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Culture in sustainable infrastructure

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The high failure rate of infrastructures around the world is alarming, most especially when such failures constrain economic growth and development. In most cases, existing institutions or strategies designed to maintain and reproduce effective infrastructures in areas that lack them have been mostly unsuccessful, particularly in sub-Saharan Africa. A carefully conducted survey covering the six geopolitical zones in Nigeria confirms the low-level stability, supply, quality and maintenance of infrastructure and its services. Using the severity index in matrix order model developed in this study, major factors responsible for unsustainable infrastructure delivery and failures are identified. The paper further argues that these major factors are interrelated rather than being peculiar to Nigeria or sub-Saharan Africa. Suffice it to say that the effects of these problems are widespread and of global impact. However, what cuts across all the major factors responsible for unsustainable infrastructure delivery and high failure rates are gross institutional lapses. In view of the fact that sustainable infrastructure is essential for sustainable development, this paper emphasises the uniqueness of the recipients' cultures and values alongside the integration of indigenous communities and infrastructure users: from conceptualisation to delivery within the framework for institutional building and sustainable infrastructure provision.

1. Background

The purpose of this paper is to establish the importance of human culture in the provision of sustainable infrastructure. An introduction to this subject requires a brief description of what constitutes sustainability and its associated concepts, an understanding of what sustainable infrastructure provision is all about and some examples of cultural influence on sustainable infrastructure, and specifically road infrastructure. In context, however, it is important to state that infrastructure forms an indispensable part of the measurement of living conditions and standards of living. It is also a proxy measure for a development index. Therefore sustainable infrastructure is a proxy indicator for sustainable development.

In simple terms, 'sustainability' implies prolongation, support and maintenance without necessarily compromising future capabilities. However, studies (ADB, 2009; Baker, 2006; Lafferty and Meadowcroft, 2000; Who, 2005; World Bank, 1994, 2003) reveal that sustainable infrastructure depends on key elements and the interrelationships between them; these elements being sociopolitical, economic, the physical environment and the population (otherwise classed either as users or in terms of their cultural make-up). For this reason, when the ability to replicate an existing infrastructure or the capability to procure a new one is compromised, it is likely to cause poverty and in some cases chaos that would inevitably undermine social–political, economic and physical environments. This is likely to make the whole arrangement for sustainable infrastructure provision discriminatory at best, not to say unbearable and non-viable.

Infrastructure provision can be viewed as decisions made through collective choice mechanisms during the process of acquiring goods, works and services. This process may lead to the award and execution of contracts (Ostrom *et al.*, 1993); they cover the types of goods, works and services to be provided, the quantity supplied, their quality, stability and maintenance, the arrangements for their production and financing, and monitoring the performance of those who produce them.

This definition of infrastructure provision does not emphasise the involvement of users. However, because humans are obviously involved in collective decision-making, human

interactions are fundamental to this process. Understanding the sociology of human interactions is therefore essential to the provision of sustainable infrastructure. This paradigm is widely perceived as human culture.

Nevertheless, it is evident from studies that culture is indispensable to humankind, not only as regards sustainable development but also for satisfactory moral, emotional and intellectual wellbeing (Hasna, 2007; Lfs, 2006; Unesco, 2001). Regrettably and sometimes arguably in the recent past, the cultural factor is often undermined in the conceptualisation, planning and management of infrastructure globally.

In particular, researchers (Helbing *et al*., 2001; Lay, 1992) have shown that road infrastructure predates contemporary human civilisation. This is basically due to cultural multiplicity and to the economies and even the military expeditions of ancient civilisations. Communities, kingdoms and empires have grown because of the availability of local infrastructures and most especially roads. For example, Rome from approximately 312 BC was the first regional power to construct straight strong stone or paved roads that eventually covered 78 000 km in Europe and North Africa to support its military campaigns and trade (BBC, 2011). Other evidence for such construction exists in India, Persia (Iran) and other parts of the Middle East (Lendering, 2001). In northern Europe, England has the oldest engineered timber road (i.e. corduroyed) network, with its associated construction and maintenance support institutions (Current Archaeology, 2001; O'Flaherty, 2002). (Institutions are defined as humanly devised constraints that outline human interactions; they function and structure incentives in human exchange, be they political, social or economic. Therefore, institutional change is a way of shaping societal evolution and the means to understand and visualise the spectrum of historical change (North, 1991).)

For clarity, it is important at this stage to describe how this paper is subdivided. It consists of six major sections:

- a background
- some examples of infrastructure failures
- an outline of the research methodology, consisting of a case study, research survey, questionnaire and hypotheses
- analysis of the survey results: confirmation of the hypotheses, ranking of procedures and measurement of spread and ranked position of major variable factors
- discussion of survey results
- observations, deductions and conclusions.

1.1 Some examples of infrastructure failures

In Nigeria, urban and rural roads deteriorate rapidly during the rainy seasons, domestic and industrial sewage is still being discharged into ditches and open drains leading to hazardous emissions, and choked drains have resulted in floods in many towns and cities (Awortwi, 2003; Awotona, 1987). Added to these unsanitary conditions is the risk of accidents from poor roads and transportation systems. Furthermore, it is customary for people to wait for public funding for rehabilitation and replication instead of maintaining existing infrastructure. However, declining financial resources coupled with inadequate funding is making public capital infusion very unrealistic, while rapid deterioration of infrastructure is on the increase (WBG, 1996). As a result, most infrastructures are underfunded. The demand for sustainable infrastructure in Nigeria is thus overwhelming compared with its current potential to provide and invest in such infrastructure.

Similarly, in America, underfunding of infrastructure is still an issue. Studies have revealed that mass infrastructure failures in Arizona, New Jersey, Minneapolis and New Orleans are not isolated cases but are symptomatic of disrepair and underfunding of systems in various parts of America. American Society for Civil Engineers (ASCE, 2005) ratings of the state of road infrastructure in America revealed the very poor condition and wasteful nature of American roads (BBC, 2007a). The ASCE emphasised the current dismal conditions of the road infrastructure in all US states, a situation worsened in particular by the current inadequate funding at the local, state and federal levels.

