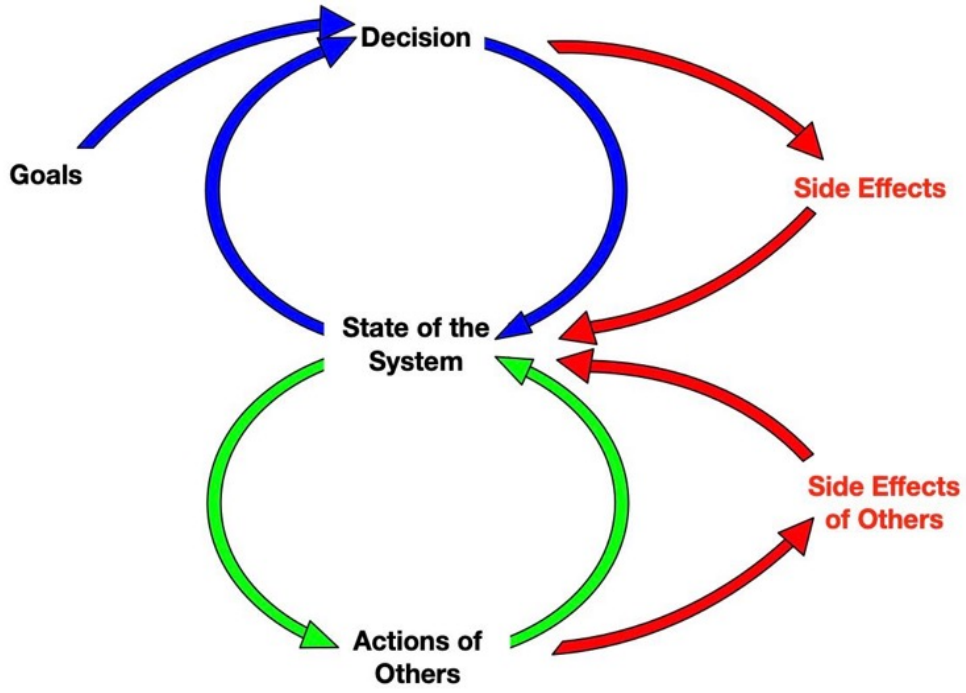

Fig. 19 Secondary Loop Influence with Side Effects

3.5.5 Merging Soft Systems Methodology and System Dynamics

It is evident to me that, from a systems perspective, SSM and System Dynamics represent perspectives from different approaches, but that could, if combined offer a rich way in which practitioners might counter *Novelty*. By definition SSM resides in the 'soft' systems approach, however, System Dynamics is seen as being from the 'hard' systems approach, potentially due to the close association with Systems Engineering, however this is disputed by Lane who argues that this association is "too crude a piece of pigeon-holing" (2000, p.18).

The fusing of the two approaches is not new; in an Action Research project, Rodriguez-Ulloa & Paucar-Caceres (2005), combined both approaches to "allow the emergence of a synergistic intellectual tool for systemic studies of complex situations." (ibid., p.310). In this model, Soft

System Dynamics Methodology, (SSDM) combined the ontological, epistemological and methodological elements to create a 10-stage process. It is argued that SSDM offers a thorough approach to combining both SSM and System Dynamics; however, it is further argued that this exceeds the requirements of this project, in that the requirement for a new model is not seen as essential, but that using System Dynamics to augment SSM helps develops a contextual Systems Perspective for the practitioners.

Kelly (cited in Eden, 1998) offers an approach that is more consistent with the above aspiration – cognitive mapping, which is described as "[T]he cycle of problem construction, making sense, defining the problem, and declaring a portfolio of solutions" (ibid., p.8). The theory is based on three key assertions (ibid., p.3):

1) Firstly, man makes sense of his world through contrast and similarity, that is meaning in the context of action derives from relativism.
2) Secondly, man seeks to explain his world – why it is as it is, what made it so.
3) And thirdly, man seeks to understand the significance of his world by organising concepts hierarchically so that some constructs are superordinate to others.

In a later paper, Eden (2004) references Forrester's work on System Dynamics (in relation to Feedback Loops) and provides a significant tool for helping to identify potential sources of *Novelty*. The author argues for the importance of correctly coding the polarity (positive/negative) of the causal loop nodes as this will, in aggregate, depict the summary effect of the system, in that a causal map that depicts an overall positive/amplifying/reinforcing effect is likely to lead to unanticipated side/effects, i.e., *Novelty*. The opposite is also true, an overall negative/attenuating/balancing effect will move toward a more stable state. Eden offers the following aide for assessing whether the system under review is either Reinforcing or Balancing as follows "[W]hen the loop contains an odd number of negative arrows then the loop is depicting self-control. That is, any perturbation in the state of the variables will result in stabilizing dynamics to bring activity into control. Alternatively, an even number of negative arrows or all positive arrows suggest regenerative or degenerative dynamics where a perturbation results in exponential growth or decline." (ibid., p681-2).

3.6 Chapter Summary

The purpose of this section was to undertake a literature review in order to answer the first research question – *"What are the discrete Areas of Knowledge relating to the programme threat and its remediation?"* This review has examined the 4 Areas of Knowledge and established the respective key findings and four Summary Observations; I will use these to develop the Conceptual Framework and the Research Method. Before this, in Chapter 4, I discuss the key implications arising from this theoretical review of the literature.

CHAPTER 4 ~ KEY IMPLICATIONS FOR THIS PRACTITIONER PROJECT

In this section, I consider the implications that the literature review raises for this Practitioner Project and I will frame this within the four Areas of Knowledge that comprise the Conceptual Framework. The section will conclude with some key summary observations that arise from the literature review and which I will explore in the Research Study.

4.1 Comments on Complex Adaptive Systems (Feedback and Emergence)

This review has reinforced my view that the Problem Space is a Complex Adaptive System. I have discussed the role of emergence in relation to (a) 'perpetual *Novelty*' and (b) 'non-linear behaviour' that is both caused by and causes, the bifurcation of system characteristics. Given the high level of inter-twining and interconnectivity in the Problem Space, I would expect the potential for *Novelty* to be both considerable and indeed inevitable without the application of adequate regulatory systems.

I introduced *CAS* into this project as I am interested to know how Problem Space practitioners can counter or regulate the number of emergent states (as systemic hazard) that can lead to *Novelty*. This is especially so in the context of a strange or chaotic attractor, where new, unknowable and unpredictable states arise. I contend that the literature goes some way to explain my lived experience where practitioners did not address the central phenomenon of *Novelty*; I propose that this is because they neither understood CAS, its implications for practice, nor appropriate supporting processes or structures.

I view the comprehension of the role of systems, emergence and feedback as vital in the regulation of hazard; indeed Winter et al., (2006) in discussing real-world programme management skills and knowledge, argue that the field of complexity offers an advance to the body of knowledge. The regulation of feedback offers specific opportunities to control within the Problem Space, specifically that of reinforcing feedback, (also expressed here as positive or amplifying feedback).

4.2 Comments on Novelty

In this section, I have explored the phenomena of *Novelty* as risk and questioned whether the existing management approaches are adequate. Of key importance is the 'unknowability' of

Novelty and that existing risk management methods and processes are arguably inadequate in providing an organisational, or rather, systemic regulating capability. From the analysis of risk approaches, and given the approaches in current operation, it is evident that the approaches are effective in dealing with reducible threats, those that are quantifiable and known, but these practices cannot deal with risks that are irreducible and unknowable – responding to this requires a different approach. Finally, I would note the importance of exploring practices from other fields to counter the effects of *Novelty*. In seeking to understand why *Novelty* may be difficult to counter, I have explored the nature of uncertainty and established that, in organisations and systems, we should expect a level of uncertainty and 'ignorance'. Similarly, I have established that in most organisations, and as a corollary the Problem Space, it is reasonable to expect accidents as 'normal'. Of significance is the view that risk and *Novelty* is borderless, this supports the use of any remediation across organisational boundaries to fully understand its impact.

Having reviewed several core policy documents relating to the management of risk in the Problem Space both in DefSy and the wider security environment, it is clear to me that the practices were (at the time of writing) evolving. Furthermore, when taken as a whole, there is a weakness in the ability to respond to 'uncertainty'. While it is implied, I did not see adequate recognition of the unknowable nature and non-linearity of hazard as a source of *Novelty*; this could explain the lack of awareness I observed in the preliminary PAR phase of this project. In endeavouring to understand the potential sources of *Novelty* I adapt Levin's (1998, p.433) definition of Hazard and propose the following as being applicable for this Practitioner Project:

> Hazard – alternative developmental pathways, due to the innate properties of a complex system (i.e. biological, chemical, physical, organisational or extra-organisational – the Problem Space) which can result in Novelty.

The extra-organisational nature of the Problem Space, with its "intricate inter-twining or inter-connectivity of elements" (Chan, 2001, p.1) and with the absence of a regulating 'global controller', impedes the capacity to respond to emergent risk. When we add to this problem of the unknowable nature of nascent *Novelty*, I would argue that this 'constraint' represents a significant issue with the Problem Space in relation to the response capability. This is especially so when current practices for managing risk are seen as ineffective and do not cut across the same extra-organisational space.

4.3 Comments on Understanding (the Problem Space)

In seeking to set out how practitioners can develop their response capabilities, there is a general thrust to this argument. Once the practitioner has developed the skills to 'Understand', through Sense-making and Situation Awareness, then applying this ability within a systems paradigm is helpful. This paradigm acknowledges both the co-evolutionary nature of the Problem Space and the constraints placed upon it by Requisite Variety. Understanding the limits of any system, and mapping these systems and their relationships, helps to see where *Novelty* may emerge (through feedback) and, in turn, help to prepare tactical/organisational responses.

I have outlined the key theories I believe to be pertinent to a practitioner's understanding of the Problem Space. Critical thinking has been discussed and how biases and heuristics can hinder critical thinking and decision making under uncertainty (or in a Problem Space experiencing *Novelty*). In discussing the nature of knowledge, I noted that several the discrete descriptions are aligned with the underlying paradigms of this research; for example, knowledge as an accumulation (emergence), knowledge is information in action (system variables). As a Researching Practitioner within the Problem Space, I argue that 'system knowledge' is an asset, something that must be retained to avoid reducing the *value* of the whole system. I also note Simon's admonition that when we seek to simplify the complex real world, we introduce discrepancy; as we have discounted information that in aggregate constitutes the system. This is in accord with the nature of the emergent being irreducible and Kaplan & Garrick's implicit claim that using numbers is overly reductive in managing risk. I am also mindful of flawed assumptions of rationality that stem from unconscious cognitive bias. Kahneman's (Systems 1 & 2) construct helps me to understand that where decisions are made under stress or uncertainty, or even in a cursory manner, it is likely to lead to faulty decisions and in turn error. I consider the preliminary PAR and conclude that there is a distinct lack of knowledge and in many areas; I agree that critical thinking as a reflective tool helps us with our decision making.

I have reviewed the relatively new theme of SM, both retrospective and prospective, before moving to discuss SA. It is my view that SA constitutes the goal of the practitioner and SM can be an effective tool through which this goal can be achieved. I have distinguished between retrospective and prospective SM; while the former is useful in 'Understanding' the context, it does not necessarily help with SA nor does it help to anticipate *Novelty*. As we have seen

there is bias in our assessment of past events, this means we should avoid over-confidence in perceived learning from these events. This is notable given the focus on so-called 'Lessons Learnt' processes within the Programme Management Body of Knowledge applicable to 'closing a project'. Given 'path dependency' (Walby, 2003) and the 'sensitivity to initial conditions' (Schneider & Somers, 2006) – both central tenets of Complexity Theory – we should acknowledge that all situations are different to a degree, and these differences, however minor, can be significant as events unfold.

What emerges from this review of the field of SA, I would argue, is the importance of the Subject Matter Expert (SME); the notion of someone who remains functionally tied to the role, profession or function for some time and ideally in the same domain and who has developed 'signal detection capability'. While this may be contradictory given *Novelty* cannot be predicted, I would contend that there is value in 'Understanding' the system, specifically in relation knowledge of system levers, i.e., how to regulate the system to counter the emergence of *Novelty.*

4.4 Comments on Response

I began this section by touching on Resilience (specifically the differences between general and specified typologies), Co-evolution and Requisite Variety, and I would assert that to understand these three theories is foundational in countering *Novelty.* General resilience is of specific interest as this relates to the whole of the system, focuses in irreducible hazards at a system of systems level (that may be interacting) and reflects the themes of this present research problem. The capacity for response, and to counter *Novelty,* meets the definition of Requisite Variety, where the system capacity must at least match the stimuli to which it is exposed, otherwise, the system cannot be seen as viable. To be aware of the limitations of both the system itself, but also any 'planned' interventions, places the practitioner, and indeed the Problem Space, in a much stronger position. Conversely, to not actively consider (the theories) increases the likelihood of exposure to *Novelty* as interventions may be inadequate.

In discussing the Problem Space Response characteristics, it has been argued that an informed use of SSM and SD, offers a rich way in which to better understand the system's complexity, the interactions and their causal relationships, and how regulation might occur through the attendance to feedback. Furthermore, it is argued that a combination of approaches, for example, SSDM may augment the ability to counter *Novelty*.

The use of SSM presents useful approaches to 'Understand' the system using RDs and CMs. This 'understanding' can then be augmented using 'causal diagrams' (from System Dynamics) to identify potential *Novelty* (so-called side-effects, or unanticipated effects) from the resultant 'reinforcing' feedback. This is not to say that any management action (to bring about 'balancing' feedback) will not result in *Novelty* as, by definition, adjusting/regulating an input will itself feedback positively – and potentially lead to *Novelty* in the other direction.

In seeking to develop a personal Systems Paradigm, I argue that practitioners should again look across the AoK for linkages, or system levers, to regulate these 'side-effects' or 'unanticipated effects', or in the vernacular of this project – *Novelty*. It is argued that any remediation 'toolset' should recognise that any system changes through time, it is dynamic with delays between action and consequence; in the words of John Maynard Keynes – "the material to which it is applied is... not homogeneous through time" (1938, p.1).

4.5 Chapter Summary and Key Implications

The following observations have emerged from the review of the Areas of Knowledge and I will explore these further through the Research Study.

1) I am interested to explore how practitioners respond to the information shared within the Conceptual Framework relating to CAS (Emergence and Feedback) and whether they recognise any potential benefits in its application.
2) Given the nature of emergent *Novelty*, I am interested to understand how practitioners perceive the related information that I will present in the Conceptual Framework. I would also anticipate some level of commentary on their capabilities to counter *Novelty* and if they agree that their controlling systems are inadequate.
3) Through the literature review, I found that a rich appreciation of the prevailing environment, together with critical thinking skills, and the application of both Sense-making and Situation Awareness, can help practitioners increase Understanding. I am interested to explore whether the research participants agree with this position.
4) I contend that Understanding that the Problem Space has a degree of general resilience at the system level and co-evolves with the environment, constrained by its Requisite Variety, helps practitioners to dynamically and intelligently deploy (through ongoing signal detection and Situation Awareness) Soft Systems Methodology and System Dynamics regulate feedback. This reduces the likelihood of *Novelty,* or would at least enable the

system to develop mitigations for deeper threat exposure. When this is included within the Conceptual Framework, I am interested to explore the applicability of this response approach with study participants.

5) I contend that I have demonstrated that the current approaches to risk management are arguably inadequate in addressing systemic *Novelty*, it is at least the case that performance in this area can be improved in order to improve its 'general resilience' and therefore its 'Requisite Variety'. Given this nature of the Problem Space, I assert that any opportunity in this area should be developed and tested and it is to this process I now move.

CHAPTER 5 ~ CONCEPTUALISATION

Based on the preliminary problem discussions, the observations of the extant research issues together with the ongoing interaction with the CoP, I develop the underlying philosophy of this thesis and present this in Chapter 5. The main objective of the chapter is to introduce the Conceptual Framework as an approach through which practitioners can counter *Novelty* at the Problem Space level.

5.1 Countering Systemic Novelty – The Conceptual Framework

Having satisfied the first Subsidiary Research Question in the Theoretical Background Chapter, I now progress to the second Subsidiary Research Question - *"How can the key areas of knowledge be developed into a method to address the threats to eco-system stability?"*

In this chapter, the core output of the Practitioner Project – a holistic, cross-disciplinary Conceptual Framework (as a strategic tool to address the research problem) is introduced; the framework is preliminarily entitled *CSN* – being an initialism for *Countering Systemic Novelty*. Before setting out the conceptual framework itself, I introduce a mechanism for describing the need for and defining the components of *CSN* – which are entitled AoK Capsules. I found the development of these capsules to be helpful in establishing the need for the model as they were incrementally tested with an informal community of practice[22] from within DefSy. After setting out the Capsules, the Conceptual Framework – *CSN* – is then discussed; this will include the 16 Characteristics and discrete elements of each Area of Knowledge.

[22] In one discussion, on Weick's 1993 paper relating to the Mann Gulch Fire, contributors used the term 'firefighters' to describe the way in which risk is managed in DefSy. This became a temporary 'frame' for how to construct the Conceptual Framework and as such as referenced in the Capsules.

5.2 Area of Knowledge Capsules

COMPLEXITY (EMERGENCE & FEEDBACK) CAPSULE
Description: This AoK acknowledges the context (Problem Space) is not 'ordered' or homogeneous, rather its 'complexity' and heterogeneity are critical factors that lead to emergent properties through the existence of positive feedbacks.
KEY DEFINING STATEMENT
The Problem Space is a Complex Adaptive System where *Novelty* arises and cannot be predicted. Novelty has been found to be an emergent property of *CAS,* a property which is non-predictable, and which can be exponentially self-reinforcing to such an extent it destabilises the system. Novelty has been compared to strange attractors (for an accessible example consider the Butterfly Effect) and is 'non-linear' in its behaviour, due in large part to the bifurcation of system variables in the environment. Practitioners have stated that they are not aware of this construct (*CAS*) which leaves the Problem Space in a persistent state of threat.
ARGUMENT
Given the nature of the Problem Space (being situated with DefSy), it is not beneficial to maintain the linear approach to management in general and to risk specifically. Developing both an understanding of complexity and knowledge of its implications to the prevailing situation is advantageous for practitioners in countering threats arising from *Novelty*. It is further argued that:
Without this knowledge/capability, practitioners are more likely to suffer from the consequences of Novelty to a greater extent due, in part, to ignorance of connections and feedback. Perpetually fire-fighting, dealing with the symptoms and not the causes, is a costly use of resources that might be better expended on growth/improvement than remediation activity.
With this knowledge/capability, practitioners will see the context variables as inter-twining and that actions in one area lead to direct and indirect consequences elsewhere in the system.

NOVELTY CAPSULE
Description: This AoK acknowledges that novelty, or threats, exist and/or emerge within this complex Problem Space, the extent to which this can be managed is a critical area.
KEY DEFINING STATEMENT
Novelty is inevitable, as are the effects. There is a great deal of uncertainty and lack of understanding, of *Novelty*, in the Problem Space that can lead to both individual and organisational accidents. These can be consequences of 'unanticipated side-effects' of reinforcing feedback. The idea of latent and nascent hazard has been identified and the latter is seen as a potential source of Emergent Systemic Novelty: Risk and Risk Management conventions have been reviewed and found to be inadequate in countering this phenomenon.
ARGUMENT
Novelty exists in the Problem Space. Given the nature of the *Novelty* and the inadequacy of existing Risk Management Processes, the Problem Space is exposed to significant and repeated risk. Given this is situated with DefSy, this represents a major issue for Senior Practitioners and a focused effort should be directed to knowledge development relating to the emergent nature of risk management. It is further argued that:
Without this knowledge/capability, practitioners are more likely to suffer from the consequences of Novelty to a greater extent. Perpetually fire-fighting, dealing with the symptoms and not the causes; this is a costly use of resources that might be better expended on growth/improvement than remediation activity. It is also likely that the implementation of remediations will lead to side-effects that cannot be anticipated and may worsen the situation.
With this knowledge/capability, practitioners can move to leverage Response Capability, upstream in the flow of risk. Risk Management will be more informed and a more gradual, systematic approach to regulation would be adopted.

UNDERSTANDING CAPSULE
Description: This AoK acknowledges that Novelty is largely unknowable, holding a deep understanding of the Problem Space is essential in making sense of the potential future states.
KEY DEFINING STATEMENT
The importance of critical thinking stands out as a key capability required to address *Novelty*. Prospective Sense-Making and Situation Awareness skills have been highlighted as being particularly important to enable practitioners to put themselves in a position of "being ahead of the plane" (Sarter & Woods, 1991, p.51). It is argued that this 'future orientation' together with considerable field expertise (via Retrospective Sense-making) will also allow for improved risk management and, in turn, improve the ability to counter SN.
ARGUMENT
Developing a wider understanding of the Problem Space is beneficial in countering Novelty. While essential retrospective knowledge and experience is not sufficient to counter Novelty. Prospective, anticipatory, skills are also vital. It is further argued that:
Without this knowledge/capability, practitioners are likely to remain as ill-informed 'fire-fighters' who are unable to remediate the causes, or hazards, as the immediate sources of Novelty. Potentially implementing remediations that are unrelated to the flow of risk, wasting valuable time and effort and leave the Novelty unaddressed.
With this knowledge/capability, practitioners can move to leverage informed Response Activity that can affect remediations to counter, to some degree, Novelty.

RESPONSE CAPSULE
Description: This AoK acknowledges that, once 'Understanding' has been developed, being able to deploy measures (mitigations and contingencies), is essential in countering and regulating Novelty.
KEY DEFINING STATEMENT
A systems philosophy has been examined that is consistent with the overall research paradigm. Being situated in a wider environment, Requisite Variety has been outlined as a governing mechanism that relates to system capability. Soft Systems Methodology has been reviewed and it is proposed that this approach is conducive in supporting the transforming of organisations away from hazard through regulation of feedback. System Dynamics has been reviewed, as a mindset and as a toolset, and is proposed as an effective technique for practitioners to both understand the Problem Space itself (for example using causal mapping) and anticipate *Novelty* (or unanticipated side-effects). The nature of knowledge has been reviewed and the benefits of 'relational knowledge' have been highlighted, which would be a complementary and effective attribute for practitioners in the countering of *Novelty*.
ARGUMENT
The ability to actively address Novelty is at the heart of this Practitioner Project. Knowledge of an effective toolset is a vital attribute for practitioners in the countering of Novelty. It is further argued that:
Without this knowledge / capability, practitioners will have knowledge of the three previous AoK, without actually addressing Novelty. Remediation will remain largely uncertain, incomplete as will any possibility of success in countering Novelty.
With this knowledge/capability, as a capstone to the three previous AoK, practitioners can have a significant skillset at hand. They will be contextual experts that are valuable in maintaining system equilibrium through effective regulation of variables.

The Capsules demonstrated (with practitioners in the Problem Space) the need to address *Novelty* via the discrete AoK. In this section, I set out *CSN* and the structure of the framework in more detail (see Figure 20). The facets of the Conceptual Framework are set out as follows:

1) Framework: At this level, I am setting out the top-level view of the whole framework;
2) Areas of Knowledge: These are the discrete and main 'characteristics of the framework; these are multi-disciplinary;
3) Knowledge Key Sub-Themes: Each AoK is then explored further and key elements that have proven essential are explicated;
4) Knowledge and Learning Nodes: These are the lowest level of knowledge
5) Knowledge Intersects: while the discrete AoKs have been seen to be of use of Problem Space practitioners, it is argued that greater, synergistic benefits can be achieved when these are taken together in situational combination.

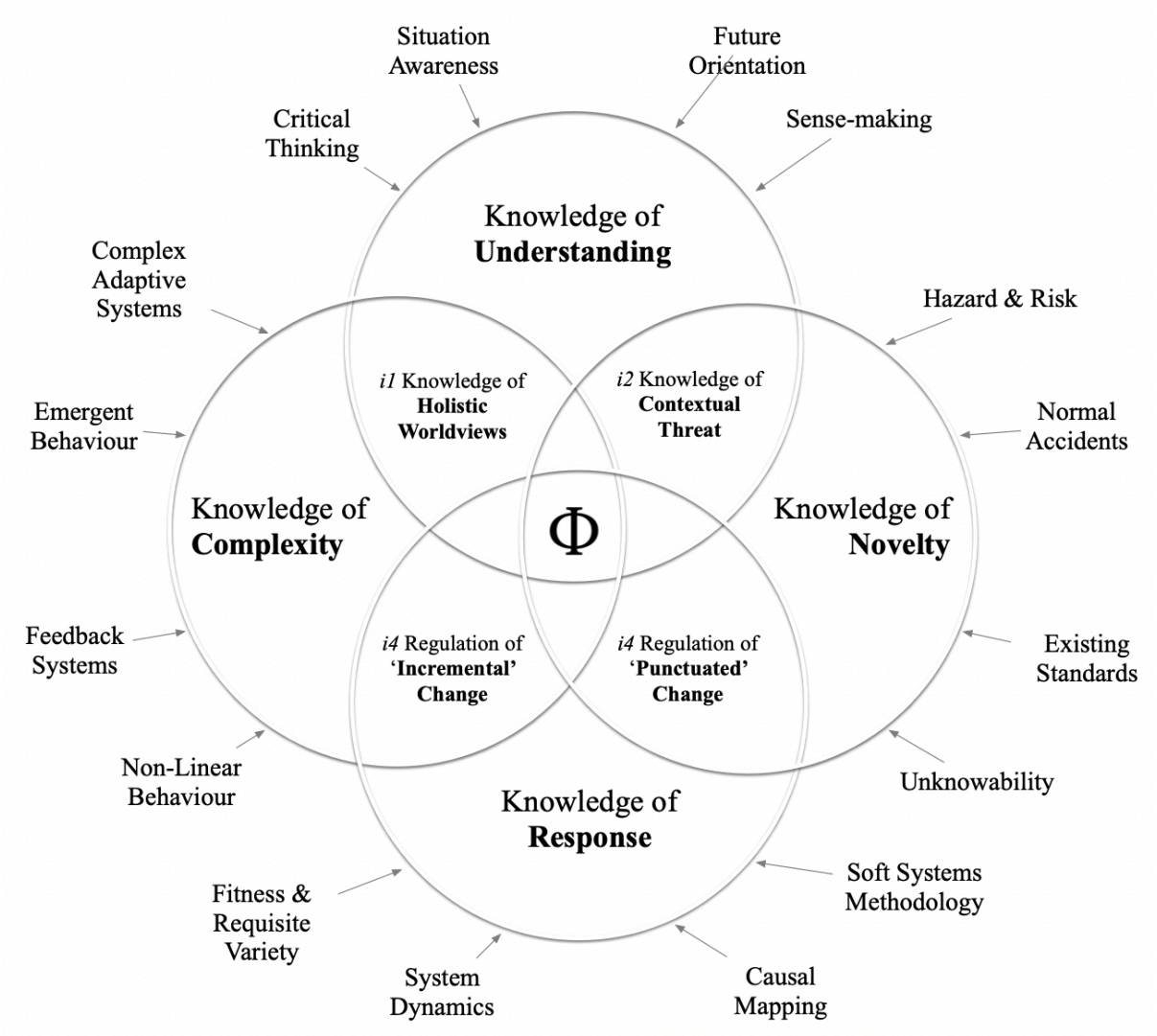

Fig. 20 CSN: A Conceptual Framework (Expanded)

5.3 The 16 CSN Characteristics

In this section I set out the 16 components or characteristics of the Conceptual Framework; these are set out within the logic of the structure established above. I will highlight the key terminology throughout.

5.3.1 On Complexity (Emergence and Feedback)

The key areas or characteristics discussed are (a) Emergence, (b) Feedback Systems, (c) Non-linearity.

5.3.1.1 Emergent Behaviour

This characteristic establishes the emergent nature of systems; I present emergence as a macro-property where the interactions of agents give the system it's essential, ordered and self-organising properties. I set Macro-emergence aside as not meeting the definition of the Novelty, whereas Micro-emergence represents the nature of *Novelty*. The characteristic then moves to one of the central features of Complexity – the notion of Attractors; *Novelty* is representative of a strange attractor illustrating the potential for chaos. Hierarchies within the CAS are set out in relation to constituent nodes/variables as agents. These nodes and variables are arguably incalculable practicably, which leads to a similar difficulty in conceiving the level of Novelty due to the network density.

5.3.1.2 Feedback Systems

The Feedback characteristic is another core feature of *CAS.* Feedback is the mechanism through which systems can maintain equilibrium or homeostasis; as a regulatory tool, it is a pre-eminent feature in the theory of cybernetics. It is important to note that feedback can lead to the emergence of the central phenomenon under study in the present research – *Novelty*. System Dynamics, which is itself a response characteristic, centres on feedback, both reinforcing (amplifying) and balancing (attenuating). Appreciation of the causal nature in systems helps to understand how the emergence of system *Novelty* may occur.

5.3.1.3 Non-Linear Behaviour

The non-linearity characteristic demonstrates the degrees to which uncertainty prevails across the system. Reinforcing feedback leads to uncertainty of outcome due in part to 'side-effects', which are actual consequences of bifurcation, when system information/effects adapt to

evolving environmental conditions. The effect is not proportional to cause, and a small change can lead to unpredictable outcomes, and we cannot deduce micro-structural causes.

5.3.2 On Novelty

This AoK addresses the nature of both hazard and risk within the Problem Space. The inevitability of accident and error, as normality, is addressed as is the weakness of existing management standards that see the process as an administrative task, and which cannot see the richness of the hazard complexity. The framework then explores *Novelty* in relation to its unknowable nature together with the issues around cross-boundary behaviour.

5.3.2.1 Hazard & Risk

The Hazard & Risk characteristic discusses the innate properties of a system that can act as a source of *Novelty* (as risk). The nature of Uncertainty is discussed and how a practitioner's assumptions can lead to the emergence of hazard in the system. This is especially the case when assuming causality through a limited understanding of the contextual variables. At a practical level Risk Bow ties are introduced (as a tool) to demonstrate how hazard can move from an emergence through to exposure and what steps can be made to counter this process.

5.3.2.2 Normal Accidents

This characteristic aims to demonstrate the inevitability of accidents in organisations. Accidents (as both individual or organisational) can take the form of active and latent failures. In the same way as a hazard is an unrealised risk so is a latent failure; it can be mitigated, but the risk effect is likely to be realised and with material impact. The nature of CAS, i.e., the density of the network of interactions, creates an Accident Environment that is difficult to counter. Organisations that demonstrate 'High reliability' are situated in high volatility industries (like DefSy) and have discrete capabilities that can help to militate against error and failure of 'Hazard'; knowledge of these HROs would be beneficial to practitioners.

5.3.2.3 Existing Standards

Here I draw attention to current practices relating to the management of risk and hazard. I have found that there is a linear response to non-linear problems, both through discussions with practitioners and through the grey literature. Where there is a level of certainty relating to issues, existing systems may be appropriate, but this is seldom axiomatic; bifurcation is highly probable in the most stable of systems. The sequential process of 'administering' risk is subject

to bias and heuristic thinking that can lead to a loss of the rich detail of the problem complexity. I argue that risk management conventions are overly reductive, exceeding the principle of parsimony, i.e., it is overly simplified and as such, in some cases, counter-productive.

5.3.2.4 Unknowability

Instances of Novelty are new, they arise from the interaction of state-space variables; they will be unique at the coarsest level of detail. In this sense we need to ask whether it is possible to have experience that is valid or relevant – is *Novelty* unknowable a priori and what does this mean for the possibilities of development to counter the phenomenon. One specific issue, which was a key area of dissonance at the foundation of this research, was the borderless nature of *Novelty* and the framework addresses the question of management across organisations. If organisations focus on internal or external hazards that are known, what steps are in place for those hazards that are unknowable and emerge at the interstices of organisations?

5.3.3 On Understanding

In this AoK I outline the proposed model through which practitioners can begin to better grasp the challenges facing the Problem Space. We have seen that Novelty is unique, certain behavioural trends and situational traits can be better perceived through improved critical thinking. The framework then explores Sense-making as a vehicle for providing a rich understanding of the current situation over time and specifically the future; the AoK then closes with a commentary on Situation Awareness.

