Looking Inwards for Sustainability: Nigerian Cities and Building Demolition Wastes or Wealth.

Abstract

Cities could generally be described as sustainable before the replacement of manual labour with machines known as the industrial revolution of the 18th century in Europe. Nevertheless, the Industrial Revolution has been associated with environmental degradation and other negative impacts. The trend continued for two centuries until it was realised that there is a limit to the capacity of the earth to withstand such impacts. The damage to the earth needs to be halted by choice or forced by natural consequences. The idea of pursuing economic development with minimum negative socio-economic and environmental impacts comes to be known as Sustainability. The built environment becomes at the centre of the sustainability agenda due to the enormous negative impact to the environment. Moreover, it was reported that 90% of all materials resources ever extracted might be used in the built environment. Unfortunately, many of these materials, including 10% unused are discarded as wastes. In the UK example, 90-120 million tonnes of construction and demolition (C&D) waste is generated annually. This makes C&D wastes even more critical to the sustainability agenda; and in search for solution, in the words of Janine Benyus, it may even involve the urban westerners learning from the wisdom of the preindustrial societies that have been living in harmony with the nature. In the preindustrial community of Kano in Nigeria, there is virtually zero C&D waste; rather it is merchandise. The different categories of the stakeholders were interviewed to establish how the system works, the conditions that led to its emergence, and limitations. It was discovered that the end-of-life management of buildings in Kano is a naturally evolved industrial ecology analogous to the natural ecological system, whereby the bye-product of one process becomes the raw material for another with no waste. Furthermore, a conceptual model of the system was developed using the biomorphic adaptation of the shell of an African snail. It was therefore argued that sustainability practices are inherent within the African traditions rather than to be learnt from outside.

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Introduction: Sustainability and the Management of Building Demolition Waste in Nigeria.

From ancient civilisations of Mesopotamia, Egypt, or Rome, to the later cities of the Middle Ages, including Nigeria's cities of Oyo and Kano, man had been living sustainably on the earth with minimum impact on the natural environment up to the beginning of the eighteenth century. Nevertheless, as described by Hawkes (2011), unsustainable architecture or rather the conflict between human and natural environment started to climax from the inception of the industrial revolution in Europe. This assertion was corroborated by Morris (2013, p. 12), where he opined that before the Industrial Revolution, buildings were typically vernacular made from locally available materials and technology. Oxford Dictionaries (2015) defines Industrial revolution as: "*The rapid development of industry that occurred in Britain in the late 18th and 19th centuries, brought about by the introduction of machinery. It was characterized by the use of steam power, the growth of factories, and the mass production of manufactured goods*".

The Industrial Revolution was however driven by fossil fuel consumption and natural resources extraction with consequential degradation of the natural environment and new social phenomena such as population increase and urbanisation, consumerism and solid waste generation, and new order for social stratification in the society (Chappine, 2015). The damage of the industrial activities to the natural environment continued until it was realised there is a limit to the capacity of the earth. Moreover, the continued unsustainable exploitation of nature beyond its capacity is either stopped by choice, or forced by natural consequences (Meadows, Meadows, Randers, & Behrens, 1972); including the possibility for the extinction of the human race (Mark, 2000). Consequently, sustainability becomes the man's major issue of the 21st century (RIBA, 2009a, 2009b, 2009c, 2009d).

The built environment is at the centre of the sustainability agenda due to its huge environmental impacts. The vernacular architectures once adapted to the natural environment were replaced with buildings that rely on the supply of unsustainable energy generated from fossil fuel for the running of the newly introduced mechanical services (Banham, 1969; Hawkes, 2011). Aaron Betsky cited by (Belogolovsky, 2009) described the idea of man-made structures with limited sunlight, restricted air and views substituting the once open land with

abundance of sunlight and fresh air in a perfect harmony with the skyline as the *"architecture's original sin"*.

The negative contribution of buildings to the global warming, starts with the embodied "energy" consumed in the manufacturing of the building materials to the stages of construction, operation, and demolition (Berge, 2009). Buildings are responsible for 70% of the energy consumption (Brandon & Lombardi, 2011), nearly half of the estimated 560 Million UK Carbon emission (RIBA, 2009b, 2009c, 2009d), and 30% of the global emission (Belogolovsky, 2009). The impacts of buildings are not only limited to energy consumption and carbon emission, but also 40% of the global acid rains (Belogolovsky, 2009), natural ecology, water, land, and solid waste (Kibert, 2005). There is a report that 90% of all materials ever extracted may be residing in the built environment (Kibert, 2005).

Furthermore, many of these materials are returned to the earth as wastes with the associated negative impacts. In the UK alone, an alarming figure of annual 90-120 million tonnes of waste are associated to construction and demolition (C&D), with more than 10% of unused materials as disclosed by government sources (Osmani, 2012; UK Green Building Council, 2013). Subsequently, a solution to the solid waste generated from demolition of buildings at the end of its usefulness will ameliorate one of the major sustainability challenges facing humanity- resources consumptions. One possible approach to achieve this objective is for construction to learn from other sectors; an idea advocated by Latham (1994), Egan (1998) and others as cited by (Keraminiyage, 2009, p. 3; Lee, 2002, p. 25). However, if construction must learn from any other sector, the best of such other sectors for lessons in the management of waste is the natural ecological systems.

In the natural ecological systems there are no wastes, rather an inter-dependent relationship between different species. The droppings from animals for instance, will be utilised as nourishment for the plants; and the carrion left behind by predatory animals is a ready meal for the scavengers (Bishop, 1973, p. 15). Consequently, no waste is generated; the potential waste from one organism becomes a raw material for another in a close-loop cycle. Additionally, the natural ecosystem utilises renewable solar energy, organic storage systems, segmented operations, efficiency, interdependencies between systems, and adaptation. Can the construction industry be organised in the same fashion of natural ecological system with zero waste output?