In the UK, road infrastructure failures are uncommon, if not non-existent in some parts of the UK compared with sub-Saharan Africa, Asia, Latin America and the USA. However, there are occasional infrastructure failures due to maintenance problems and ineffective planning. One example is the track maintenance failure in Cumbria in 2007 that contributed to the crash of a train travelling from London to Glasgow, with one death and several injuries (BBC, 2007b).

Further examples of infrastructure failures in the UK include those following natural disasters that result in displacements, blackouts, water shortages and transportation failures such as the ones in Gloucestershire, the southwest, the Midlands, Yorkshire and Humberside after the severe flooding of 2007, costing the economy an estimated £3 billion (ICE, 2008). As revealed in Sir Michael Pitt's report (Pitt, 2008), this flooding resulted basically from the inability to plan effectively for pluvial and fluvial flooding. In civil engineering, surface (pluvial) flooding results from heavy rainfall and ineffective drainage, which could lead to moisture being accumulated within structural layers; this can cause serious problems for infrastructure, possibly leading to pore pressure and reduced material resistance to shear within the sub-grade and base layers. Settlement could sometimes result because some soils such as clay expand when moist. However, river (fluvial) flooding results from either natural or culverted watercourses

that could also damage existing infrastructure if not adequately planned and designed for by flood risk assessments. This is how ineffective planning could result in infrastructural failures. This paper will present the methodology used in order to clarify the overall approach, constraints and ethical choices when applicable.

2. Research methodology

The general aim of this investigation is to verify some existing hypotheses and rank the factors most responsible for failures in infrastructure and service provision. This aim derives from a pilot study conducted while examining a wide cross-section of views; the study uses quantitative research and a case study. The latter will be examined from a global perspective.

2.1 Case study

Nigeria was chosen as a case study for sub-Saharan Africa because its population makes up almost a quarter of that region. It consists of approximately 504 ethnic groups comprising 774 local government areas and over 6932 local communities. The country also has one of the largest regional energy reserves. Despite these advantages it is seen as having one of the worst cases of dearth and failure of infrastructure of any country in the region.

2.2 Research survey

The survey was conducted using structured interviews and a questionnaire using the two-stage stratified random sampling technique. Stratified random sampling is a method whereby the sample size is subdivided into segments, otherwise referred to as strata, based on some specified characteristics, each of which is then subjected to random sampling (Gay, 1996; Leed and Ormrod, 2001). The technique was adopted in order to achieve an aggregate cross-section of the study population, while the questionnaire method ensured cost effectiveness and anonymity. These data were generated using an ordinal scale, which places the respondents in relation to each other in terms of the intensity of their attitude towards an issue (Kumar, 1999). It therefore shows the strength of one respondent's view in relation to those of others.

The six geopolitical zones in Nigeria constituted the first stratum; afterwards respondents were randomly selected from the second stratum, the respondent's sector or organisation in each of the six selected states, with one from each geopolitical zone. The six geopolitical zones were the south-west (Lagos state), south-south (Edo state), south-east (Imo state), north-west (Kano state), north-central (Kaduna state) and north-east (Adamawa state); respondents were drawn from public and private sectors and from non-governmental organisations. The sample size for this investigation was 600, divided into 100 potential respondents for each of the six geopolitical zones. The questionnaires were distributed accordingly.

2.3 Questionnaire

The questionnaire was structured as follows.

Part A: some personal questions concerning willingness to respond to the questionnaire, geopolitical regions, sector/organisation, status, range of monthly income and age.

Part B: the current state of the infrastructure, categorised by stability, supply, quality, maintenance, response rate to infrastructure maintenance, staff of infrastructure service providers and monthly costs of infrastructure services.

Part C: Respondents were later asked to rank in order of severity 18 identified causes of infrastructure failure.

For the purposes of this paper the emphasis is on parts B and C in order to test some hypotheses from the initial pilot study and effectively identify major causes of infrastructure failure.

2.4 Hypotheses

- Infrastructure services are very unstable in Nigeria.
- There is a dearth of infrastructure in Nigeria.
- The quality of infrastructure and its services is very low.
- The rate of infrastructure maintenance is low in Nigeria.
- The response rate to infrastructure maintenance is very poor in Nigeria.

3. Analysis of survey results

Using the ordinal scale, respondents were asked to rate the stability of infrastructure services, the quality of infrastructure and its services, infrastructure maintenance and response rates to infrastructure maintenance and supply in Nigeria. Each was cross-tabulated with geopolitical zones to ascertain the relative cross-section of views across the country and to verify the hypotheses listed above (see Tables 1–5).

Respondents were also asked to identify and rank factors from a list of 18 identified causes of infrastructure and service delivery failures (see Table 6). These data were analysed using the severity index in matrix order (SIMO) model (Omoregie *et al*., 2005), which takes into consideration the peculiarities of the data collected. The major causes of infrastructure and service provision failures are shown in order of severity by geopolitical region. The model incorporates the variation of each factor to establish its relative spread across geopolitical zones. This is very important as some factors in a survey could be significant in only one or two strata (i.e. geopolitical regions), yet could significantly affect the total result (i.e. national output). Measuring variation of spread alongside the severity of each factor is therefore very important when ranking procedures in view of the fact that it locates the true ranking of each variable factor in relation to the

Response	Non-response	Satisfaction		Dissatisfaction		Total
		Very stable	Stable	Unstable	Very unstable	
Frequency	6	7	34	170	186	403
Percent of total	1·5	1·7	8·4	42·2	46·2	100
		10·1		88·4		

Table 1. Ratings on stability of infrastructure services

Response	Non-response	Satisfaction		Dissatisfaction		Total
		Very adequate	Adequate	Inadequate	Very inadequate	
Frequency	15	4	43	159	182	403
Percent of total	3·7	1.0	10·7	39·5	45·2	100
		11·7		84·7		