5.3.3.1 Critical Thinking

Before introducing the core characteristics of this AoK, I would highlight the risk of bias as being a major challenge for practitioners in the Problem Space. Bias, both conscious and unconscious bias presents a significant test for practitioners as this can not only frame the understanding of variables, but also the response strategy. This is one type of Normal Accidents that lead to the central phenomenon arising. I see both reflective and reflexive practices as essential in tackling biases and particular attention should be given to controlling the circumstances where thinking takes place. For example, workplaces can offer considerable stressors for practitioners and this can lead to System 1 type thinking which can be laden with bias and 'fight or flight' responses. The importance of more considerative approaches should not be underestimated, i.e., System 2.

5.3.3.2 Sense-making

This characteristic is concerned with how the actor gains a maximal understanding of the prevailing variables in the Problem Space. Retrospective sensemaking makes use of the actor's past experiences, records of events to date and the lived experiences of others in order to understand ambiguous and confusing issues or events. However, given *Novelty* is new, retrospective only goes so far to immerse the actor into the Problem Space. Looking forward from the instantiation of *Novelty*, Prospective Sensemaking takes a view of the history to date and uses multiple actor perspectives to anticipate the future and uses a bridging strategy to resolve problems (or close the gap) through scenario testing. Prospective Sense-making is subjective and information-rich and assumes that no picture is complete as it evolves through time and space.

5.3.3.3 Future Orientation

This characteristic is concerned with the fact that mental models are not static, they exist in time and space and therefore co-evolve in this environment. There is also a focus on adopting a more dynamic approach to understanding as I see existing approaches as being inadequate and reductive. In conceiving the status of mental models, in time and space, I point out the relationship between stimulus and response, i.e., Ashby's Law of Requisite Variety. Mental models require expansion, and this is a goal for Problem Space practitioners, here the Conceptual Framework links over to other AoK components, for example, feedback and Situation Awareness.

5.3.3.4 Situation Awareness

This characteristic is concerned with the dynamic nature of the Problem Space, which is constantly shifting as linked nodes evolve due to feedback. In this setting requisite knowledge is required to similarly evolve in line with Ashby's Law, as system variables change their nature and, through SM, the implications of these changes are understood. Perception skills, the ability to comprehend environmental changes and project the potential implications are key facets within *CSN*. One of the central underlying themes for *CSN* is the importance of the Subject Matter Expert, constantly developing both their technical expertise and environmental awareness: these are invaluable within the context of this research.

5.3.4 On Response

This represents the aim of this research, what 'practical' steps can be made to counter the central phenomenon of *Novelty*.

5.3.4.1 Fitness and Requisite Variety

This characteristic discusses the capability, resilience or adaptive capacity, of the environment into which *Novelty* arises, or the fitness of the landscape. It is concerned with the number of traits in the system, and the extent to which these traits connect across the system nodes and entities. Effectively it is concerned with the level of general resilience or co-evolution in the system: this is an indicator of the brittleness of the system, or how soon risk exposure can cascade throughout the network of variables. Another way of expressing this is the Ashby Space, which is an evolution of Ashby's Law and is concerned with how requisite variety may evolve through time and space. This is a useful tool for practitioners as combined with situational awareness and deep system knowledge, it enables the optimisation, or regulation of system variables, and a response identified.

5.3.4.2 Soft Systems Methodology (SSM)

This characteristic discusses SSM and how it can be used when combined with the knowledge gained throughout this process to regulate *Novelty*. SSM allows practitioners to better understand the nature of the processes under review and its purpose through the development of a Human Activity System, that is a Root Definition and Conceptual Model. The 7 stage Checkland Methodology is core to the response capability and how it can be applied in developing scenarios to aid the future orientation discussed above. I do not propose SSM as a reactive process improvement exercise, i.e., to improve operational performance; instead, it is used to aid learning and identify weaknesses in systems that may allow oscillation, or bifurcation, of system variables. It is pre-emptive regulation, or mitigation intervention, that it used across the Problem Space. In its application, it places significant focus on the varying perspectives of practitioners to gain a broad and rich response capability.

5.3.4.3 Causal Mapping

This characteristic discusses the benefits of using Causal Mapping (CM) in countering *Novelty*. Understanding the larger influences in the system is vital to both Sense-making and Situation Awareness; Subject Matter Experts can use CM to illustrate their knowledge of

relational systems and map the polarity of feedback. Illustrating this feedback shows the reinforcing and balancing effects of feedback on the system under review and allows practitioners to focus on those areas that are likely to require attention. For example, where a process is determined to be a 'reinforcing feedback loop' there is the opportunity for both a lack of control to emerge but also system bifurcation – each is likely to result in Novelty and system threat. Using both CM and Connection Loops will help practitioners to understand the inter-twining of variables and allow the implementation of mitigations.

5.3.4.4 System Dynamics

This characteristic demonstrates the benefits of taking a more advanced approach to modelling systems and counter *Novelty*. Using Systems Dynamics, which can use Causal Mapping to generate representations of *CAS*, practitioners see processes as Open rather than Closed Systems recognising that nothing is exogenous to the system. Linking to Complexity, all systems are sensitive to initial conditions, and therefore encourages extensive mapping. Practitioners will challenge linear mental models, when evaluating the levels of accumulating hazard, using Stocks and Flows and regulating feedback tools and techniques. Using feedback loops, practitioners will see the effects of continuous adjustments to risk scenarios and will map this as far as is practically possible: in 'extended maps systems' multiple levels of feedback loops will be used. These richer maps will reduce the likelihood of 'unanticipated side-effects' which can be a major source of *Novelty*. Advanced practitioners will integrate this characteristic with Soft Systems Methodology, Situation Awareness and Cognitive Maps, combined with the Law of Requisite Variety; they will then consider the results in terms of the Ashby Space to project likely scenario options.

5.4 Recognising Emergence in CSN

One of the strengths of the Conceptual Framework is the emergent knowledge states. The first and straightforward pathway reflects a sequential growth; as practitioners gain additional knowledge new connections lead to a synergy of system knowledge. The second reflects intersecting knowledge; where two AoK are applied in tandem and these are shown below.

5.4.1 CSN Intersects – The integrated elements.

- Intersect 1: In this space, the combined knowledge of complexity and understanding gives the practitioner a Holistic Worldview. Emergence and Feedback blend with Sense-making

and Situation Awareness which contrasts with the prevailing linear approach to quotidian management processes interactions. Practitioners begin to question assumptions on linear decision making and causality.

- Intersect 2: In this space, combining the characteristics of Understanding and Novelty provides the practitioner with a grasp of Contextual Threat. Events are anticipated with greater depth and richness and, it is anticipated, much earlier than prevailing practices allow. The Situation Awareness acknowledges perpetual *Novelty* that leads to accidents and this is largely Unknowable in a fine grain level of detail.
- Intersect 3: In this space, the combined knowledge of the nature of Novelty and Response allows the practitioner to regulate for the effects of Punctuated Change. As the practitioner is balancing the system variables, when *Novelty* occurs, practitioners can adjust system variables, and information flow, to mitigate the effects of risk exposure with minimal impact and reduce the change of a cascade effect occurring. This might be more beneficial in the operational/tactical space.
- Intersect 4: In this space, combining knowledge of Complexity and Response allows the practitioner to regulate the broader system and regulate for Incremental Change. At this level, the practitioner is advising on policy development and organisational change. Where events unfold at the hierarchically higher level. As they understand the system and its areas of feedback, interventions on the 'larger' scale can be activated.

5.4.2 Phi – Total Immersion in the system's information construct.

I represent the third emergent knowledge state by the symbol for Phi and is at the heart of the Conceptual Framework. This denotes a level of maturity where the practitioner has knowledge of all Areas of Knowledge together with the intersects. In keeping with one of the core elements of this research, it is an emergent optimal state of knowledge and capability. I have borrowed Phi from Integrated Information Theory: it represents the nature of this specific emergent state as it is irreducible and cannot be deconstructed without being lost altogether; it represents the nature of causality and the effects that interdependent variables have on one and other. I argue that at this level, practitioners are optimally placed to be able to respond effectively to a large range of threat scenarios.

5.5 Basis for Confidence in CSN

The Conceptual Framework has been arrived at following several stages: including lived experience observations; an early cursory literature review; a partial action research set and, as seen in the previous chapter, a full and comprehensive literature review. Throughout the development of the Conceptual Framework iterative discussion has taken place with an informal Community of Practice that has, in the main supported the development of the scope of the framework. It is appropriate to point out that, of course, due to the complex adaptive nature of the Problem Space, practitioners can never understand the full granularity of threat. Equally the diagrammatical representation of the approach does not fully convey the connections across the varying elements of knowledge – similarly, this can never be fully represented. However, the Conceptual Framework provides a heuristic, a knowledge base and philosophy through which we can appreciate complex problems in a richer and pragmatic light, and one that resolves the weaknesses of the linear approach.

5.6 Chapter Summary

In this chapter, the core output of the Practitioner Project – a holistic, cross-disciplinary Conceptual Framework has been introduced; this framework is preliminarily entitled *CSN* – being an initialism for *Countering Systemic Novelty*. Before setting out the conceptual framework itself, I introduced a mechanism for describing the need for the components of *CSN* – which are entitled AoK Capsules – that have been discussed with practitioners in the development of the proposed Conceptual Framework. In explicating the four Areas of Knowledge, 16 characteristics have been laid out in detail and the synergistic benefits have been explained when these characteristics are brought together.

As the purpose of this Practitioner Project is to meet the aims and objectives established earlier; I now argue that I have at this point answered Subsidiary Research Questions 1 and 2. In order to answer Question 3, I now introduce the Research Methodology, and this is set out in Chapter 6.

CHAPTER 6 ~ METHODOLOGY

In this chapter, I outline the research philosophy, strategy and methods used in order to fully meet the 3rd research objective, which is:

> "To provide an assessment of the validity and applicability of the conceptual framework by seeking the collective views of senior leaders and practitioners in the Defence and Security sector in HMG, specifically in the area of risk and programme management".

6.1 Research Paradigm

In defining the practical approach to research, Crotty 1998, p.2) asserts there are two main questions to answer in this process, "[F]irst, what methodologies and methods will we be employing in the research we propose to do? Second, how do we justify this choice and use of methodologies and methods?". Crotty (ibid) presents these questions as Four Research Elements (Table 11), which is the general approach adopted in this research study.

Table 11 Crotty's Four Research Elements

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While I have sought to approach this research in a pragmatic, iterative manner, and indeed I subscribe to Crotty's above-stated philosophy, the representation for this project is set down on more conventional lines. Namely, (a) a framing philosophy & paradigm; (b) epistemology; (c) theoretical perspective; (d) methodology; and finally, (e) method.

6.2 Framing Thoughts on Research Paradigms

> "A paradigm may be viewed as a set of basic beliefs (or metaphysics) that deals with ultimates or first principles. It represents a worldview that defines, for its holder, the nature of the "world," the individual's place in it…" (Guba & Lincoln, 1994, p.107).

Burrell and Morgan (1979, p.3) present a hierarchy that descends from ontology, down through epistemology, human nature and finally methodology along 'continua'. These continua range from the Objective Approach to the Subjective Approach, which Holden & Lynch (2004, p.398) argue as being "as a continuum's polar opposites with varying philosophical positions aligned between them". This is not a universally held view, however, and while Grix (2004, p.54) states, "ontology is logically prior to epistemology, and that the two concepts must be kept apart..." he adds (importantly) that "they are inextricably linked". It is my view that, at this level of understanding, this is an unclear position, as all 'things' are linked (through feedback) and hence cannot be separated, unless as a linear presentational object. Crotty (1998, p.10) goes further, breaking with this ontological primacy model, and argues strongly that ontology and epistemology can "emerge together" and excludes ontology from his own work. In determining the 'paradigmatic approach' for this project, I considered the seemingly linear approach, espoused by Burrell & Morgan and Grix, as overly rational and with a confusing usage of terms, somewhat more directly, Crotty (1998, p.3) describes this confusion as being a "grab-bag". The presumption that we undertake research in this linear, sequential fashion is at odds with the interconnected, holistic and pragmatic worldview guiding this study, consequently, I adopt and adapt Crotty's (ibid.) approach.

6.3 Epistemology

In this application of Crotty's (ibid.) approach I now consider the identification of the epistemology, or to follow Hay (2002, p.64) – firstly determine "[W]hat's out there to know", then "[D]etermine what and how we can know about it". Epistemology is concerned with "the question of what or should be regarded as acceptable knowledge in a discipline" (Bryman & Bell, 2003, p.13); as such, it is important to note that within the theory of knowledge epistemology is "embedded in the theoretical perspective" and as such "informs the research" (Crotty, 1998, p.3). In a detailed discussion on the distinction between both 'Objective and Subjective' paradigms, Diesing (1966, p.124) argues that the issue has "long been a topic of discussion among philosophers and social scientists", adding that objectivists "require

observable, replicable facts", whereas the subjectivists require "that the essential, unique characteristic of human behaviour is its subjective meaningfulness, and any science which ignores meaning and purpose is not a social science". Developing Diesing's position, Crotty (1998, p.7-9) advances three epistemological positions that help to identify my own position:

1) Firstly, Objectivism holds that meaning, and therefore meaningful reality exists as such apart from the operation of any consciousness.
2) Secondly, Constructionism rejects this view of human knowledge, and there is no objective truth waiting for us to discover it. Truth, or meaning, comes into existence in and out of our engagement with the realities in and of our world.
3) Thirdly, in Subjectivism meaning does not come out of an interplay between subject and object but is imposed on the object by the subject: here the object as such does not contribute to the generation of meaning.

While these stances seem logical and straight-forward, it is by no means so; epistemological positions are not "watertight compartments" (Crotty, 1998, p.9). Depending on the publication or author, labels are interchangeable and can be both ontological and epistemological: for example, Grix (2001, p.27) labels Objectivism and Constructivism as (dichotomous) ontological stances and Positivism and Interpretivism as their respective epistemologies. A lack of clarity that led me to question the broader, or more specifically, the practical purpose and value of the "epistemological industry" (Dewey, cited in Morgan, 2014, p.1045). Citing Rescher, Johnson & Duberley (2000, p.157) are philosophically informative in considering, and determining, the epistemological stance for this project. The authors refer to the historic distinction between episteme and doxa as positions on knowledge and describe the former as "genuine" and the latter as "suitable for the conduct of everyday affairs". Relatedly, Dewey's term for knowledge, i.e., warranted assertability also states that truth was not a question of what was empirically verifiable or testable, instead, it is a question of whether it helps people to deal with their worlds (Johnson & Duberley, 2000, p.159). Hence the goal of inquiry may be a transformed situation rather than some correspondence with an inaccessible reality (ibid.); this is consistent with my present study, which is seeking to develop a *valid* and *applicable* mechanism for improving performance in the management of *Novelty*.

In pursuance of this study's aims and objectives, I reject the objectivist view of knowledge. My theoretical perspective does not allow for 'root' causes to be determined (absolutely) and therefore, I find it difficult to reconcile how I can both understand and measure knowledge.

This view is supported by Woermann et al., (2018, online) who argue that as a "complex system does not exist independently from the parts that constitute it" and (as we are part of that system) then "this means that there is no objective position from which to study complex phenomena." On subjectivism, while I acknowledge that meaning can be different for everyone, this is not the preferred route for this research. This is in part related to the adverse cognitive effect of heuristics and bias in giving meaning to phenomena (for example note Kahnemann & Tversky, 1974; De Martino et al., 2006; Nickerson, 1998). This research is concerned with seeking the collective view of experts (in the field of defence and management sciences) around a proposed remediation mechanism for the central phenomenon, and contextual practitioners have been be involved in the identification of both the phenomenon and remediation. Given this approach, Constructionism is the most appropriate epistemological stance and foundation for this research as knowledge are "being constructed in and out of interaction between human beings and their world and developed and transmitted within an essentially social context" (Crotty, 1998, p.42).

6.4 Theoretical Perspective

Having established the epistemological position (for this study), I now set out the theoretical perspective, or the "philosophical stance informing the methodology" Crotty (1998, p.3). The two assumptions inform the stance; first, the primacy of a worldview based on Complexity (over Reductionism) and second, the Pragmatic stance.

6.4.1 On Complexity

The worldview guiding this study aligns with the field of complexity and specifically, that of *CAS*, which Chan (2001, p.2) describes as –

> "…dynamic systems able to adapt in and evolve with a changing environment. It is important to realize (sic) that there is no separation between a system and its environment in the idea that a system always adapts to a changing environment. Rather, the concept to be examined is that of a system closely linked with all other related systems making up an ecosystem."

The key facets of a *CAS* include elements that are critical from my perspective, these include: (a) Distributed Control, (b) Connectivity, (c) Co-evolution, (d) Sensitive Dependence on Initial

Conditions, (e) Emergent Order, (f) Far From Equilibrium, and (g) State of Paradox (ibid. p5-6).

Within this worldview reality exists in both time & space (state-space), co-evolving as a system within a wider system. Reality does exist externally, but we/humans are also part of this reality and not separate from it; existing as emergent phenomena or agents within the state space (Holland, 2000, p.33). Reality, or our perception of the instances of reality, is an irreducible emergent phenomenon that is unmeasurable, or not 'apprehensible' (Guba & Lincoln, 1994, p.109), as there can be no empiric, quantifiable evidence of its existence. For these reasons, this research conflicts with the realist/positivist/objectivist stance, and hence, I reject this approach.

If I were to take a simple oppositional view, then the interpretivist/subjectivist paradigm might be the chosen method for this research; however, the journey to this point has not been as simple as this implied 'binary switch'. As I undertake this study with a worldview grounded in complexity and pragmatism and were I to take a position (on the philosophy of 'reality'), it would be fluid and contingent on the understanding of the problem to hand.

6.4.2 On Pragmatism

A focus on contingency is important in undertaking this study. It relates to the practical nature of this research project and reflects that, as the prevailing context changes, then as should the theoretical perspective: in effect *'we are part of the context*[23]*'*. I note Charles Sanders Peirce's Pragmatic Maxim "[C]onsider what effects, which might conceivably have practical bearings, we conceive the object of our conception to have. Then, our conception of those effects is the whole of our conception of the object." (cited by Legg & Hookaway, 2019). This research plan is rooted in a pragmatic philosophy; it led to the deployment of Crotty (1998) as an approach that views the ontological primacy as an "infantile need for security" (Rorty, cited in Johnson & Duberley, 2000, p.159) that has "dominated philosophy since the Ancient Greeks" (ibid). The focus of this research has been on the product, and its inherent value 'or practical bearings', which developed in parallel with the philosophical foundations. While I am indeed concerned with the nature of reality, I eschew the requirement for a fundamentalist position. It is my

[23] This is consistent with Johnson and Onwuegbuzie's (2004) 3rd Principle of Pragmatism. i.e., Knowledge is viewed as being both constructed and based upon the world we experience and live in.

position that neither the realist/positivist/objectivist nor the interpretivist/subjectivist paradigm are consistent with my own. The focus on contingency, fitness and complexity drive my theoretical perspective that supports both the method and the methodology – Pragmatism.

6.4.3 Inference

In undertaking this study, I reflected on the syllogism of the underlying reasoning behind the Research Problem. In breaking down the Research Question, I highlight the following statements as being critical to determining the logical approach (Peirce, cited in Reid, 2003, p.2) and identify the rule, the case and the result.

- Rule: Emergent properties arising from the interaction of system agents or eco-systemic initiatives (...) are both unknowable and unbounded;
- Case: There is – a lack of understanding and regulation of '*Novelty'*;
- Result: There are – threats to the stability of the ecosystem under study.

I view the directionality (of reasoning) to be critical to the research process; the following are forms of reasoning that can describe the study to be undertaken: (a) Deductive reasoning: when the premises are true, the conclusion must also be true and generalising occurs from the general to the specific; (b) Inductive reasoning: where known premises are used to generate untested conclusions where generalising occurs from the specific to the general, and finally; (c) Abductive reasoning: where known premises are used to generate testable conclusions and where generalisability occurs from the interactions between the specific and the general (Saunders et al., 2009, p.145). Table 12 sets out the Rule, Case and Result statements against the forms of reasoning set out above in determining the directionality for this study, I propose three further factors to guide and underpin the logical approach for this study.

1) Given, the lack of a priori knowledge (of the central phenomenon), it follows that *the case* follows *the result* and, therefore, Abduction, also known as '*Inference to the best explanation*' (Harman, 1965) describes the preferred inferential logic;
2) There is an attraction toward this more pragmatic approach that resonates with the Theoretical Perspective adopted in this Practitioner Project;
3) Abduction is consistent with the approach to Understanding as defined in this study as it is the "as the gist of sensemaking" (Patokorpi & Ahvenainen, 2009, p.137).

Table 12 Determining the Directionality of Reasoning

DEDUCTIVE
If: Emergent properties arising from the interaction of system agents or ecosystemic initiatives (...) are both unknowable and unbounded
And: There is …a lack of understanding and regulation of *Novelty*
Then: There are... threats to the stability of the ecosystem under study
INDUCTIVE
If: There is …a lack of understanding and regulation of *Novelty*
And: There are... threats to the stability of the ecosystem under study
Then: Emergent properties arising from the interaction of system agents or ecosystemic initiatives (...) are both unknowable and unbounded
ABDUCTIVE
If: Emergent properties arising from the interaction of system agents or ecosystemic initiatives (...) are both unknowable and unbounded
And: There are... threats to the stability of the ecosystem under study
Then: There is …a lack of understanding and regulation of *Novelty*

6.5 Research Approach

In this section, I describe both the approach I adopted to undertake the research and I also provide a rationale for its selection (Crotty, 1998, p.6). This will place the choice of method within the overall research strategy.

6.5.1 Methodology – A Rationale

At this juncture, I summarise, in Table 13, the non-linear learning journey to this point, defined by convergent, weaving pathways that led to the identification of methodological approach. In this sense I establish that the study did not proceed along the Ontology, Epistemology, Methodology and Method conventional path; I would best describe the route as being of a pragmatic and organic nature.

Table 13 Identifying the Methodological Approach: Journey to Date

Pathway 1	I had observed, from lived experience, that issues were emerging in DefSy as a result of interaction across organisations/systems;
Pathway 2	I had undertaken previous research relating to strategic change management that, at a cursory level, examined CAS —a passion that endures;
Pathway 3	I had committed professionally to bring these two interests together to diagnose the 'problem' that I had been asked to investigate and bring forward proposed remediations;
Pathway 4	I had developed a Community of Practice (CoP) from within the 'Problem Space' with practitioners/actors/agents[24] and following iterative research and discussion devised and agreed to a Proto-Model to depict 'Areas of Knowledge' that (might) be sufficient to counter the problem. I then followed this with a detailed literature review to evolve the model into the more detailed Conceptual Framework (CSN); again, I took advantage of the input and challenge from the CoP.

The rationale for the study has two intents '[T]o produce knowledge and action directly useful to a group and (....) to empower people through raising consciousness" (Johnson & Duberley, 2006, p.138). If this definition is used to describe the 'choice of research strategy' (Grix, 2001, p.36) then the 'guiding methodological strategy' (Mason, 2006, p. 30) can be labelled as 'Action Research (AR)', which Reason (2003, p. 106) asserts:

> "must not be seen as simply another methodology in the toolkit of disinterested social science: action research is an orientation to inquiry rather than a methodology[25]. It has different purposes, it is based on different relationships, and it has different ways of conceiving knowledge and its relation to practice."

24 Development of the proposed framework took place with professional colleagues across the range of "Other Government Departments' and the Ministry of Defence.

25 This conflicts with Crotty (1998, p.5), for example, who specifically includes Action Research as a methodology.

In addition to the above, I was drawn to the characteristics of AR (Reason & Bradbury, 2005, p.xxii) as affirming the suitability of, and application, to this study – in that AR:

- Responds to practical and pressing issues in the lives of people in organisations and communities
- Engages with people in collaborative relationships
- Draws on many ways of knowing
- Is strongly values-oriented, seeking to address issues of significance concerning the flourishing of human persons, their communities and the wider ecology in which we participate
- Is a living emergent process which cannot be pre-determined but changes and develops as those engaged deepen their understanding of the issues to be addressed.

Going further, Kemmis et al., (2013, p.5) argue that Participatory Action Research (PAR) allows researchers to:

- Work from 'within', to develop practices;
- Use a shared language (which is critical in DefSy);
- Allows practitioners to participate and develop forms of action;
- Enables Communities of Practice in specific fields; and,
- Allows practitioners to develop their practices to meet changing environmental demands.

I believe PAR encapsulates my overall approach to this Practitioner Project. The reference to the living nature is consistent with my philosophy given the co-evolutionary process taking place within and part of the wider environment.

6.5.2 Introducing the Delphi Technique

In this section I explore the practicalities of the preferred research method – the Delphi Technique, including study population; study sample; topics; procedures; tools for data collection; and procedures for data analysis and interpretation (Given, 2008, p.517). Question 3 of the subsidiary research questions asks: "[C]an the validity and applicability of the method be verified across a range of relevant practitioners?". In seeking to answer this question, I

undertook a 'Classical' Delphi study (for example, Hasson et al., 2000, p.1011). Dalkey describes the Delphi Technique as:

> "the name of a set of procedures for eliciting and refining the opinions of a group of people. In practice, the procedures would be used with a group of experts or especially knowledgeable individuals." (1967, p.1).

Okoli & Pavlowski state that the (Delphi) method originated in the 1950s by the RAND Corporation to obtain the "most reliable consensus of a group of experts" (2004, p.16). The authors add that the method has been used in a range of applications, including the development of Conceptual Frameworks, adding that it can be used to gain consensus as well as generating alternate scenarios (ibid., p.17). Habibi et al., (2014, p.8) in examining the Delphi Technique in qualitative research cite the definition of the method by Linstone and Turoff (1975, p.3) "a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem".

Yang argues that the "primary objective of the Delphi study is to obtain consensual and consistent opinions from a group of experts in two or more successive rounds on a given research subject" (2003, p.4). As a researcher with some experience of working with very senior, and influential, actors in DefSy I was particularly drawn to one of the core attributes of this method, i.e., anonymity[26]: Delphi panel members do not interact in the information gathering process, instead the views of panel members are collated, analysed and then circulated by a facilitator. This removes the potential for undue influence, in a group workshop for example, by more senior members on others; from the group to individuals, or a dominant group member on the wider group (Hanafin, 2004, p. 10). Other advantages include flexibility & simplicity; knowledge sharing; cost-effectiveness (Avelle, 2016, p.314-5). There are disadvantages proposed in the literature; these include concerns on reliability; validity and credibility; that the focus on anonymity can lead to lack of accountability and the consensus can lead to a diluted version of the best option (Hanafin, 2004, p.11). Further, perceived disadvantages include researcher bias; researcher shortcomings; panel member petulance and

[26] Due to the sensitive fields in which the panel members operate, anonymity enabled me to access very senior participants to this project. Although a small number of panel members withdrew (as they were asked to provide names on the consent documentation), anonymity provided sufficient assurance to maintain the integrity of the panel.

bias against the method (Avella, 2016, 315-6). Having considered both the advantages and disadvantages, Delphi remains the preferred method to answer the final subsidiary question and in the next section I set out the practicalities.

6.5.3 Composition and Panel Size

Due to the heterogeneous nature of the discrete Areas of Knowledge, a key consideration was whether to use a single or multiple panel/s (Habibi, Sarafrazi & Izadyar, 2014, p.10). To determine the most favourable solution, I considered two factors; firstly, whether I was examining the nature of each AoK or whether I was assessing the validity and applicability of the 'totality of the AoK', represented by the Conceptual Framework. I came to the view that as it was the latter that is under review, that one panel would be appropriate and that between 9 and 12 participants would an adequate size, given the nature and scope of influence of the individuals: I drew the elected practitioners from the functional fields of DefSy, notably risk management and programme management[27].

Given the expertise in this discrete area of government, together with the constructively and critical contribution the panel has made throughout the development of the framework, I view the constitution of the expert panel to be appropriate. Indeed, while Amos & Pearse see panel eligibility as an essential step in the Delphi process (2008, p.99), the objective of the study influences this decision (ibid.).

I formed the Delphi Panel from a pre-selected group of experts from a range of sources, including HM Ministry of Defence, HM Cabinet Office, HM Home Office and the National Technical Authorities. Using generic descriptions, I would categorise the roles occupied by expert panel members as generally being in, or related to, Programme and/or Risk Management. Prior to the study, several of the panel members took part in the preliminary PAR stage, they were, therefore, largely familiar with the overall intended process. In all cases I provided the following artefacts to the Panel Members prior to commencing the study:

1) Consent Form (I recorded these as approved before the Study commenced)
2) Countering Systemic Emergence Novelty (CESN) Panel Member Information Pack:
   a) Component 1 – An overview explanatory document.

[27] For the purposes of this research project, I am using generic descriptions of roles; this was a requirement with the participants.

b) Component 2 – A more detailed document setting out the Areas of Knowledge.

Due to the discrete and sensitive characteristics of the Problem Space, the choice of experts has been in development for some time and most (members) have contributed greatly throughout the development of the Conceptual Framework. While data saturation is not necessarily an issue for Delphi Panels (Avella, 2016, p.317), due to the significant contribution to the development of the model the panel has made, I did anticipate a degree of diminishing return as panel members returned their submissions.

6.5.4 Panel Questions

Though there had been early and ongoing interaction with the panel members, this process had highlighted the need for significant 'on-boarding' to the research process. Consequently, I offered of face-face conversations to candidates to 'walk-through' the process and specifically the Delphi Question Development. In introducing the panels to the questions, I included a summary of the Research Question and an overview of the Delphi Process. The latter conveyed the Delphi Question Development and Response Phrasing (Aigbavboa, 2015, p.4) for this study (Table 14).

Table 14 Delphi Question Development

KEY QUESTIONS	RESPONSE PHRASING
Why I am interested in this study?	This study emerged gradually; in a reality seen as a fluidic and which respects no borders. In this time-space I saw threats to the stability of DefSy that was similarly fluid, emerging in forms akin to neuronal activity. The ability to manage this was of interest to me as a Researching Practitioner and I developed a Conceptual Framework (nominally CSN) for operationalisation within the Problem Space.
What I need to know that I do not know now?	This study will evaluate CSN for its validity and applicability, it is not seeking confirmation of completeness (as this is seen as undeliverable given the fractal nature of uncertainty, i.e., every scenario cannot, by definition, be foreseen). It is seeking a consensus view from experts on this sufficiency.

KEY QUESTIONS	RESPONSE PHRASING
How will the results from the Delphi Study influence HMG approach to the management of systemic stability?	The result of the study will enable the provision of an advanced development programme for practitioners in the functional context. When enacted the goal of this programme will be to minimise threats to the eco-system.

6.5.5 Programme Schedule

I planned the Delphi Study to take place over 2-4 Survey Rounds (Keeney, Hasson & McKenna, 2001, p.177); where I use descriptive terms to 'label' each Round (from Okoli & Pawlowski, 2004, p.26). These contextualised descriptions are:

Round 1 – Brainstorming: Detail and Schedule: The purpose of the first round was to identify issues that the study would address in later rounds (Powell, 2002, p.378). Given I had undertaken both a preliminary literature review and iteratively tested the findings with an informal community of practice, the function of Round 1 was to seek as many responses or key factors relating to the validity and applicability of the Conceptual Framework in countering *Novelty*.

Round 2 – Narrowing Down, Detail and Schedule: Having sought and gained comments on the validity and applicability of the Conceptual Framework, Round 2 circulated a set of collated statements[28] where I asked the panel to "review and comment" (Aigbavboa, 2015. p.6) on the agreed findings of Round 1. This took the form of rating respondent's agreement (with the collated statements) on a scale between 0 (Strongly Disagree) – 9 (Strongly Agree) and where 5 represents 'no opinion'. In the analysis I derived a set of measures, one being the Group Mean, to enable the narrowing down of responses, I would discount those collated statements with a Group Mean of less than 4.0 due to the low level of agreement.

Round 3 – Consensus Seeking: Detail and Schedule: Where responses that deviate markedly returned to the expert panel for reconsideration. During this round, I sought agreement on the

[28] I only sought responses from those participants that responded to the previous round. This approach applied to subsequent rounds also.

rankings of responses from Round 2 and asked panel members to consider their ratings from Round 2 against the Group Mean and amend where they saw appropriate.