This is the question attempted by Kibert, Sendzimir, and Guy (2000), whereby they proposed a conceptual reorganisation of the construction industry to operate in line with the principles of natural ecology as well as in harmony with the natural environment under the tag of *Construction Ecology*. The three tenets of Construction Ecology are the close-loop material cycle, the use of renewable energy, and conservation of nature. Nevertheless, the idea of construction ecology is adopted from the biomimetic concept of Industrial Ecology, whereby human economic activities are organised in the style of nature with the bye-product of one process used as the raw material for another process. Industrial ecology is a widely accepted concept that was recognised as the main theme of the National Technology Strategy Policy of Clinton's administration in the US (Benyus, 1997). The popularity of the Industrial Ecology concept as an analogy to the natural ecology suggests a recognition of the superiority of the natural system over the artificial.

Similarly, where there is a human system that resembles the natural ecological system in its operations and interrelation of its constituent sectors; where such system produces zero waste; where a bye-product from one operation becomes the raw material for another. What of if such a system emerges naturally without a systematic efforts and policy statement as in the National Technology Strategy of the US? Then it can be argued that such a system is more favourable in line with the sustainability thinking than other systems that exhibit fewer characteristics of the natural systems. This paper examines the operations of one such a system that may satisfy this description- the management system of buildings demolition in the Nigerian cities. The question this paper seeks to answer is, how does the system work to generate virtually zero demolition waste?

Method

The practices of handling demolition waste as a concurrent phenomenon and the concept of the industrial ecology as theoretical presupposition qualifies this study as suitable for the use of case study strategy. As described by Yin (1981) and Yin (2009), case study is a synchronous study of situations whereby the subject is not distinct from the context with lowest researcher's control over events. Similarly, the researcher has no control over the variables in the building demolition waste management practices in the Nigerian cities. Moreover, case study is considered convenient for exploratory and descriptive inquiries that seek to answer the how question as in this research.

Players in the industry with first-hand experience in a minimum of one building demolition project were selected to participate in this research. Such information laden persons were expected to identify next three participants for the research in a snowball fashion; nevertheless, while in the field this was seldom practical. Therefore, seventy five per cent of the research participants were identified directly by the researcher. An equal quota of three participants from each of the seven stakeholder groups were expected to form the sample for the research, but this was equally not practical while in the field. This was because some of the participants belong to more than one stakeholder group and the willingness and availability of the participants could not be obtained evenly across the stakeholder groups. A total of sixteen personalities from across all the stakeholder groups participated in the research (see figure 1).

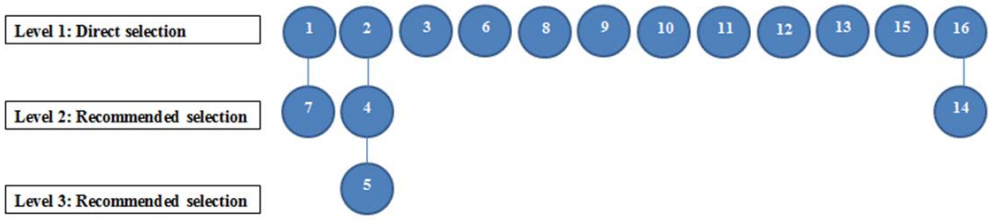

Figure 1: Research Participants Selection

Information was obtained from the research participants through a semi-structured in-depth interview guided by themes developed from the best practices of waste managements across different sectors; with emphasis on the lessons from natural ecological systems. However, information was solicited from real-life projects in which the research participants had played an active role. Thereafter, the interviews were transcribed verbatim for analysis using the QDA miner tools.

- Culture, favourable Environment, and the Economy are the three conditions that led to the emergence of the system.
- Different stakeholders motivated by economic incentives make the system work with no legislative or policy interference.
- Ironically lack of consideration for occupational health and safety, standardisation, legislation, documentation, and awareness contribute to the thriving of the system.
- Most of the materials are reused, and less, and only materials that could not be reused are recycled, then used as fuel, then landfill.

» The system can be described as an industrial ecology analogous to the natural ecological system, whereby the bye-product of one process becomes the raw material for another with no waste.

Conditions for the Emergence of the Practice

From the account of the research participants the emergence of the demolition waste handling practice in Nigerian cities can be attributed to three conditions, namely: culture, favourable Environment, and the economy as explained below.

Culture

Culture was defined as *"the collective programming of the mind which distinguishes members of one group or category of people from another"* (Geert & Jan, 1991). There is a correlation between environmental sustainability and the national culture as hinted in the writing of Park, Russell, and Lee (2007), as demonstrated in management theories, employee motivation, leadership, organisational structure, planning and problem solving approaches (Hofstede, 1980, 1984). Similarly there are contributions of culture to the emergence of the practice of demolition waste management in Nigeria.

Culture was mentioned by some of the interviewees as one of the factors that might influence the current practice (ENIE03; ENIE13; ENIE16). At an instance a research participant (ENIE13) remarked *"…this depends upon the culture and level of development of any community*. He might be making reference to the old sustainable tradition and customs of the Hausas described by Schwerdtfeger (1982, pp. 58,87-88); whereby a dead person is buried in or around his/her room and the buildings is allowed to collapse naturally over time. The timbers from the roof are used for a new building or as firewood, while the mud and the space of the collapsed structure is used in making bricks and rebuilding another room for the next generation. Possibly this culture might have persist and unconscientiously influence the prevalence of the culture of reuse of building materials among the present day generation of the Hausas in Nigeria. Moreover, the Hausas are renowned for their conservative attitudes in so many respects (Adamu, 2006; Callaway, 1987; Whitsitt, 2003). In a study west Africa with Hausas inclusive was classified along short term orientation societies associated with the attribute of respect for traditions (Geert & Jan, 1991).