Table 2. Ratings on infrastructure supply

Response	Non-response	Satisfaction		Dissatisfaction		Total
		High	Fair	Low	Very low	
Frequency	15	34	43	111	200	403
Percent of total	3·7	8·4	10·7	27·5	49·6	100·0
		19·1		77·1		

Table 3. Ratings on quality of infrastructure and services

Response	Non-response	Satisfaction		Dissatisfaction		Total
		High	Fair	Low	Very low	
Frequency	5	24	24	121	229	403
Percent of total	1·2	6·0	6·0	30·0	56·8	100·0
		12·0		86·8		

Table 4. Ratings on infrastructure maintenance

		Satisfaction		Dissatisfaction		
Response	Non-response	Very adequate	Adequate	Inadequate	Very adequate	Total
Frequency	7	8	61	118	209	403
Percent of total	1·7	2·0	15·1	29·3	51·9	100·0
		17·1		81·2		

Table 5. Ratings on response rate to infrastructure maintenance

others. At this stage, it is important to confirm the hypotheses listed above by means of frequency counts.

3.1 Confirmation of hypotheses

The five hypotheses above will be tested simply with the aid of frequency counts. The typical null hypothesis is that no difference exists between respondents' satisfaction and the dissatisfaction levels (i.e. the mean and variability of both levels (data) is the same). Table 1 represents respondents' satisfaction levels expressed as a percentage of the total number of respondents. The level of dissatisfaction with respect to the stability of infrastructure services is 78·3% higher than the level of satisfaction. The first hypothesis that infrastructure services in Nigeria are very unstable is thus statistically significant because 78·3% is a significant difference and far exceeds the chance level. This means that this result does not contain sufficient information to cast doubt on the hypothesis. So, the null hypothesis is rejected outright. Similarly, the second hypothesis that there is an extreme dearth of infrastructure supply is also statistically significant, as shown in Table 2, as the number of respondents dissatisfied was 73% higher than those who were satisfied. Equally, the third, fourth and fifth hypotheses can be tested from Tables 3, 4 and 5, respectively. The difference between the levels of dissatisfaction and satisfaction for Table 3 is 58·6%, 74·8% for Table 4 and 64·1% for Table 5. Therefore, the assertions that the 'quality of infrastructure and its services', 'infrastructure maintenance' and 'response rate to infrastructure maintenance' are very low in Nigeria are confirmed. The next stage is to describe the ranking procedures developed and adopted in this study.

Variable	Variable factor [F(*j*)]
Lack of supportive institutions	F(1)
Misallocation of investments	F(2)
Lack of effective competition	F(3)
Inadequate maintenance	F(4)
Inconsistent billing strategy	F(5)
Inadequate cost recovery strategy	F(6)
Lack of suitable technical and managerial skill	F(7)
Lack of financial and managerial autonomy	F(8)
Corruption	F(9)
Lack of transparency and accountability	F(10)
Poor wages and remuneration	F(11)
High construction and equipment procurement cost	F(12)
Weather and difficult environmental terrain	F(13)
Inconsistent political, social and economic policies	F(14)
Insufficient funding for infrastructure	F(15)
Hostile communal conflicts	F(16)
Too much pressure on existing infrastructure	F(17)
All of the above	F(18)

Table 6. Identified causes of infrastructure failures and their codes

3.2 Ranking procedures

Table 7 comprises the frequencies of variable factors in their various ranking positions. The ranking positions are designated P1 to P18 in the order of priority accorded by respondents, and are presented horizontally in a decreasing arithmetic pattern. For example, the factor with the highest severity is ranked as 1, the second highest as 2 and so on to the least severe factor, which is designated 18. The number of times a factor is ranked in a particular position is then represented as its frequency count for that position. The relevance of the index factor column is due to prioritisation by respondents and to the many cases of multiple occurrences of variable factors in different ranking positions.

The effects of multiple occurrences of a factor in different ranking positions (e.g. 'corruption' coded F(9) appearing in 12 different factor ranking positions) cannot be accounted for by the mere frequency counts for one ranking position independently of the others (see Table 7). For example, in ranked position number 1 (p1), the highest frequency count for a particular variable factor

Variable factors F(*j*)	Frequencies of ranked variable factors position (μ_{ij}) p1	p2	p3	p4	p5	p6	p7	p8	p9	p10	p11	p12	p13	p14	p15	p16	p17	p18	Index Factor σ_i/18
F(1)	36	19	15	10	14	15	11	14	10	7	8	10	1	6	2	1	4	1	1·00
F(2)	101	41	33	17	13	19	14	9	10	6	3	4	4	2	4	1	0	0	0·94
F(3)	3	6	16	12	14	12	8	10	6	10	8	5	10	4	3	1	2	0	0·89
F(4)	22	55	39	41	25	11	14	9	9	1	3	4	1	1	1	1	2	1	0·83
F(5)	0	5	9	16	20	18	9	5	9	9	13	7	9	1	2	0	1	0	0·78
F(6)	0	4	9	11	14	16	12	8	9	10	10	6	2	14	3	1	0	0	0·72
F(7)	3	9	11	18	9	17	22	23	16	12	10	4	4	2	2	3	1	0	0·67
F(8)	0	17	12	7	11	9	11	19	18	12	5	10	6	4	2	5	0	0	0·61
F(9)	142	63	19	13	13	9	3	6	4	4	1	0	3	0	0	0	0	0	0·56
F(10)	5	35	35	30	33	20	19	7	9	10	1	2	1	0	0	1	0	0	0·50
F(11)	0	5	10	11	21	20	10	7	7	11	11	2	4	1	2	1	1	0	0·44
F(12)	1	1	7	8	10	19	10	7	9	8	4	13	8	4	3	1	1	0	0·38
F(13)	3	1	13	7	12	7	9	12	6	5	1	3	7	8	9	7	2	2	0·33
F(14)	4	10	12	23	15	24	28	25	11	5	2	4	2	7	3	1	0	0	0·27
F(15)	6	19	33	27	21	14	20	11	15	8	6	4	5	2	6	2	0	0	0·22
F(16)	0	1	1	3	6	6	10	6	8	7	7	6	3	6	8	6	4	2	0·17
F(17)	1	5	11	19	10	6	6	10	3	7	8	4	2	1	4	8	4	3	0·11
F(18)	59	14	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	1	0·06

Table 7. Frequencies of ranked variable factors (identified causes of infrastructure failures)

(F(9)) was 142; this factor reappeared in ranked positions 2 to 11 and 13 with frequency counts of 63, 19, 13, 13, 9, 3, 6, 4, 4, 1 and 3, respectively (see Table 7). Ranking this factor using only the highest frequency count magnitude of 142 without considering the impact of its frequency counts in other ranking positions completely negates its true severity.