6.5.6 Results Analysis

One of the reasons I elected to a Delphi Study was so I could gather and blend both quantitative and qualitative analysis to provide added texture to this study. Following Round 1, I undertook an Open Coding/Affinity Analysis exercise to determine the key themes; I followed this with 'nine-point Continuous Variable Scale' questionnaires to help determine consensus. To demonstrate consensus, I used a set of statistical analyses which included mean and median averages, standard deviations and interquartile ranges. In order to provide the added texture, I reviewed the narrative statements provided by the panel and included these in the analysis. In defining consensus, I established the following definition:

- Consensus IQR = <=1.0
- Strong Agreement IQR = >1.0 – <=2-0
- Weak Agreement IQR = >2.0 – <=3.0
- No agreement IQR = >3.0

6.5.7 Summarised Research Methodology

The purpose of this section was to set out the background to the research and the identification of the Research Philosophy that frames and guides the project and to provide an explication of the Research Design. I have asserted the practical, iterative nature of the study to date and, following Crotty's "many arrows, loosed several ways" (1998, p.1) Shakespearian quote, the research approach can now be summarised as:

Epistemology: Constructionist ->

Theoretical Perspective: Pragmatism->

Methodology: Abductive Participatory Action Research->

Method: Delphi Technique.

6.6 The Broader Research Strategy

In Table 15 I present the baseline schedule for the Practitioner Project Plan (Independent Research Stage), which I anticipated would be a sufficient timeframe for the completion of the programme as it includes an element for optimism bias (Atkinson et al., 2006, p.688) in the form of a 'Project Float'. Kothari (2004, p.10) cautions that the availability of time to undertake the research is a key consideration, hence the cautious timings proposed herein.

Table 15 Practitioner Project Plan (Independent Research Stage)

TASK	WORKING SCHEDULE
Deep Literature Review	October 2018 – March 2019
• Undertake Delphi Panel Study • Round 1 • Round 2 • Round 3	• April – June 2019 • May 2019 • June 2019 • July 2019
Final Write Up	April – July 2019
Project Float Time	July – August 2019
Submission	August 2019
Viva Voce Examination	February 2020
Dissemination / Publishing Plan • Paper 1. Using Delphi in workplace change • Paper 2. On the Practitioner Project • Developmental Programme Project • Book Development	Post- Programme Activity • April 2020 • June 2020 • August 2020 • September 2020 – September 2021

6.7 Chapter Summary and Risks

Having established the approach to the project, together with the overall strategy and methodology, there were evident risks and constraints inherent to the plan and these are set out here.

1) Timeframe: Due to the nature of some of the operational roles contained within the Delphi Panel it was possible that these may change at short notice. I sought to mitigate the effects through the identification of reserve panel members.
2) Security context: It was also important to note that, again during the timeline of the project, the wider security context may change, and this may impact on the deliverability of the project.
3) Organisational context: I noted that my employing organisation is in a fluid state and it was possible this may alter during the project.
4) My own professional development: Whilst it was unlikely that my career path would alter materially; there was potential that a move to another function may have occurred. However, this was unlikely given my commitment to both this study and the current role.

6.8 Research Ethics

Given the operational context within which this research takes place, i.e., DefSy, I contend that the need to show ethical issues have been both considered and followed was paramount. The aim of this section is to demonstrate, and clearly so, and especially given the research context, that I have considered and mitigated any ethical risks that arise during this project and adhere to applicable ethical standards.

In establishing the ethical philosophy for this research, I have considered both the Deontological stance and the Teleological (Utilitarian) stances. The Deontological stance considers the intent of the action, whether the action is rule-based, whether it fits the moral norms. Conversely, the Teleological (Utilitarian) stance considers the consequences of the action, whether the aggregated good exceeds the aggregated loss. Similarly, Kant (1724–1804), in discussing both Categorical Imperatives, i.e., those acts that are morally good in and of themselves and the Hypothetical Imperatives, i.e., those that are good at achieving an effective consequence; the latter do not consider the moral or virtuous ‘goodness’ in this definition. Having reviewed this position, I argue that, whether it is the Deontological stance vs the Teleological stance, or the Categorical Imperatives vs the Hypothetical Imperatives, there are two potential spectra of subjective assessments.

Taking positions at the extremes of either spectrum might be difficult, hence this research takes a more pragmatic view, which is in line with the research philosophy. I will adopt a position that is closer to the Deontological stance undertaking research activity that will reflect the

Categorical Imperative but will seek to understand elements from the opposing views. I see acts as good and duty-bound in and of themselves, but as the motivation for this research is societal improvement through the minimisation of '*Novelty*' then I recognise that the aggregated results of the research will have some costs. In approaching this research, I undertook a review of relevant ethical frameworks to find the themes or areas of attention, that might be in common; these common features are consistent with the above Ethical Position.

The Economic and Social Research Council has established the Framework for Research Ethics (FRE), the aim of which is to "set out good practice for social science research, detailing our principles and expectations from researchers, research organisations (ROs) and research ethics committees (RECs)" (ESRC, 2015). The framework sets out six core principles, as follows:

1) Research should aim to maximise the benefit for individuals and society and minimise risk and harm;
2) The rights and dignity of individuals and groups should be respected;
3) Wherever possible, participation should be voluntary and appropriately informed;
4) Research should be conducted with integrity and transparency;
5) Lines of responsibility and accountability should be clearly defined;
6) Independence of research should be maintained and where conflicts of interest cannot be avoided, they should be made explicit.

The University of Derby requires all students, who are undertaking post-graduate research complete a document entitled '[R]equest for ethical approval for research undertaken by staff, post-graduate research and post-graduate professional students. This document required that those undertaking research show how they intend to address the following areas (where relevant):

- Consent
- Deception
- Debriefing
- Withdrawal from the investigation
- Confidentiality
- Protection of participants
- Observation research
- Giving advice
- Research undertaken in public places
- Data protection
- Animal Rights
- Environmental protection

Within the Ministry of Defence, there is a strict procedure that applies to human research. In general terms, the guidance states that if the research involves anonymous input, ethical approval is not required (Linton, 2008, p.44). In all instances, adherence to MOD JSP (Joint Services Publication) 536: Ethical conduct and scrutiny in MoD research involving human participants is required by researchers and the relevant section within this document Section 7. Scope directs the procedure applies to all research in which the research:

1) Conducts research on human participants, including (but not limited to) administering substances, taking blood or urine samples, removing biological tissue, radiological investigations, or obtaining responses to an imposed stress or experimental situation.
2) Conducts research to collect data on an identifiable individual, either directly (such as by focus groups or interviews) or indirectly (such as by questionnaire or observation).
3) For the purpose of research, uses non-public domain records and papers that contain information that is private or personal and could identify an individual (or group of people) or has the potential to cause harm.

As these conditions do not apply to this research project, it follows that I do not require approval for this project, and I have agreed to this with the research sponsor. Key to this decision is the anonymous nature of the data collected throughout the research itself. I submitted the required 'Request for ethical approval for research undertaken by staff, post-graduate research and post-graduate professional students' and after receiving approval I would attest to my deep commitment to the principles behind this undertaking. Chief among this consideration is the prevention of harm to those involved in this study and to balance adherence to both deontological and utilitarian ethical stances.

CHAPTER 7 ~ METHOD AND RESULTS

The purpose of this chapter is to provide an exposition of the process I undertook to gather the data. I will then present the data collected through the study and will follow this with an analysis of this data. I will then draw conclusions and present the final summary of the research study.

7.1 Data Collection

Data collection took place over a three-month period; as this occurred over several national and organisational holidays this led to extend follow up activity which exceeded the planned timescale. The pre-study engagement led to high and sustained interest from the panel in general; however certain panel members required significant support that added to the time pressures. In this section I explicate the processes for data collection across each of the three survey rounds, I set out the research artefacts and then provide the findings from each study and how they informed the subsequent rounds.

7.1.1 Data Analysis – Delphi Round 1

In this opening round, I sent the following documents to the panel members:

a) Ethical Approval briefing and consent letter. All panel members are required to both read and sign this document which provides a briefing of the research and information relating to privacy and withdrawal from the exercise (see Appendix 11.4).

b) *CSN* Panel Member Information Pack – Component 1. I developed this component as an introduction to the present programme for those who took part in the early elements of the programme. It evolved over time to its present state and provided an overview to panel members (see Appendix 11.5).

c) *CSN* Panel Member Information Pack – Component 2. I developed this component to provide a composite of the Areas of Knowledge Capsules and the 16 Characteristics (Appendix 11.6).

d) Delphi Panel Round 1 Instrument. This is the first of three data collection instruments (Appendix 11.7). The research is looking for consensus on two themes; first, on the **validity** of the model and second the **applicability** of the model.

e) The return rate for Round 1 was 83.3% with 2 participants withdrawing for health reasons and 2 withdrawing for confidentiality reasons. I recruited two members from a reserve list in order to ensure the aspirational minimum of 10 participants

f) Table 16 lists the 52 individual responses generated by the panel of experts for Round 1 that relate to the 'Validity of the Conceptual Framework'. The frequency for all responses is 1 as none were duplicated, which is arguably due to the long-form qualitative responses.

Table 16 Delphi I Responses Relating to the 'Validity of the Conceptual Framework'

INDIVIDUAL RESPONSES
Whilst emergent issues may lead to novel risk events, the impact of a risk on an organisation consists of a relatively bounded, and therefore known, set of variables. It would be helpful to clarify the interaction between the unknown elements of the risk (nature of event, likelihood etc) and the known or bounded elements of the risk (impact on organisation).
This model would be suitable for assessing/ planning for a subset of risks relevant to defence and security organisations. It would be helpful to provide specific details of the types of risk this approach is most suitable for assessing – potentially with worked examples – to clarify the purpose of the model.
The current model may create a tendency to over-analysis and unnecessary complexity. It would be helpful to incorporate a clear iterative approach to assessment to ensure that the method allows early development of outputs and focuses on delivering the right level of analysis to answer the exam question.
As a project manager, existing risk management tools are reductionist. They do not acknowledge the complex environment in which we work, or our individual biases that impact our ability to foresee, plan for and address risk. This model allows for a more mature approach to risk management that is based on an understanding of the real world.
Existing project management tools often consider risk through a single lens – how to understand it, unknown risk, how to respond. This model allows risk to be viewed through the four lenses, enabling space for constructive tension, and therefore a more coherent view of risk.
Currently, in government security, traditional risk management tools are used to identify and counter risk. These are not sophisticated enough given the systemic threats we face and the global threat actor base. This tool would allow security staff to consider risk in a way that acknowledges the inherent uncertainty of the context.

INDIVIDUAL RESPONSES
We currently do not consider the management of unknown threats, so this would be a useful too. We are clearly missing risks.
We use an organisational template for programme risk management, this does not view threats as complex, it is viewed as an administrative task.
Our consideration of unknown threats is immature at a corporate level, the model would be useful to challenges the limits of assumptions.
For us the scope of the Model's use would need to be bounded to either focus on areas where we may seek to help ministers set policy OR in relation to threats to internal process/governance.
The model would likely raise all sorts of questions which we are not yet mature enough to answer. Functional Leadership's implementation, to comply with Cabinet Office frameworks, may itself not be mature enough to allow/expect functions to think outside of the box while they are still trying to define and focus on what is manageable.
The non-linearity point is really interesting, probably obvious, and also challenging to many of our response plans – if these are the symptoms these are our responses.
A recent TLB workshop identified the need to challenge their world view and truisms regarding the 'linearity' of development expectations and the requests that will be made on them.
In an annual planning exercise this could be used to consider the connections and dependencies of systems/functions and the changes they are introducing in the context of possible external change.
We use the same template for enterprise-level and project/programme risk management. This does not view threats as complex and is a more "routine" task and reactive.
We are . . .beginning to consider and the complexity of dependencies and their impact on risk as we implement portfolio management. To do this we are beginning to distinguish between the risks relating to the individual components or projects and the interaction between component risks which can lead to the emergence of one or more overall risk at the portfolio-level.
This model needs to augment and supplement existing processes.
I agree that a systems philosophy is needed.
Ideas from Taleb's "Black Swan" and "Antifragile" may help.

INDIVIDUAL RESPONSES
Our thinking is. . . immature. For proposed new projects, a portfolio risk assessment will be used to determine whether the authorisation of a particular project would raise the overall portfolio risk to a level unacceptable to the business.
Risk is treated as a linear process. Although there is organisational encouragement to take a holistic view the need to follow a process and complete set artefacts to ensure compliance and business case approval remove any opportunity to take a helicopter view of the business context and therefore potential wider risks.
The concept demonstrates that an individual does not need to be a deep expert in the area to build the knowledge of understanding. In fact, the inference is that this would be a bad thing hence, the fact that people can build, develop and be trained is a valid approach.
Issues are simple – they have occurred. Risks are complex. The way that we are 'taught' to manage them over simplifies risk management and as a result the true sources of risk are not treated. This framework acknowledges this and tries to get at the root cause
Approvals dominate our risk approach – this needs to stop. Finance is often an excuse not a root cause or an impact of bad risk management
P3M and MoR governance highlight the need for ownership. This concept is more about an individual's responsibility to think and reflect – which should be commended
Concur with examples!!!
Our organisation would first need to address the lack of good risk management undertaken and ensure it is carried out with purpose, not just an administrative task, before it could adopt such a framework.
The logic of the framework is sound. I find that individuals who work in the strategic space understand complex risk easier as they naturally think holistically. Individuals with a more siloed thinking may struggle with this.
In our organisation individuals are almost encouraged into silo thinking through the requirement to review and manage risks in only their business area. Adopting this framework would challenge that way of working and improve the management of organisational risk.
Root cause analysis is seldom (if ever) used during risk management within our organisation. The result being poor or incorrect mitigation and subsequent risks. This framework could address this issue.

INDIVIDUAL RESPONSES
Ability to understand and identify emergent risks, coupled with an unwillingness to implement mitigating actions due to "risk to operations", is the cause of prolific fire fighting in our organisation. This framework could address this issue.
A cynics view; no matter how sound the framework is, when it comes to risk, there is always an unknown unknown!
A lot of what is discussed relates to experience and instinct and ensuring that this is captured and acted upon
Root causes of risks and issues are often buried deep in the organisation, not sure how this can be addressed at project/programme level.
The conceptual validity of the model from a practitioner perspective appears sound. It addresses absence of thinking and identifies several gaps that are found in often rigid Programme management models; which are often used as a bible; and stifle creative and broader thinking regarding Threat
If a PM 'Bible' is to be used; often the default position with more rigid and structured organisations; specifically, by less experienced narrow view senior managers who direct an approach; this model provides for many more factors impacting several Projects or Programmes and therefore its validity becomes solid in this respect. By its application the use of the model could reduce the risk from Threat,
The model opens broader consideration of Threat Management and how it integrates in to the 'Risk assessment' umbrella. Threat; is often confused solely with Risk management in some current organisational thinking. This model examines, explores and articulates the broader thinking that could be orchestrated and applied using this model.
The model clearly identifies tools for Threat assessment and management in some organisational thinking is identified but not linked to broader elements of their management of Programmes.
This model embraces a 'Chaos' type theory application and allows management for any outcomes from any number of known and unknown inputs
There is no activity including training to identify unknown threats or to even recognise the potential of this. Heightened awareness across organisations would be hugely beneficial.
There is no mechanism at any level to share lessons learnt in the context of errors and subsequent consequences. There are consequences to admitting failure which may prevent Perhaps as a consequence of fear of admitting failure

INDIVIDUAL RESPONSES
The definition of risk management is sometimes, narrow. Risks taking into account the wider external environment is not
Issue management is presented with simple mitigation and viewed as being managed or mitigated against – viewed as a low level PMO function Greater multi-displinary challenge undertaken in an open environment
In the IT project management space, risks are managed within the confines of the platform only there would be benefits to having wider, constructive debate that facilitates improved learning. Benefiting local PMs and at a corporate IT level
In my experience in a fast-paced IT project management environment MoR is not treated as a priority. Risks are captured ad-hoc and not actively managed or appropriately escalated, resulting in a reactive response when it becomes an issue.
The risk management tool used by our organisation focusses on capturing and monitoring risks and issues. It does not consider wider dependencies between projects/programmes/portfolios.
Our current risk management approach tends to only include input from project team members (PM, Project Board members etc). With greater organisational focus on MoR risks could be identified by individuals across the business, reducing the likelihood of risks being missed.

I reviewed the 47 responses relating to the 'Validity of the Conceptual Framework' *(*shown above) through an Open Coding exercise (Affinity Analysis) to establish a set of 'Collated Statements'. Following this analysis, I evaluated the responses and 71 individual references were catalogued against the 'collated statements'; the results are shown in Table 17. It was possible to infer worth more than a single collated statement from each source statement given the breadth and number of responses.

Table 17 Collated Statements following Open Coding / Affinity Analysis

CS	COLLATED STATEMENTS – VALIDITY		
1	The model is valid as it 'Identifies Limitations in Current Practices', e.g., risk management, programme management and budget setting.	23	32.4

CS	COLLATED STATEMENTS – VALIDITY		
2	The model is valid as it 'Improves Current Limited Practices', e.g., risk management, programme management and budget setting.	16	22.5
6	The model is valid as it 'Evolves Current Direction' in this general area.	7	9.9
9	The model is valid as it 'Adds Credibility with Academic Underpinnings'.	7	9.9
10	The model is valid as it can be used in a 'Targeted Intervention'.	6	8.5
11	The model is valid as it can 'Develop People/Groups' to improve organisational performance.	4	5.6
12	The model is valid as it can 'Develop Specialists' this will improve organisational performance.	2	2.8
13	The model is valid as it could be a 'Development Programme'.	2	2.8
3	The model is valid as it highlights the 'Immaturity of Current Systems'.	1	1.4
4	The model is valid as it highlights a limiting 'Lack of Knowledge of *Novelty* as Risk' in the operating environment.	1	1.4
5	The model is valid as it highlights a limiting 'Lack of Knowledge of Emergence/Non-Linearity' in the operating environment.	1	1.4
7	The model is valid as it highlights a limiting 'Lack of Knowledge of Understanding' in the operating environment.	1	1.4
8	The model is valid as it avoids over analysing and has a clear methodology and approach	0	0.0
14	The model is valid as it uses clear and accessible language and terminology	0	0.0
	Sum of all counts relating to Validity of the Collated Statements	71	

Table 18 lists the individual responses generated by the Delphi Panel of Experts for Round 1 that relate to the '*Applicability of the Conceptual Framework*'. The frequency for all responses is 1 as none were duplicated, which is arguably due to the long-form qualitative responses.

Table 18 Delphi I Responses Relating to the 'Applicability of the Conceptual Framework'

INDIVIDUAL RESPONSES
Many government organisations have an immature approach to risk management, and do not currently plan effectively for non-novel risk scenarios. For these types of organisations, focusing effort on improving basic risk management will have a much greater impact on risk mitigation than attempting to apply this methodology to identify and plan for novel risks. If this methodology is to be valuable it should be targeted at organisations/ problem spaces with mature risk management already in place.
The approach will require specific practical advice on application – there is currently much assumed knowledge within the framework (eg definition of methodologies) and this will require further explanation and clarification.
This should be part of the Major Project Leadership Academy. It would build on the existing models on systems thinking and risk management.
This should be part of the Project Leadership Programme. It would be a useful module to add following the simulation exercise to consider how our own biases affect our approach to work and how novelty can challenge our attempt to control the environment around us.
This could be used to support Security Advisers and the Government Security Function develop a coherent approach to risk management across government. It would allow us to move away from reductionist Management of Risk style registers to a more mature conversation at board level.
This could be applied to discrete groups of people, or those deployed in Intervention Teams / Project Pre-mortem Review Teams.
This model could be used to develop junior/middle project managers as an internal qualification.
This could be applied to capability planning assumptions.
This could be very usefully applied to project review and investment appraisal teams.
This is already being applied, I believe, to a certain degree in war-gaming, but it could challenge the assumptions and stress test outcomes to prevent more linear response doctrine being developed.
In an annual planning exercise this could be used to consider the connections and dependencies of systems/functions and the changes they are introducing in the context of possible external change.

INDIVIDUAL RESPONSES
Models are an aid for decision-making but not a replacement for it. Their use requires a thorough understanding of the mechanics and assumptions underpinning them.
This model could be piloted with discrete groups of people, possibly as part of a project closure exercise, to "test" the benefit but I am not sure that our level of understanding is sufficiently mature. Training and guidance would be needed.
The language used to describe the model would need to be simplified into "plain English".
Alternatively, could it be translated into a methodology which allows the idea to be implemented successfully by people who may not need to understand the nuances of the concept?
In terms of enabling better/earlier policy setting to respond to or understand emergent threats to national resilience I am challenged by a perception that significant policies are only set after there is either sufficient public interest or evidence - which would possibly suggest that the novelty is less new and better recognised but that the responses are not developed. The model would hopefully add credibility and help small teams justify their earlier recognition and suggestions of prospective policy setting.
Incentives to broaden thinking and change behaviours have not been covered. Hence, in organisations where linear thinking is the norm what are the incentivise or punishments to ensure better knowledge of the four areas
Interestingly there is no mention of the risk to the delivery of benefits. For P3M this is the sole focus of risk and risk management. I wonder whether this is a model more focused on BaU, incremental change or indeed strategy development, scenario planning rather than Transformational change
Is this something that everyone can learn or will certain personality types be more comfortable with the certain knowledge areas.
How does strategic misrepresentation, delusion or deception effect the individual more so if this is the prevailing direction from the wider team/group/organisation
While my organisation has some detailed understanding of the certain elements of AoK i.e. the use of pre-mortems and scenario planning. The fact that these tools need to be brought together to ensure that the richness of the risk is identified and used correctly makes this a potential difficult concept to apply

INDIVIDUAL RESPONSES
I am aware of some of these approach causal loops, relational thinking, systems thinking, critical thinking how easy it is for someone to have both the academic theory and the pragmatic outlook to leverage the CESN?
If an individual displays good knowledge across the four areas and hence risk is better managed. How do they get rewarded? Reward goes to those who fire fight. So why should they maintain that way of thinking?
By over reflecting we can create our own 'Gordian' knot how can we break this thinking down into manageable chunks.
What does good look like – how can you measure the success of this concept?
Risk agenda are often set by those who are looking at the tactical impacts of risk. Senior officials or programme directors do not have the time to reflect and bring together the strategic context to identify the contextual threat
This framework would be a good tool to use at Portfolio, Programme and, to a degree, Project level. The practical application though would need to be decided. To cover all elements, surely a group approach would ensure better success.
Would need to get the support and buy-in from the major Project management institutes for it to be widely adopted and embedded into the culture.
Should be used at during the early stages of the concept phase of any major programme or when designing new operating models for organisations
I had difficulty in understanding some of the language, which could be a limiting factor if the intension is to roll out to a wider audience
The model as a Theoretical application would suit Middle and Senior Managers working in complex Programme environments
The model applicability appears more suited to senior managers and leaders. Embracing and leading using this model would allow them to structure their Teams and Organisation to fully embrace the forward thinking and rounded principles the model extolls.
MOD and Government Departments structure would need to change to allow application to be a realistic proposition
The principles of the model while distinct have linkage to Project Management Principles such as Agile; and Enterprise Architecture theory. It is in the differentiation of these models, and the overlap of concepts that the complexity and challenge may be seen

INDIVIDUAL RESPONSES
The practical application of the model by junior and middle managers working in environments where modern and more novel Programme Management thinking is challenged would be a 'Threat' given the limited evidence available to support its use.
The principle of the model is complex. Theoretical understanding by middle and junior Project and Programme Delivery Teams would in my opinion be difficult to achieve, as a standard delivery training package. Assessment of the broader more creative thinking of candidates who otherwise would meet the course standard would possibly be required
This approach should be compulsory on entry to the workplace adapted in accordance with exposure to risk/issue management as required by the job holders role
The pan-government approach to risk/issue management would benefit from a re-work using this model
I can see value when applied at the programme and portfolio level. But value achieved when senior executives action and follow through
The model could provide teams with a broader view of how their work fits in with wider programmes and initiatives, rather than narrowly focussing on their own projects.
The model could facilitate wider lessons learned and reduce the element of the unknown for projects.
The model would require significant buy-in 'from the top down' to encourage and empower teams to address MoR as a priority, not just an administrative task, as well as taking a more holistic view.

I reviewed the 42 responses relating to the 'Applicability of the Conceptual Framework' shown above through an Open Coding exercise (Affinity Analysis) to establish a set of 'collated statements'. Following this analysis, I evaluated the responses and 56 individual references were recorded against the collated statements, these are shown in Table 19. It was possible to infer worth more than a single collated statement from each source statement given the breadth of a number of responses.

Table 19 Collated Statements following Open Coding / Affinity Analysis

2	The model is applicable as it 'Improves Current Limited Practices', e.g., risk management, programme management and budget setting.	12	21.4
6	The model is applicable as it can 'Develop People/Groups' to improve organisational performance.	11	19.6
5	The model is applicable as it can be used in a 'Targeted Intervention'.	5	8.9
7	The model is applicable as it could be a 'Development Programme'.	5	8.9
1	The model is applicable as it 'Identifies Limitations in Current Practices', e.g., risk management, programme management and budget setting.	4	7.1
3	The model is applicable as it 'Evolves Current Direction' in this general area.	4	7.1
8	The model is applicable as it can 'Develop Specialists' this will improve organisational performance.	4	7.1
4	The model is applicable as it 'Adds Credibility with Academic Underpinnings'.	3	5.4
11	The model is applicable as it highlights a limiting 'Lack of Knowledge of Understanding' in the operating environment.	3	5.4
13	The model is applicable as it uses clear and accessible language and terminology	3	5.4
9	The model is applicable as it highlights the 'Immaturity of Current Systems'.	1	1.8
10	The model is applicable as it highlights a limiting 'Lack of Knowledge of Emergence/Non-Linearity' in the operating environment.	1	1.8
12	The model is applicable as it highlights a limiting 'Lack of Knowledge of *Novelty* as Risk' in the operating environment.	0	0.0
14	The model is applicable as it avoids over analysing and has a clear methodology and approach	0	0.0
	Sum of all counts relating to Applicability of the Collated Statements	56	

In total, across both Validity and Applicability (of the Conceptual Framework), 90 responses were received and catalogued as 127 'Collated Statements'.

7.1.2 Data Analysis – Delphi Round 2

The results of Round 1 were used to form the 'Round 2 Instrument' (see Appendix 11.8) and circulated to the participants who were asked to rate each of the collated statements using the following scale: from 1 to indicate strong disagreement through 9 to indicate strong agreement. In this section, I provide an analysis of the results of Round 2 for both the Validity and Applicability of the Conceptual Framework. I present this information from two 'Thesis Indicators'; TI-1 refers to the tendency toward agreement or disagreement (denoted by scoring higher or lower on the Likert Scale) and TI-1 refers to the level of consensus as defined by the Inter-quartile range score (IQR).

7.1.2.1 Collated Statement Analysis – Validity

The following analysis provide a summary of the findings of Round 2 for the Collated Validity Statements; a full set of supporting box and whisper charts, together with individual observations are shown in Appendix 11.9.

7.1.2.1.1 Thesis Indicator 1 – Thesis Indicator 1 – Agreement Tendency

Before commenting on the degree of consensus, I refer to the additional measure of Agreement Tendency of the 140 (100%) individual responses, i.e., scores for discrete statements, for which the results demonstrated **97 (69%)** of the Collated Applicability Statements showing a 'High Agreement Tendency, i.e., Group Mean Scores of greater than 6.75. A further **29 (21%)** as showing an 'Agreement Tendency, i.e., Group Mean Scores of between 4.5 and 6.75. A total of **12 (9%)** achieved group mean scores of between 2.25 and 4.5 demonstrating a 'Disagreement Tendency, and finally **2 (1%)** demonstrated 'High Disagreement Tendency'.

7.1.2.1.2 Thesis Indicator 2 – Degree of Consensus

In line with the established definitions of consensus established earlier (see Chapter 7.2), the results of Round 2 (Table 19) demonstrated **6 (43%)** of the 14 Collated Applicability Statements reached consensus (IQR <=1.0), **7 (50%)** reached strong agreement (IQR >1.0 and <=2.0), **1 (7%)** reached weak agreement (IQR >2.0 and <=3.0) and **0 (0%)** demonstrated no agreement (IQR >3.0). The tabulated results are fully set down in Table 20[29].

[29] It is worth noting that from the early stages, that 'developmental' statements 6, 7 & 8 appear to be reporting similar values in aggregation. While the individual scores vary somewhat, and the underlying source statements

Table 20 Analysis of Collated 'Validity' Statements in Delphi Round 2

CS	COLLATED STATEMENT - VALIDITY	Min	Max	Mean	Med	St Dev	IQR
1	The model is valid as it 'Identifies Limitations in Current Practices', e.g., risk management, programme management and budget setting.	**6**	**9**	**8**	**8**	1.2	1.9
2	The model is valid as it 'Improves Current Limited Practices', e.g., risk management, programme management and budget setting.	**7**	**9**	**8**	**8**	0.7	**1.0**
3	The model is valid as it 'Evolves Current Direction' in this general area.	**7**	**9**	**8**	7	0.8	**1.0**
4	The model is valid as it 'Adds Credibility with Academic Underpinnings'.	4	**9**	7	7	1.6	**1.0**
5	The model is valid as it can be used in a 'Targeted Intervention'.	**5**	**9**	7	7	1.2	1.5
6	The model is valid as it can 'Develop People/Groups' to improve organisational performance.	**5**	**9**	7	7	1.3	1.8
7	The model is valid as it could be a 'Development Programme'.	**5**	**9**	7	7	1.4	1.8
8	The model is valid as it can 'Develop Specialists' this will improve organisational performance.	**6**	**9**	7	7	1.1	**1.0**
9	The model is valid as it highlights the 'Immaturity of Current Systems'.	4	**9**	7	**8**	1.5	**1.0**
10	The model is valid as it highlights a limiting 'Lack of Knowledge of Emergence/Non-Linearity' in the operating environment.	4	**9**	7	**8**	1.8	1.8
11	The model is valid as it highlights a limiting 'Lack of Knowledge of Understanding' in the operating environment.	4	**9**	7	7	1.6	**1.0**
12	The model is valid as it highlights a limiting 'Lack of Knowledge of Novelty as Risk' in the operating environment.	4	**9**	7	7	1.8	2.5
13	The model is valid as it uses clear and accessible language and terminology	1	7	4	**5**	1.8	1.8
14	The model is valid as it avoids over analysing and has a clear methodology and approach	3	**8**	**6**	**6**	1.4	1.8

7.1.2.2 Collated Statement Analysis – Applicability

The following analysis provides a summary of the findings of Round 2 for the Collated Applicability Statements; a full set of supporting box and whisper charts, together with individual observations are shown in Appendix 11.10.

7.1.2.2.1 Thesis Indicator 1 – Agreement Tendency

Before commenting on the degree of consensus, I refer to the additional measure of Agreement Tendency of the 140 (100%) individual responses, i.e., scores for discrete statements, the results demonstrated **95 (68%)** of the Collated Applicability Statements showing a 'High Agreement Tendency, i.e., Group Mean Scores of greater than 6.75. A further **30 (21%)** as showing an 'Agreement Tendency, i.e., Group Mean Scores of between 4.5 and 6.75. A total

also vary, it is possible that respondents are viewing the statements as similar and allocating proximal scores. I do not believe that this lessens the findings as all three scores attest to the validity and applicability of CSN as a development tool.

of **11 (8%)** achieved group mean scores of between 2.25 and 4.5 demonstrating a 'Disagreement Tendency, and finally **4 (3%)** demonstrated 'High Disagreement Tendency'.

7.1.2.2.2 Thesis Indicator 2 – Degree of Consensus

In line with the established definitions of consensus established earlier (see Chapter 7.2), the results of Round 2 (Table 19) demonstrated **6 (43%)** of the Collated Applicability Statements reached consensus (IQR <=1.0), **5 (36%)** reached strong agreement (IQR >1.0 and <=2.0), **3 (21%)** reached weak agreement (IQR >2.0 and <=3.0) and **0 (0%)** demonstrated no agreement (IQR >3.0). The tabulated results are fully set down in Table 21.

