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Elimination of Waste and Inefficient Facilities in Existing Buildings for Sustainability in Developing Nations

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ABSTRACT: A major reason why many developing nations have not made significant advancement in sustainable development (SD) agenda is the neglect of existing building stock which forms the bulk of built assets. Although sustainable development is a universal challenge, it cannot be approached in the same way for all nations, but rather practical response can be defined nationally or locally. This paper reviewed literature into the possibility of using an improvement strategy model to eliminate waste and inefficient facilities in existing buildings from occupants and property managers' view points for sustainability in developing nations using Nigeria as an example while emphasis is placed on the multi-stakeholder/interdisciplinary approach in which each professional in the built environment add discipline-specific data to a single shared model. Many writers have criticized the ignorance of end-user requirements during the construction briefing, highlighting the communications gap between the end-users, designers and owners, and that little had since improved. This paper suggests a way forward in which "bottom-up" improvement policy formulation and subsequent implementation would stem from occupants and property managers rather than "top-down" governance approach in most developing countries. The concepts of lean thinking, zero emission and green building were incorporated into the Building Information Modeling to develop an improvement strategy model for existing buildings with the condition that the use is retained. It is envisaged that improvement would be cheaper financial-wise than to demolish and rebuild; environmental friendly; and bring about an appreciably reduced maintenance cost.

Keywords:
Existing buildings, Improvement, Facility manager, Sustainable development, Waste and inefficient facilities, User's requirement.

INTRODUCTION

The United Nation Earth Summit of 1992 in Rio de Janeiro, Brazil called on member States to adopt national sustainable development strategies that should build upon and harmonize the various sectoral economic, social and environmental policies and plans that are operating in their respective countries.However, over ten years after the target of 2002 set for their formulation and elaboration, many developing countries are still struggling to make significant advancement in sustainable development (SD). Wood &Muncaster (2012) observed that, "the "developed world" as a whole has huge numbers of buildings designed and constructed to standards that were barely adequate in their day and inadequate for today and tomorrow; and those in the developing world are even poorer."Jiboye (2009) also noted that "despite efforts at both the local and international levels(in Nigeria)… current realities suggest that the goal of achieving sustainability in the country is yet to be realized".A major reason for this has to do with neglect of existing old buildings, as Wood (2006) noted that "sustainability cannot be achieved without addressing the existing building stock. Even if every new building was a 'sustainable building', their impact on sustainability as a whole will be minimal for some time." This paper therefore proposed an improvement strategy model to eliminate waste and inefficient facilities in existing office buildings for sustainability in developing nations. Jiboye (2011) wrote that, "One peculiar feature of governance in Nigeria is the use of Top-down approach to policy formulation and implementation."

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This paper seeks the opposite, whereby improvement policy formulation and subsequent implementation would stem from occupants and facility managers.

Background

The retrogressive trend witnessed in Festac Town, Lagos Nigeria once dubbed 'Little London' when it was built 36 years ago because of its state-of-the-art infrastructure had since sent tongues wagging questioning whether infrastructural maintenance is alien to the people. Okojie (2013) wrote: "As a mark of the country's penchant for lack of maintenance culture, the once beautiful town is now a shadow of itself, given the collapse of virtually all its infrastructure. Rather than finding lasting solution to the rapid decay of infrastructure in the estate, it has been accusations and counter accusations between the residents and management of the Federal Housing Authority (FHA). The Managing Director of FHA blamed the deterioration of infrastructure in the estate on the residents who he accused of departing from the authorities original design and concept."The comment of the Managing Director of FHA is thought provoking and it ushered in a vital dimension of sustainability i.e. if occupants depart from original building design (or carried out alteration/ modification works, as it would seem in this case), then the accommodation (i.e. spatial arrangement) or other facilities offered were not meeting their needs and must have had elements of waste and inefficiencies.