Comment [DU1]: ????

Another aspect of the Hausa culture relevant to this discussion is the informal traditional housing and finance that provide the majority of the housing stock for the Hausas and probably Africa in general. The Hausas live in patrilocal communities organised in co-residential kinship groups whereby family heads are expected to self-build and provide residential accommodation for their families sometimes with some contributions from members of the kinship (Schwerdtfeger, 1982, pp. 33-35). This culture is further reinforced by the collapse of the official housing policy (Ogunshakin & Olayiwola, 1992), and myriads of other challenges facing the housing sector in Nigeria (Akeju, 2007). In order to meet up with the obligation of providing shelter for the family in the midst of scarce resources, reuse of salvaged building materials may provide an easier succour.

The tendency of the Hausa culture towards *argumentum ad antiquitatem*- ie appeals to antiquity may be another cultural influence that may have contributed to the emergence of the current practice of demolition waste management. The Hausas believed that the older a materials, the more qualitative it should be. This philosophy may be a fallacy; nevertheless, it reinforces the culture of reusing salvaged building materials as well as attracting economic values to the materials. According to one of the interviewees with thirty (30) years of experience as architect and civil servant, he said- *"the older the material is, the more probability that, it will be of higher quality. You will realise that the most recent materials are even destroyed in the process of decommissioning; therefore they are less valuable"* (ENIE13) . He went further to elaborate on this point as follows: *"that is what I said- if what the stakeholder wants is aesthetics, then definitely newer materials from decommissioning may be valuable, but where quality is considered, the older ones are better. It is logical that if a building material can last for fifty years in a building and is still in good condition, it means the quality is tested and trusted. There is a probability that it will last for more years. Even the manufacturer of that components will enjoy preference for even the new materials he is making now; his products have been tested and even among the newer products now, his own will be more valuable. He has established goodwill with the public- his product has been tested and trusted"*. He is not the only participant with this view, as the same view was expressed by (ENIE14).

A common proverb in the Hausa language most often cited to support older items as more valuable says, *"da tsohuwar zuma a ke magani"*, meaning only an old honey can cure. The reasons for the prevalence of this philosophy may be beyond the scope of this write-up; however, this philosophy is friendly to the environmental sustainability context. It is contrary

to the unsustainable fashion and trend culture in other societies, whereby a temporary seasonal cyclical phenomena is adopted temporarily and discarded as fast as it comes (Bhardwaj & Fairhurst, 2010).

This philosophy of prioritising older materials might further be supported by the transition of the Nigerian consumer market from the British standard goods to the Chinese sub-standard products that flood the market (Falola & Achberger, 2013, p. 219; Raine, 2013). In Nigeria, labelling a product as made in China is synonymous to low quality. This psychology of Nigerian consumers was the subject of public discussions among Nigerian citizens as well as a concern for the authorities of the two countries (Agency Report, 2015; Okafor, 2015).

In the context of demolition waste management, this culture and tradition encourages the prevalence of reuse of the salvaged building materials in yet another building or for other purposes not necessarily in the construction sector. In an analogy to the natural ecological systems, a waste from one building becomes a raw material for use in another building or other sectors eliminating any waste. This is practically a form of an Industrial Ecology. Moreover, reuse of materials is considered second most sustainable waste management strategy in line with the principle of the waste hierarchy and the EU directive on waste management (DOE, 2012; Kibert, 2005; Nowak, Steiner, & Wiegel, 2009).

Economy

Performance of the national economy intertwined with the socio-political economy of the Nigerian society can be speculated to contribute to the emergence of the practice of the end-of-life management of buildings. More than half of the research participants regarded performance of the national economy to be an important factor that influences the practice. While some of the participants casually mentioned the performance of the national economy (ENIE03; ENIE07; ENIE08; ENIE09; ENIE16), there was also a striking recurrence of phrases related to the economy in the interviews. *"Of course the economy, the more affluent the people are the more they want bigger things, the more they want luxury, so these things lead to decommissioning of buildings"* was the response of (ENIE06). The same sentiment was echoed by (ENIE16), when he stated- *"if the economy is doing well we have more decommissioning taking place. Like what I noticed in 2010, I have more decommissioning than any other year. When the economy is booming people will want a change in service"*.

Another participant mentioned- *"People buy used materials because the national economy is not doing very well. I believe if the economy is booming, nobody will buy second-hand*

materials. On the other hand, if the economy is doing well, more people will need to demolish".

However, the above statement may be confusing; in the first part it implies when the economy is performing well, people may not have to use salvaged materials, while on the other part it mentions that when the economy is good, more people will demolish. Nonetheless, the two can be reconciled in the sense that when the economy is booming more people will get richer and will need to demolish properties for upgrades or change of purpose. On the other hand, the socio-economic structure in Nigeria- a wealthy country that is polarised, with super rich upper class and extremely poor lower class and virtually no middle class (Aigbokhan, 2000; Aiyedogbon & Ohwofasa, 2012; The Economist, 2014), the lower class are pushed to the use of salvaged materials. In other words, when the national economy deteriorates, the purchasing power of the citizens worsens. This leads to the choice of salvaged building products rather than new ones for its relatively lower costs.