The same effect is caused by considering all frequency counts in all ranking positions for a particular factor without taking preference of ranking or ranking positions accorded it by respondents into account. As a way of tackling this significant problem in this type of survey, a SIMO model was developed and applied in this investigation using prominent mathematical and statistical tools such as 'index values', 'matrix' and 'midhinge'. After effective ranking, the model further distinguishes without prejudice the major or critical variable factors from the minor ones by defining a demarcation line termed the 'threshold value'. These processes are explained in the Appendix.

3.3 Measure of spread and ranked positions of major variable factors

To establish variations in quantitative terms and measure the relative spread of views from one geopolitical region to another, the coefficient of variation relative to the mean or average score was derived for each variable factor. This is carefully tabulated in Table 8 and re-tabulated in Table 9 for the major variable factors. The higher its percentage, the more varied or less homogeneous the choices accorded the variable factor across all the geopolitical regions.

The survey revealed that corruption (used here to mean the abuse of public office or public trust for private gain) (F(9)) is the most prevalent variable factor responsible for unsustainable infrastructure delivery and failures in Nigeria. While its severity magnitude was the highest in the survey, its hierarchy of spread was the second most homogeneous in the survey (see Tables 9 and 10), an indication that corruption was the second most homogeneous or most occurring among the major variable factors. On average, corruption came topmost in the actual ranking position of major factors (see Tables 9 and 10). Similarly, inadequate maintenance (F(4)) came second, while insufficient funding for infrastructure (F(15)) and lack of transparency and accountability (F(10)) both came third in actual ranking positions (see Table 8). The misallocation of investments (F(2)) was ranked in fourth position, while lack of suitable technical and managerial skills (F(7)), inconsistent political, social and economic policies (F(14)) and the lack of supportive institutions (F(1)) were all ranked in fifth position.

Variable factor	Severity of factors result values across regions						Mean, *m*	Standard deviation, *s*	Standard error	Coefficient of variation [(*m*/*s*)100]: %
	South-western	North-central	North-eastern	North-western	South-eastern	South-south				
F(1)	21·47	10·77	15·42	34·81	8·03	44·22	22·45	14·29	5·84	63·66
F(2)	20·70	20·03	22·54	50·81	30·86	117·44	43·73	37·92	15·48	86·72
F(3)	13·61	5·22	13·97	19·44	5·66	24·62	13·75	7·60	3·10	55·26
F(4)	35·97	22·27	24·16	40·99	29·87	45·69	33·16	9·34	3·81	28·18
F(5)	11·73	11·59	13·93	10·44	15·70	21·28	14·11	3·99	1·63	28·25
F(6)	14·71	5·33	12·72	14·15	5·51	23·46	12·65	6·75	2·76	53·39
F(7)	22·98	9·17	17·15	16·77	12·62	32·20	18·48	8·18	3·34	44·24
F(8)	13·26	4·88	10·74	27·12	12·61	20·80	14·90	7·87	3·21	52·82
F(9)	46·47	26·21	38·23	38·75	41·87	69·04	43·43	14·23	5·81	32·78
F(10)	32·67	18·82	25·24	17·81	21·18	42·70	26·39	9·64	3·94	36·55
F(11)	13·86	7·00	17·10	8·89	4·43	32·80	14·01	10·29	4·20	73·45
F(12)	18·06	3·59	10·42	8·89	5·71	18·27	10·82	6·17	2·52	56·98
F(13)	4·03	10·29	7·80	22·07	12·27	13·39	11·64	6·11	2·49	52·49
F(14)	22·46	11·44	12·57	9·77	24·41	31·87	18·75	8·83	3·61	47·11
F(15)	28·81	18·92	18·98	13·83	24·07	36·05	23·44	8·01	3·27	34·17
F(16)	4·02	12·01	4·30	4·74	4·85	13·00	7·15	4·17	1·70	58·27
F(17)	23·40	3·05	8·04	9·05	2·00	18·60	10·69	8·58	3·50	80·22
F(18)	2·06	22·94	4·00	11·61	20·94	11·39	12·16	8·52	3·48	70·07

Table 8. Severity magnitudes and coefficient of variation

4. Discussion of survey results

All these major factors responsible for infrastructure failures in Nigeria are interconnected. They are also not peculiar to Nigeria, or even to sub-Saharan Africa as a whole. However, levels of intensity may differ from one country to another. For example, it is well known that the existence of corruption in construction contracting is not unique to developing economies. According to the *Global Corruption Report* this problem is common to most industrialised nations, particularly when infrastructure projects are big and complex and involve large amounts of capital (*Transparency International*). This report asserted that in the UK alone, the cost of corruption amounts to over £3·75 billion annually. In another survey conducted by the Chartered Institute of Builders (CIOB, 2006), 96% of 1404 respondents interviewed asserted that corruption exists in the UK construction industry. There are similar stories in America, Japan, China, India and Pakistan.