Waste and Inefficient Facilities

Waste is "any activity, which absorbs resources but creates no value" (Womack & Jones, 1996).The Advanced English Dictionary (AED) (2013) defined "waste" as "any material unused and rejected as worthless or unwanted; a trait of wasting resources", while "inefficient" was defined as "not producing desired results, or lacking ability to perform effectively". Ability itself was defined as "possession of qualities desired to get something done". Adopting these to buildings, 'waste' could be seen as those partitions within or without the building(s), which the occupants do not need or find useful, for example, multiple passageways or corridors in a building which could have been more useful to the occupants if converted to store(s). Bullen & Love (2011) referred to such as "inefficiencies in spatial layout".Bootle&Kalyan (2002) claimed that UK businesses are throwing away £18 billion a year through the inefficient use of space. Utility costs can also increase when day lighting is not well supplementing electrical lighting in buildings due to poor design.

'Inefficiencies' in built assets can also be seen as a building or its components not having the ability to function efficiently. An example is a building having a2 sliding window in a humid and hot environment without provision for artificial ventilation; in such situation, the window can only provide a maximum 50% opening as compared to louvres that would provide up to 90% opening. Thus the former has more of aesthetic than functional value, which is the opposite for the latter. Therefore, the sliding window may be regarded as 'inefficient' because it does not have the 'ability' to provide enough ventilation in the environment without further provision for artificial ventilation, whereas it can be more efficient in temperate regions or in built assets with further provision for artificial ventilation such as air conditioners. This problem is more pronounced in Nigeria as in many other developing countries where electricity supply is erratic, thus provision of artificial ventilation alone would still not solve the problem of the 'inefficient' windows. The Nigerian architect is often criticized for giving more preference to aesthetics rather than functional value.

There is no doubt that there are a number of other factors and barriers that affect our ability to make our existing building stock more sustainable, however, until we are also able to address these two major issues of 'waste', and 'inefficient facilities' from occupants' and property managers' viewpoints, the pace of SD in the developing nations will remain slow.

MATERIALS AND METHODS

This paper re-evaluated existing buildings and their role to sustainability through the improvement (as against maintenance) of their standards and it adopted the definition of 'Maintenance' as repair works carried out to restore a building to its original standard at construction, while 'Improvement' is any work carried out to upsurge the initial standard of the building. Thus, maintenance reinstates the original standard, while in improvement;it is upgraded (Fig. 1).

Wood (2006) pointed out that, "A shortcoming of existing buildings is that they were constructed to the standards of the past, while standards, as measured by building regulations, have tended to increase over time in as far as they improve sustainability, both in quality and quantity. There is no requirement generally to bring existing buildings up to the standards applicable to new buildings; thus most existing buildings are some way below the standard of new buildings." Thus, while maintenance could address problems of deterioration and decay associated with physical obsolescence, it cannot solve problems of functional, economic and social obsolescence. Maintenance carried out on non-sustainable existing building can at best reinstate it to its original non-sustainable standard. Bullen & Love (2011) stated that, "Improvements carried out during adaptive reuse were considered to provide the opportunity to link the performance of a building directly to the objectives of sustainability."

Many other terms have been used to describe maintenance in literature, however in a bid to produce consistency in this paper, such terms are not used save in relevant quotations mainly because they have ambiguous meanings, as observed by some authors: Mansfield (2002) observed that there is a surfeit of terms used to cover improvement such as adaptation, refurbishment, upgrade, conversion, renovation and that they exist in a "state of happy confusion". Mansfield (2011) noted that, "across the literature there continues to be some confusion regarding the

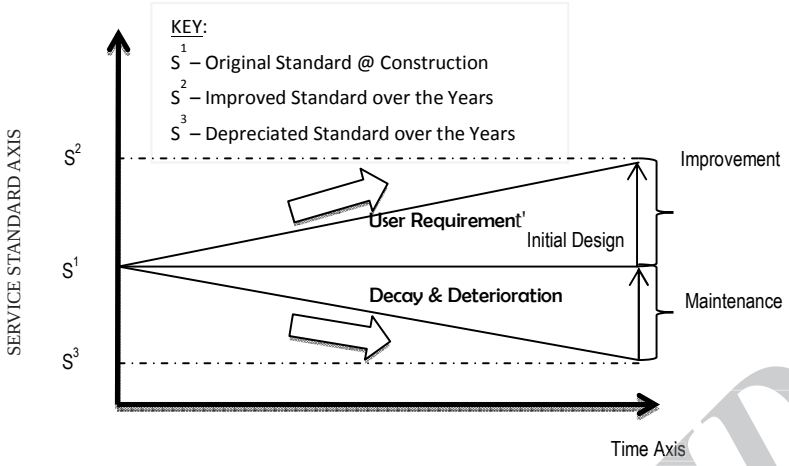

Fig. 1: Improvement & Maintenance (Source: Adeyemi, 2010)