The political-economy and social stratification in the Nigerian society might be beyond the scope of this paper, nevertheless the environmental and social benefits of this practice are very much relevant to the sustainability agenda. Economic incentives help to organise the different segments of the industry to operate in such a way as to produce virtually zero waste from building demolition. While waste management systems in the economically advanced nations are driven by legislations, economic incentives are the major force influencing waste management practices in the less economically advanced nations (Schneider & Ragossnig, 2014). The interplay of the culture, the environment, and the national and political economy to generate the economic incentive that sustains the industry of salvaged building materials in Nigeria. All the stakeholders and more especially the specialists *"Yangwangwan"* have one economic benefit or the other from the handling of the salvaged materials.

The Operation Environment and Factors

The salvaged building materials in Nigeria are handled coincidently, in line with the principles of the waste hierarchy known as the waste pyramid, however in a more specialised manner. The waste hierarchy pyramid recommends that the most sustainable and preferable manner of managing waste that cannot be avoided is reusing, followed by recycling, thereafter using the waste as fuel to recover energy; and unavoidably dumping in the landfill. According to the accounts of the research participants, all materials from a decommissioned

building are salvaged for reuse in different ways and manner not necessarily in the same manner as its original role.

The reuse of materials is in three different ways as in the concept of recycling, upcycling, and downcycling (Sassi, 2008). Where a material is reuse in similar role as in the decommissioned building can be referred to as simply reused; and where it is upgraded to be reused in a more significant role it can be referred to as *"up-used"*, and when used in a less significant role, it can be referred to as *"down-used"*. An example is the aluminium roofing sheet that can be reused as roofing sheet, up-used as partition or as a door, or down-used to produce cooking pots or a mould for baking bread.

On the other hand, the minimum impact or complete absence of building regulations and legislation, lack of formalisation of standards, and indifference to occupational health and safety, may be the factors that interact to create the favourable environment to derive the thriving of this phenomenon in Nigeria. Demolition is most often not considered as a subject for building regulation, while legislations are imported and non-specific to the construction sector. These four factors might have interacted to produce the environment conducive for the thriving of the current practice of the end-of-life management of buildings in Nigeria as discussed below.

Building Regulation

There is no clearly defined role for the building regulatory authorities in the process of building demolition in Nigeria. Nevertheless, an insider from one of the regulatory authorities identified only one circumstance where the demolition may become relevant in the building approval process. It is usually when the staff of the authority realised that there is an undisclosed existing structure on the proposed site for a new construction; then the old structure should be demolished before the approval for a new development is given. He admitted that the practice of obtaining approval prior to demolition is rarely practiced. He said: *"there is a provision in the law to obtain approval before demolition a building but it is not practiced. A government parastatal submitted application for building approval, and they requested permission to demolish the old structure; and permission was granted; but this example is very rare; in my life for two decades, this is the only case I am aware" (ENIE16).* Supporting the same position, another research participant said- *"It does not really affect building demolition. Only in recent times and in some states that approval is emphasized. I think less than forty per cent of all buildings in Nigeria are approved" (ENIE03).* Which implies that if less than 50% of building developments are approved; therefore demolition is

very secondary, then? None of the research participants disagree with this position, rather it was suggested by some others that the regulatory authorities should play a central role in the demolition of buildings and the building regulations should be tailored to encourage the sustainable practices.

Legislation

Concerning legislation, as reported by G. Idoro (2004), construction industry legislations in Nigeria are often adopted from the United States or UK; nevertheless, can such legislations be as effective in Nigerian society with completely different cultural orientation? It will be an equivalent of speaking a foreign language to a native while expecting him/her to immediately grasp and start using the language fluently! The same type of question was answered by Hofstede (1980), while discussing why American management theories may not work elsewhere. Following a survey of the employees of a multinational organisation with samples whose only difference is in their nationalities, he concluded that many of the employees' motivation, organisational structures, and management styles are influenced by the national cultures. In a survey whereby all other variables are the same and the only dependant variable was the national culture, it was realised that variation in national cultures requires different approaches to management. Equally, in the area of sustainability, there is a correlation between environmental sustainability and the national culture (Park et al., 2007). It is not surprising then when only thirty eight per cent of the research participants interviewed believe that legislations can be instrumental to bringing improvement to the practices of managing buildings at the end of its lifecycle. Notwithstanding, legislations that are original and in harmony with the indigenous cultures may generate more impacts to the practice and the environmental sustainability paradigm.

Standardisation

Serendipitously, what may be referred to as informal standardisation procedure has been part of the on-going practice of handling salvaged materials from decommissioned buildings in Nigeria. In the words of one of the marketers of the salvaged materials, "*Materials are graded informally for the purpose of marketing and maximising profit. Naturally, materials are not sold at the same price; the condition and level of deterioration of the item determine the price. The buyers too are aware and they buy according to their budget and the purpose it is going to be used*" (ENIE01). This claim was confirmed by another interviewee when he

said, *"Yes, people categorize the materials according to their quality; even the prices are not the same"* (ENIE10). The two doctrines of *caveat emptor*- "buyers beware" and *caveat venditor*- "let the seller beware" are all operational in this circumstance. The seller grades the merchandise and prices it according to the quality and the buyer too inspects and purchases according to the suitability of the materials to his/her purpose. What may be absent from this process are the technical specifications such as materials strength, fire ratings and other materials properties specifications that might be rated in figures and laboratory procedures.