Although it can be clearly argued that corruption is the 'consequence of the lack of personal moral standards', nevertheless 'moral standards' are products of societal evolution and interactions. Therefore, the individual can only reject,

Variable factor	Coefficient of variation (spread): %	Hierarchy of spread (X_1)	Severity magnitude	Hierarchy of severity magnitudes (X_2)
F(4)	28	1	194	3
F(9)	33	2	257	1
F(15)	34	3	143	5
F(10)	37	4	163	4
F(7)	44	5	108	8
F(14)	47	6	121	7
F(1)	64	7	133	6
F(2)	87	8	236	2

Table 9. Hierarchy of spread of major variable factors

Variable factor	X_1	X_2	½ (X_1 + X_2)	Actual ranking of major factors
F(9)	2	1	1·5	1st
F(4)	1	3	2·0	2nd
F(15)	3	5	4·0	3rd
F(10)	4	4	4·0	3rd
F(2)	8	2	5·0	4th
F(7)	5	8	6·5	5th
F(14)	6	7	6·5	5th
F(1)	7	6	6·5	5th

Table 10. Actual ranking positions of major factors

accept or modify what is available (existing standards) within society. Subsequently the individual's choice is directly or indirectly influenced by the 'society'. Therefore, corruption not only manifests the failings of the individual but also the society, system or environment in which corruption dwells. As cited in Akintoye *et al.* (2006) and in Rwelamila *et al.* (2006), Klitgaard (1998) argues that corruption 'equals monopoly plus discretion minus accountability', and that corruption is not a crime of passion but of calculation. So, when bribes are large and the chances of being caught are small and penalties if caught meagre, then the temptation to indulge is high. Jackson and Hlahla (1999) also argue that combating corruption should start with the formation of better systems in which monopolies and official discretion are carefully regulated, reduced and clarified.

Furthermore, when corrupt practices are frequently seen to undermine the structures of governance, it becomes more or less the norm in social order. These practices are particularly insidious in the judiciary, an institution that is supposed to uphold the rule of law. In some cases, judges are pressurised into verdicts for sociopolitical and personal expediencies (Justice Aloysius Katsina-Alu (Chief Justice of Nigeria) as cited in Ise-Oluwa (2010)).

As a consequence, transparency and accountability in governance are eroded. These subversions are core institutional lapses with enormous potential to cripple any existing system or organisation. The whole idea of creating institutions in developing economies is in most cases modelled on existing establishments elsewhere, without taking into account the conditions of those to be served. Once an enabling institutional framework is established, expectations of consistent political, social and economic policy are raised.

Policy can be classified as any rule set by an organisation to govern its operations. In most cases these come as programmes intended to lessen or resolve social, economic or physical problems. It also defines the boundaries of an organisation or individual in any field of endeavour. However, policies as a rule are themselves institutions, and they are also a product of an institutional arrangement with the aim of fostering effective management and development. To this end the inconsistent political, social and economic policies plaguing infrastructure and service delivery in Nigeria are also caused by the institutional failures identified earlier.

Institutional failures can also be the reason for the misallocation of investments, when priority is given to relatively unimportant projects and new investments, with less attention to essential projects, services, cost recovery and maintenance. When infrastructure is not adequately maintained, it shortens its life-span and creates low capacity utilisation, rent-seeking behaviour and, in some cases, outright vandalism. It also increases the expenditure required for new infrastructure, as exemplified by weak financial resourcing and insufficient funding for infrastructure.

All of the factors discussed above are major global phenomena. For example, in 1990 World Bank and United Nations studies classed Nigeria as one of the poorest countries, with an average per capita income of 72 cents per day and an average per capita consumption of 57 cents per day. Therefore only 15 cents per day was left on average for private capital formation, public investment in infrastructure and the running of vital public services. Furthermore, some of these limited funds are channelled to other areas unimpeded by conventional checks and balances because of corruption already identified as a major institutional lapse.

Institutional lapses can also be adduced as reasons for the lack of suitable technical and managerial skills. This is particularly true when skilled manpower or well-qualified candidates are not accorded due recognition in work placements; in some instances their services are disparaged or ignored because of extraneous factors such as religion, race, tribalism, ethnicity, immigration and corruption.

What this research reveals is that the factors identified and discussed are not peculiar to Nigeria. They have international dimensions, inherent in some developed economies. Another interesting and apparently more relevant consideration is that all the variable factors responsible for unsustainable infrastructure delivery and failures tend towards institutional lapses. It is thus appropriate to give a brief overview of the attempt to address these lapses in Nigerian procurement systems.

The two modes of procurement commonly used in Nigeria are competitive and selective tendering (Mansfield *et al.*, 1994; Ogunje 2002). The World Bank's country procurement assessment report (CPAR) for Nigeria (Ekpenkhio 2003; World Bank, 2000) identified gaps in the country's procurement system. In response to the recommendations in the CPAR, the Nigerian government in 2002 issued new policy guidelines on public procurement and contract award procedures in 2002 (circular no. F.15775). The CPAR was accepted by the government, with exceptions for the registration of contractors and the involvement of political office holders such as ministers and commissioners in the awards of contracts. In 2007, the Public Procurement Act (Public Procurement Act, 2007) was signed into law, and the Bureau of Public Procurement was set up. The new laws were published in the Federal Republic of Nigeria official gazette no. 108 vol. 94 of 2007. This Act finally brought to fruition the recommendations in the CPAR.

However, in revealing the effectiveness of these procurement reforms, it is important to discuss some challenges encountered during the field work carried out in this study.

4.1 Challenges encountered during field work

The first challenge encountered in this study was in the north-western geopolitical region, where prospective respondents were initially very reluctant to communicate with the research data collection team. However, this attitude was eventually overcome because some members of the team understood the people, their culture, religion and language.

Another notable experience was at St Saviours Road in Benin City in Nigeria's south-southern zone. The team observed a scene along a failed portion of this road frequently used by taxi motorcyclists (scooter drivers). This road was in a state of utter disrepair and the team decided to photograph it before trying to find a way around it. This part of the road was seriously waterlogged and could not be traversed by four-wheeled motor vehicles. The scooter riders were making a lucrative income by transporting people across the failed section. So, some of the scooter riders objected vehemently to the photos being taken, demanding to know why the photos were being taken. They damaged one of the cameras beyond repair and seized the other. They were of the view that members of the team were journalists out to report their activities on the failed part of the road.