term refurbishment; many terms have been used as synonyms, including alteration, retrofitting, restoration, renovation and upgrading." Brandon (2012) suggested that in a discipline, there is need for a common language which allows communication across related topics without fear of misunderstanding. These terms include adaptation, refurbishment, rehabilitation, remodeling, retrofitting, revitalization, among others.

Concept of Sustainable Development

The concept of SD came into general usage following publication of the 1987 report of the Brundtland Commission - formally, World Commission on Environment and Development (WCED). It is this Commission, set up by the United Nations General Assembly that coined the most often-quoted definition of SD which is "development that meets the needs of the present generation without compromising future generations to meet their own needs" (WCED, 1987).

Pezzy (1989), in a paper for the World Bank, listed 60 published definitions of sustainable development, while Hartshornet al. (2005) also noted that, "… it is estimated that there are between 30 and 60 separate definitions of sustainability and that there is little agreement as to its meaning in practical or even theoretical terms."Gilmour& Banks, (2011) observed its abstruse meaning thus: "… for many, sustainable development is often seen as a complex issue that is not definable in practical terms. The difficulty lies in defining sustainable development consistently owing to its very broad nature; often any definition occurs in political statements that are rather general and open-ended." According to Mansfield (2009), "Notwithstanding the efforts of the EU[1] Commissioners and national governments to provide a cohesive policy to address the negative impacts of sustainability or sustainable development, there is considerable difficulty in providing a consensus definition of these terms."

Slessor, cited in Abley&Heartfield (2001) said, "At best, Bruntland serves as a starting point but it hardly suffices as an analytical guide or policy directive." Hartshornet al. (2005) went on to explain that "A particular difficulty with the considerable disagreement over a precise meaning is that it obscures the political, philosophical and technical issues that remain unresolved from the "environment versus growth" debate." Lee and Huang (2007) also identified SD as the "most challenging and controversial issue" with respect to its interpretation and application.

Many writers agreed however, that the same approach cannot be used universally to achieve SD, for example, Rana (2009) observed that "the same goal of sustainable city will not be suitable in quest of sustainability in all cities of the world, while societal and cultural resources are different."Strzelecka (2008) however suggested that while SD is a universal challenge, practical responses should only be defined nationally and locally.Hence, it would be rational and sensible to say that developing nations should tailor responses to SD within their local environmental, economic and social extents along the triple bottom line approach in order to make significant advancement. This paper adopted this approach.

Improvement of Existing Buildings

Much of the building stock for the next century already exist and thus, to make a serious impact on improving sustainability, existing stock should be more fully considered. Wood &Muncaster (2012) observed that, "The rate and scale of improvements needed to existing buildings to "save the planet" are immense and extensive programmes are seen as necessary." According to Wood (2006), "No building is an island. Buildings relate one to another and to the infrastructure, which links and serves them and their users. There are, for instance, cultural, heritage and physical links to be built upon and added to by new buildings and improvements to existing buildings." Hui, Wong & Wan (2008) added that, "In addition to the extension of the economic life of buildings, rehabilitation helps improve

the living environment, increase property values, reduce the urgency for redevelopment, and enhance public safety and the image of city." Teo& Lin (2011) also wrote that "the level of adaptation a building shall receive always seems puzzling to property portfolio managers", which this paper also addressed, mainly from occupants' viewpoint.

Stone (2005) also observed that "Buildings outlast civilizations, they evolve and they are changed, but their reuse emphasizes continuity." AED, (2013) defined 'reuse' as "use again after processing". Stone (2005) went on to say that "The re-use of existing structures has been a common practice since the first buildings were constructed and yet very little theoretical analysis of the subject exists. At the start of this new century, in an attempt to preserve our cultural heritage, large numbers of existing buildings are remodeled in preference to demolition." This had lent a support to the essence of this research.