Table 21 Analysis of Collated 'Applicability' Statements in Delphi Round 2

CS	COLLATED STATEMENT - APPLICABILITY	Min	Max	Mean	Med	St Dev	IQR
1	The model is applicable as it 'Identifies Limitations in Current Practices', e.g., risk management, programme management and budget setting.	**6**	**9**	**8**	**9**	1.4	2.8
2	The model is applicable as it 'Improves Current Limited Practices', e.g., risk management, programme management and budget setting.	**5**	**9**	7	7	1.0	**0.8**
3	The model is applicable as it 'Evolves Current Direction' in this general area.	**5**	**8**	7	**8**	1.1	**1.0**
4	The model is applicable as it 'Adds Credibility with Academic Underpinnings'.	3	**9**	**6**	7	2.2	3.0
5	The model is applicable as it can be used in a 'Targeted Intervention'.	**6**	**8**	7	7	1.4	**0.8**
6	The model is applicable as it can 'Develop People/Groups' to improve organisational performance.	**5**	**9**	7	7	1.1	**0.8**
7	The model is applicable as it could be a 'Development Programme'.	**6**	**9**	**8**	7	1.0	**1.0**
8	The model is applicable as it can 'Develop Specialists' this will improve organisational performance.	**6**	**9**	**8**	7	1.1	1.8
9	The model is applicable as it highlights the 'Immaturity of Current Systems'.	3	**9**	7	**8**	1.8	2.0
10	The model is applicable as it highlights a limiting 'Lack of Knowledge of Emergence/Non-Linearity' in the operating environment.	4	**8**	7	7	1.3	1.5
11	The model is applicable as it highlights a limiting 'Lack of Knowledge of Understanding' in the operating environment.	4	**8**	7	7	1.3	1.5
12	The model is applicable as it highlights a limiting 'Lack of Knowledge of Novelty as Risk' in the operating environment.	4	**8**	7	7	1.3	**1.0**
13	The model is applicable as it uses clear and accessible language and terminology	1	**6**	4	5	1.7	2.0
14	The model is applicable as it avoids over analysing and has a clear methodology and approach	2	7	**5**	**6**	2.0	2.8

7.1.3 Data Analysis – Delphi Round 3

The results of Round 1 were used to form the 'Round 2 Instrument' (see Appendix 11.11) and circulated to the participants who were asked to rate each of the collated statements using the following scale: from 1 to indicate strong disagreement through 9 to indicate strong agreement. In this section, I provide an analysis of the results of Round 2 for both the Validity and

Applicability of the Conceptual Framework. I present this information from two 'Thesis Indicators'; first, on the tendency toward agreement or disagreement and second the level of consensus on the discrete ratings.

7.1.3.1 Collated Statement Analysis – Validity

The following analysis provides a summary of the findings of Round 3 for the Collated Validity Statements.

7.1.3.1.1Thesis Indicator 1 – Agreement Tendency

Of the 140 (100%) individual responses, i.e., scores for discrete statements, the results demonstrated **101 (72%)** of the Collated Validity Statements showing a 'High Agreement Tendency, i.e., Group Mean Scores of greater than 6.75. A further **26 (19%)** as showing an 'Agreement Tendency, i.e., Group Mean Scores of between 4.5 and 6.75. A total of **11 (8%)** achieved group mean scores of between 2.25 and 4.5 demonstrating a 'Disagreement Tendency, and finally **2 (1%)** demonstrated 'High Disagreement Tendency'.

7.1.3.1.2 Thesis Indicator 2 – Degree of Consensus

In line with the established definitions of consensus established earlier (see Chapter 7.2), the results of Round 3 (Table 21) demonstrated **12 (86%)** of the Collated Validity Statements reached consensus (IQR <=1.0), **2 (14%)** reached strong agreement (IQR >1.0 and <=2.0), **0 (0%)** reached weak agreement (IQR >2.0 and <=3.0) and **0 (0%)** demonstrated no agreement (IQR >3.0). These tabulated results are fully set down in Table 22.

7.1.3.2 Collated Statement Analysis – Applicability

The following analysis provides a summary of the findings of Round 3 for the Collated Applicability Statements.

7.1.3.2.1 Thesis Indicator 1 – Agreement Tendency

The results demonstrated **98 (70%)** of the Collated Applicability Statements showing a 'High Agreement Tendency, i.e., Group Mean Scores of greater than 6.75. A further **31 (22%)** as showing an 'Agreement Tendency, i.e., Group Mean Scores of between 4.5 and 6.75. A total of **8 (2%)** achieved group mean scores of between 2.25 and 4.5 demonstrating a 'Disagreement Tendency, and finally **3 (1%)** demonstrated 'High Disagreement Tendency'.

Table 22 Analysis of Collated 'Validity' Statements in Delphi Round 3

CS	COLLATED STATEMENT - VALIDITY	Min	Max	Mean	Med	St Dev	IQR
1	*The model is valid as it 'Identifies Limitations in Current Practices', e.g., risk management, programme management and budget setting.*	**6**	**9**	**8**	**8**	0.8	**0.8**
2	*The model is valid as it 'Improves Current Limited Practices', e.g., risk management, programme management and budget setting.*	**7**	**9**	**8**	**8**	0.7	**1.0**
3	*The model is valid as it 'Evolves Current Direction' in this general area.*	**7**	**9**	**8**	7	0.8	**1.0**
4	*The model is valid as it 'Adds Credibility with Academic Underpinnings'.*	4	**9**	7	7	1.6	**1.0**
5	*The model is valid as it can be used in a 'Targeted Intervention'.*	**6**	**8**	7	7	0.7	**0.0**
6	*The model is valid as it can 'Develop People/Groups' to improve organisational performance.*	**5**	**8**	7	7	0.9	**0.8**
7	*The model is valid as it could be a 'Development Programme'.*	**6**	**8**	7	7	0.8	**1.0**
8	*The model is valid as it can 'Develop Specialists' this will improve organisational performance.*	**6**	**9**	7	7	1.1	**1.0**
9	*The model is valid as it highlights the 'Immaturity of Current Systems'.*	4	**9**	7	**8**	1.5	**1.0**
10	*The model is valid as it highlights a limiting 'Lack of Knowledge of Emergence/Non-Linearity' in the operating environment.*	4	**9**	7	**8**	1.4	1.8
11	*The model is valid as it highlights a limiting 'Lack of Knowledge of Understanding' in the operating environment.*	4	**9**	7	7	1.6	**1.0**
12	*The model is valid as it highlights a limiting 'Lack of Knowledge of Novelty as Risk' in the operating environment.*	**6**	**9**	7	7	0.9	**0.8**
13	*The model is valid as it uses clear and accessible language and terminology*	1	7	4	4	1.8	1.5
14	*The model is valid as it avoids over analysing and has a clear methodology and approach*	3	7	**6**	**6**	1.2	**0.8**

7.1.3.2.2 Thesis Indicator 2 – Degree of Consensus

In line with the established definitions of consensus established earlier (see Chapter 7.2), the results of Round 2 (Table 21) demonstrated **11 (79%)** of the Collated Applicability Statements reached consensus (IQR <=1.0), **3 (21%)** reached strong agreement (IQR >1.0 and <=2.0), **0 (0%)** reached weak agreement (IQR >2.0 and <=3.0) and **0 (0%)** demonstrated no agreement (IQR >3.0). These tabulated results are fully set down in Table 23.

Table 23 Analysis of Collated 'Applicability' Statements in Delphi Round 3

CS	COLLATED STATEMENT - APPLCABILITY	Min	Max	Mean	Med	St Dev	IQR
1	The model is applicable as it 'Identifies Limitations in Current Practices', e.g., risk management, programme management and budget setting.	***6***	***9***	***8***	***8***	*0.9*	***0.0***
2	The model is applicable as it 'Improves Current Limited Practices', e.g., risk management, programme management and budget setting.	***5***	***9***	*7*	*7*	*1.0*	***0.8***
3	The model is applicable as it 'Evolves Current Direction' in this general area.	***5***	***8***	*7*	***8***	*1.1*	***1.0***
4	The model is applicable as it 'Adds Credibility with Academic Underpinnings'.	*4*	***9***	*7*	*7*	*1.5*	*1.8*
5	The model is applicable as it can be used in a 'Targeted Intervention'.	***6***	***8***	*7*	*7*	*0.9*	***0.8***
6	The model is applicable as it can 'Develop People/Groups' to improve organisational performance.	***5***	***9***	*7*	*7*	*1.1*	***0.8***
7	The model is applicable as it could be a 'Development Programme'.	***6***	***9***	***8***	*7*	*1.0*	***1.0***
8	The model is applicable as it can 'Develop Specialists' this will improve organisational performance.	***6***	***9***	***8***	***8***	*0.8*	***0.8***
9	The model is applicable as it highlights the 'Immaturity of Current Systems'.	***5***	***8***	*7*	*7*	*0.9*	***0.8***
10	The model is applicable as it highlights a limiting 'Lack of Knowledge of Emergence/Non-Linearity' in the operating environment.	***6***	***8***	*7*	*7*	*0.6*	***0.0***
11	The model is applicable as it highlights a limiting 'Lack of Knowledge of Understanding' in the operating environment.	***6***	***8***	*7*	*7*	*0.7*	***0.0***
12	The model is applicable as it highlights a limiting 'Lack of Knowledge of Novelty as Risk' in the operating environment.	*4*	***8***	*7*	*7*	*1.3*	***1.0***
13	The model is applicable as it uses clear and accessible language and terminology	*1*	***6***	*4*	*4*	*1.5*	*1.8*
14	The model is applicable as it avoids over analysing and has a clear methodology and approach	*2*	*7*	***5***	***5***	*1.6*	*1.8*

7.2 Themes Identified from the Data

In this section, I review the information arising from the data analysis, specifically I am looking to see if the results support the Validity and Applicability of the Conceptual Framework, which is the 3rd objective of this Practitioner Project. Should this be the case, then I will adjudge that I have achieved all the objectives and fulfilled the overall aim of this study.

7.2.1 Analysis of Delphi Round 1

In Delphi Round 1, I was able to collect a total of 90 *'Source Statements'* in relation to the Validity and Applicability of the Conceptual Framework (in countering *Novelty* in the Problem Space). Once I had recorded the statements, I then carried out an Open Coding / Affinity Analysis of these submissions and this in the identification of 14 'Collated Statements' (this is abbreviated as CS when I refer to individual statements) from the 129 catalogued responses. Once I had concluded this exercise, I grouped these source statements, for both Validity and Applicability, into the 'Collated Statements' to determine the usage frequency. It is worth noting that due to the fullness of some of the responses it was not unusual to allocate a source statement into two collated statements; the result of this cataloguing is as follows:

- 6 of 90 (0.66%) responses catalogued against 0 Collated Statements
- 84 of 90 (93.33%) responses catalogued against 1 Collated Statements
- 45 of 90 (50.00%) responses catalogued against 2 Collated Statements

Even at this early stage, I was able to draw a preliminary inference on the validity and applicability of *CSN*; though some responses were either unsupportive or did not fall readily into generalisable inferences (a small percentage of the total submissions). I was able to catalogue and categorise the former criterion without difficulty; however, I discounted those falling within the latter criterion as to include them would require that I broaden out the meaning of the collated statements which I felt would dilute their meaning. As I have said, I was, even at this early stage, able to draw an overall positive inference from the narrative responses in Round 1. However, I was conscious to try not to lead the panel to simply affirm the collated statements in Round 2 and, consequently, I sought to frame all statements in the positive, even those that potentially opposed the model as written at that stage. I refer specifically to the use of academic terms and that the model 'did not use plain English'. I determined that the consistency of the statements would be easier for the panel to understand and it would perhaps point them to deliberately challenge the positive assertion. Indeed, this is evident in the results, where the respective statements are the lowest of the set.

7.2.2 Analysis of Delphi Round 2

In this section, I review the results of Round 2 of the Delphi study. The purpose of this discussion is to review the data itself, the findings and what this means for this research study more broadly. I will firstly review the results relating to Validity, followed by a review of the results relating to Applicability. This will then close with an overarching commentary on the progress to date.

The purpose of this research study is to answer the 3rd Research Objective:

> '[T]o provide an assessment of the validity and applicability of the conceptual framework by seeking the collective views of Critical National Infrastructure practitioners and senior leaders, specifically in the area of risk and programme management

Delphi Studies are processes that seek to generate consensus on a specific problem, which for this study I have defined as having an inter-quartile range of less than or equal to 1.0. However,

I found that this 'thesis indicator' (what became TI-2 Degree of Consensus) alone did not demonstrate the validity nor the applicability of the Conceptual Framework, just on the proximity of their respective scores, which would not be beneficial in answering the research question. To satisfy this requirement, I chose to add another 'thesis indicator' – TI-1 Agreement Tendency (on the validity/applicability of the Conceptual Framework). This measure analysed the individual ratings provided by the participants and, where the majority of scores were less than 4.5 (the mid-scale score) I saw that that panel 'Generally Disagreed' (that the Conceptual Framework was Valid and Applicable). Conversely, where the majority of scores were greater than 4.5, I saw that the panel 'Generally Agreed'. Together with the inter-quartile range, this would allow for the following assessment: Do the participants (a) agree that the model is valid and applicable (via TI-1) and (b) to what extent are the scores in consensus? (via TI-1). The discussion on Rounds 2 and 3 will be on this basis.

7.2.2.1 On the Validity of the Conceptual Framework

When reviewing Table 18 from Round 2, one impression that I view is immediately apparent is the preponderance of the scores in excess of ***4.5*** in the Min, Max, Mean and Median columns. This demonstrates that respondents were largely in agreement with the validity of the respective statements. As I was processing the submitted returns, it was clear almost immediately that those respondents, which had contributed to the development of the Conceptual Framework, were more likely to rate the statements higher. Conversely, those respondents that joined the panel after the development of the Conceptual Framework rated their statements lower. I believe it is possible to infer from this that the length of exposure to the Conceptual Framework increases the understanding of its benefits. The Mean and Median demonstrated further obvious characteristics; in that, all but one statements scored higher than **66%,** and in both measures, i.e., equal to or greater than 6 out of 9. CS13[30] (see Figure 21) represented a clear exception to the overall scoring with a Mean of **4/9** and a Median of **5/9**, the difference is due to the minimum score being only **1/9**.

[30] CS13 – "The model is valid as it uses clear and accessible language and terminology'.

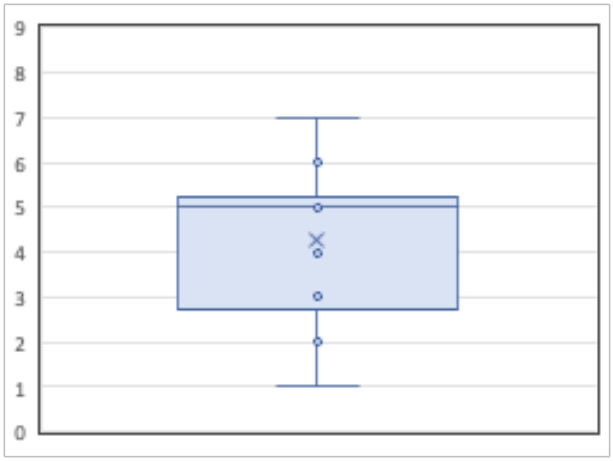

Fig. 21 CS13 – The model is valid as it uses clear and accessible language and terminology

7.2.2.2 Commentary on Thesis Indicators

In the first thesis indicator, TI-1 Agreement Tendency, when presented in logical groupings of 'Generally Agree' vs 'Generally Disagree', the distinction between the two categories is both stark and encouraging. Figure 22 illustrates this clearly, with **90%** generally agreeing with the statements. I believe this strongly supports the Validity of the Conceptual Framework as currently constructed, especially given that the academic 'richness' has emerged as being a strength in the responses.

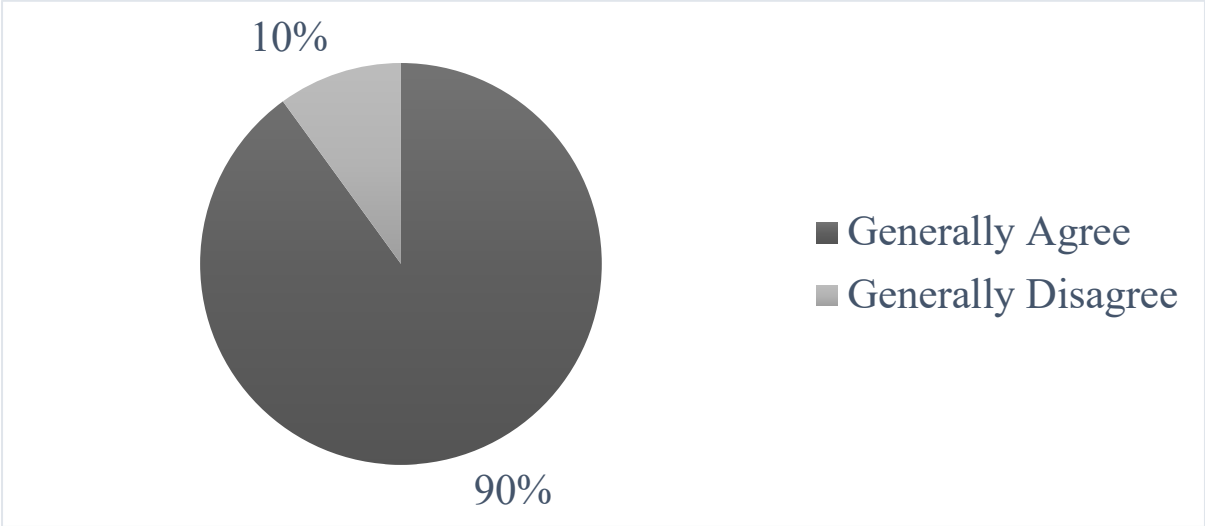

Fig. 22 TI-1 – Agreement Tendency on Validity of the Conceptual Framework – Round 2

For the second indicator, TI-2 Degree of Consensus as illustrated in Figure 23, the results were again positive with **93%** either in 'consensus' **(43%)** or 'strong agreement' **(50%)**, with a

further **(7%)** demonstrating 'weak agreement'. Notably, there were no data to support 'no agreement'.

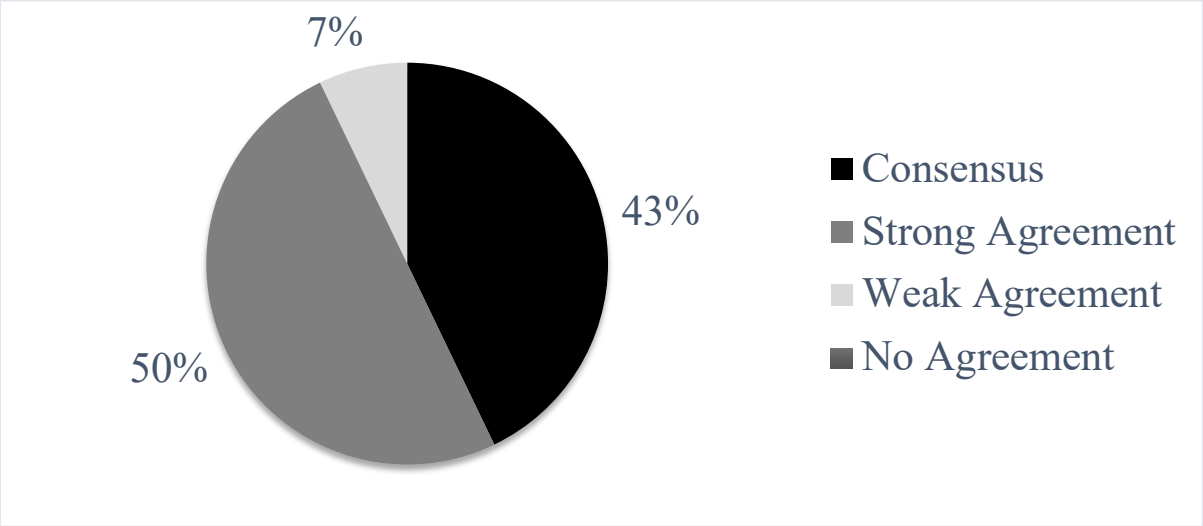

Fig. 23 TI-2 – Degrees of Consensus on the Validity of the Conceptual Framework – Round 2

Of note is the analysis of CS12[31] (Figure 24), which was the only statement that demonstrated weak agreement. In reviewing the individual returns, I was able to deduce that while the lowest score was from the final member (to join the panel) this was probably coincidental, as other low scorers were not late to the study. However, from my knowledge of the panel members I was able to highlight a further inference; that those scoring lower were from the Programme Management field, while those scoring higher were from the Risk Management field. Given the statement relates to how the Conceptual Framework 'highlights a limiting 'Lack of Knowledge of *Novelty* as Risk' in the operating environment', I believe this is a strong inference that I can attribute to those in the Risk Management field being more familiar to the idea of *Novelty* than those in the Programme Management field.

[31] CS12 'The model is valid as it highlights a limiting 'Lack of Knowledge of Novelty as Risk' in the operating environment'

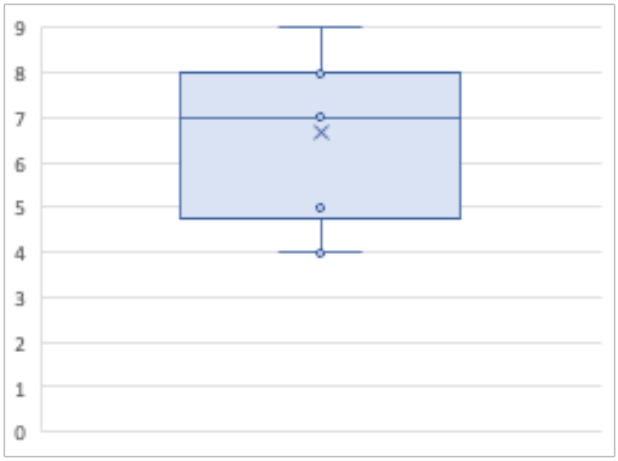

Fig. 24 CS12 The model is valid as 'it highlights a limiting 'Lack of Knowledge of Novelty as Risk'

7.2.2.3 On the Applicability of the Conceptual Framework

As with the analysis of Collated Validity Statements, those relating to Applicability had a similar impact and I have shown this in Table 20, again the preponderance of the scores in excess of **4.5** in the Min, Max, Mean and Median columns is immediately apparent. This is not that surprising as Applicability is largely a question that falls from Validity, and there is likely to be a relationship to some degree. Though the scores are different across many responses, the profile is largely the same, however, there is some noticeable difference relating to the TI-1 Agreement Tendency indicator that I will discuss shortly. The patterns underneath the data are also largely the same, and again I believe it is possible to infer from this that the length of exposure to the Conceptual Framework increases the understanding of its benefits. As with the Collated Validity Statements CS13[32] was an exception (Figure 25), and while the Maximum rating was lower **6/9,** when compared to *Validity,* the Min, Mean and Median had remained the same. The low scores were from the same respondents as in the Validity analysis, which I would view as further supports the inference that any developmental materials than emerge from this study would benefit from making them more accessible to participants.

[32] CS13 'The model is applicable as it uses clear and accessible language and terminology'

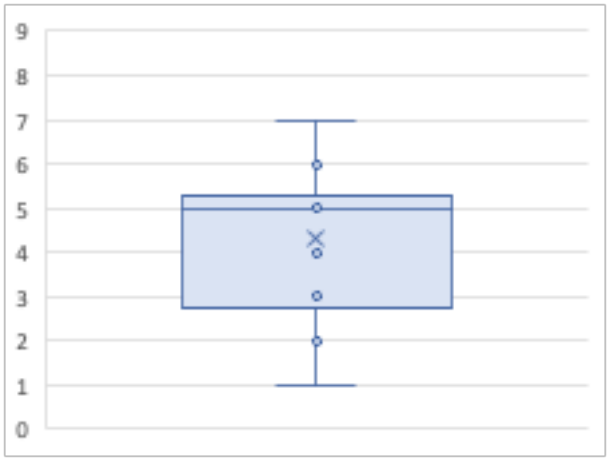

Fig. 25 CS13 'The model is valid as it uses clear and accessible language and terminology'

7.2.2.4 Commentary on Thesis Indicators

In relation to TI-1 Agreement Tendency, the distinction between the two categories is as evident as it was for Validity, with **89%** generally agreeing with the statements (Figure 26). As with the analysis for the Validity of the Conceptual Framework I believe this to strongly support the Applicability (of the Conceptual Framework) as currently constructed; though there is a need to address the language and terminology used as the framework develops.

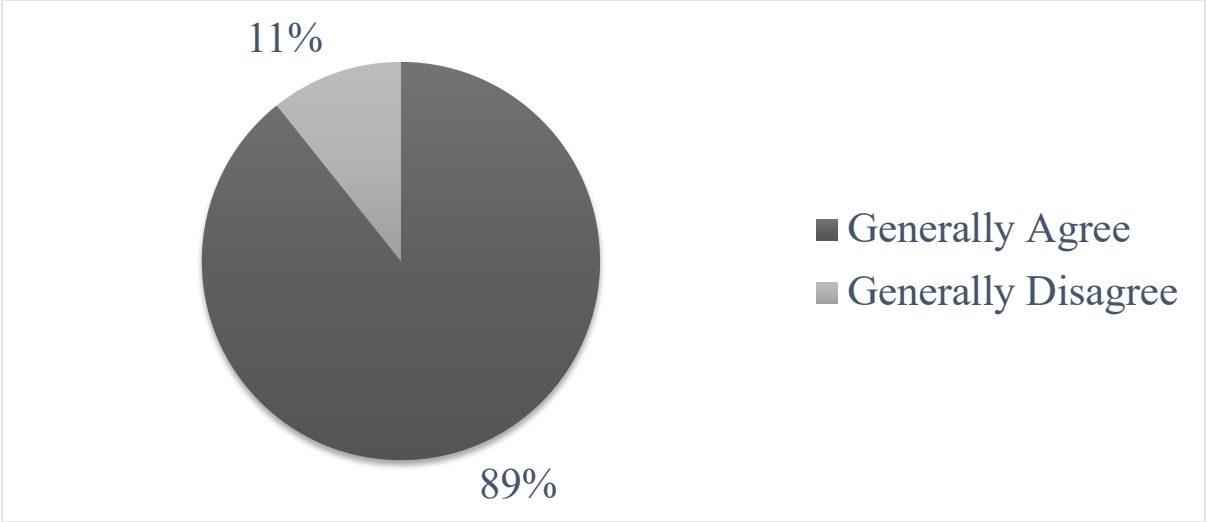

Fig. 26 TI-1 Agreement Tendency on Applicability of the Conceptual Framework – Round 2

For the second indicator, illustrated in Figure 27, the results were positive with **79%,** either in 'consensus' **(43%)** or 'strong agreement' **(36%),** and **(21%)** demonstrating 'weak agreement'. To this point there has been some similarity in the analysis of the data, but here the information differs. While support for the Applicability of the Conceptual Framework is strong, there is some variation in the scoring.

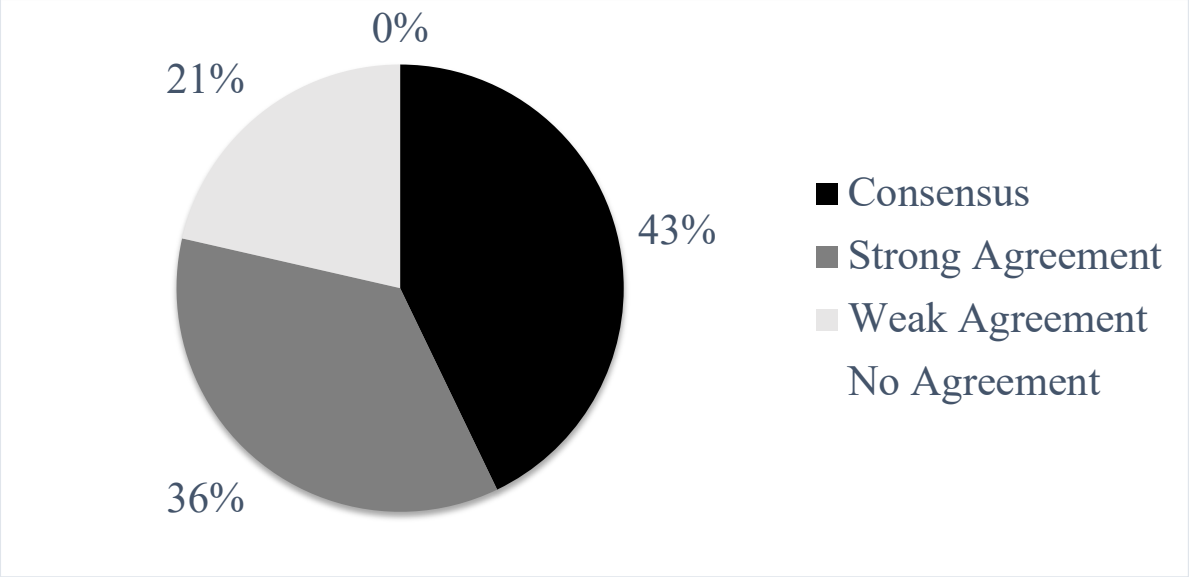

Fig. 27 TI-2 Degree of Consensus on the Applicability of the Conceptual Framework – Round 2

I found it interesting that while the 'consensus' figures remained at ***43%,*** accepting that the discrete scores may have changed, there was a reduction in 'strong agreement' and an increase in 'weak agreement' with 3 statements having IQR =>2.0, indeed 1 statement had an IQR of 3.0. As this study is seeking to reduce *Novelty,* I found a review of these 3 statements to be instructive. I note that CS4 'the model is applicable as it 'Adds Credibility with Academic Underpinnings' scores the highest IQR, which demonstrates the least agreement from Round 2. When I consider this alongside CS13 'the model is applicable as it uses clear and accessible language and terminology' (which has the lowest ratings), this clearly supports the inference that to ensure improved accessibility, I would need to address the language and terminology.

Given this discussion, I believe there is a sound argument to say that, having undertaken Round 2, most respondents agree as to the Validity and Applicability of the Conceptual Framework, and across both Thesis Indicators. I have inferred from these results that the strength of ongoing engagement during the study, including the discussions on research findings, led to a common understanding from the preliminary action research cadre, some of whom joined the expert panel. Conversely, I have considered whether this may have also been a weakness, in that some of the critical challenges may have diminished over the timespan of the study. However, this is certainly not been the case, and the level of interest in the project and the anticipated benefits has endured and possibly reinforced the level of challenge.

I argue that there are several findings from the analysis of Round 2, these are:

1) that the length of exposure to the Conceptual Framework increases the understanding of its benefits within DefSy;
2) the use of iterative action research has enabled and helped the development of this Conceptual Framework to the point where it can help to mitigate the Novelty within DefSy;
3) that any developmental materials that emerge from this study need to be more accessible to participants through changes to both the language and terminology;
4) those panel members in the Risk Management field are more familiar or receptive to the idea of Novelty than those in Programme Management. As the operating context for this Practitioner Project is DefSy; this is a considerable hazard to major strategic programmes.

7.2.3 Analysis of Delphi Round 3

In reviewing the analysis for Round 3, I will adopt a slightly different approach; while I will undertake the same assessment as for Round 2, I will also review any findings when comparing Rounds 2 & 3. As with the Round 2 review, I am looking here for any specific or general implications for this study; particularly, I am interested in whether I can answer the 3rd objective of this Practitioner Project. I will firstly review the results relating to Validity, followed by a review of the results relating to Applicability. This will then close with an overarching commentary on the progress to date.

It is worth remembering that the purpose of Round 3 was to determine whether any panel members, having reviewed the group mean scores, felt they should adjust their own scores. I did not expect fundamental changes to the scores, and this was for two reasons; first, the level of agreement was already strong and second, given the personal strength of the panel members I felt they would be unlikely to move their views significantly. It is also worth observing that I had expected the level of interest to wane, but it was clear that the panel remained very interested in how their scores compared with the group. Where clear differences (in scores) existed, an increased level of dialogue ensued, and in several cases extensive and detailed discussion. For clarity, I would repeat that I asked the panel to only review those scores that had not achieved consensus; hence these scores would not change in this round.

7.2.3.1 On the Validity of the Conceptual Framework

I begin with a review of the information relating to the Thesis Indicators, which I will follow with a discussion on the changes between Rounds 2 & 3.

7.2.3.2 Commentary on Thesis Indicators

I did not anticipate much movement from Round 2 for these indicators, and indeed this proved to be the case. In regard to TI-1 Agreement Tendency, the proportion of the responses that were viewed to 'Generally Agree' rose slightly from **90%** to **91%** (Figure 28).