Some other interviewees suggested that the properties of the materials *ab initio* come into play in this situation. An interviewee (ENIE06), for instance remarked that, "*the initial grading of the materials helps in using as reusable material in a demolished building. You find that in some the deterioration over time is not significant"*. Nevertheless, how much a particular item has deteriorated over time; and what is its' capability to perform the same or different function in a building, and for how long? All these are questions that need to be answered! It is these same issues that might have prompted some of the interviewees to think that some form of standards, guides, and legislations are necessary to minimise risks and develop a more organised sector (ENIE03; ENIE13; ENIE15; ENIE16). In order to emphasize this point, ENIE12 () stated that *"There is a need for standardisation; that is why I said there is a need for a comprehensive act of legislation; when we have the comprehensive act we have the standardisation, the description of the materials, the manual, the shop drawing of whatever we have. Whenever there is any building construction you have to furnish the client with all the information on how the building was erected including the lifespan and maintenance, and the method of erecting and coupling that building"*. This suggests a need for re-grading the materials before it is reused.

Occupational Health and Safety

The occupational health and safety issues in the Nigerian construction industry in general may be regarded as neglected. The occupational health and safety legislation on factories is considered to be inclusive of the construction industry. Nevertheless, the implementation of the Factory Act that should include the construction industry (National Occupational Safety and Health Information Centre, 2006; Rotimi Williams), is usually inclined towards manufacturing at the implementation phases by the government (G. I. Idoro, 2008). Consequently, provisions for health and safety were ignored by the players in the industry and record keeping becomes at best haphazard and in most cases non-existent (G. I. Idoro,

2008). Moreover, accident data from construction sites may not be reliable as the firms may not be willing to disclose such information to protect its image and it is legally optional. More worrisome is the awareness of the workers about the health and safety procedures in construction and demolition in particular. In only two out of sixteen cases, occupational health and safety (OHS) issues were considered as part of the challenges in the practices of the end-of-life management of buildings in Nigeria until prompted by the interviewer. Consequently, the workers are exposed to occupational hazards on building demolition sites.

The absence of any restriction due to considerations for the occupational health and safety may have contributed to the possibility of the handling building demolition in Nigeria with minimum waste. Nevertheless, the natural human predisposition towards vitality, integration, and health will support any attempt at encouraging safety procedures on the building demolition sites in Nigeria (Deci & Ryan, 2000). This will be made feasible when the stakeholders are enlightened that their physiological need for safety may not necessarily be in conflict with the pursuit of their economic targets.

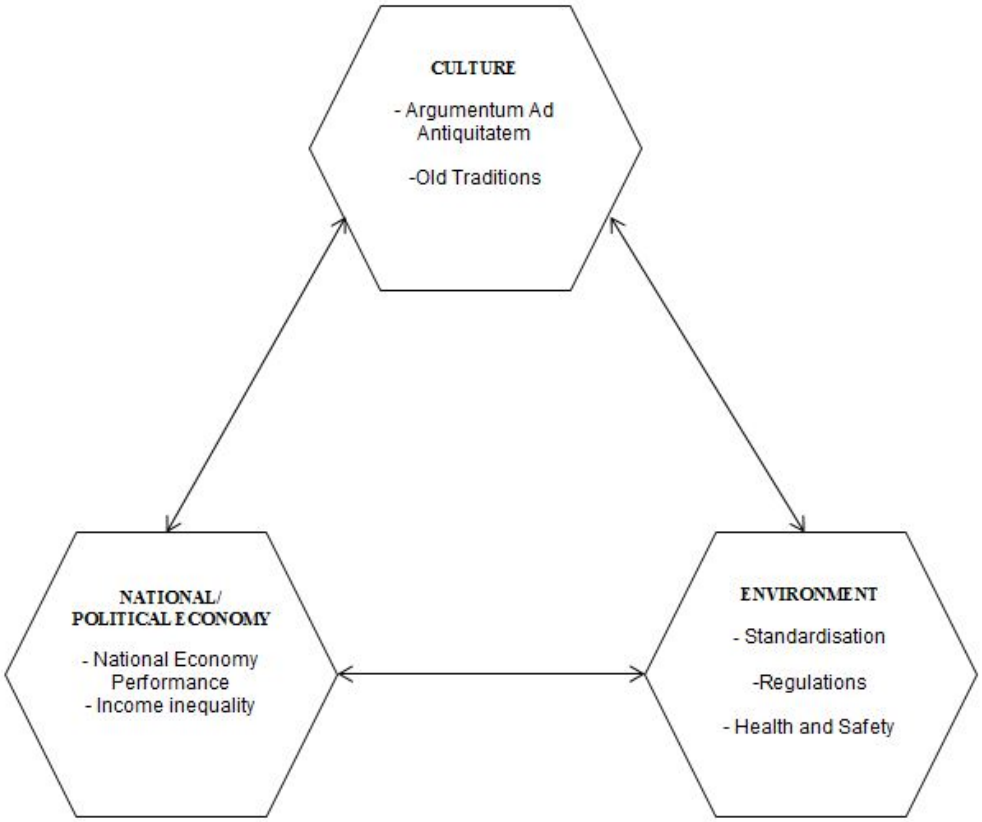

Figure 2: Conditions for emergence of the practice

Constraints

The occupational health and safety, standardisation, legislation, documentation, and lack of awareness are the five issues identified to be the constraints in the end-of-life management of buildings in Nigeria, while at the same time might have contributed to the flourishing of the practice. There is the need for sector specific legislation that will compel some more formal standardisation and documentations of building demolition activities. Nevertheless, any legislation without consideration for the cultural factors and the merits of the existing practices is likely to end up being counterproductive and not practicable.