Wood &Muncaster (2012) observed that, "Despite their poor construction and condition, older properties are attractive to many in the population. They are part of existing urban communities and are often seen as more appealing visually and cheaper to purchase than new homes on barren estates on the edge of town." Newton & Bali (2008) said that the challenge of achieving SD in the 21st century will be won or lost in the urban areas with policy makers believing that improvement of existing buildings will deliver sustainability in the built environment.

Nelson (2008) said that capital sustainable improvement with an associated cost "resets the building life, improves performance, and makes the building's use more predictable for an extended period of time".

Elimination of Waste and Inefficient Facilities Models

Four models that deal mainly with the issues of elimination of waste were examined during the literature review and they include (1) Lean Thinking, (2) Green Building, (3) Zero Emission, and (4) Building Information Modeling (BIM).

Concept of Lean Thinking

Lean thinking is an improvement model that emphasizes the identification and elimination of muda (Japanese word for waste) wherever it exists in a system, and that value is defined by the customer (end-user). According to Nicholas and Soni (2006), the two overarching philosophy of Lean Principles for sustainability is "elimination of waste" and "continuous improvement" (or kaizen in Japanese). Wang (2011) explained that Kaizen is a system of continuous improvement in quality, technology, and safety among other things. The concept of muda (seen as the opposite of value) which became one of the most important concepts in quality improvement activities primarily originated from Taiichi Ohno's famous production philosophy of Toyota Production System (TPS) in the early 1950s. Ohno (1988) classified waste into seven types as shown in the table below (Nos. 1-7); many have however added the eighth - "unused human talent" (e.g. Womack & Jones, 1996). Table 1 shows the types of muda as applied in this paper.

The concept of lean production had since been applied to a vast range of operation and processes in widely differing industries with tweaking of details, including the construction industry from where terms such as "lean construction" and "lean design" emerged. Lean design and construction are fashioned

Table 1: Types of Waste (Source: Womack & Jones, 1996)

S/N.	Waste Type	Modified Description
1	Transportation	Distant location of complimentary offices causing unnecessary movements for users.
2	Inventory	Building materials kept for maintenance that are not necessary or have short life spans.
3	Motion	Poor ergonomic design affecting productivity, quality & safety e.g. walking, reaching, twisting.
4	Waiting	Delay, due to inadequate provisions for access to carry out maintenance activities, etc.
5	Over-processing	Adding design features not needed by users, e.g. bath tubs in general convenience; irregular office shapes thereby reducing functionality; etc.
6	Over-production	Large accommodation space, too many corridors, etc. not needed or appreciated by users.
7	Defects	Defect in design: including inflexibility; wrong specifications leading to dampness, conditions suitable for fungi growth or attack, excessive condensation, corrosion and possibly electrical faults, etc.; inadequacies (e.g. conveniences, ventilation, lightening), etc.
8	Human talent	Non-inclusion of end-users' inputs & requirements in design, maintenance or improvement.

after Lean Six Sigma, which is a set of tools and strategies for process improvement originally developed by Motorola in 1985. To undertake improvement activity in business (or building) processes in a systematic way using Lean Six Sigma, the useful framework is DMAIC (Dahlgaard & Dahlgaard-Park, 2006). It involves five phases, namely:

Define the problem, the voice of the end-user, and the project goals, specifically.

Measure key aspects of the current design and collect relevant data.

Analyze the data to investigate and pinpoint the areas for improvement. Attempt to ensure that all factors have been considered.

Improve or optimize the current standard based upon data analysis. Here, various options are compared with each other at this stage to determine the most promising solution

Control: the need to ensure that the goal is achieved and held. Putting a control plan in place is vital to ensure that the process is carried out consistently through feedbacks. There is also need for the design to be flexible.

Some organizations add a **R**ecognize step at the beginning, which is to recognize the right problem to work on, thus yielding an RDMAIC methodology. Jørgensen& Emmitt (2009) gave the following working definition for lean design and lean construction in their research work:

Applies a systems' perspective to enhance value and eliminate/ reduce waste and drivers of waste in the construction project;

Adopts customer (client/user/stakeholder) preference as the reference for determining what is to be considered value;

Approaches design and construction management through a focus on processes and flows of processes;

Adopts an understanding of design and construction/ production activities from a perspective of three simultaneous conceptualizations, namely: transformation; flow; and value-generation; and

Manages design and construction/production processes with (end-user) demand-pull approach as far as this is applicable.