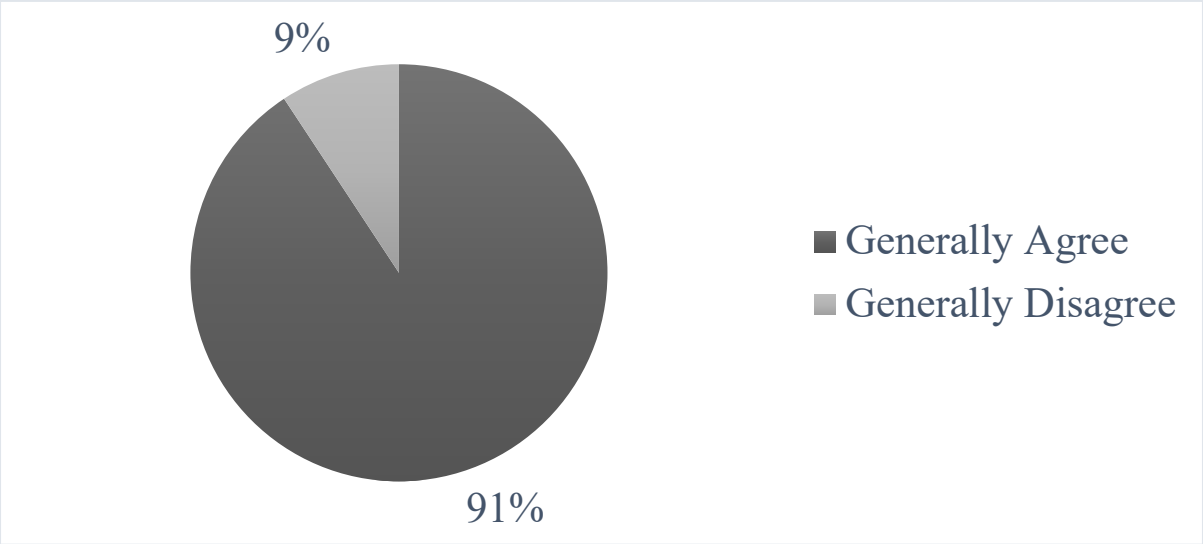

Fig. 28 TI-1 Agreement Tendency on the Validity of the Conceptual Framework – Round 3

As with Round 2 the data supporting the disagreement related to the accessibility of the language that I used in the Conceptual Framework (see Figure 29). Interestingly, while the Min and Max scores remained the same for this statement, (**1** & **7** respectively), the median and mean reduced, suggesting participants agreed to a greater extent that the language could be easier to understand. The reduction in the IQR from **1.8** – **1.5** supports this assertion. As with Round 2, I argue that the level of familiarity with the terminology is a factor in these results.

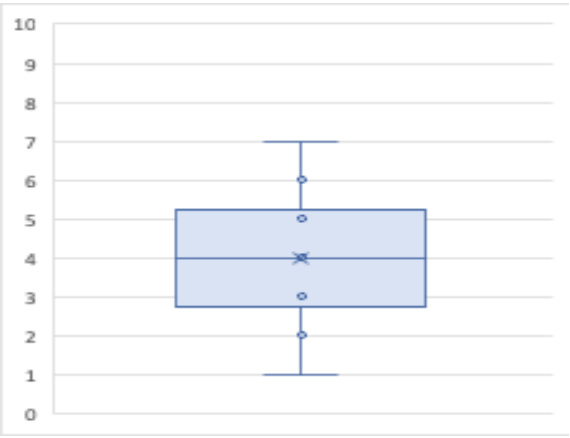

Fig. 29 CS13 – The model is valid as it uses clear and accessible language and terminology

In relation to TI-2 Degree of Consensus (Figure 30), the shift was considerably better in terms of a move toward consensus. The data were again positive with **100%** (an increase from 93%) either in 'consensus' **(86%** - an increase from **43%)** or in 'strong agreement' **(14%** - a decrease from **50%)**. At this stage, none of the collated statements reported 'weak agreement' or 'no agreement'.

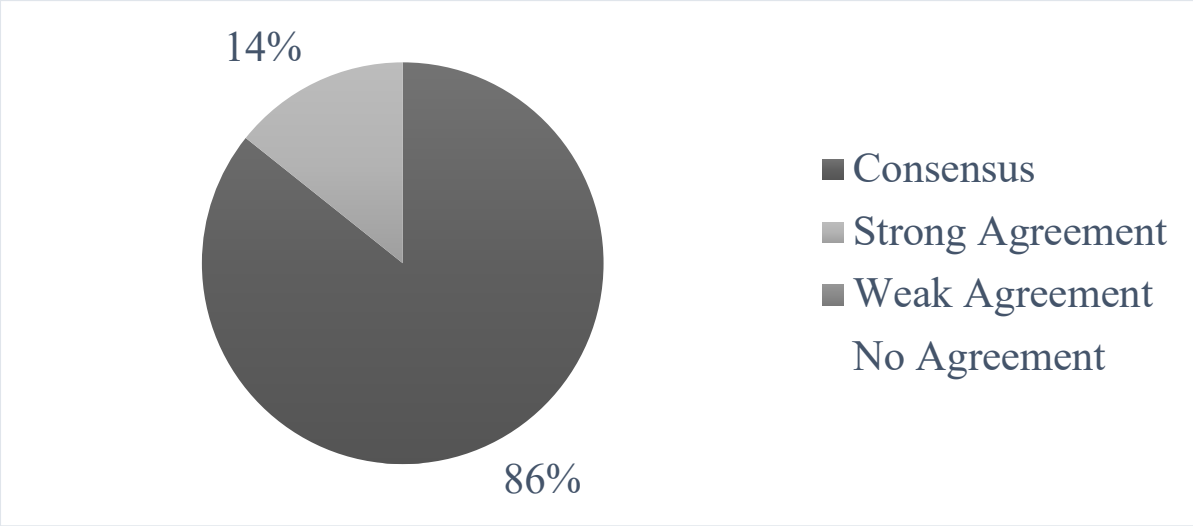

Fig. 30 Degrees of Consensus on the Validity of the Conceptual Framework – Round 3

Those statements demonstrating 'strong agreement' relating to CS13 as mentioned above in relation to TI-1 Agreement Tendency, but also CS10 (Figure 31). The distribution supports my assessment that the length of time associated with the model is critical to its understanding. While this statement does not gain consensus the participants clearly agreed with it, with a median score of **7.5** and a mean of **8.0**.

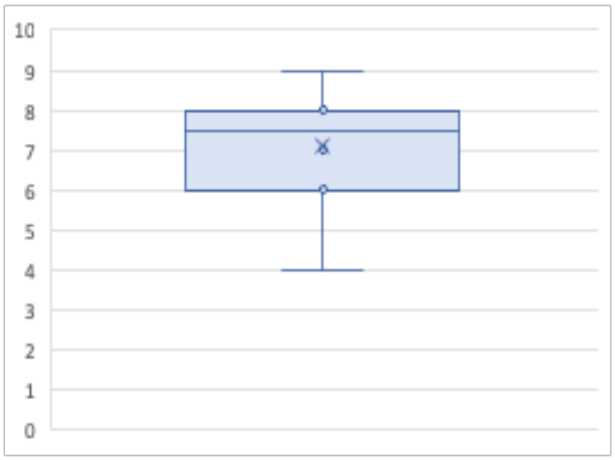

Fig. 31 CS-10 The model is valid as it highlights a limiting 'Lack of Knowledge of Emergence/Non-Linearity'

7.2.3.3 Validity: Comparison between Round 2 and Round 3

At this stage it is beneficial to briefly touch upon the main areas of movement between Rounds 2 & 3, in relation to the Validity of the Conceptual Framework. I have explained that Round 3 only examined those statements that had not achieved consensus at Round 2 – and these are 'greyed out' for clarity of presentation in Table 24. In this table, most statements, under review in this round, improved in the level of consensus, except for CS-10 & CS-13 which I have discussed above. Of note is CS-12, which moves from an IQR or **2.5** (weak agreement) to **0.8** (consensus); it is especially gratifying as this was one indicator that generated significant dialogue throughout. Those participants who had scored the statement lower sought an explanation when they had seen a higher group mean, it was at this stage that other interest, from outside the research study emerged. It was clear at this juncture that the framework had gained significant traction amongst the panel, and key shapers within DefSy, demonstrating its value. Given these observations, which the data supports, I would assert that I have now demonstrated the Validity of the Conceptual Framework.

Table 24 Validity: Comparison between Round 2 and Round 3

CS	COLLATED STATEMENT - VALIDITY	R2Mean	R3Mean	R2Med	R3Med	R2IQR	R3IQR
1	The model is valid as it 'Identifies Limitations in Current Practices', e.g., risk management, programme management and budget setting.	***7.8***	*7.7*	***8.0***	***8.0***	*1.9*	***0.8***
2	The model is valid as it 'Improves Current Limited Practices', e.g., risk management, programme management and budget setting.	***7.7***	*7.7*	***7.5***	***7.5***	***1.0***	***1.0***
3	The model is valid as it 'Evolves Current Direction' in this general area.	***7.6***	*7.6*	***7.0***	***7.0***	***1.0***	***1.0***
4	The model is valid as it 'Adds Credibility with Academic Underpinnings'.	***7.1***	*7.1*	***7.0***	***7.0***	***1.0***	***1.0***
5	The model is valid as it can be used in a 'Targeted Intervention'.	***7.0***	*7.0*	***7.0***	***7.0***	*1.5*	***0.0***
6	The model is valid as it can 'Develop People/Groups' to improve organisational performance.	***7.0***	*7.0*	***7.0***	***7.0***	*1.8*	***0.8***
7	The model is valid as it could be a 'Development Programme'.	***6.9***	*6.8*	***6.5***	***7.0***	*1.8*	***1.0***
8	The model is valid as it can 'Develop Specialists' this will improve organisational performance.	***7.4***	*7.4*	***7.0***	***7.0***	***1.0***	***1.0***
9	The model is valid as it highlights the 'Immaturity of Current Systems'.	***7.3***	*7.3*	***7.5***	***7.5***	***1.0***	***1.0***
10	The model is valid as it highlights a limiting 'Lack of Knowledge of Emergence/Non-Linearity' in the operating environment.	***7.0***	*7.1*	***7.5***	***7.5***	*1.8*	*1.8*
11	The model is valid as it highlights a limiting 'Lack of Knowledge of Understanding' in the operating environment.	***6.9***	*6.9*	***7.0***	***7.0***	***1.0***	***1.0***
12	The model is valid as it highlights a limiting 'Lack of Knowledge of Novelty as Risk' in the operating environment.	***6.7***	*7.2*	***7.0***	***7.0***	*2.5*	***0.8***
13	The model is valid as it uses clear and accessible language and terminology	*4.3*	*4.0*	***5.0***	*4.0*	*1.8*	*1.5*
14	The model is valid as it avoids over analysing and has a clear methodology and approach	***5.7***	*5.7*	***6.0***	***6.0***	*1.8*	***0.8***

7.2.4 On the Applicability of the Conceptual Framework

In discussing 'Applicability' I will follow the format of the previous section and begin by discussing the Thesis Indicators before a discussion on the changes between Rounds 2 & 3.

7.2.4.1 Commentary on Thesis Indicators

In relation to TI-1 Agreement Tendency (Figure 32), given the already high level of support for the Conceptual Framework, and the reason for any disagreement being the issues of language, I was not expecting a considerable change to the scoring. However, I was again pleased with the level of interaction (at this stage) with participants, who sought clarification on their understanding of certain phrases; once I had answered the queries, the scores increased in several areas. This was especially the case in statements, CS-4, 10 & 11 which contributed to an increase in 'General Agreement' from **89%** to **92%.** This again supports the theory that as the level of familiarity with the complex terms used increased, so does the appreciation of the potential benefits.

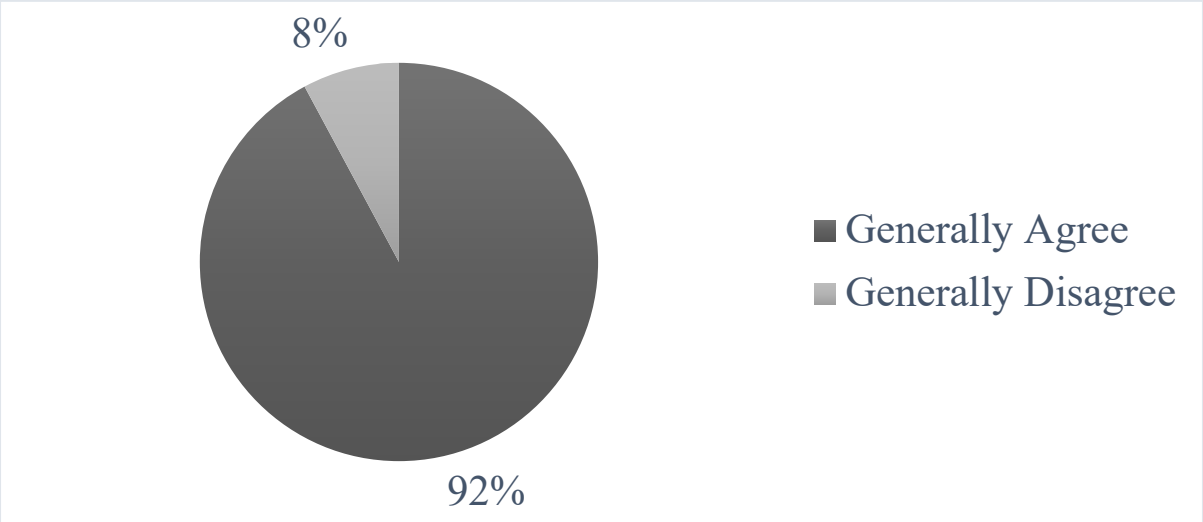

Fig. 32 TI-1 Agreement Tendency on the Applicability of the Conceptual Framework – Round 3

In relation to TI-2 Degree of Consensus for Applicability (Figure 33), the picture resembled Validity, with all statements moving toward consensus. The data were again positive with **100%** (an increase from 93%) either in 'consensus' **(79%** - an increase from **43%)** or in 'strong agreement' **(21%** - a decrease from **36%)**. At this stage, none of the collated statements reported 'weak agreement' or 'no agreement'.

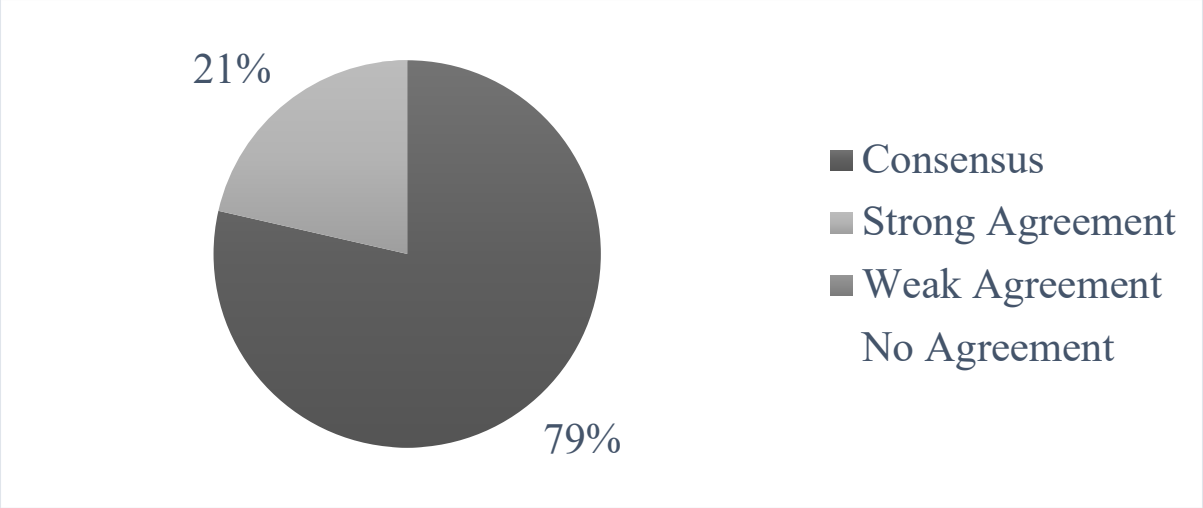

Fig. 33 Degrees of Consensus on the Applicability of the Conceptual Framework – Round 3

7.2.4.2 Applicability: Comparison between Round 2 and Round 3

While the progression toward consensus was positive for Validity, it was more so for Applicability. The applicability of the Conceptual Framework (Table 25) is perhaps the most important facet as this is how practitioners realise benefits, i.e., the reduction in system threat. This interest has been very apparent to me through the conversations during Round 3.

Table 25 Applicability: Comparison between Round 2 and Round 3

CS	COLLATED STATEMENT - VALIDITY	R2Mean	R3Mean	R2Med	R3Med	R2IQR	R3IQR
1	The model is applicable as it 'Identifies Limitations in Current Practices', e.g., risk management, programme management and budget setting.	***7.9***	***7.9***	***9.0***	***8.0***	*2.8*	***0.0***
2	The model is applicable as it 'Improves Current Limited Practices', e.g., risk management, programme management and budget setting.	***7.2***	***7.2***	***7.0***	***7.0***	***0.8***	***0.8***
3	The model is applicable as it 'Evolves Current Direction' in this general area.	***7.3***	***7.3***	***8.0***	***8.0***	***1.0***	***1.0***
4	The model is applicable as it 'Adds Credibility with Academic Underpinnings'.	***6.3***	***6.5***	***7.0***	***7.0***	*3.0*	*1.8*
5	The model is applicable as it can be used in a 'Targeted Intervention'.	***7.1***	***7.1***	***7.0***	***7.0***	***0.8***	***0.8***
6	The model is applicable as it can 'Develop People/Groups' to improve organisational performance.	***7.1***	***7.1***	***7.0***	***7.0***	***0.8***	***0.8***
7	The model is applicable as it could be a 'Development Programme'.	***7.5***	***7.5***	***7.0***	***7.0***	***1.0***	***1.0***
8	The model is applicable as it can 'Develop Specialists' this will improve organisational performance.	***7.6***	*7.7*	***7.0***	***8.0***	*1.8*	***0.8***
9	The model is applicable as it highlights the 'Immaturity of Current Systems'.	***7.0***	***6.8***	*7.5*	***7.0***	*2.0*	***0.8***
10	The model is applicable as it highlights a limiting 'Lack of Knowledge of Emergence/Non-Linearity' in the operating environment.	***6.7***	***6.9***	***7.0***	***7.0***	*1.5*	***0.0***
11	The model is applicable as it highlights a limiting 'Lack of Knowledge of Understanding' in the operating environment.	***6.7***	***7.0***	***7.0***	***7.0***	*1.5*	***0.0***
12	The model is applicable as it highlights a limiting 'Lack of Knowledge of Novelty as Risk' in the operating environment.	***6.5***	***6.5***	***7.0***	***7.0***	***1.0***	***1.0***
13	The model is applicable as it uses clear and accessible language and terminology	*4.0*	*3.7*	*4.5*	*4.0*	*2.0*	*1.8*
14	The model is applicable as it avoids over analysing and has a clear methodology and approach	***5.2***	***5.3***	***5.5***	***5.0***	*2.8*	*1.8*

Statements that achieved the most movement, CS-1 from IQR **2.8** (weak agreement) down to **0.0** maximum consensus; CS-9 from IQR **2.0** (weak agreement) down to **0.8** support the assertion that the framework improves current practice. In addition, the CS-8, 10 & 11 again relate to overall performance improvement in the area of threat abatement. As with Validity, I would assert that I have now demonstrated the Applicability of the Conceptual Framework.

7.3 Summary Findings and Recommendations

Having undertaken this research, I can now assert both the Validify and Applicability of *CSN*; this is predicated on the following measures:

Validity

- TI-1: 91%. This score indicates the Expert Panel generally agree that the Conceptual Framework is valid.
- TI-2: 86%. The panel is in consensus on the scores provided, with 14% in strong agreement.

Applicability

- TI-1: 92%. This score indicates the Expert Panel generally agree that the Conceptual Framework is applicable.
- TI-2: 79%. The panel are in consensus on the scores provided, with 21% in strong agreement.

On the basis of these quantitative measures and with the additional consideration of the qualitative contributions from the expert panel, I provide the following resultant recommendations.

a) A wider review is undertaken of the efficacy of risk management, both from an organisational perspective and programme management perspective;
b) Review the assessment process for discrete risks to incorporate a consideration of unanticipated side effects (resulting from non-linearity);
c) Consideration is given to the importance of Requisite Variety in all business cases (for change);
d) Leadership Development Programmes are reviewed with a consideration of both non-linearity and Requisite Variety;

e) Consideration is given to the development of specialists to examine 'discrete' opportunities for practice development.

7.4 Chapter Summary

In this chapter, I set out my journey of gathering the evidence to answer the 3rd Research Objective. I have explained how I developed the expert panel, gathered and analysed the data, and finally established the results of the findings. I undertook a Delphi study as my chosen research method, and this proved to be more successful than I expected: first it proved a positive choice for the actual gathering of data and second it attracted significant interest from parties external to the research.

In terms of the data and the information to answer the research question, I gathered, via the expert panel in Round 1, 90 source statements upon which I would build the basis for the study rounds. These were then analysed into what became 14 'Collated Statements' that were assessed on both Validity and Applicability (of *CSN*). In Round 2, the panel ranked the responses and both sets of responses gained positive results across two indicators (TI-1 Agreement Tendency & TI-2 Degree of Consensus) and when asked to review respective scores in Round 3, these scores then improved to a point where I judged that the 3rd Research Objective had been answered.

Throughout this exercise it has been encouraging to see the commitment of the expert panel to see this study through; from the preliminary 'critical friend' discussions to concluding this study, some have been involved for over two years. I believe this is a testament to the importance of the study.

Finally, given the nature of the findings, both qualitative and quantitative, I propose some recommendations for the development of practice, at this stage this is limited to the context of this Practitioner Project—the Defence and Security Sector in HMG.

CHAPTER 8 ~ SYNTHESIS, REFLECTION & CONCLUSION

According to a House of Commons Briefing Paper – 'UK Defence Expenditure' (Dempsey, 2018), the HMG plans to spend £38.8B on defence in 2019, the planned expenditure for defence equipment between 2014 and 2024 is £163B (NAO, 2015). These financial commitments alone point to the need for stability in programme management. However, as important would be effects on quality and timeliness of pan-government programme deliverables were *Novelty* to emerge in the Problem Space.

It was within this setting that a core group of senior actors asked that I undertake this present study given the apparent lack of capability in responding to threat exposure. The commission was to develop an approach through which DefSy can improve its performance in this vital area of government, and it was against this project that I elected to undertake this Doctoral Programme. Following some initial work with a group of practitioners, a Community of Practice, I proposed and established the project's Problem statement and the following 'Aims and Objectives':

The aim of this project was:

To create a conceptual framework that (a) raises awareness of the environmental phenomena affecting programme performance, and (b) provides a logical approach through which these phenomena can be countered.

To achieve this above aim, I developed the following objectives:

1) To provide a detailed exploration (via the Literature Review) of the characteristics seen to be affecting pan-government programmes performance within the 'System under Study.
2) To develop a Conceptual Framework, based on the literature review, that can be used to address the systemic Novelty.
3) To provide an assessment of the validity and applicability of the Conceptual Framework by seeking the collective views of senior leaders and practitioners in the Defence and Security sector in HMG, specifically in the area of risk and programme management.

Having now concluded the research study, I now evaluate whether I have met the requirement placed upon me by the core group of DefSy senior actors; I will also evaluate the contributions

made as a result of undertaking this project. I will then outline the main limitations of the study before providing a recommendation for further research.

8.1 Summary Findings and Reflection Against Objectives

This project adopted pragmatism within its overall philosophy; in-keeping with this approach, I will determine whether the summary findings of the study can be seen to have *warranted assertability* (Dewey, cited in Boyles, 2006). To be able to make this claim, propositions must have been subject to "on-going self-correcting processes of enquiry" (Oxford Reference 2016, warranted assertability entry), which means it should be seen to be valid at that time. This is especially the case for Objective 3, which is the basis of the Delphi Study. Within these assertions, I also return to the abductive approach to determining evidence arising from this study, i.e., inference to the best explanation (Harman, 1965).

8.1.1 Review of Objective 1

In this Practitioner Project, the first research objective was '[T]o provide a detailed exploration (via the Literature Review) of the characteristics seen to be affecting pan-government programmes performance within the 'System under Study'. In responding to this objective, I reviewed the key literature relating to both the emergence of the characteristics and how they might be remediated. I examined Complex Adaptive Systems (incorporating Emergence and Feedback) to identify the natural processes through which these characteristics arose, and reviewed the notion of Novelty, which had arisen in the early stages of this project and became the central phenomenon of this study. Given its characteristics, i.e., 'continual adaptation' & 'perpetual Novelty' (Arthur, 1997); its 'inter-twining or inter-connectivity of elements' (Chan, 2001), 'feedback loops' (Forrester, 1992; Stacey, 2005; Mitleton-Kelly, 2003) and 'emergence' (Clayton & Davies, 2006; Corning, 2007; Schneider & Somers, 2009; Goldstein), I was able to infer that the Problem Space was representative of a CAS. Specifically, I was able to infer that the Problem Space was a 'Strange Attractor' that is characterised by largely unpredictable, and to some extent unknowable a priori, behaviours resulting from non-linearity and bifurcation—*Novelty*.

Having found that *Novelty* would be contributing to the research problem, I then explored this concept from the perspectives of hazard & risk and how organisations currently look to control this phenomenon. What has become clear, through this study, is that *Novelty* results from

hazard that exists across the domain; it is ubiquitous. Problems arise when all the right circumstances are in place to allow *Novelty* to emerge – which Reason's (2006) Swiss Cheese Model illustrates. Holton (2004) perhaps encapsulates the problem by describing the problem of 'unmeasurable uncertainty' or 'subjective probability'. Given these attributes, I found the existing processes were inadequate, they assumed predictability, or linearity of risk. They assumed risk was identifiable (and therefore quantifiable) as this was the initial first step in the prevailing models (see HMG's Orange Book on risk management [2004] and the updated version [2019]). This was not possible given Holton's description. 'Risk management' is advancing in the wider context, indeed discrete organisations have been established to examine national-level threat (CPNI and NCSC as examples); the material emerging within those organisations is starting to introduce prevention as a first step in the processes; language is also beginning to reflect a less reductive approach (NCSC, 2016). However, this has not permeated DefSy yet, and certainly not as part of an overall framework; this dynamic development perhaps accounts why some elements of DefSy will have 'Recognised Ignorance' and even 'Total Ignorance' of uncertainty (Walker, 2003).

In seeking to address this lack of insight, I sought to examine how practitioners might better understand the contextual variables within DefSy, which in turn would allow for better 'regulation of feedback' and the avoidance of hazard. I found that an appreciation of knowledge, as a 'strategic resource' (Zack, 1999), through critical thinking is a vital foundation for increasing Understanding. Given the focus of this study, I found Zack's 'Relational Knowledge' to be particularly relevant due to its focus on connections and relationships and as an aid to critical thinking. I also found that the awareness of bias and heuristics enables practitioners to avoid any potential reliance on the reductive and overly rational (Simon, 1956) approaches to risk. Kahnemann's work on 'Two Cognitive Systems' (2003) highlights the importance of considered thinking and the dangers of instinctive thinking when placed in the context of risk management where a rushed decision could be highly significant. This presents problems for the management of *Novelty,* given its immediate presentation. Having reviewed Sense-making, I found that the Weickian approach, whilst informative, may not be sufficient due to its retrospective nature. Given that *Novelty* is unknowable, knowing what happened previously may not be helpful, in fact, it could lead to further *Novelty* if practitioners misapply these lessons – see Weick's review of the Mann Gulch fire (1993). Rather I adopt Dervin's approach to Sense-making that takes a 'prospective' approach and examines gaps in understanding, through testing scenarios, by understanding prevailing values and cultural

indicators. Importantly, this is achieved by a person that is "embedded in a context-laden situation" (2008). The main point here is the importance of being present and in context at the time of analysis, not removed from it. The aspiration for Sense-making (SM) is to achieve Situation Awareness (SA) and I found Endsley's model to be applicable to DefSy. Perhaps given its origins in the military context, the model is based on (the abilities) of 'perception' & 'orientation' and then at its highest level, 'projection', the latter level is deemed as representing a skilled expert. I would conclude, then, that the development of 'embedded (SM), skilled experts (SA)' would be an aspiration for any Conceptual Framework and allow practitioners to think "ahead of the plane" (Sarter & Woods, 1991).

I have found that the three Areas of Knowledge discussed above: (1) Complex Adaptive Systems; (2) *Novelty*; (3) Understanding, are almost foundational for the final area which is (4) Response. Indeed, without this final area, the Conceptual Framework would be practically ineffective. In examining 'response' I have found one principle to be a core consideration—Ashby's Law of Requisite Variety (RV): I would assert that an understanding of this theory is significantly advantageous in regulating *Novelty.* RV sits theoretically within the same field as *CAS* and compliments 'understanding', it states that the level of response capability should be sufficient to absorb the level of potential system stimulus. RV enables systems to adapt to prevailing environments, i.e., co-evolution: I have identified two mechanisms for achieving this balance, Soft Systems Methodology (SSM) and System Dynamics (SD), SSM (Checkland, 1981) enables practitioners to gain an understanding of how any system works, its purpose and guiding principles and has been used in numerous related contexts (see for example, Information Security, [Hitchings, 1995]; National Security, [Fischbacher-Smith, 2015]; Change, [Jacobs, 2004] and Programme Management, [Male et al., 2007]). I have found that SD allows for the regulation of feedback (that is inherent across all systems) as it highlights how to bring systems back into equilibrium. When a system is found to be 'reinforcing', the practice of SD points to the source of this behaviour and where a considered response should be enacted – 'balancing' regulation of hazard and countering of *Novelty.*

Having undertaken this literature review, and identified four Areas of Knowledge, I assert that I have achieved the first objective of this Practitioner Project.

8.1.2 Review of Objective 2

The second objective of this Practitioner Project was '[T]o develop a Conceptual Framework, based on the literature review, that can be used to address the 'Systemic Novelty'. While developing *CSN,* I explored other frameworks and models to assess whether they were suitable for adaptation to address the Research Problem and incorporate the AoK. I examined the well-established Cynefin Framework (Snowden, 2007) which takes a complexity perspective on understanding across four dimensions: (1) Simple; (2) Complicated; (3) Complex and (4) Chaotic. While the model is advanced and covers some of the same areas as *CSN*, I felt it was insufficient from the perspective of response. I drew similar conclusions in respect of the VUCA model, which covers: (1) Volatility; (2) Uncertainty; (3) Complexity, and (4) Ambiguity. VUCA, due to its origins in defence (Lawrence, 2013, p.2) was of specific interest, but again did not explore 'response' sufficiently. As I was leading the development of the model with a group of practitioners from a specific context, we felt the model needed to be tailored to the needs of the sector and multi-faceted. Hence, I developed *CSN* as a multi-disciplinary conceptual framework over the course of the project and with the element of practical remediation as a discrete component. This not only sets out the main Areas of Knowledge practitioners should be aware of to counter *Novelty,* but also how that can be used in combination to maximise its effects. At its later stages of development, the model received wide-reaching support from key parties within government and has been deployed as a whole, or in part, on core development projects. Having concluded the development of *CSN* as a Conceptual Framework, I assert I have met the 2nd Objective.

8.1.3 Review of Objective 3

The third and final objective was '[T]o provide an assessment of the validity and applicability of the Conceptual Framework by seeking the collective views of senior leaders and practitioners in the Defence and Security sector in HMG, specifically in the area of risk and programme management.' To this end, the Delphi Study was undertaken and, as a result of a three-round process, I demonstrated both the validity and applicability of CSN. This is assessed and confirmed by the expert panel who agreed that CSN is Valid (91%) and with a high Degree of Consensus (86%). The panel also supported the Applicability of CSN (92%) and with a high Degree of Consensus. Having provided this assessment of CSN as a Conceptual Framework, I can assert I have met the 3rd Objective of this Practitioner Project.

8.1.4 Reviewing the Aim of the Practitioner Project

Having achieved the above objectives it follows that I have, (a) raised awareness of the central phenomenon of 'Systemic Novelty', and (b) provided a logical approach through which this phenomenon can be countered. On this basis, I assert that I have met the aim of this project and have answered the initial project commission.