Role of the Stakeholders- *The " Yangwangwan*

There are five stakeholder groups usually involved in the management of buildings at the end of its service. The stakeholder groups include client who owns and decommissioned the building, the end users of the salvaged materials, and the marketers that serve as middle men

for trading the salvaged materials. Other stakeholder groups are the workers or the demolition contractors, and the government. All of these stakeholder groups is attracted by one economic incentive or the other. To the end-users the economic incentive is in the low cost of purchasing the salvaged products compared to the alternative new building materials. While to the owner/disposer may be the economic benefit is in the value of money gained from the sales of the salvaged products. Members of the supply chain take the advantage of serving as intermediary resellers that acquire the materials at a cost and sale at a profit to the would-be users. The workers or contractors and the "foragers" are equally attracted by the wages they earn and the potential for serving as reselling agents. For the government the benefit is in the jobs created for the citizens and potential for generating tax.

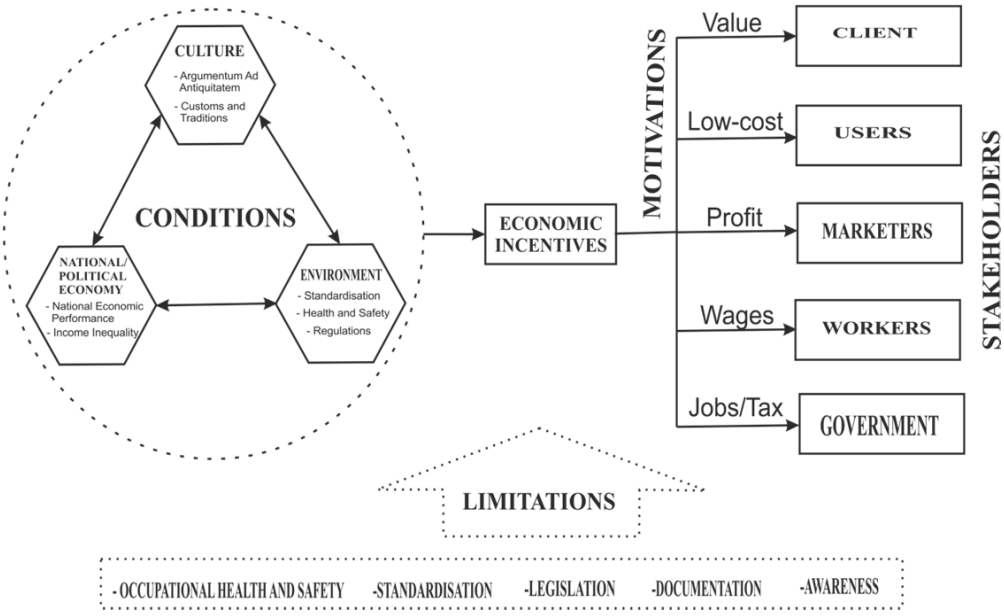

Figure 3: Operation mechanisms of the building demolition waste handling in Kano

Developing a Model for the end of Life Management of Buildings in Nigeria: the Snail Filter

The process of managing buildings at the end of its service can be represented as a conceptual model using the biomorphic structure of an African land snail. Biomimicry refers to the

development of sustainable solutions to human problems by adopting biological principles from nature, whereas biomorphism is the mimicking of naturally occurring physical forms without necessarily any similarities in functional principles (Pawlyn, 2011, p. 2). The physical structure of the shell of the giant African snail can be used to depict the operations in handling salvaged building materials as in the diagram (Figure 2.0). The protective coiled shape of the snail shell is in segments, and each of the segments can be considered to represent a procedure in the overall process of salvaged materials handling.

While the head of the snail is visible above the shell when it is not retracted, a typical shell consists of segments that are disproportionate in size and arranged in a diminishing order to form a funnel shape structure. The first and largest segment is 50-60% of the overall size of the shell, followed by the second segment that is about 20% of the overall size. The third and fourth segments are within 8-15% range each. The fifth and sixth segments are much smaller of approximate proportion of 1-5% of the overall size of the shell. Each of these segments is twisted as a segment of a spiral that is connected to the next segment forming a complete bigger spiral (see 2 below).

Figure 4: African snail (http://www.fotolibra.com/gallery/41499/giant-african-land-snail-illustration/)