The seized cameras were later released after the scooter riders were convinced that the team was made up of students and that the information collected was purely for research. Some of the scooter riders confided to the team that their means of sustenance depended on failed infrastructure such as that section of St Saviours Road in order to survive the prevalent poverty and unemployment. It was learnt that similar activities take place in other parts of the city such as the Ugbowo, Upper Mission and Okhoro areas and the Ogida and Uselu quarters, particularly during the rainy season.

One could attribute this scenario to the severity of income disparity and unemployment in the area that forced some people to take advantage of failed structures such as the one at St Saviours Road in order to survive. It was not surprising to find the scooter drivers apparently ready to fight anyone who could compromise their only means of sustenance. This is anecdotal evidence of the degree to which failed infrastructure can affect the thinking and behaviour of the poor.

Another interesting incident during the field work occurred in Imo state in the south-eastern zone of Nigeria, where some individuals purporting to be local council personnel forbade the team from taking photographs in a certain town. Nonetheless, the level of decay of infrastructure in this part of the country was the worst experienced in the survey, at least as far as the authors observed. There were initial difficulties in data collection in the town, as the response rate was extremely low (less than 10%). Potential respondents were very unwilling to return their questionnaires, which resulted in the extension of the authors' stay there by 3 days.

However, a similar technique used by the team in Kano state in the north-western region produced the response the team wanted and needed. It was observed that the people of this region responded quickly to anyone who could speak their language and understand their way of life. This was unlike Imo state, where even the most literate and enlightened were apprehensive. While some respondents in this region demanded remuneration for the return of the questionnaire during the first data collection exercise, these same people became very accommodating during the follow-up. Their cooperation must have been due to the technique of bridging the communication gap by using their language, culture and value system. However, extreme care was taken by the team not to interfere with the responses to the questionnaire.

5. Observations

The recommendations of the World Bank CPAR for Nigeria and the efforts by the federal government to reform the

Nigerian procurement system based on the CPAR are to be commended. These recommendations are aimed at building sustainable and supportive institutions to strengthen the existing procurement framework in Nigeria, thereby making the Nigerian procurement system more efficient, accountable and transparent. As well-intentioned as these objectives are, however, the findings gathered from this study (most especially the experience gathered during the survey) reveal that these efforts will not yield the desired results.

The experience of the data collection team points to the fact that the average Nigerian's loyalties are complex. The order of allegiance is from the small to the large scale: first to immediate family, then to ethnicity, then religion and only finally to country. This partly accounts for the spate of corruption, religious conflicts and other practices such as bias towards a particular ethnic group or community. Census figures are sometimes manipulated to justify increases in revenue allocation, dominance of the military, political interests and even the awards of contracts. This presents an obvious contrast to some other parts of the world. In the west, patriotism is sometimes seen as overriding other interests, notwithstanding the prevalent distaste for taxation. Nevertheless, the basic human instinct is to secure immediate interests whenever and wherever possible. It is of note that the recent members of parliament allowance scandal in the UK was also driven by immediate interests and expediencies. Therefore disloyalty to procedures and established statutes is not peculiar to Nigeria alone.

A varying commitment to one's country or place of birth from one region or country to another reveals a difference in perception, trust in society, belief and values. Policies, guidelines or strategies underpinning infrastructure and service delivery ought to reflect these differences.

On the appropriateness of procurement systems, it has been argued (Kumaraswamy, 1994; McDermott, 1999; Rowlinson and Root, 1997) that sustainable and synergistic procurement strategies must be generated by the people for whom the project is intended. Therefore, it is inappropriate to superimpose procurement strategies or mechanisms. Contractual arrangements and forms of contracts currently practised in many developing countries were found to be out of date and irrelevant to the circumstance and therefore in need of reform. Even the ICE conditions of contract are constantly being amended to meet the prevailing conditions within the UK construction industry (Hill, 1991).

6. Deduction

The disregarding of culture, beliefs and value systems – and even the very users of infrastructure and services themselves, at all stages of the process from conceptualisation to delivery – is a major flaw in all international best practice for procurement. Procurement systems must be appropriate to circumstances. It is therefore the view of the present study that when users of infrastructures or services are not involved in conceptualisation, planning and delivery of infrastructure, there is little if any chance of success. This is particularly the case in the Niger Delta region where due to lack of input by indigenous communities (people whose outlook is shaped by culture, common religion, language or inherited social conditions (Liu and Fellows, 1999; Martins and Taylor, 1996; Ng, 1994)) in the conceptualisation and delivery of infrastructure, militant youths frustrate the efforts of government in providing such infrastructure by sabotaging the development of it. In extreme cases, contractors' staff are kidnapped and the project frustrated and sabotaged. The people's participation in infrastructure provision is essential for community development. To this end, the uniqueness of cultures and value systems could be suggested as parameters that should form the framework for building effective and supportive institutions.

It is the view of the authors that as long as there is a variety of cultures and people, globally applicable best practices and international implementation procedures for procurement, contractual arrangements and forms of contract are futile. All delivery of infrastructures and services must take into account the cultural uniqueness of intended users in the analysis of procurement systems. From this study, it is further argued that as long as people have different cultures, value systems and beliefs, there is no such thing as 'international best practice for procurement', for the simple reason that some acceptable norms or values in the west might be unacceptable in the other parts of the world. However, workable institutional strategies can serve as interfaces between set objectives in infrastructure provision, and the people classed either as users or in terms of cultural norms.