On achieving this finding, I now highlight what became an important 'unanticipated consequence' that relates to inference. As a result of the findings of this study I am now able to return to the approach to inference (adopted for this Practitioner Project); which I had established as being abductive in nature. I had set out the logical approach as follows:

- **If:** Emergent properties arising from the interaction of system agents or ecosystemic initiatives (...) are both unknowable and unbounded;
- **And:** There are... threats to the stability of the ecosystem under study;
- **Then:** There is …a lack of understanding and regulation of Novelty.

Having now confirmed that *CSN* can improve performance in addressing hazard[33], I believe I can now draw inference from adopting a *Deductive* stance as the following logic can be argued to apply.

- **If:** Emergent properties arising from the interaction of system agents or ecosystemic initiatives (...) are both unknowable and unbounded;
- **And:** There is …a lack of understanding and regulation of Novelty;
- **Then:** There are... threats to the stability of the ecosystem under study

This revised logic gradually emerged during the final round of the Delphi Study and in conversations with several stakeholders and perhaps explains the significant increase across DefSy. A key element appears to be the underscoring of threat as a non-linear, emergent phenomenon, one that requires a contingent approach based on advanced understandings (of both the problem and the response). I believe that actors within the Problem Space view the 'unknowability' element (of *Novelty*) to be an important challenge, but they should view this

[33] This is inferred from (a) a number of the qualitative 'source statements' gathered during Round I, and (b) a number of the quantitative assessments recorded during Round II and III and shown in the Box Plots (Appendix 9).

with caution. Situations do not repeat exactly, 'the sensitivity to initial conditions' means that small differences can lead to significantly different outcomes, so care should be taken when advancing 'solutions' that are based on prior experience to new problems. This is especially important given the nature of this unique Problem Space and the potential impact to Defence and Security across HMG and the wider environment.

8.2 Contributions

In the introduction to this thesis, I established the importance of stability in DefSy and therefore that any contribution to this stability must be explored. In this chapter, I will set out the contributions that I contend I have achieved, across several measures, as a result of undertaking this Practitioner Project. I will consider the following contributions: Empirical; Theoretical; Practical; and finally, Methodological.

8.2.1 Empirical Contribution

Having undertaken this successful study, a number of observations are worthy of mention that relate to both the findings, the choice of method itself and the overarching approach. Before I undertake this commentary, I would first like to comment on the role and importance of Requisite Variety (RV) arising from this project. RV refers to the amount of variety a system must have in order to meet external challenge, effectively it refers to system capability, its adaptability to new challenges. This research study has demonstrated, through Round I Source Statements an evident lack of RV across DefSy; the following are representative examples:

- "Current approaches are" … "not sophisticated enough given the systemic threats we face and the global threat actor base";
- "Our consideration of unknown threats is immature";
- "Our organisation would first need to address the lack of good risk management undertaken and ensure it is carried out with purpose"; and
- "Root cause analysis is seldom (if ever) used during risk management within our organisation."

Second, Round III of the Delphi provided further corroboration (of this issue) with the expert panel in consensus that the research had identified weaknesses in current practice. Accordingly, this supports the argument that DefSy has limited capability to counter *Novelty*. Study

participants (who are both experts and able to effect change within DefSy) also agreed that *CSN* was applicable within this context and could increase the capability of the system thereby increasing DefSy RV. I would argue that variety of response is the 'sine qua non' of organisational performance and will need to be clearly articulated in organisational business cases (for change): this may be difficult however, as the current processes do not necessarily provide for such analysis.

Returning to the observations and firstly in relation to the findings, the diverse quantitative indicators gained through the Delphi study add to the literature and can perhaps form the basis of further research. Given the generalised view that *CSN*, as a discrete and verified Conceptual Framework (developed for DefSy), has been found to offer improvements to current practice, then it is possible there may be broader applications for the model.

An important note from data collection and subsequent analysis relates to the profile of the scores from the initial stages. There was a clear distinction between those participants that formed part of the Community of Practice/Critical Friend group and those who were invited to join once the framework have been developed. While it was not universal, there was a general pattern that the initial group scored generally higher (on both validity and applicability of the model) then those that joined later. I believe this strongly supports the benefits of PAR in the development of similar projects. Moreover, it highlights risks to the validity of projects where PAR is not deployed—this is very much in accord with the assertions made by Kemmis et al., (2013) referred to in Chapter 6 of this present study.

8.2.2 Theoretical Contribution

As I have demonstrated in this project, the notion of 'Emergent Novelty' is not new. I would contend however that there has been a gap in the literature relating to the use of a multi-disciplinary Conceptual Framework to counter *Novelty* within DefSy risk and programme management systems. Whilst there is recognition that greater awareness of risk is needed within project management (Raz et al, 2002), it is acknowledged that the way we view risk might be inadequate. For instance, risk is often described in a linear way (Cavallo & Ireland, 2014) which is criticised as "obscuring the non-linear nature of that are affected by determining factors such as time (NCSC, 2016). Indeed, Cox (2008) highlights a weakness in risk management arising from the arguably unproven use of Risk Matrices. Aven (2016, p.11) goes further and calls for greater consideration of uncertainty in the management of risk. By

adopting a CAS perspective, this study has explored risk from a non-linear, emergent perspective and in doing so addresses criticisms about the linear trends prevalent in risk literature. This assertion is supported by Aven (ibid., p.11) who argues that developments in the application of "risk management should consider uncertainty and emerging risks". With no prior literature found on *Novelty* in the specific DefSy context, this study makes a theoretical contribution to the literature in this respect. Within this broader contribution, I would also argue that the introduction of the synergistic features – the *CSN* Intersects and Phi – into DefSy also contribute to the literature. These four facets demonstrate how a conceptual integration of diverse theories (see Fauconnier, 2003), or AoK, can help DefSy practitioners, senior decision-makers, risk and programme managers develop new mental frames. These new conceptual spaces will help with the Sense-making processes, via 'Gap-bridging' (see Savolainen, 2006) and help to counter the emergence of *Novelty*.

8.2.3 Practical Contribution

Since a core group of senior actors (in DefSy) acknowledged the need to improve how DefSy 'manages' threats, I have undertaken this substantial development Practitioner Project. Given some of the initial observations I reviewed the theme of 'risk management', as it was highlighted that current practices could be improved; I also reviewed the theme of 'resilience management' as I saw this as a core theme for this project. The idea of 'general resilience' guides the central learning theme around Complex Adaptive Systems (and its component characteristics) and system regulation via Soft Systems Methodology and System Dynamics enables DefSy to counter *Novelty*. This I contend is one of the reasons this framework is unique as a developmental model for practitioners in the Problem Space.

This study has contributed a validated framework for deployment within DefSy, which I have entitled Countering Systemic Novelty or *CSN*. a multi-disciplinary approach that is both valid and applicable for the highly complex and sensitive context. The core components (of *CSN*) include four Areas of Knowledge; four Intersects that provide descriptions of the synergistic knowledge; and, the notion of Phi. Phi represents an aspirational level of knowledge for practitioners, where they can be placed into varying scenarios and navigate the landscape in such a way that they can leverage *CSN* to regulate and counter *Novelty*. As different approaches will lead to different outcomes (Aven, 2016, p.4), which is consistent with the 'sensitivity to initial conditions' (Schneider & Somers, 2006), I contend that the adoption of

the *CSN's* approach (guided by Ashby's Law, discussed in this present study) improves the anticipation and treatment of *Novelty* in DefSy. I have evaluated the practical contribution of *CSN* (through this study) and received either consensus or strong agreement on a set of indicators from an expert panel of senior DefSy actors and practitioners. Given there is no pre-existing multi-disciplinary validated model in place, I believe this constitutes a practical contribution.

During the data capture stages of this project, several panel members referred to the applicability of *CSN* in specific and discrete operational settings, and these are being explored currently. However, more pleasingly other panel members, and those who could not take part for organisational reasons have identified interest in *CSN* as a research base for several other, high-profile development programmes. Firstly, the Civil Service Leadership Academy have expressed an interest in *CSN*; as a practical component for inclusion in a course for Directors-General and CEOs from across the public and private sectors is presently in design. Secondly, recommendations and referrals have been made to work with the National Leadership Centre (HMG Cabinet Office), whose brief is to improve management across the public sector. More practically, I have been asked to present the findings of the research to the MOD Board and internally within the Cabinet Office. Additionally, and supporting the conceptual elements of *Intersects* and *Phi* (which underpin the development of Deep Subject Matter Experts) I have been asked to deploy *CSN* into an organisational review within the parent organisation; this is a testament to how this specialist knowledge can increase the capacity of DefSy. The above underlines the finding of the research that *CSN* is both valid and applicable and a contribution to practice. I would contend this work compliments the growing role of complexity within policy domains is evident through initiatives such as CECAN – the Centre for the Evaluation of Complexity Across the Nexus – a publicly funded programme. Whilst CECAN is not working in DefSy at present, the recognition that they give to complexity and risk across policy domains supports the currency of this project.

8.2.4 Methodological Contribution

While the use of 'Complexity related' Delphi studies is evident in other contexts—see Gajić & Palčič (2019) study of Complexity in an International Development Project—the use in this present study does not add anything new the research methodology literature per se. However, there are four specific observations I would offer that I think are of note.

1) ***How the ethical constraints associated with the Problem Space, and DefSy itself, guided the selection of the Delphi method.*** This related primarily to 'anonymity' amongst panel members, which is a key characteristic of the research gathering processes in a Delphi study. Having considered a number of approaches and tested the levels of receptivity from the expert panel, the benefits of Delphi was seen as being both less challenging to operationalise and held a degree of added credibility—given the anonymity element. In relation to the choice of research method itself, I had noted that prior to 2014 there had been little research in a combined PAR/Delphi approach (Fletcher & Marchildon, 2014), and given the nature of DefSy I suspect this was indeed the case (in this context). The practical difficulties of working through an anonymous panel prevented the interaction of the group; for example, workshops were not possible. Leveraging the participants was key to progression of the study, and this confirmed Kemmis et al.'s (2013) position on allowing those taking part to, not only contribute their views, but to also help shape the consequential changes. This philosophy was indeed the case for this project[34].

2) ***The way in which CSN evolved in parallel with the development of the expert panel.*** From the initial community of practice (CoP) that discussed the limitations of programme and risk management practices and some very early thoughts on emergence. How this group evolved and guided the adoption of participatory action research (PAR) as the chosen methodology (which according to Baum et al (2006, p.854) is "[A]t its heart is collective, self-reflective inquiry that researchers and participants undertake, so they can understand and improve upon the practices in which they participate."). Finally, how the PAR group evolved (in part) to form the Delphi expert panel. While there were some issues associated with this approach, for example the apparent asymmetric levels of knowledge associated with length of involvement and the fact some potential expert panel members could take part throughout for ethical reasons, the 'co-evolutionary' approach is noteworthy.

3) ***A secondary form of 'inter-rater reliability (IRR)' assessment.*** In addition to the Delphi assessment itself—and the use of inter-quartile ranges—the ongoing 'iterative sense-checking', described above, might be described as a 'co-produced' IRR process. As IRR has been viewed as "providing important method for ensuring rigour" (Armstrong, at al.,

[34] It is worth noting that since this project, the Delphi Technique has been adopted within discrete areas of the Problem Space in the design of strategic programmes.

1997, p.1) I would argue that this strongly adds to the strength of this methodology and is therefore of interest.

4) ***The assessment of 'General Agreement' as an indicator, in addition to Consensus.*** A reservation, associated with the adoption of Delphi, is that it seeks consensus on a position that could be positive or negative[35] which might have added little view in the present study. There was a risk that I might achieve consensus, that may have related to low scores for the model, i.e., the IQR may define consensus, but that the agreement was the model was neither valid nor applicable. To address this issue, I adapted the analysis to discern both consensus ***and*** the level of agreement on validity and applicability (of *CSN*). I would argue that this adds considerably to the robustness of and credibility of the Conceptual Framework and is of interest.

The results of this survey point to a need to improve performance in the area of risk and programme management; there are a range of reasons for this position. It could be the case that risk management is seen as fundamentally inadequate for any setting, or that this concern only applies in the area of Defence and Security, where the expectation is for excellence in threat management. I do not think this is a binary choice and the truth lies between these two positions. Notwithstanding this view, there is a requirement and desire to improve performance and *CSN* has been found to provide this opportunity.

8.3 Limitations

The progress of this programme has not been without limitations and these are summarised below, however, my overall assessment is that these have been manageable, though some caused more anxiety than others.

1. A key limitation has been the contextual changes I have experienced since the commencement of the programme (in 2014). Changing roles from being an external contractor working in the public sector (at commencement) through to joining the Civil Service and moving roles have required repeated justification of the benefits to the

[35] See Sharma et al., (2012) review of the Delphi Technique, with specific reference to consensus-reaching.

prevailing environment. Indeed, the research problem at enrolment bears little similarity to this present project.

2. The research method presented practical limitations. The Problem Space, being situated in DefSy, presented issues relating to confidentiality. This required a careful choice of panel members and limited the preferred route of data collection. In hindsight, however, the choice of Delphi is now seen as being an optimal research method for data collection rather than the product of a constrained research option set.

3. I sought participation from academics on the Delphi Panels. However, the indicators of 'applicability' as well as the particularly private/closed context of Defence and Security led to poor participation and a decision was made not to extend the Delphi to this group.

4. Operationalising the data collection presented other transactional limitations, as the collection was undertaken electronically, security firewalls (in the Problem Space) resulted in a delay of the documentation (for Round 1) being delivered to participants. While I saw the size of the panel as being sound and led to consistency (and saturation) of statements in Round 1, an aspiration to have a larger set from peripheral roles was not possible given security issues. The nature of the working environment constrained the size of the Delphi Panel and this, combined with a challenging operational context greater, limited the progress of Round 1 of the survey.

5. The nature of the present study, being a multi-disciplinary Conceptual Framework, has presented some time pressures as more effort was required to explain some of the terms set out in CSN. Whilst unavoidable given the framework's composition, the effects could have been ameliorated with a greater allowance for completion; however, as the timescales were planned, the effect was to increase to my workload. One limitation, that is also a strength of the Delphi Technique is the anonymity of participants (to each other), in practice, this resulted in numerous explanations of issues and intentions, where this would not have been required were anonymity not required.

As we have seen from this project, there will be innumerable variables that could constitute potential limitations, ultimately this will depend on the will of the leadership in the operational context to assess the overall benefits of the programme. As the research has shown that the programme is both valid and applicable to the Problem Space and that it can improve the resilience of DefSy, it is likely the limitations will be manageable.

8.4 Future Implications

Having concluded this research study, and having achieved its Aims and Objectives, I would contend I have met the requirement of the long-term commission given to me by the initial core group of senior actors. This being the case, I will now be presenting the results of the study back to that group, together with a method through which CSN, as the longer-term improved capability, can be deployed. I will be proposing that wherever this is deployed, the process will begin with a Delphi Study to obtain the level of perceived maturity in dealing with *Novelty.* Once a consensus of the level of maturity has been established, a discussion would then take place on the deployment of a development programme.

Table 26 provides an example of how organisations might structure the individual components/lessons. In a scenario where an organisational, or pan-organisational system is defined as being in a state of Low Maturity, it would be suggested that practitioners are at Tier 0, and from there a sequence of lessons would take place along the Areas of Knowledge groupings. Each lesson would focus on those of the 16 characteristics as detailed in Chapter 5.3 that are relevant to the specific Area of Knowledge.

As the programme would be a work-based programme, attendees would consider the application of the characteristics into their workplace problem. As the programme advances, increased emphasis would be given to the synergies that arise in the 'Intersects' (discussed in Chapter 5.4) as AoKs augment each other; this would culminate in a session on the specialist nature of Phi, when all characteristics and intersects merge into an advance level of knowledge in what can be described as High Maturity State. At both the practitioner and organisational/pan-organisational level, there would be an acknowledgement that the ability to counter *Novelty* had increased.

Table 26 Development Programme Outline

Tier	Complexity	Novelty	Understanding	Response
0	Elements focussed, Disconnected	Risk Manager, Surfer	Retrospective to Current Focussed	Linear Planner, Reactive
1	System focussed, Interconnected	Risk Manager, Surfer	Retrospective to Current Focussed	Linear Planner, Reactive
2	System focussed, Interconnected	Hazard Regulator, Explorer	Retrospective to Current Focussed	Linear Planner, Reactive
3	System focussed, Interconnected	Hazard Regulator, Explorer	Retrospective to Prospective Focussed	Linear Planner, Reactive
4	System focussed, Interconnected	Hazard Regulator, Explorer	Retrospective to Prospective Focussed	Feedback Regulator, Dynamic

In order to maximise and assess the impact of the programme, I would recommend the application of the framework to a PAR project; ideally, one that looks to resolve a work-based problem. I have explored options for internal and external assessment options to provide a formalised assessment on the completion of the programme and I have also explored accreditation for the programme itself by an awarding body. Plans are in place to explore this further following the completion of the programme.

8.5 Recommendations for Further Study

In setting out the results of the programme, one specific and key observation has arisen. The use of regulation tools is perceived to be administrative, more bureaucratic processes rather than active management tools and I would like to explore whether a more interactive approach to 'risk management' would garner increased interest. Moreover, whether this would result in a richer and more dynamic approach to risk regulation within DefSy. Having undertaken this study, I believe that an internal action research project should be undertaken to apply systems dynamics more actively in the practice of risk management across DefSy.

8.6 A Personal Reflection

Having now concluded this Practitioner Project I would now like to reflect on my own development since beginning the programme. To say this programme has been

transformational for me personally would not be hyperbolic. Although categorising these changes is, by definition, reductive and conflicts with my holistic worldview, using the term 'hues' seems to assuage this conflict. Also, another facet of this research has been the rise of pragmatism in my personal approach to life, for example, in a professional context, if I maintained what might be seen as a somewhat 'academic posture' would run counter to the need to disseminate the totality of growth and learning. In effect, I now need to bring my development to life through others and this needs to be in an accessible way – the findings of the study support this view. Returning to the theme of 'hues', I would cite the following to describe my overall growth: Professional Advancement; the inter-disciplinary approach of this Framework; Personal Behaviour Development and Philosophical Development; I expand on these here.

8.6.1 On Professional Advancement

My motivation in undertaking this project was to improve the extent to which I could augment organisational performance, in whichever context I was working. Due to a significant professional workload, I had to take a break for some 18 months, on reflection I was very pleased to return to the programme and revivify the journey. At that time, I had joined the Ministry of Defence, working in a DefSy function, and a discussion with my course leader, Dr Tracey Wond, led to my re-engagement into the programme. What I have noted, from reviewing my personal journals, is that the situational reviews and contemporaneous reflexivity evolved over the period in question. I have considered the reflections on my workplace and professional advancements, in line with the reflexive exercises I undertook. What I have noted is that I seemed to have placed myself into stressful situations, but these have generally led to, perhaps coincided, with some sort of professional development opportunity. Reflexity has enabled a greater sense of my own personal, subjective analysis of my personal growth too; understanding how someone from a challenging background is able to move into a vastly different setting is a testament to how such a journey can be transformational.

8.6.2 On the Inter-disciplinary approach of this Framework

Deep subject matter experts and senior actors have now acknowledged and validated *CSN* as offering the opportunity for mitigating systemic threat. However, having spent considerable time with this project, I feel this presented some limitations to my own development and, were

I to undertake the project again, I would have chosen to specialise in a single Area of Knowledge, Systems Dynamics.

With that being said, I regard the inter-disciplinary nature (of this project) as enabling a skill set rather than a single specialism, which this is consistent with the choice of a professional doctorate, rather than a PhD. I do feel I have developed deep SME level knowledge on four areas rather than one, and I now have a firm foundation for a choice of further development. A major, positive finding emerging from this project was the synergistic benefits of the Conceptual Framework: when I realised that the variables were 'inter-twined' and 'inter-connected', it was almost an epiphany, a realisation that opened my eyes to the pan-disciplinary nature of reality. To adjoin Sherman and Meadows '[T]here are no separate systems; the world is a continuum. Nothing is exogenous.'

8.6.3 On Personal Behaviour Development

There have been many discrete areas of development, along varying axes, but one example is in the area of 'Political Networking'. In this area, I had determined that in order to accelerate my personal impact, I needed to expand my personal connections. At that time, I had been in the civil service for about 18 months compared to others at my grade, who had been in the MOD for over 20 years. These colleagues typically had far more extensive, and richer, networks that that had cultivated over time and the immaturity of my own this was frustrating my performance. I decided to review and improve this situation through Assessment Two: Professional Development Review and developed a strategy to bring about tangible improvements – the key to which was the decision to source a personal mentor. In electing this individual, my criteria were relatively straightforward – they had to be 'connected', someone who had clearly demonstrated their ability to move things along through breadth, depth and strengths of their connections. I was very fortunate to find this person—CJ. Through an initial meeting, we agreed to a single objective, to develop my network at a meaningful level and for the ensuing 12 months, we met regularly and discussed discrete challenges that I felt met the criteria for the intervention. At the end of the programme of meetings, my network, and as important the skills and behaviours, had advanced to such a degree it enabled my move into another area of HMG, a sensitive area of the Cabinet Office.

8.6.4 On Philosophical Development

I came into this research project with a worldview that perceives life as living in a reality (which I see as waves of information) but also part of this reality. This worldview has become, through my ongoing reflections (of daily interactions and observations), even more ingrained; but it has not been without challenge. When undertaking a particularly deep reflexive phase, I tried to examine the worldview/work-view dichotomy, which forced me to question whether I would be able to effectively situate my learning into the Problem Space, within DefSy. The nature of the workplace, I observed, was still based on the rational, the reductive, the easy to understand. I was not, in that context, able to gain traction for some of the learning, which raised questions regarding the capability of the system (another manifestation of Requisite Variety?). This phase took place over several weeks and I concluded that the constraints were local; the networking I had begun reinforced my perception of the local limitations. This situation cannot be said of my current place of work: the culture is more advanced, more informed – indeed it uses the vernacular of complexity in everyday communications. I feel my own worldview fits within these local connections: using the language of this study – the variables are requisite.

The purpose of this reflection was to review my own development during this study. Bourner et al., (2001, p.72) argue that the difference between a PhD and a professional doctorate is that the latter will "include the capacity to make a significant original contribution to the knowledge of professional practice through research, plus one or more of the following:

- Personal development (often specifying reflective practice);
- Professional level knowledge of the broad field of study;
- Understanding of professionalism in the field;
- Appreciation of the contribution of research to the work of senior professional practitioners."

I would argue that all these additional factors have been advanced, to a great extent, through this study. In addressing the contribution to professional practice, I would say the following have achieved this goal: (a) the momentum gained during the study, (b) the interest shown by interested 3rd parties, (c) the validated *CSN* and finally, (d) the proposed models for the introduction *CSN* into practice, which includes assessment against a maturity model. I am very pleased that work is advancing well with the future development of this programme in a number of areas across HMG.

8.7 Conclusion

This study was initially commissioned by senior actors within the Defence and Security sector, as a result of a presentation I gave relating to the emergence of risk in pan-government programmes. The commission was two-fold and centred around the development of a Conceptual Framework that would, (a) address the immediate situation; but more importantly, (b) prevent this situation from re-occurring. In answering this commission and working within a framework of Participatory Action Research, I found 'Systemic Novelty' to be at the heart of the research problem. Given it was apparent that existing systems do not address this phenomenon adequately, I worked with a small group of practitioners (as a Community of Practice and critical friend group) and began the development of what became, *CSN* – a conceptual framework that 'Counters Systemic Novelty'.

This Practitioner Project established an overall *Aim* together with three *Objectives* to answer the Research Problem and it has achieved these objectives. It has explored the relevant literature review and established *CSN* as the Conceptual Framework, finally, it has undertaken a three-round Delphi study that tested the Validity and Applicability of the framework within the research context–DefSy. This was the first such research study within this context and as such adds to the research literature across a range of areas. The study ultimately found that *CSN* was both Valid and Applicable for adoption within DefSy and the process of adoption has already commenced.

The study surpassed its original intent as national level development programmes are already showing interest in the framework. *CSN* has also been found to have wider benefits too, with some of the facets being deployed into other areas of organisational development; policy reviews and reorganisation programmes are two such examples.

The research questions, together with the contributions from research participants have provided additional depth to the study and identified other areas for development within the research context. These relate to the level of maturity of risk management, both at the organisational level and at the programme management level; both areas are currently being explored given the narratives contained within the emergent findings.

Finally, I would contend that the structure of this Practitioner Project has not only provided a route through which the research problem can be addressed, it has also provided the opportunity for considerable personal growth.

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APPENDICES

1. Soft Systems Methodology – Principles

CONTENT REMOVED DUE TO COPYRIGHT REASONS

Source: Wilson (2001, p.27)

2. Soft Systems Methodology – Root Definition Rules

1) A RD should be one sentence in which the major verb represents the transformation process. Additional sentences (outside the RD) may be used to define the meaning attributed to certain words within the RD if necessary.
2) The mnemonic CATWOE (together with the defined meanings of its elements) is used as a test of the structure and words used in the RD. Once consistency between the CATWOE elements and the words used in the RD has been achieved, CATWOE has served its purpose and has no further relevance to the construction of the CM.
3) The elements T and W must be identifiable in every RD. Thus they are mandatory. The elements C, A, O and E are included or excluded on the basis of the analysts' judgement. A well- structured RD should only have one transformation process.
4) Words and/or phrases may be included within a RD to qualify other words and/or phrases to add richness or specificity to a RD without them being represented as CATWOE elements. They therefore do not affect the structure of the R D. However, words and/or phrases must not appear as CATWOE elements without also appearing in the RD.

3. Soft Systems Methodology – Conceptual Model Rules

1) The CM must be constructed from the words in the RD without recourse to the specific situation. Thus, the inclusion of activities and/or sets of activities within the CM must be defended against specific words or phrases within the RD.
2) Since each activity in the CM could be the source of a RD for expansion to a more detailed level, sufficient words should be used within the activity to be precise about the transformation process it describes.
3) The CM should be defensible against the FSM. The major implication of this is that there should be adequate connectivity, reference to resourcing and at least one 'monitor and control' subsystem within the CM.
4) Arrows within a CM are essentially logical dependencies and should have a consistent format. Arrows which represent accumulated dependencies (such as activity performance information and constraint information) may have a different format and labelled to indicate their content. Temporary dependencies as dependencies with unknown destination (such as control action) should be of a different format. In essence arrows which look the same should mean the same. Double-headed arrows are not permissible. (The desire to include them between two activities usually means that an activity is omitted. This is usually a feedback, updating or control type activity.)

4. Ethical Approval briefing and consent letter

Dear Participant,

Participant Briefing and Consent Letter: Doctorate in Professional Practice: Countering Emergent Systemic Novelty (CESN) -

Firstly, I would like to thank you again for agreeing to take part in this research programme.

Further to earlier conversations and correspondence, I am collecting data from you that will be used in my thesis as part of my Doctoral Programme at the University of Derby.

The purpose of the research is to *"To provide an assessment of the future applicability of the CESN conceptual framework by seeking the collective views of both security and defence actors together with an academic perspective from the field of operations science, specifically in the area of risk management."*

What you will be asked to do in this research: The research takes the form of an expert panel who are treated as anonymous throughout to each other. This panel will take part in a number of surveys that seeks consensus on the viability of the Conceptual Framework mentioned above. In practical terms this exercise takes the following form:

Round 1 - Schedule ~ May 2019 - panel members are asked to provide 7 key factors relating to the validity of the Conceptual Framework in countering the threat of Emergent Systemic Novelty. (there would be some reading in advance that may take approximately 30 minutes).

Round 2 - Schedule ~ May/June 2019 - collated responses are fed back to panel members who are asked to rank each statement.

Round 3 - Schedule ~ June 2019 - an analysis of the rankings is played back to participants to review their responses to check for consensus.

It is hoped that the totality of time/effort should be not exceed two – three hours over the three rounds.

I should point out that the intention of this research is for the final results to be published and disseminated via other modes. At all times your details will be protected in line with the Privacy Notice below.

Privacy Notice

The information that you supply for this Delphi Study be held and processed in compliance with the Data Protection Act 2018, the General Data Protection Regulation (GDPR) and subsequent legislation. The data you provide will only be used for this research project, and will not be

disclosed to any third party, except as part of the dissertation findings, or as part of the supervisory or assessment processes of the University of Derby.

This information will be used by Chris Sheader (Unimail c.sheader2@unimail.derby.ac.uk) in the context of his research on the DProf programme. The lawful basis for collecting and processing this data is that it forms part of a degree programme of study at the University of Derby.

The participant agrees that if they wish to withdraw from the study they will, within 21 days of providing data, communicate with the researcher to indicate they wish to withdraw and provide the self-generated unique identifier below. All data and information relating to the individual requesting withdrawal will be deleted.

The data from consenting participants will be retained until project completion when the student has received their grade and degree award following submission of their work. It is anticipated that the data will be securely destroyed by Chris Sheader.

_____	_____	_____
Name of Participant	Digital signature	Date

Unique Identifier: _____ 3 Letters & 3 Numbers (not name, birthdate etc).