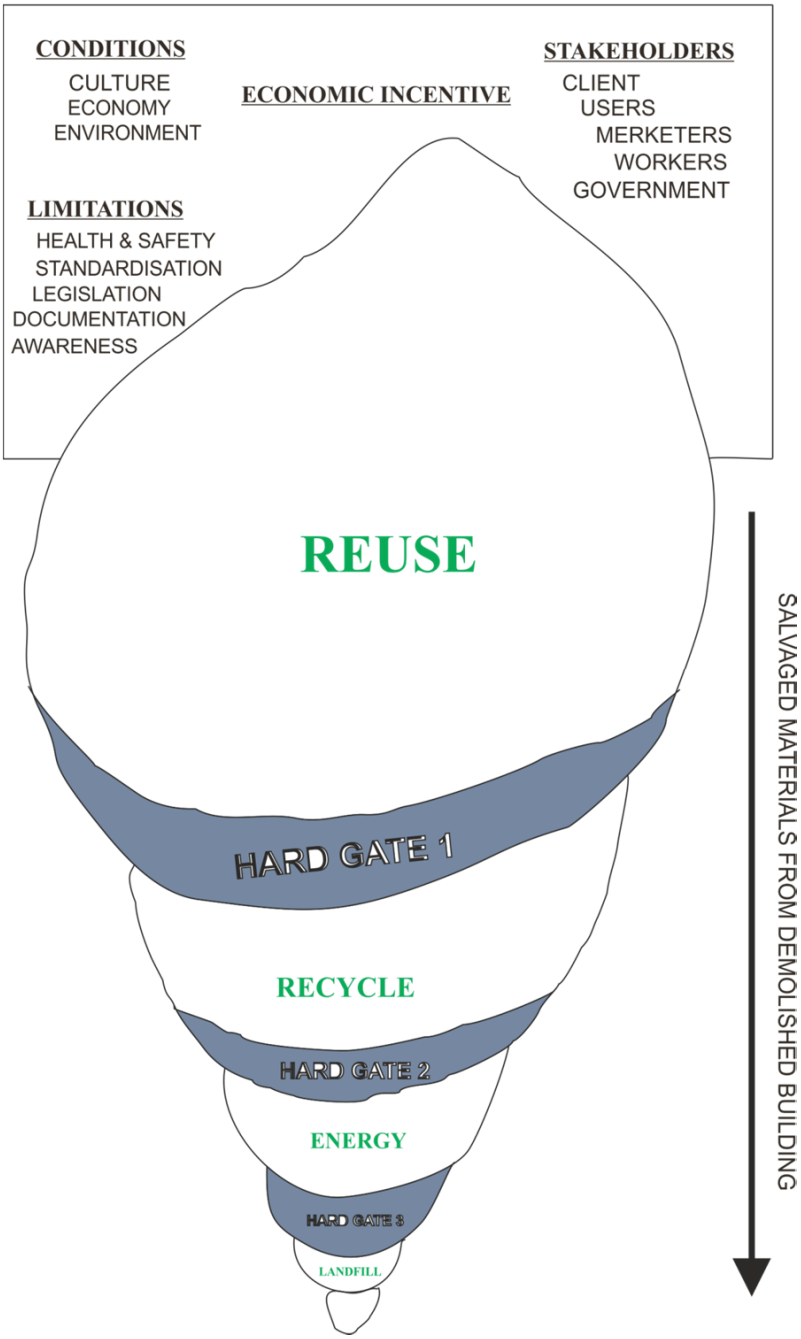

Figure 5: The Snail Filter

The materials handling at the end-of-service of buildings in Kano with resultant minimum waste can be represented by the physical structure of the snail shell. The activity starts with

the removal of materials while dismantling the building structure. The materials are removed in most cases with the reuse agenda as a sanctuary for the materials instead of dumping in the landfill; this is similar to the retraction of the snail head and body into the shell for protection on sight of danger. When the salvaged materials are retracted into the protection of the "shell", the first and bigger segment can be assumed to represent the reuse of the salvaged materials, which is the largest and most important technic coinciding with the first and largest segment of the snail shell. Most materials, probably as much as 50-60% as the proportion of the first segment of the snail shell, are reused as narrated by the research participants. Materials that could not in any way be reuse in exactly the same purpose or for a different purpose will be examined for viability for recycling; and this is done by passing through a conceptual filter or hard gate that guarantees only qualified materials pass to the next segment. The recycling procedure can be assumed to be represented by the second and third segments of the shell and all materials that are recycled are recommended not to be in excess of the 20% coinciding with the proportion of the corresponding shell segments. Other materials that do not satisfy any of the conditions in the previous stages can be considered for use as fuel after passing through another imaginary filter and are recommended not be more than 10% of the materials to coincide with the proportion of the fourth segment of the shell. Then the fifth segment coinciding with disposal in the landfill should not be more than 5% coinciding with the proportion of the fifth segment of the snail shell. However, it should be noted that the numerical percentages are only recommendations inspired by the proportion of the segments in the snail shell, as this study did not include quantitative measurements.

The upper part of the model corresponding with the head of the snail is segmented to represent the economic incentive, conditions for the emergence of the practice, the different stakeholders, and the constraints in the practice.

Operations of the Model

From the accounts of the research participants, a theoretical filters or hard gates may be assumed, adopted from the process protocol (Lee, 2002), whereby all salvaged materials are screened to ensure that only materials that cannot be reused in any other way whatsoever are allowed to pass to the recycling phase. While only materials that could not be used are considered for recycling, there is another filter or hard gate 2, which sieves the materials to ensure that only materials that could not be recycled pass to the next stage of energy recovery. Materials that could neither be reused nor recycled are considered for energy

recovery. Where the material could not be used as fuel either, then it may unavoidably be dumped in the landfill after undergoing another screening at hard gate 3. In this process, most of the salvaged materials were reused and smaller proportion of the materials were recycled, and much smaller proportion were treated as fuel, while very little quantity is deposited in the landfill. The concept of hard gate adopted from the process protocol refers to a resolute decision prior to proceeding to the next stage of a process (Aouad et al., 1998).

This was further attested by an analysis of the municipal solid waste conducted by B. Nabegu (2008) and A. B. Nabegu (2010). In one of these studies samples of the municipal solid waste were collected for three months from landfills in three different residential areas of Kano according to Gordon guide for data collection in cities; and the samples were separated into groups for analysis. In the second study, secondary data was collected from the only government agency responsible for the management of municipal solid waste, the Kano State Refuse Management and Sanitation Board (REMASAB). The different classifications of the solid wastes in these studies include biodegradable matter, industrial waste, non-biodegradable matter, including some glasses and metals. However, there was no mention of demolition and construction waste whatsoever. The small pieces of glasses and metals might likely be from household items such as bottles and cans and probably very insignificant quantity from building demolition. Demolition and construction bye-products are not considered as waste in this community; it is rather a marketable commodity with a relatively developed market and stakeholders. Handling of the reusable building demolition bye-products constitutes an independent economic sector with various players. How the materials are handled with minimum quantity going to the landfill can be demonstrated in a process diagram below.