In the same vein, it is pointless to have commenced the London ringways (series of four ring roads cancelled in 1973 after three sections had been constructed) (Wikipedia, 2011) without careful consideration of public opinion on environmental concerns and cultural values. When the London ringways were being conceived and planned in the 1960s, it was revealed that, besides the environmental impact, they would have led to the demolition of over 20 000 houses in a city with a shortfall of 500 000 at a time of peak concern over the preservation of local communities and Victorian housing (Hamer, 1987). Another point in question is the controversial UK government Aviation White Paper for the commencement of the third runway at Heathrow airport. This runway would have been situated to the north of the Heathrow boundary between the A4 and the M4, and would require a sixth terminal. The government pledged to go ahead with the expansion plans despite the serious cultural and environmental impact on Heathrow and its environs, but it was argued that this expansion would tear

families apart, displace communities and inevitably destroy irreplaceable historic villages and buildings. If the project had commenced, the village of Sipson, comprising over 700 houses with its social and historical infrastructure, would have been destroyed, whereas Harlington and Harmondsworth would be seriously affected, to say nothing of the pollution, noise and the carbon footprint, thought likely to breach legal limits. However, there was also the view that the proposed runway and terminal 6, costing over £4·5 billion, would create more jobs, enhance the economic stability of West London and Thames Valley and ease traffic in the wake of the prevailing redundancies and traffic congestion. In view of the likely catastrophic impact of this project on the environment and the indigenous communities, the need for effective consultation would have been overwhelming if the requirement for sustainable infrastructure is anything to go by. This development has now been abandoned as a result of public outcry.

7. Conclusion

All hypotheses on the poor state of infrastructure and its services in this investigation were confirmed and the major causes of infrastructure and service delivery failures identified. Those failures are corruption, inadequate maintenance, insufficient funding for infrastructure, lack of transparency and accountability, misallocation of investments, lack of technical and managerial skills, inconsistent political, social and economic policies.

The discussion, observations and deduction sections of this paper highlight the need to strengthen existing stakeholders' frameworks in delivery systems by encouraging 'users' and 'community' participation in the delivery of sustainable infrastructure services, most especially when there is an overwhelming call to tailor infrastructure services to needs and circumstances. The stakeholder structure is currently lopsided towards public and private provisions, and less recognition is given to community–users' relevance. Community–users' participation would obviously prioritise in high premium 'culture' and value systems (an obvious prerequisite for sustainability). This means that community, users and other likely recipients would participate in the conceptualisation, planning and management of infrastructure and its services. This would be an obvious change from the old business of imposition and extrapolation of usage capacities instead of genuine assessments of 'effective demand', feasibility and resources availability.

However, the community–user provision model alone is inadequate in view of obvious limitations in mobilisation of resources: financial, enabling technology and high-level technical support and training. There is the need for an agreed sharing of responsibilities with the public sector, private sector or public–private partnership. The recommended and probable framework for future consideration that can integrate culture and values in procurement systems and institutional building seems to be the public community–user provision or the private community–user provision. It is not unlikely that the public–private community–user provision could also be considered in the future.

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Appendix

Severity index in matrix order (SIMO)

The following are the steps employed in building the model.

The factors responsible for unsustainable infrastructure provision and failures were coded from 1 to 18, i.e. F(1), F(2), F(3),… F(18) (see Tables 6 and 7).

Ranking positions are created in decreasing order of severity corresponding to the number of factors under consideration, i.e. p1, p2, p3,… p18 (see Table 7).

The frequency counts of each factor are entered under the various ranking positions respondents have given them (see Table 7). It is expected that a particular factor could have frequency counts in multiple ranking positions.

The last column of index factors as shown in Table 7 is derived by the inverse array of arithmetic numbers 1, 2, 3,… 18 to give 18, 17, 16, 15, 14,… 1 multiplied by the inverse of 18 or (1/18) to give 18/18=1, 17/18=0·94, 16/18=0·89, … 1/18=0·06 (see the last column of Table 7).

The severity of all factors is calculated by multiplying the matrix of frequency counts under the various ranking positions (i.e. 18×18 matrix) by the column of index factors (i.e. 1×18 matrix) explained in the preceding item to give the array of severity magnitudes in the first and second matrices shown in Figure 1.

The variable factors and their severity magnitudes as explained above are re-arranged in decreasing order of severity, i.e. p(1), p(2), p(3),… p(18) (see third, fourth and fifth matrices in Figure 1 and see Figure 2).

The threshold value or demarcation point is the midhinge of Figure 2 (see procedures for determination of midhinge and Equations C to F below).

These processes could also be represented in a mathematical format (see Equation A).

$$\text{A.}\quad f(j)=\sum_{i=1,j=1}^{i-n,j=n}\left(\mu_{ij}\frac{\sigma_i}{n}\right)$$

where $\sigma_i = (n + 1) - i$

j = variable factor under consideration: for $j = 1, 2, 3,\ldots n - 1, n$

i = ranked position of the variable factor under consideration: $i = 1, 2, 3\ldots n - 1, n$

Thus σ_i represents variable factor position 1; σ_2 represents variable factor position 2, and σ_n represents the nth variable factor position.

$\frac{\sigma_i}{n}$ = severity index factor, for $i = 1, 2, 3,\ldots n$

μ_{ij} = frequency of variable factor 'j' under ranked variable factor position 'i'. Thus, Equation A becomes the set of equations:

$$\text{1.}\quad \mathrm{F}(1)=\mu_{11}\frac{\sigma_1}{n}+\mu_{12}\frac{\sigma_2}{n}+\mu_{13}\frac{\sigma_3}{n}\ldots\mu_{1n}\frac{\sigma_n}{n}$$

$$\text{2.}\quad \mathrm{F}(2)=\mu_{21}\frac{\sigma_1}{n}+\mu_{22}\frac{\sigma_2}{n}+\mu_{23}\frac{\sigma_3}{n}\ldots\mu_{2n}\frac{\sigma_n}{n}$$

$$\text{3.}\quad \mathrm{F}(3)=\mu_{31}\frac{\sigma_1}{n}+\mu_{32}\frac{\sigma_2}{n}+\mu_{33}\frac{\sigma_3}{n}\ldots\mu_{3n}\frac{\sigma_n}{n}$$

$$\vdots \quad \vdots \quad \vdots \quad \vdots \quad \vdots \quad \vdots$$

$$n.\quad \mathrm{F}(n)=\mu_{n1}\frac{\sigma_1}{n}+\mu_{n2}\frac{\sigma_2}{n}+\mu_{n3}\frac{\sigma_3}{n}\ldots\mu_{nn}\frac{\sigma_n}{n}$$