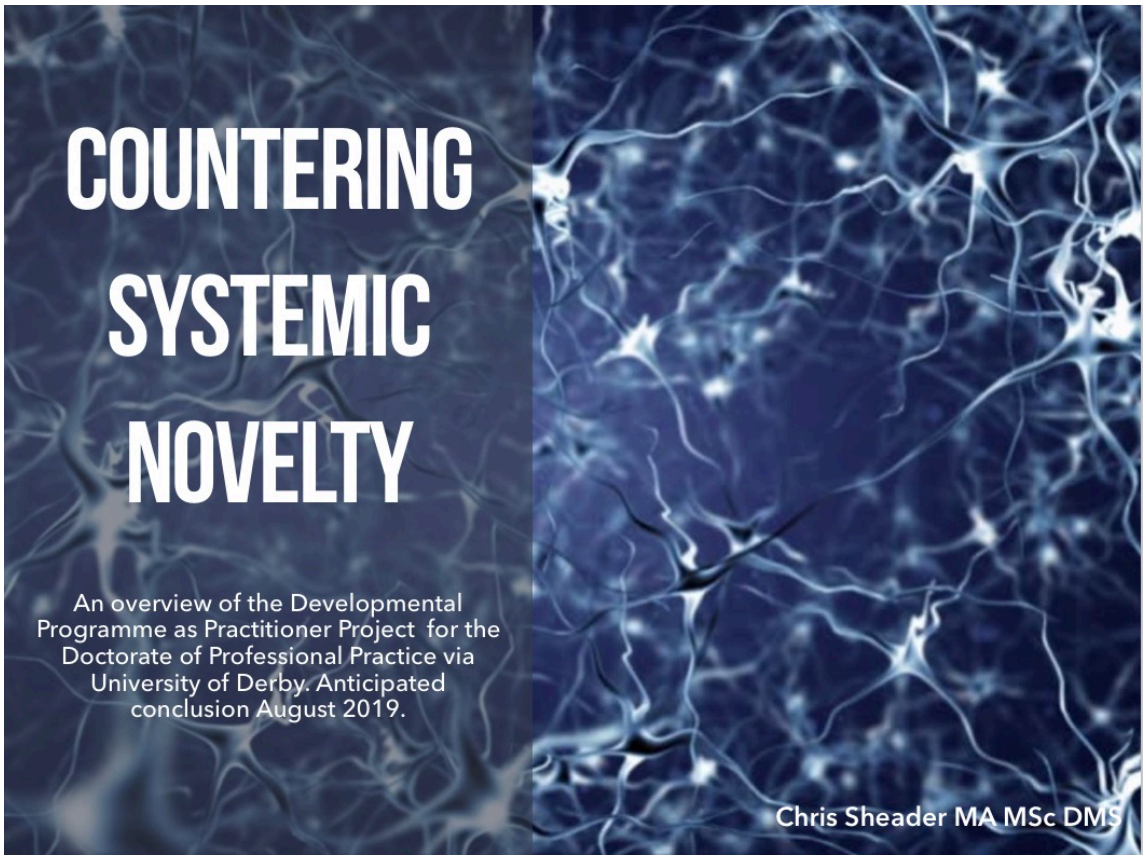
I give my explicit consent for my details to be used as stipulated: Yes | No

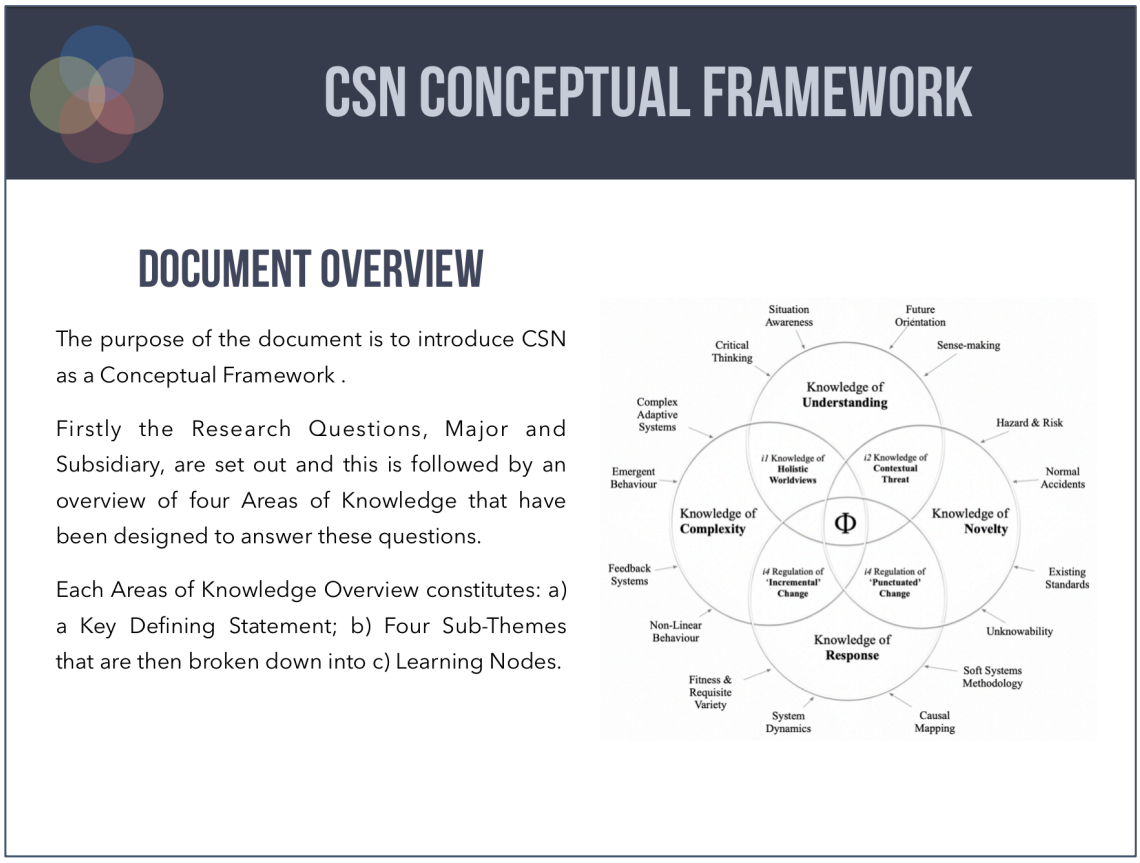
As a data subject you can request withdrawal of consent at any time by contacting gdpr@derby.ac.uk

Our Data Protection Officer (DPO) is James Eaglesfield on (01332) 591762. Our Deputy DPO is Helen Rishworth on (01332) 591954. Alternatively, you can email gdpr@derby.ac.uk

Further information on how we handle your information can be found here on our website - https://www.derby.ac.uk/its/datagov/privnotice/

5. CESN Panel Member Information Pack - Component 1





AREAS OF KNOWLEDGE

Complexity

Hazard

Understanding

Response

RESEARCH PROBLEM

The management of risk is an organisational, and therefore bounded function. However, this has been seen (via the researcher's lived experience) as being limited and an inward-looking practice. Where external examination had been witnessed, this had considered 'known' issues, and not considered potential 'emergent issues' arising from the interaction of extra-organisational, ecosystem initiatives that are both unknowable and unbounded. This lack of understanding of 'Emergent Systemic Novelty' (as the central phenomenon), and its active regulation presents significant threats to the resilience of the operating context, i.e., the Problem Space.

MAJOR RESEARCH QUESTION

Can a holistic, multi-disciplinary conceptual framework be deployed as a strategic tool to address the research problem thereby help to maintain the stability of the Defence and Security sector across HMG (known as the Problem Space)?

SUBSIDIARY QUESTIONS

Q.1. What are the discrete Areas of Knowledge relating to the programme threat and its remediation?

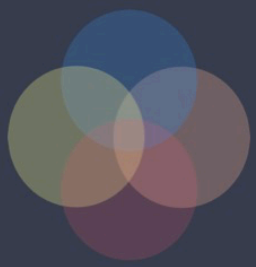
Q.2. How can these Areas of Knowledge be developed into a method to counter the threats to the Problem Space?

Q.3. Can the validity and applicability of the method be verified across a range of Problem Space Practitioners?

Emergent Systemic Novelty

COMPLEXITY QUESTIONS

To what extent is the operating environment straight-forward, predetermined and predictable? What are the systemic variables and how are they governed?



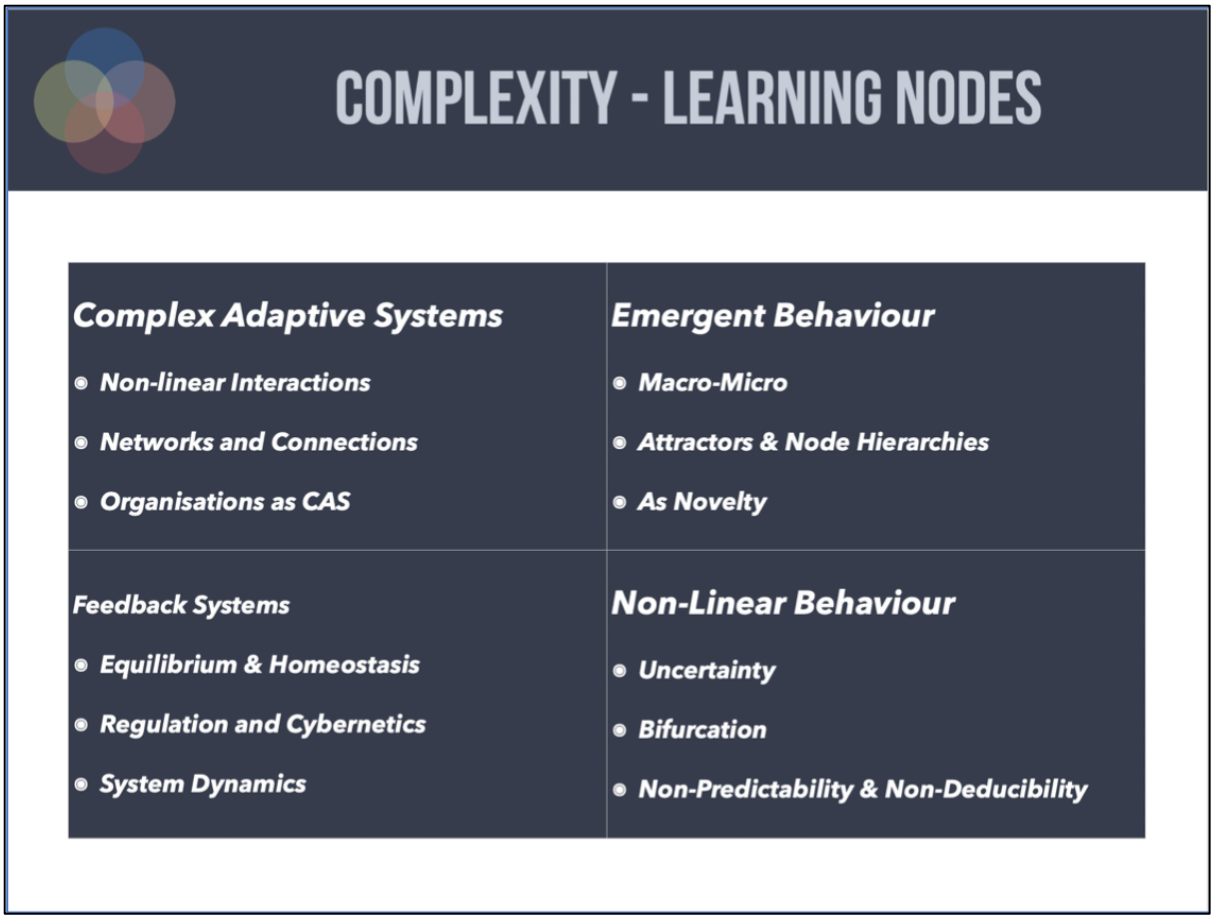
KEY DEFINING STATEMENT

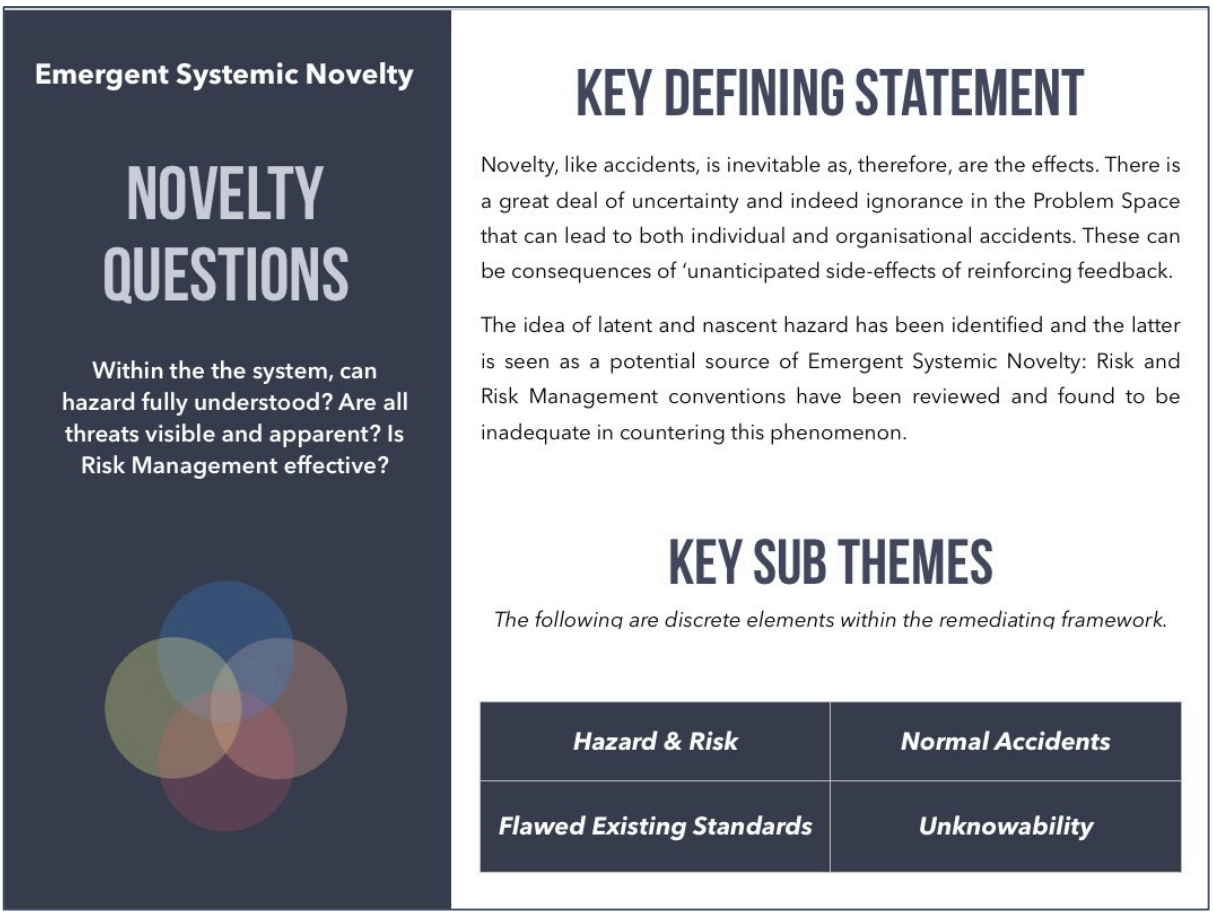
The Problem Space is a Complex Adaptive System where novelty arises and cannot be predicted. Novelty has been found to be an emergent property of complex systems, a property which is both non-predictable and non-deductible and which can be exponentially self-reinforcing to such an extent it destabilises the system. Novelty has been compared to strange attractors (for an accessible example consider the Butterfly Effect) and is 'non-linear' in its behaviour, due in large part to the bifurcation of system variables in the environment. Actor/Practitioners have stated that they are not aware of this construct (CAS) which leaves the Problem Space in a persistent state of threat.

KEY SUB THEMES

The following are discrete elements within the remediating framework.

Complex Adaptive Systems	***Emergent Behaviour***
Feedback Systems	***Non-Linear Behaviour***


COMPLEXITY - LEARNING NODES
Complex Adaptive Systems
Non-linear Interactions
Networks and Connections
Organisations as CAS
Emergent Behaviour
Macro-Micro
Attractors & Node Hierarchies
As Novelty
Feedback Systems
Equilibrium & Homeostasis
Regulation and Cybernetics
System Dynamics
Non-Linear Behaviour
Uncertainty
Bifurcation
Non-Predictability & Non-Deducibility


Emergent Systemic Novelty
NOVELTY QUESTIONS
Within the the system, can hazard fully understood? Are all threats visible and apparent? Is Risk Management effective?
KEY DEFINING STATEMENT
Novelty, like accidents, is inevitable as, therefore, are the effects. There is a great deal of uncertainty and indeed ignorance in the Problem Space that can lead to both individual and organisational accidents. These can be consequences of 'unanticipated side-effects of reinforcing feedback.
The idea of latent and nascent hazard has been identified and the latter is seen as a potential source of Emergent Systemic Novelty: Risk and Risk Management conventions have been reviewed and found to be inadequate in countering this phenomenon.
KEY SUB THEMES
The following are discrete elements within the remediating framework.
Hazard & Risk
Normal Accidents
Flawed Existing Standards
Unknowability

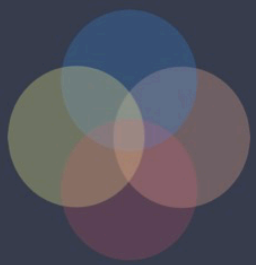
RESPONSE - LEARNING NODES

Fitness & Requisite Variety	***Soft Systems Methodology***
◉ *Fitness Landscapes & Resilience*	◉ *Human Activity System*
◉ *The Ashby Space*	◉ *Application across the Problem Space*
◉ *Optimising Variables*	◉ *Importance of Perspectives*
Causal Mapping	***System Dynamics***
◉ *Using Relational System Knowledge*	◉ *Open vs Closed System Thinking*
◉ *Reinforcing and Balancing Effects*	◉ *Stocks and Flows*
◉ *Feedback and Connectivity Loops*	◉ *Integrating Requisite Variety*

Emergent Systemic Novelty

UNDERSTANDING QUESTIONS

How can practitioners comprehend the situational factors and characteristics in their operating environment? How does time influence this understanding?



KEY DEFINING STATEMENT

The importance of critical thinking, skill, knowledge and experience stands out as a key capability required to address Emergent Systemic Novelty. Prospective Sense-Making and Situation Awareness skills have been highlighted as being particularly important to enable Actor/ Practitioners to themselves in a position of "being ahead of the plane".

It is argued that this 'future orientation' together with considerable field expertise (via Retrospective Sense-making) will also allow for improved risk management and, in turn, improve the ability to counter Emergent Systemic Novelty.

KEY SUB THEMES

The following are discrete elements within the remediating framework.

Critical Thinking	***Sense-making***
Future Orientation	***Situation Awareness***

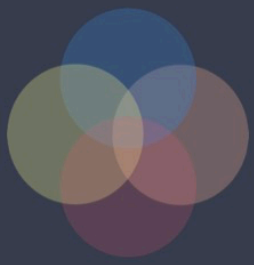
UNDERSTANDING - LEARNING NODES

Critical Thinking	***Sense-making***
◉ *Risks of Bias*	◉ *Retrospective, experience focussed*
◉ *Reflective & Reflexive Practice*	◉ *Prospective, anticipation focussed*
◉ *Kahnemann Systems 1 & 2*	◉ *Individual and Group Assessment*
Future Orientation	***Situation Awareness***
◉ *Contextual Mental Models*	◉ *Dynamic Orientation*
◉ *The Nature of Time and Space*	◉ *Perception, Comprehension, Projection*
	◉ *Subject Matter Expertise*

Emergent Systemic Novelty

RESPONSE QUESTIONS

What role does the environment have on the system? How can practitioners reduce system hazard and prevent risk?



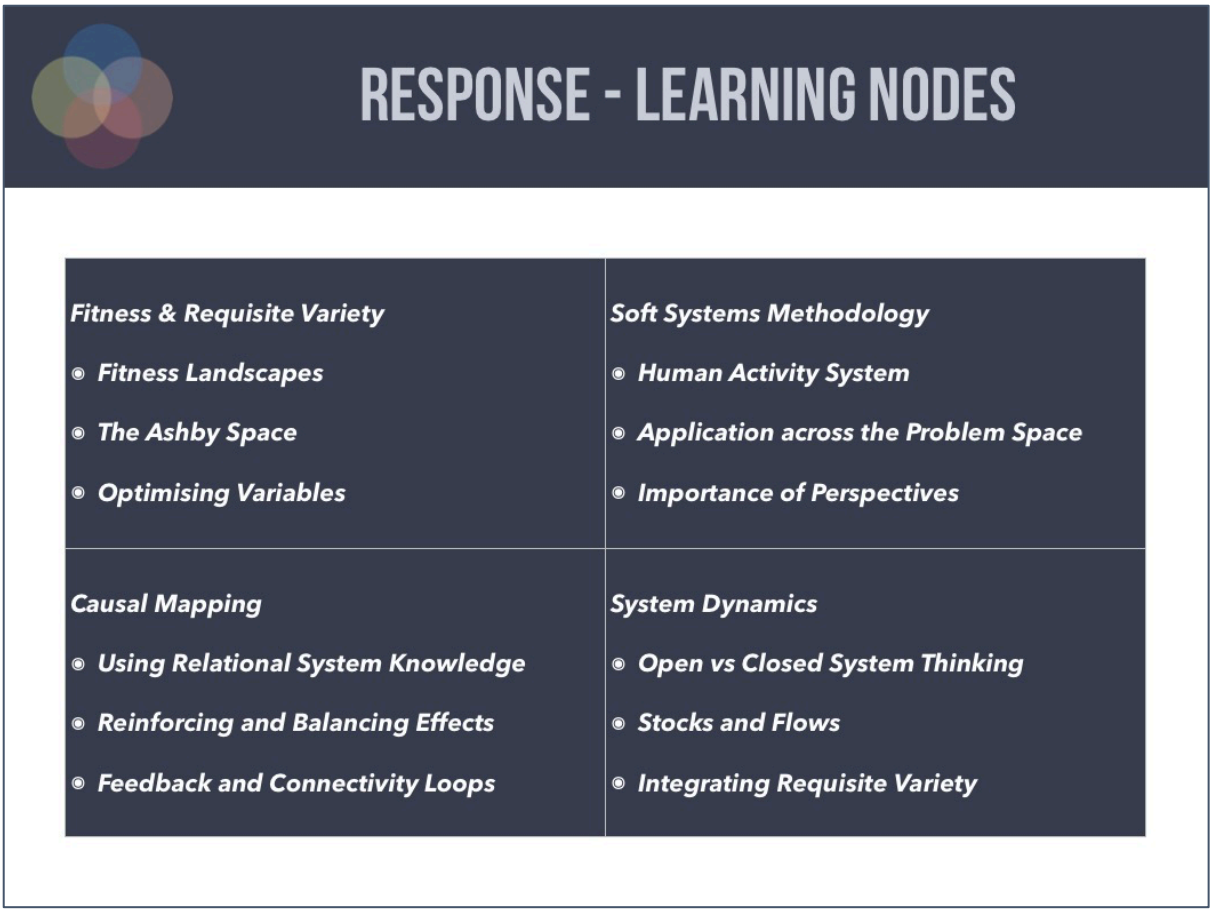
KEY DEFINING STATEMENT

A systems philosophy has been examined that is consistent with the overall research paradigm. Being situated in a wider environment, Requisite Variety has been outlined as a governing mechanism that relates to system capability. Soft Systems Methodology has been reviewed and it is proposed that this approach is more conducive to the problem at hand and supports the transforming of organisations away from hazard through regulation of feedback. System Dynamics has been reviewed, as a mindset and as a toolset, and is proposed as an effective technique for Practitioners to both understand the Problem Space itself (for example using causal mapping) and anticipate Emergent Systemic Novelty (or unanticipated side-effects). The nature of knowledge has been reviewed and the benefits of 'relational knowledge' have been highlighted; it is argued this would be a complementary and effective attribute for Practitioners in countering Emergent Systemic Novelty.

KEY SUB THEMES

The following are discrete elements within the remediating framework.

Fitness & Requisite Variety	***Soft Systems Methodology***
Causal Mapping	***System Dynamics***


RESPONSE - LEARNING NODES
Fitness & Requisite Variety
Fitness Landscapes
The Ashby Space
Optimising Variables
Soft Systems Methodology
Human Activity System
Application across the Problem Space
Importance of Perspectives
Causal Mapping
Using Relational System Knowledge
Reinforcing and Balancing Effects
Feedback and Connectivity Loops
System Dynamics
Open vs Closed System Thinking
Stocks and Flows
Integrating Requisite Variety

6. CESN Panel Member Information Pack - Component 2

This element of the Panel Member Information Pack was a composite of the Areas of Knowledge Capsules (Chapter 5.2) and the 16 Characteristics (Chapter 5.3). These are not shown here to avoid content repetition.

7. Delphi Panel Round 1 Instrument

Dear

You have been selected for this research as you have expert knowledge related to the Conceptual Framework developed during this research project. In order to I gather the richest information from you, please ensure you read all accompanying research components before completing these questions. To assist you with formatting requirements, I have provided examples that have emerged during the development of the model from interactions in the expert group.

Please provide as many responses as you can for each question, maximum 10. Once you have completed the questionnaire please return this document via e-mail to chris.sheader@cabinetoffice.gov.uk. *If you would like to discuss the completion of this questionnaire, please do let me know and I will be available for a face to face or telephone conversation.*

Q1. Having read the components, please provide your opinions the ***validity*** of the model.

Factor ID	Collated Statements / Factors
Example 1	We currently do not consider the management of unknown threats, so this would be a useful too. We are clearly missing risks.
Example 2	We use an organisational template for programme risk management, this does not view threats as complex, it is viewed as an administrative task.
1	
2	
3	
4	
5	
6	

7	
8	
9	
10	

Q2. Having read the components, please provide your opinions the ***applicability*** of the model.

Factor ID	Collated Statements / Factors
Example 1	This could be applied to discrete groups of people, or those deployed in Intervention Teams / Project Pre-mortem Review Teams.
Example 2	This model could be used to develop junior/middle project managers as an internal qualification.
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

8. Delphi Panel Round 2 Instrument

Dear Research Participant

Thank you for responding to the first round of the Delphi Study related to the management of risk and resilience within Defence and Security.

Your comments have now been analysed and 14 'Collated Statements' have been developed that capture the essence of the group's submissions. You will now be asked to rate each of the collated statements using the following scale: 1 indicates you *Strongly Disagree* through to 9 which indicates you *Strongly Agree*. Please indicate your rating in the column shown.

Two tables are attached; please use the scales shown to rate each statement in each table. The tables contain the collated statements from Round 1 related to the Validity and the Applicability of the Conceptual Framework the Critical National Infrastructure.

Validity is defined as: The information in the Conceptual Framework is seen as offering a "Thick and Rich Description" of relevant practices and theories.

Applicability is defined simply as: "the quality of being relevant or appropriate" for implementation in the Critical National Infrastructure.

You may find it helpful to refer to the components previously circulated.

Thank you again for your participation in this study. I would be very appreciative if you would return your responses by Fri 21st June, 2019, to my email address - chris.sheader@cabinetoffice.gov.uk. Should you wish any further clarification, please do email me and I will arrange a telephone call.

Regards

Chris Sheader, Doctoral Candidate

Please review the statements below and provide your opinion as to the extent to which you agree with the statement.

1 2 3 4 5 6 7 8 9

Strongly Disagree Strongly Agree

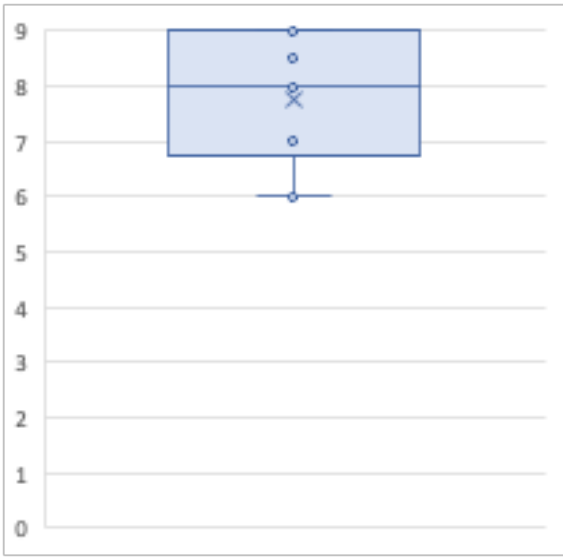
ID	Collated Statements / Factors - Validity	Rating
1	The model is valid as it 'Identifies Limitations in Current Practices', e.g., risk management, budget setting.	
2	The model is valid as it 'Improves Current Limited Practices', e.g., risk management, budget setting.	
3	The model is valid as it 'Evolves Current Direction' in this general area.	
4	The model is valid as it 'Adds Credibility with Academic Underpinnings'.	
5	The model is valid as it can be used in a 'Targeted Intervention'.	
6	The model is valid as it can 'Develop People/Groups' to improve organisational performance.	
7	The model is valid as it could be a 'Development Programme'.	
8	The model is valid as it can 'Develop Specialists' this will improve organisational performance.	
9	The model is valid as it highlights the 'Immaturity of Current Systems'.	
10	The model is valid as it highlights a limiting 'Lack of Knowledge of Emergence/Non-Linearity' in the operating environment.	
11	The model is valid as it highlights a limiting 'Lack of Knowledge of Understanding' in the operating environment.	
12	The model is valid as it highlights a limiting 'Lack of Knowledge of Novelty as Risk' in the operating environment.	
13	The model is valid as it uses clear and accessible language and terminology	
14	The model is valid as it avoids over analysing and has a clear methodology and approach	

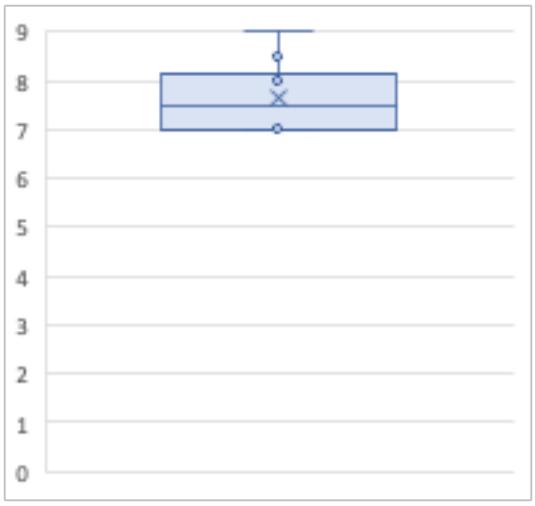
1 2 3 4 5 6 7 8 9

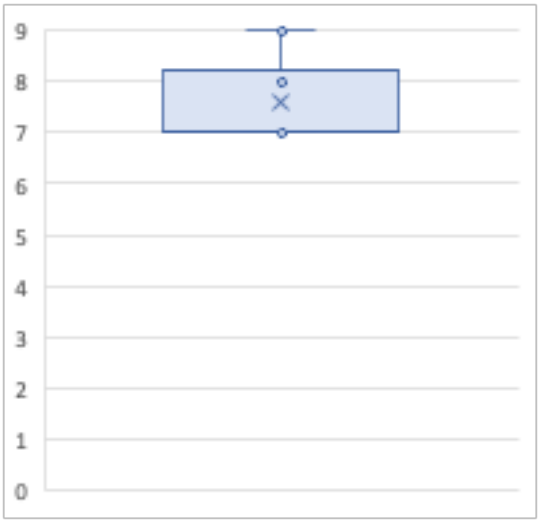
Strongly Disagree Strongly Agree

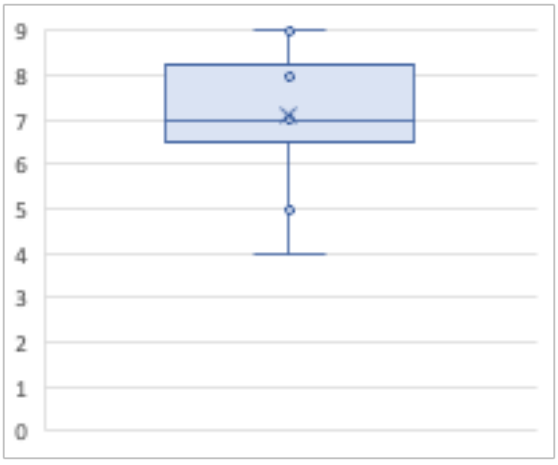
ID	Collated Statements / Factors – Applicability	Rating
1	The model is applicable as it 'Identifies Limitations in Current Practices', e.g., risk management, budget setting.	
2	The model is applicable as it 'Improves Current Limited Practices', e.g., risk management, budget setting.	
3	The model is applicable as it 'Evolves Current Direction' in this general area.	
4	The model is applicable as it 'Adds Credibility with Academic Underpinnings'.	
5	The model is applicable as it can be used in a 'Targeted Intervention'.	
6	The model is applicable as it can 'Develop People/Groups' to improve organisational performance.	
7	The model is applicable as it could be a 'Development Programme'.	
8	The model is applicable as it can 'Develop Specialists' this will improve organisational performance.	
9	The model is applicable as it highlights the 'Immaturity of Current Systems'.	
10	The model is applicable as it highlights a limiting 'Lack of Knowledge of Emergence/Non-Linearity' in the operating environment.	
11	The model is applicable as it highlights a limiting 'Lack of Knowledge of Understanding' in the operating environment.	
12	The model is applicable as it highlights a limiting 'Lack of Knowledge of Novelty as Risk' in the operating environment.	
13	The model is applicable as it uses clear and accessible language and terminology	
14	The model is applicable as it avoids over analysing and has a clear methodology and approach	

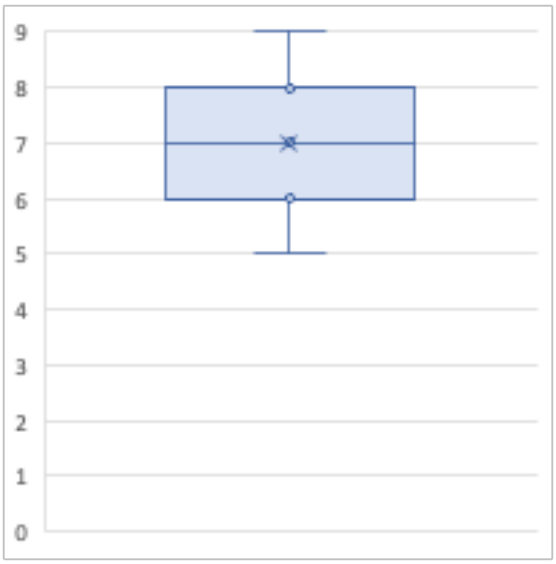
9. Results Analysis Collated Statements - Validity

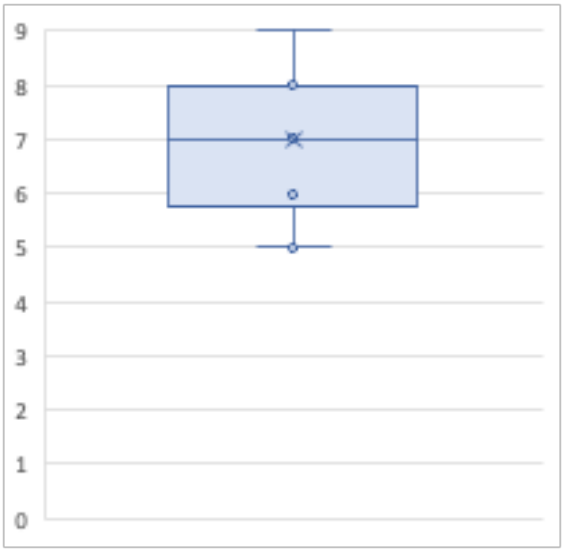
1: The model is valid as it 'Identifies Limitations in Current Practices', e.g., risk management, programme management and budget setting.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 7.8 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *did not reach consensus* with the IQR for this statement of 1.9, but in accordance with the criteria, this does indicate strong agreement. The minimum score was 6, the maximum was 9, and the Std Dev was 1.18.	