This paper adopted these working definitions together with the Motorola's quality improvement process "six steps to six sigma" (with modifications) to propose a model for improvement strategies for producing sustainable existing office buildings. It is termed "Lean Improvement Strategy (LIS)". The need for this model stemmed from the fact that much of what have been written about lean design is mainly for new build.

According to Huthwaite (2007), the universal lean design equation is "How to create value and reduce waste", he also mentioned that one of the five laws of lean design is "Law of waste prevention"; however they were applied to new builds only.

Concept of Zero Emission and Existing Buildings

The Zero Emission concept postulated by Pauli Gunter represents a shift in our concept of industry away from linear models in which wastes are considered the norm, to integrated systems in which everything has its use; it advocates for "complete elimination of waste" (Gunter, 1998). The three main objectives of zero emission could be summarized as: (a) No waste; (b) all inputs are used in production; and (c) when waste occurs, it is used to create value elsewhere, such that "the integrated whole produces no waste of any kind" (Zero Emissions Research Initiative (ZERI) , 2013). In essence, the concept deals mainly with finding good uses (or value) for 'waste', which therefore incorporates it into this paper. It uses mainly the input-output and output-input models respectively to achieve this. The principle behind input-output table (or

Table 2: Motorola's Quality Improvement Process "Six Steps to Six Sigma"(Source: Dahlgaard & Dahlgaard-Park, 2006)

Steps	Motorola Lean Production Strategies	Proposed Lean Improvement Strategy
1	Identify the product you create or the service you provide to external or internal customers.	Recognize & define your service: Sustainable building standard.
2	Identify the customer for your product or service, & determine what he or she considers important.	Identify customers & their needs: End-users' requirements & property manager's observations thru POE.
3	Identify your needs to provide product or service so that it satisfies the customer.	Determine Cause-Effect Relationship: Analysis of data from Step 2 above.
4	Define the process for doing the work.	Determine the improvement options.
5	Mistake-proof the process & eliminate wasted effort & delays.	Eliminate waste and defects from the process.
6	Ensure continuous improvements by measuring, analyzing, & controlling the improved process.	Measure your results for continuous improvement (kaizen): Feedback and flexibility of improvement design.

Fig. 2: BIM Model (Source: WSP Group , 2013)

model) is "doing more with less", thus prior to searching for a use for waste materials, there is need to verify that the existing system cannot be improved. The output-input table (which is the second stage is only valuable when the input-output table has been established), searches for options not previously considered within; another use is found for the output, and it requires a multi-disciplinary approach.

Concept of Green Building and Existing Buildings

According to Kozlowski (2003), a green building is one that "uses a careful integrated design strategy that minimized energy use, maximizes daylight, has a high degree of indoor air quality and thermal comfort, conserves water, reuses materials and uses materials with recycled content, minimizes site disruptions, and generally provides a high degree of occupant comfort." Green Building mainly represents climate-friendly buildings that consume lower energy and with low CO2 emission and according to Miller & Buys (2008) "much less is known about how green building initiatives might be incorporated into existing buildings, which make up the bulk of the market. If the challenge of climate change is to be successfully addressed, therefore, this vast stock of older buildings (developed decades ago when sustainability was not a consideration) needs to be retrofitted."

This paper did not address all the requirements of a green building, but the suggestions would give relevant information on how to improve day lighting, air quality, thermal comfort, conservation of water and occupants' comfort thereby producing green buildings from existing stock. Rey (2004) noted that "it is not contradictory to aim simultaneously at a coherent esthetical approach, a reduction in energy consumption and an improvement in comfort."

The Building Information Modeling (BIM)

BIM (Fig. 2) facilitates the creation of models which serve as a virtual representation of the actual construction process, by matching each step with a frame by frame real time representation; each professional adds discipline-specific data to the single shared model. According to Eastman et al. (2008), "The resulting building information models become shared knowledge resources to support decision-making about a facility from earliest conceptual stages, through design and construction, through its operational life and eventual demolition." Traditional building design was largely reliant upon two-dimensional drawings (plans, elevations, sections.). BIM extends this beyond 3-D, augmenting the three primary spatial dimensions (width, height and depth) with time as the fourth dimension and cost as the fifth (Wikipedia, 2011).