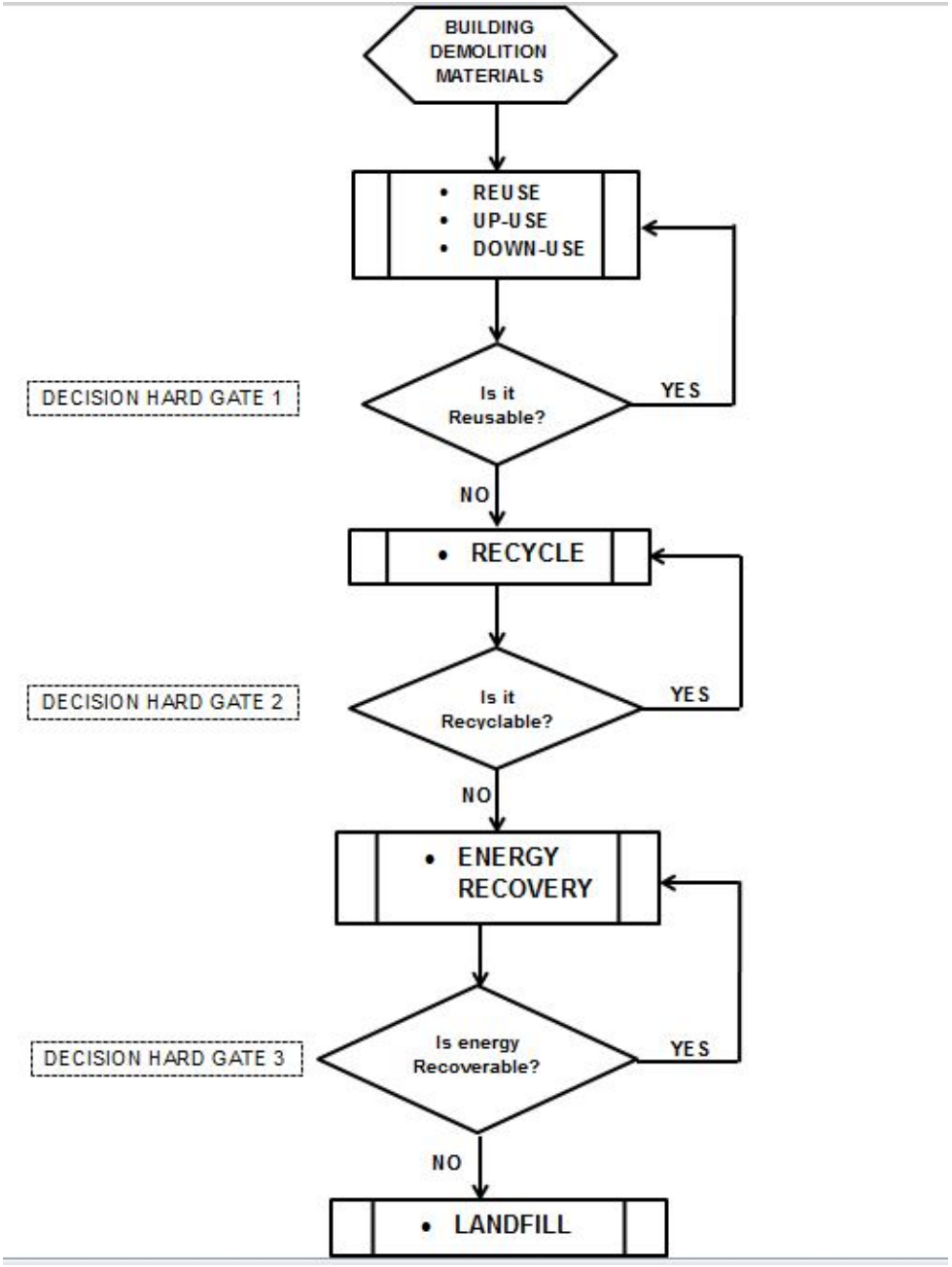

Figure 6: Salvaged Building Materials Handling Process in Kano Nigeria

Conclusion

Sustainability is indeed the man's major issue of the 21st century (RIBA, 2009d). Conferences and summits were organised on sustainability at various levels, sometimes with over a hundred world leaders (Brandon & Lombardi, 2011). Despite some initial resistance by the developing countries(NAJAM, 2005) , it was later accepted as a global agenda to pursue development for the satisfaction of the current generation without jeopardising the feasibility of the same privilege for the future generations (Brundtland, 1987). The global warming and resources consumption are surely among the most critical issues in the sustainability debate; therefore, making the built environment the centre of focus being the largest contributor to both. It is arguably observed that while setting the global agenda for sustainable development the tendency is to adopt the standards of the highly industrialised countries. Nevertheless, as demonstrated in this article, some practices inherent among the societies in the developing countries are well compatible with the global sustainability agenda. Notwithstanding the constraints of such practices that may require some improvements, some practices in the developing countries may have some merits over the alternative options.

The end-of-service management of buildings in Nigerian cities, as demonstrated in this paper, is one such a practice. It possesses many advantages in terms of the sustainability vocabulary. It is a system that produces minimum of material wastes with emphasis on reuse as the second most preferable material waste handling technique. In this paper, it the model of "*how it happens*" that is presented as the snail filter, however, the feasibility of using this model as a generic framework for the management of buildings at the end of its services is a subject of further research.

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