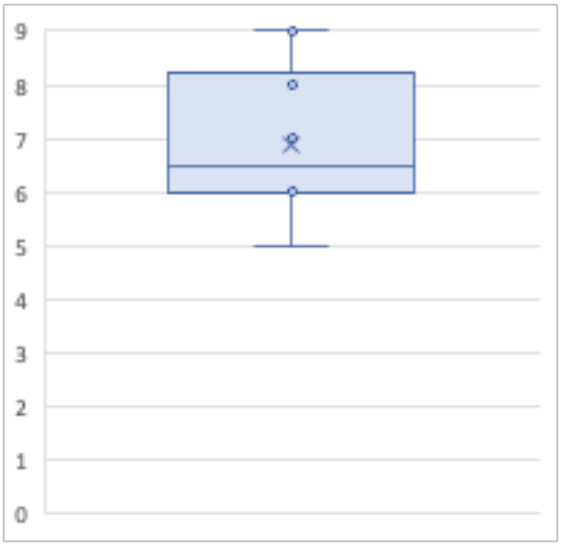
2: The model is valid as it 'Improves Current Limited Practices', e.g., risk management, programme management and budget setting.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 7.7 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *reached consensus* with the IQR for this statement of 1.0. The minimum score was 7, the maximum was 9, and the Std Dev was 0.75.	

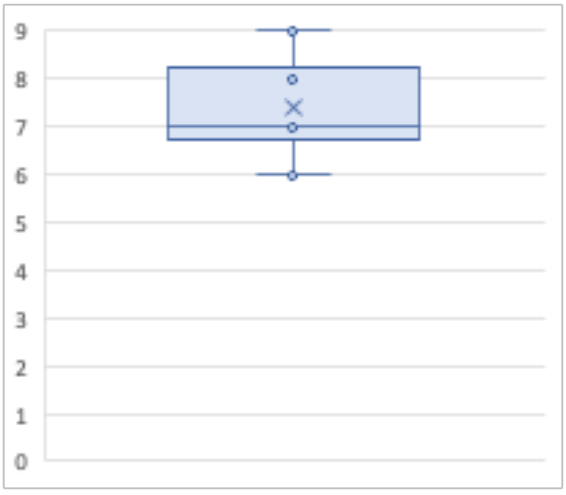
3: The model is valid as it 'Evolves Current Direction' in this general area.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 7.6 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *reached consensus* with the IQR for this statement of 1.0. The minimum score was 7, the maximum was 9, and the Std Dev was 0.84.	

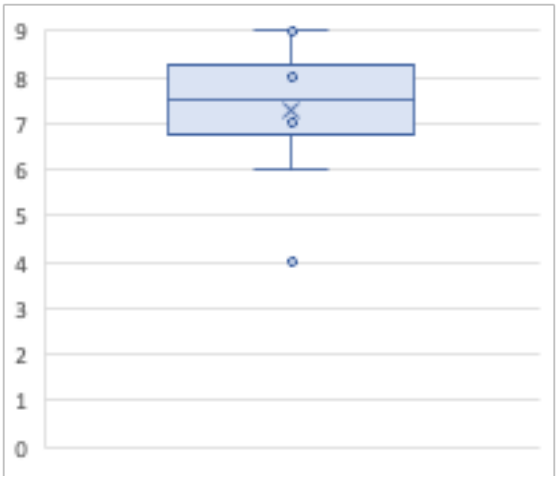
4: The model is valid as it 'Adds Credibility with Academic Underpinnings'.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 7.1 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *reached consensus* with the IQR for this statement of 1.0. The minimum score was 4, the maximum was 9, and the Std Dev was 1.60.	

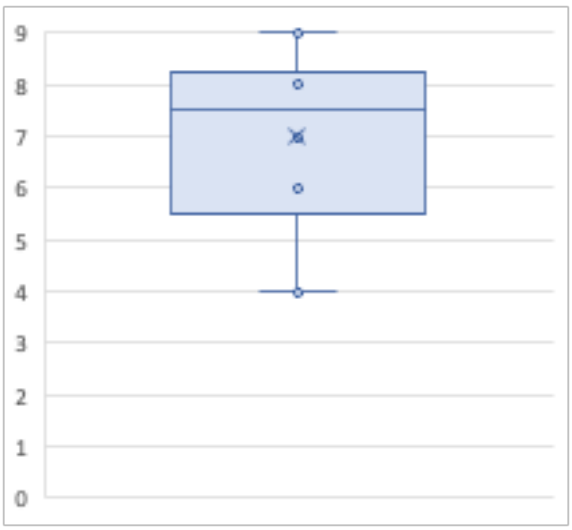
5: The model is valid as it can be used in a 'Targeted Intervention'.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 7.0 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *did not reach consensus* with the IQR for this statement of 1.5, but in accordance with the criteria, this does indicate strong agreement. The minimum score was 5, the maximum was 9, and the Std Dev was 1.15.	

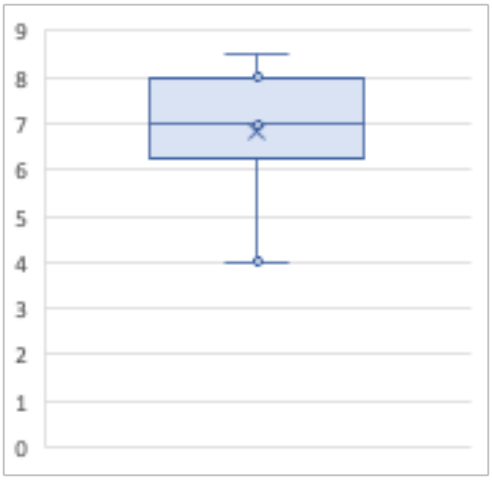
6: The model is valid as it can 'Develop People/Groups' to improve organisational performance.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 7.0 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *did not reach consensus* with the IQR for this statement of 1.8, but in accordance with the criteria, this does indicate strong agreement. The minimum score was 5, the maximum was 9, and the Std Dev was 1.33.	

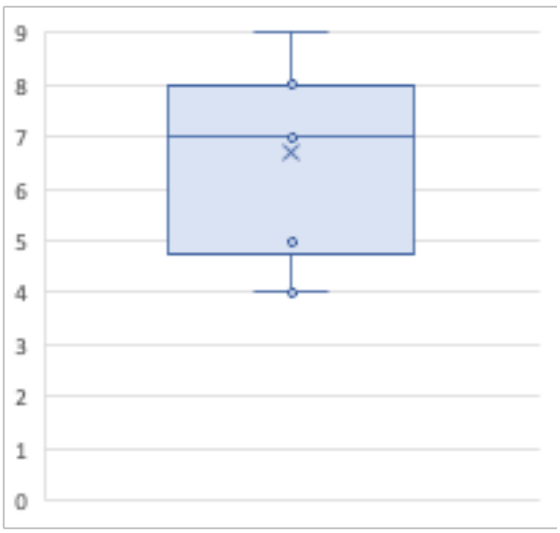
7: The model is valid as it could be a 'Development Programme'.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 6.9 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *did not reach consensus* with the IQR for this statement of 1.8, but in accordance with the criteria, this does indicate strong agreement. The minimum score was 5, the maximum was 9, and the Std Dev was 1.37.	

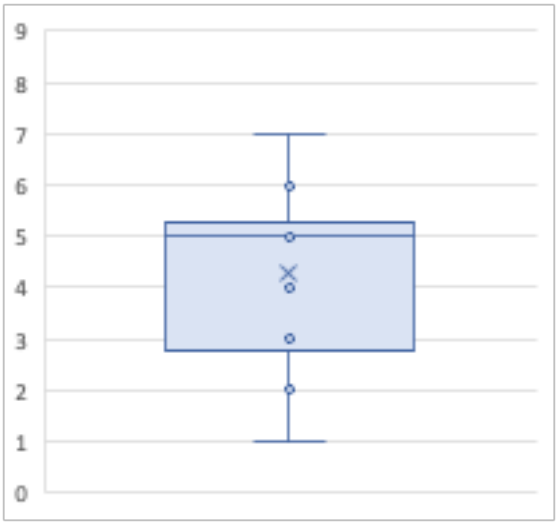
8: The model is valid as it can 'Develop Specialists' this will improve organisational performance.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 7.4 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *reached consensus* with the IQR for this statement of 1.0. The minimum score was 6, the maximum was 9, and the Std Dev was 1.07.	

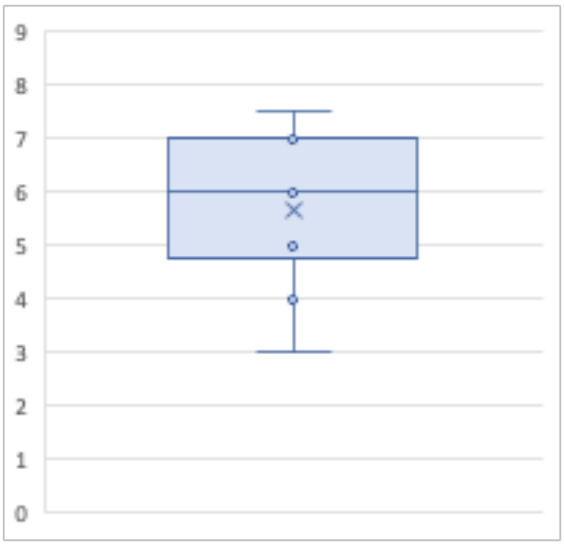
9: The model is valid as it highlights the 'Immaturity of Current Systems'.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 7.3 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *reached consensus* with the IQR for this statement of 1.0. The minimum score was 4, the maximum was 9, and the Std Dev was 1.83.	

10: The model is valid as it highlights a limiting 'Lack of Knowledge of Emergence/Non-Linearity' in the operating environment.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 7.0 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *did not reach consensus* with the IQR for this statement of 1.8, but in accordance with the criteria, this does indicate strong agreement. The minimum score was 4, the maximum was 9, and the Std Dev was 1.83.	

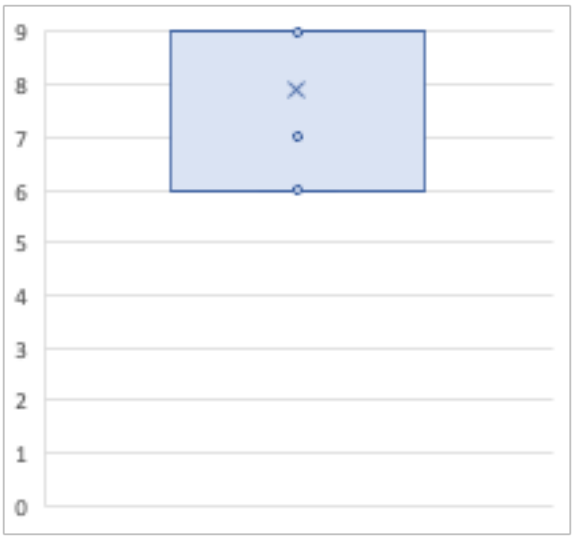
11: The model is valid as it highlights a limiting 'Lack of Knowledge of Understanding' in the operating environment.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 6.9 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *reached consensus* with the IQR for this statement of 1.0. The minimum score was 4, the maximum was 9, and the Std Dev was 1.60.	

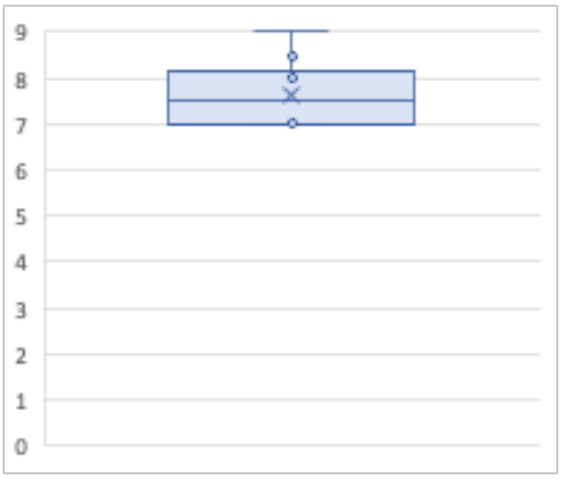
12: The model is valid as it highlights a limiting 'Lack of Knowledge of Novelty as Risk' in the operating environment.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 6.7 (on the Likert Scale) indicating an 'Agreement Bias'. The distribution of ratings meant that the panel *did not reach consensus* with the IQR for this statement of 2.5, but in accordance with the criteria, this indicates weak agreement. The minimum score was 4, the maximum was 9, and the Std Dev was 1.77.	

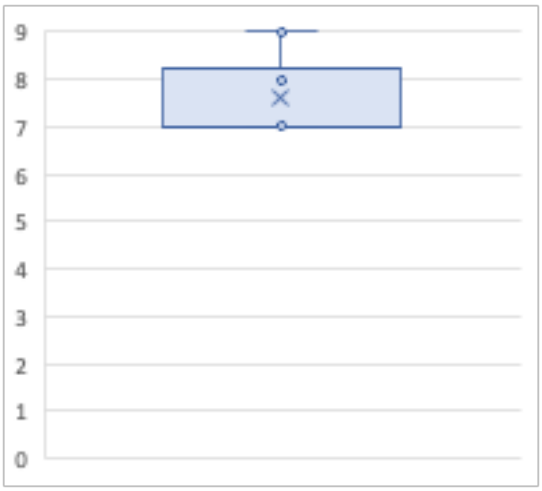
13: The model is valid as it uses clear and accessible language and terminology	
Results & Key Narratives	Box Plot
The graph visually demonstrates a lack of support for the validity statement with a Group Mean of 4.3 (on the Likert Scale) indicating a 'Dis-agreement Bias'. The distribution of ratings meant that the panel *did not reach consensus* with the IQR for this statement of 1.8, but in accordance with the criteria, this does indicate strong agreement. The minimum score was 1, the maximum was 7, and the Std Dev was 1.83.	

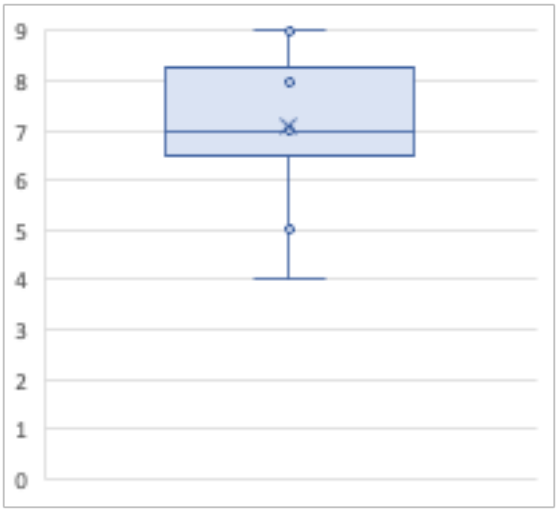
14: The model is valid as it avoids over analysing and has a clear methodology and approach	
Results & Key Narratives	Box Plot
The graph demonstrates a bias of support for the validity statement with a Group Mean of 5.7 (on the Likert Scale) indicating an 'Agreement Bias'. The distribution of ratings meant that the panel *did not reach consensus* with the IQR for this statement of 1.8, but in accordance with the criteria, this does indicate strong agreement. The minimum score was 3, the maximum was 8, and the Std Dev was 1.42.	

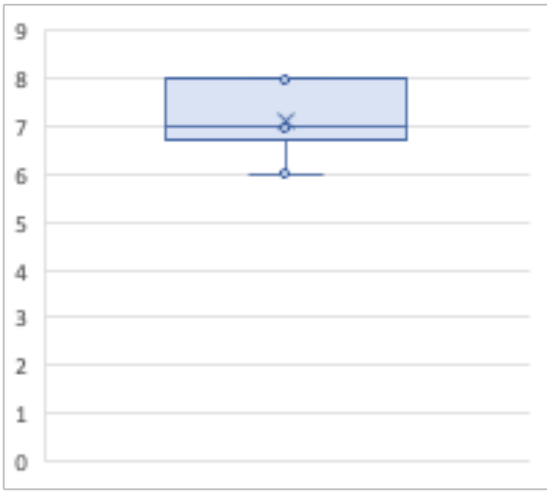
10. Results Analysis Collated Statements - Applicability

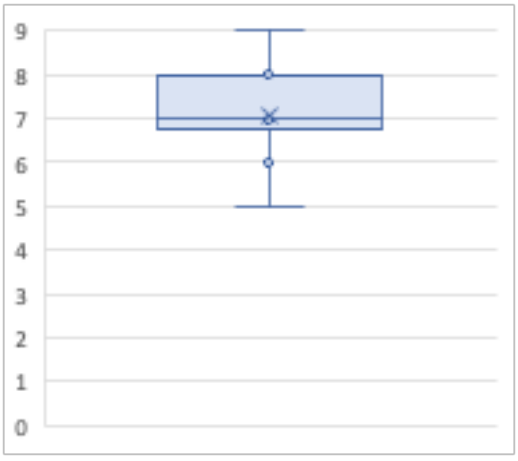
1: The model is applicable as it 'Identifies Limitations in Current Practices', e.g., risk management, programme management and budget setting.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 7.9 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *did not reach consensus* with the IQR for this statement of 2.8, in accordance with the criteria, this indicates weak agreement. The minimum score was 6, the maximum was 9, and the Std Dev was 1.45.	

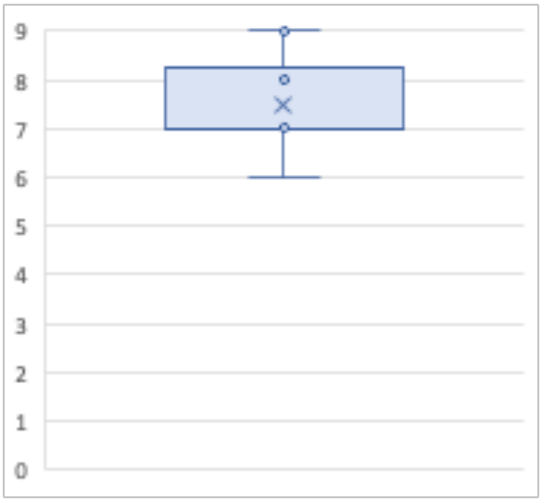
2: The model is valid as it 'Improves Current Limited Practices', e.g., risk management, programme management and budget setting.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 7.2 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *reached consensus* with the IQR for this statement of 0.8. The minimum score was 5, the maximum was 9, and the Std Dev was 1.03.	

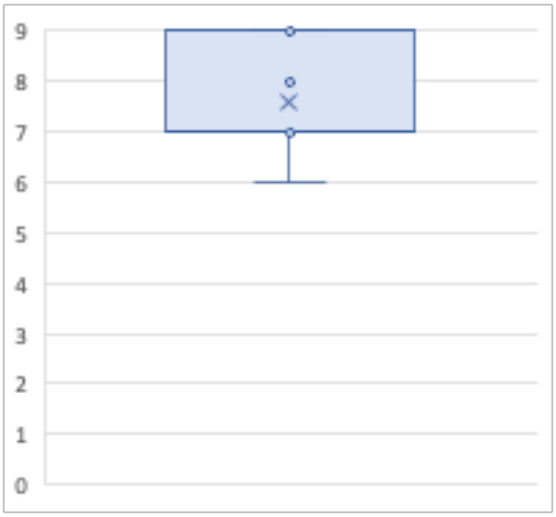
3: The model is valid as it 'Evolves Current Direction' in this general area.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 7.3 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *reached consensus* with the IQR for this statement of 1.0. The minimum score was 5, the maximum was 9, and the Std Dev was 1.06.	

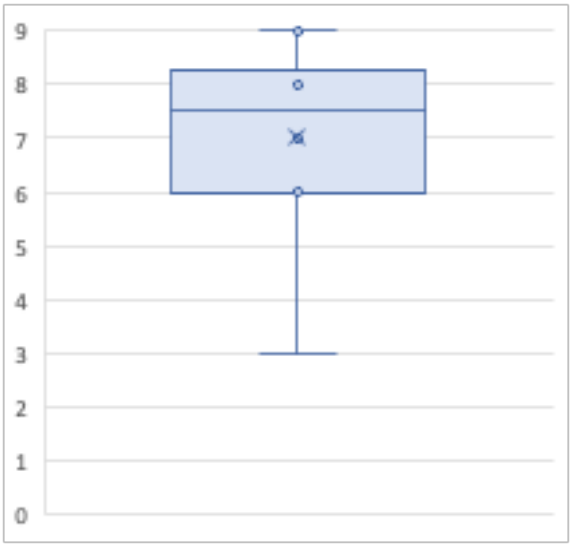
4: The model is valid as it 'Adds Credibility with Academic Underpinnings'.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 6.3 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *did not reach consensus* with the IQR for this statement of 3.0, in accordance with the criteria, this indicates weak agreement. The minimum score was 3, the maximum was 9, and the Std Dev was 2.16.	

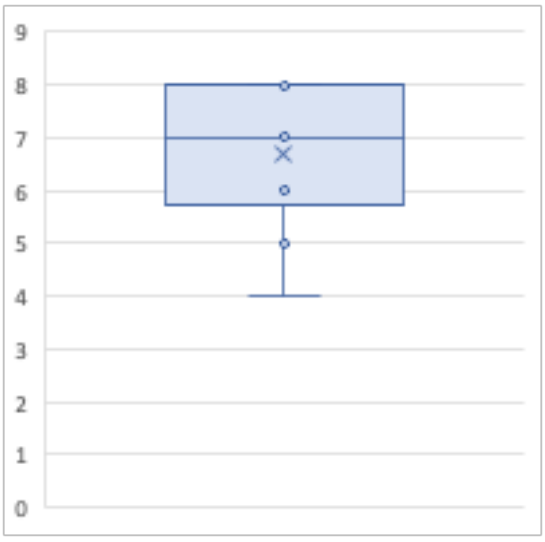
5: The model is applicable as it can be used in a 'Targeted Intervention'.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 7.1 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *reached consensus* with the IQR for this statement of 0.8. The minimum score was 6, the maximum was 8, and the Std Dev was 0.74.	

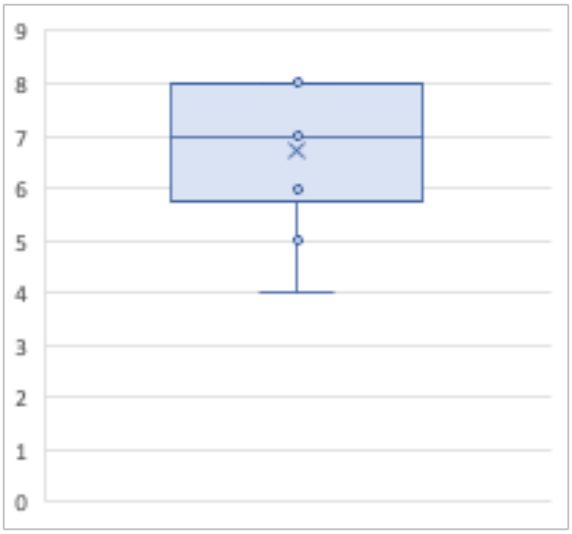
6: The model is applicable as it can 'Develop People/Groups' to improve organisational performance.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 7.1 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *reached consensus* with the IQR for this statement of 0.8. The minimum score was 5, the maximum was 9, and the Std Dev was 1.03.	

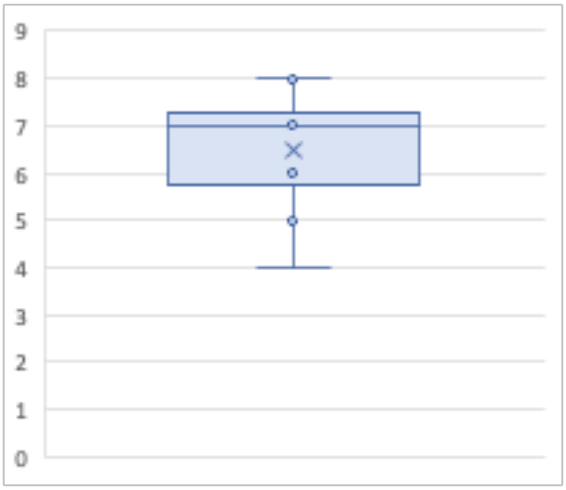
7: The model is applicable as it could be a 'Development Programme'.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 7.5 (on the Likert Scale) indicating a 'High Agreement Bias'. The distribution of ratings meant that the panel *reached consensus* with the IQR for this statement of 2.0. The minimum score was 6, the maximum was 9, and the Std Dev was 0.97.	

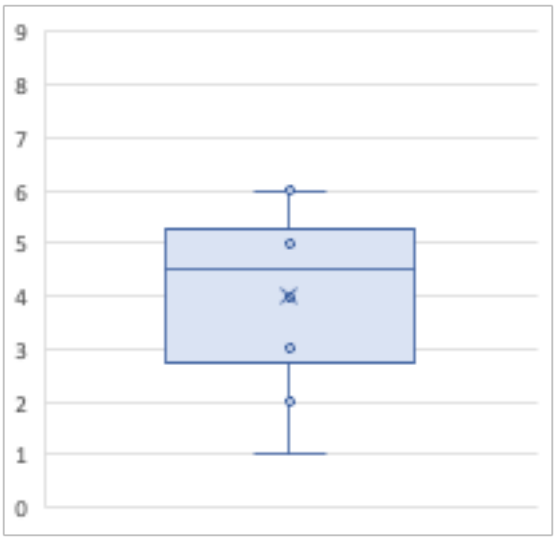
8: The model is applicable as it can 'Develop Specialists' this will improve organisational performance.	
Results & Key Narratives	Box Plot
The graph demonstrates a bias of support for the validity statement with a Group Mean of 7.6 (on the Likert Scale) indicating an 'Agreement Bias'. The distribution of ratings meant that the panel *did not reach consensus* with the IQR for this statement of 1.8, but in accordance with the criteria, this does indicate strong agreement. The minimum score was 6, the maximum was 9, and the Std Dev was 1.07.	

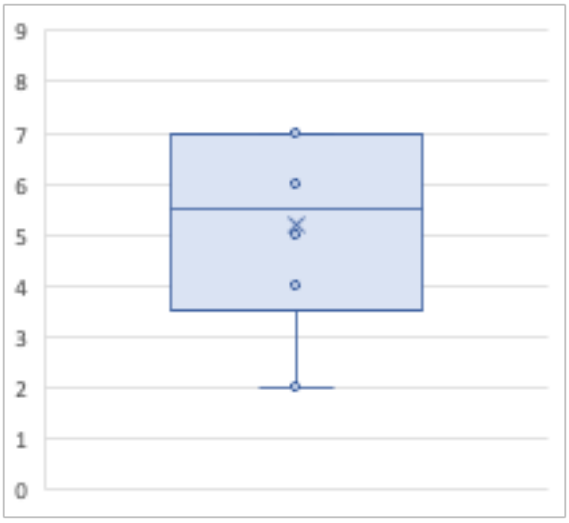
9: The model is applicable as it highlights the 'Immaturity of Current Systems'.	
Results & Key Narratives	Box Plot
The graph demonstrates a bias of support for the validity statement with a Group Mean of 7.0 (on the Likert Scale) indicating an 'Agreement Bias'. The distribution of ratings meant that the panel *did not reach consensus* with the IQR for this statement of 2.0, but in accordance with the criteria, this does indicate strong agreement. The minimum score was 3, the maximum was 9, and the Std Dev was 1.83.	

10: The model is applicable as it highlights a limiting 'Lack of Knowledge of Emergence/Non-Linearity' in the operating environment.	
Results & Key Narratives	Box Plot
The graph demonstrates a bias of support for the validity statement with a Group Mean of 6.7 (on the Likert Scale) indicating an 'Agreement Bias'. The distribution of ratings meant that the panel *did not reach consensus* with the IQR for this statement of 1.5, but in accordance with the criteria, this does indicate strong agreement. The minimum score was 4, the maximum was 8, and the Std Dev was 1.34.	

11: The model is applicable as it highlights a limiting 'Lack of Knowledge of Understanding' in the operating environment.	
Results & Key Narratives	Box Plot
The graph demonstrates a bias of support for the validity statement with a Group Mean of 6.7 (on the Likert Scale) indicating an 'Agreement Bias'. The distribution of ratings meant that the panel *did not reach consensus* with the IQR for this statement of 1.5, but in accordance with the criteria, this does indicate strong agreement. The minimum score was 4, the maximum was 8, and the Std Dev was 1.34.	

12: The model is applicable as it highlights a limiting 'Lack of Knowledge of Novelty as Risk' in the operating environment.	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 6.5 (on the Likert Scale) indicating an 'Agreement Bias'. The distribution of ratings meant that the panel *reached consensus* with the IQR for this statement of 1.0. The minimum score was 4, the maximum was 8, and the Std Dev was 0.97.	

13: The model is applicable as it uses clear and accessible language and terminology	
Results & Key Narratives	Box Plot
The graph demonstrates a bias of support for the validity statement with a Group Mean of 4.0 (on the Likert Scale) indicating an 'Agreement Bias'. The distribution of ratings meant that the panel *did not reach consensus* with the IQR for this statement of 2.0, but in accordance with the criteria, this does indicate strong agreement. The minimum score was 1, the maximum was 6, and the Std Dev was 1.70.	

14: The model is valid as it avoids over analysing and has a clear methodology and approach	
Results & Key Narratives	Box Plot
The graph visually demonstrates a bias of support for the validity statement with a Group Mean of 5.2 (on the Likert Scale) indicating an 'Agreement Bias'. The distribution of ratings meant that the panel *did not reach consensus* with the IQR for this statement of 2.8, in accordance with the criteria, this indicates weak agreement. The minimum score was 2, the maximum was 7, and the Std Dev was 1.99.	

11. Delphi Panel Round 3 Instrument

Dear

Thank you for your continued participation in this Delphi Study relating to the management of threat and hazard in the Defence and Security Sector. For this, the final phase of the study I attach the shortened data collection tool.

The attached table presents an analysis of the ratings from the responses to Round 2. The Group Mean column contains the average of the responses from the panel, while the Individual Rating column contains the response that you provided. In order to fully develop a consensus, please review the group mean for each trait. Should you desire to change your individual response based on the collective feedback from the group, you may do so by indicating a response in the Revised Rating column. I will be recalculating all responses based on this final round of the study. Please note that to develop consensus on the most valid or applicable characteristics, all responses with a group mean of less than 4.0 were eliminated at the conclusion of Delphi 2.

If you are satisfied with your responses and the overall group mean for each response, please place an X in the relevant box so that I can document your intention.

Kindly review your responses, indicate changes or a desire for no change, and forward back to me via my e-mail address - chris.sheader@cabinetoffice.gov.uk. I would very much appreciate receiving your responses by Friday 28th June, 2019.

Validity Factors

Factor ID	Collated Statements / Factors - Validity	Group Mean	Individual Rating	Revised Rating
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				

Applicability Factors

Factor ID	Collated Statements / Factors - Applicability	Group Mean	Previous Rating	Revised Rating
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				

12. Delphi Panel Results Communication

Dear

Thank you for the significant contribution you have made to this Delphi Study relating to the management of threat and hazard in the Defence and Security Sector. I hope that your involvement has raised your interest in this area, certainly I see that Emergence and Novelty play a significant role in our professional lives, whether we are aware of if it or not.

I have now tabulated the results and will be incorporated into the final thesis for submission in August this year. I thought I would share with you an early presentation of the results from the surveys; the presentation of the information should be familiar to you now. Should you want to discuss this I would be more than happy to do so.

Tables not inserted to avoid repetition.

Once the final results are established, I will send you a copy of the associated presentation for your information to show how your contribution has helped develop the Development Framework.

Many thanks again and warm regards,

Chris Sheader

Email: chris.sheader@cabinetoffice.gov.uk