Then the SIMO is:

$$\begin{bmatrix}\mathrm{F}(1)\\ \vdots \\ \mathrm{F}(n)\end{bmatrix}=\begin{bmatrix}\mu_{11} & \cdots & \mu_{1n}\\ \vdots & \vdots & \vdots \\ \mu_{n1} & \cdots & \mu_{nn}\end{bmatrix}\begin{bmatrix}\sigma_1/n\\ \vdots \\ \sigma_n/n\end{bmatrix}$$

$$\text{B.}\quad \begin{bmatrix}\mathrm{p}(1)\\ \vdots \\ \mathrm{p}(n)\end{bmatrix}=\begin{bmatrix}\mathrm{F}(1)\\ \vdots \\ \mathrm{F}(n)\end{bmatrix}$$

where $\mathrm{F}(1) > \mathrm{F}(2) > \mathrm{F}(3) >> \ldots \mathrm{F}(n)$

p(1) is the highest severity position; p(2) is the second highest severity position; p(n) is the least severe position.

Threshold value (demarcation line)

The threshold value, which is the midhinge (Levine, 2001) in the matrix of Equation A, is

$$\text{C.}\quad \text{Threshold value} = \tfrac{1}{2}[h_1 + h_2]$$

$$\text{D.}\quad D_1 = \tfrac{1}{4}[n + 1]$$

$$\text{E.}\quad D_3 = \tfrac{3}{4}[n + 1]$$

where

h_1 is the corresponding value to D_1

h_2 is the corresponding value to D_3

n is the total number of observations or variable factors under consideration in Equation B

D_1 and D_3 are specified observations within the matrix of Equation B

Rules for D_1 and D_3 are as follows.

If D_1 or D_3 is an integer, the numerical observation or item corresponding to the position of that integer in the matrix of Equation B is chosen for either D_1 or D_3.

If D_1 or D_3 is halfway between two integers, the average of the corresponding items or observations is chosen.

If D_1 or D_3 is not an integer or halfway between two integers; then the resulting value should be approximated to the nearest integer and the corresponding item or observation is chosen.

N.B. All the variable factors (elements) in the matrix of Equation B cannot be accounted in policy formulation as most severe at the same time. In order to overcome this problem, variable factors with severity magnitudes greater than or equal to the threshold value are to be considered most severe. See Equation F.

F(1)	=	132·62	Arranging in decreasing order gives	p(1)	=	F(9)	=	256·88
F(2)		236·06		p(2)		F(2)		236·06
F(3)		83·07		p(3)		F(4)		194·38
F(4)		194·38		p(4)		F(10)		162·83
F(5)		85·34		p(5)		F(15)		142·62
F(6)		78·25		p(6)		F(1)		132·62
F(7)		108·02		p(7)		F(14)		120·60
F(8)		92·92		p(8)		F(7)		108·02
F(9)		256·88		p(9)		F(8)		92·92
F(10)		162·83		p(10)		F(5)		85·34
F(11)		81·81		p(11)		F(3)		83·07
F(12)		67·66		p(12)		F(11)		81·81
F(13)		64·49		p(13)		F(6)		78·25
F(14)		120·60		p(14)		F(12)		67·66
F(15)		142·62		p(15)		F(17)		67·51
F(16)		42·97		p(16)		F(13)		64·49
F(17)		67·51		p(17)		F(18)		63·71
F(18)		63·71		p(18)		F(16)		42·97

Figure 1. Array of severity magnitudes in decreasing order

This threshold value defines the demarcation line between major factors and minor factors (see Figures 1 and 2, respectively).

p(1)	=	F(9) = Corruption
p(2)		F(2) = Misallocation of investments
p(3)		F(4) = Inadequate maintenance
p(4)		F(10) = Lack of transparency and accountability
p(5)		F(15) = Insufficient funding for infrastructure
p(6)		F(1) = Lack of supportive institutions
p(7)		F(14) = Inconsistent political, social and economic policies
p(8)		F(7) = Lack of suitable technical and managerial skill
→←		→.....***Threshold (demarcation line)***.....←
p(9)		F(8) = Lack of financial and managerial autonomy
p(10)		F(5) = Inconsistent billing strategy
p(11)		F(3) = Lack of effective competition
p(12)		F(11) = Poor wages and remuneration
p(13)		F(6) = Inadequate cost recovery
p(14)		F(12) = High construction and equipment procurement cost
p(15)		F(17) = Too much pressue on existing infrastructure
p(16)		F(13) = Weather and diffcult environmental terrain
p(17)		F(18) = All of the above
p(18)		F(16) = Hostile communal conflicts

Figure 2. Actual variable factors ranking positions

F. $|P(a)|_1^n \Rightarrow Threshold\ Value\ (magnitude)$

Where a is any 'real number' from 1 to n and the corresponding severity magnitude to $P(a)$ is the threshold value.

Using Figure 1 for example:

$D_1 = ¼\ (18 + 1) = 4{\cdot}75$ and $D_3 = ¾\ (18 + 1) = 14{\cdot}25$

D_1 and D_3 are not integers or halfway between two integers. Therefore, using the third itemised rule for D_1 or D_3 above: $D_1 = 5$ and $D_3 = 14$

corresponding item to D_1 in Figure 1 is F(15) = $h_1 = 142{\cdot}62$ and corresponding item to D_3 in Figure 1 is F(12) = $h_2 = 67{\cdot}66$.

Threshold value = $½[h_1 + h_2] = 105{\cdot}13$.

The demarcation line is thus between the magnitudes p(8) = 108·02 and p(9) = 92·92 (see Figures 1 and 2).

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