Alufohai (2012) noted that, "The move to adopt BIM in Nigeria's private and public sector and amongst different building professionals (Architects, Quantity Surveyors, Civil Engineers, etc.) has been very slow. Architects have adopted but mainly for enhancing the visual quality of their presentation." He went on to say that "The main challenges regarding cost management (in Nigeria) are poor budgeting and corruption. Projects are designed and contracts awarded on designs whose costs are not properly calculated. This often results in abandoned projects on which considerable resources have been committed and spent. An example is a Federal Secretariat Complex in the capital city, Abuja that was abandoned after it was discovered that building a vast underground car park was too expensive. Building projects in Nigerian are often a source of corruption. This often involves wild inflation of costs. The adoption of BIM will greatly enhance transparency, allowing different stakeholders (bidding contractors, parliament, civil society organizations etc.) have a better idea of true project costs and the financial implications of variations."

Occupants' Satisfaction

Kaya (2004) observed that many writers have criticized the ignorance of end-user requirements during the construction briefing, highlighting the communications gap between the end-users, designers and owners, and that little had since improved.

This paper intends to bridge this communication gap by also highlighting the importance of interaction with end-users in order to identify their requirements in existing buildings. Black (2008) observed that world class companies have intense customer focus in which the customer is an indispensible part of the process. He gave the example of Boeing who involves customers' views in its production process in what is termed "aggressive listening". The construction industry should also focus on end-users satisfaction to create world class facilities.

According to Love & Bullen (2009), "Current assessment systems do not provide a full profile of sustainability because they tend to exclude input from building occupants." Schwede et al. (2008) argued that workers would be more satisfied with a new or recently upgraded work environment and that there are indeed many instances of increased productivity resulting from environmental enhancements. Therefore it can be assumed that occupants' participation in the change design process as well as the consideration and continuity of successfully adapted environmental features, as suggested by Speckelmeyer (1993), lead to especially successful environments for specific organizations. Shika et al.(2012) observed that "To achieve sustainability objectives in buildings, a coherent strategy and action plan is needed to address occupants' expectations and needs in existing buildings."

This paper also took a cue from Schwede et al. (2008) in their research work on Occupants' satisfaction with workplace design in new and old environments used some factors to rate workspace design and management of existing buildings. They include: (1) Workspace layout; (2) Size of personal workspace; (3) Personal work surface area; (4) Workspace storage; (5) Meeting rooms; (6) Social spaces; (7) Suppression of noise; (8) Visual disturbance; and (9) Access to privacy, among others.

The Role of the Facility Manager in SD

The facility manager's role in the SD process includes commenting on the way proposals are likely to affect the future welfare of the building project, in particular, (s)he is concerned with the management, maintenance and financial consequences of investment decisions. According to Johnson, Davis, & Shapiro (2005), immediately after the architect had produced his proposal, the in-house property manager should normally be asked to comment and in doing so, he will first satisfy himself that the proposals contain no hidden danger: which include high windows openable by young children; wide stairwells with climbable balusters; blind corners on roads where children might play; and other menaces to safety. Secondly, he will look at the plans to ensure that they are not likely to give rise to expensive maintenance or difficulties in supervision and control. Finally, he will be conscious of cost.The form a development might take has an important bearing on the management problems which will emerge in the completed scheme and each detail of the embryo project must be examined to ensure that it will not give rise to dangers, difficulties of control or nuisance to the occupiers, adjoining owners or the public at large.

The involvement of the facility manager in building projects will help to address issues from the maintenance point of view and will be guided by the principle of cost-in-use in tendering advice on the suitability of forms of construction, layout and finishes (Belo &Agbatekwe, 2006). He will also try to ensure that the building project will be suited for its intended use. His role cannot be over-emphasized because the financial result of development decisions is, of course, the responsibility of the entire development team, but the consequence of failure will remain with the estate surveyor after the other team members cease to be concerned with the scheme, shortly after the

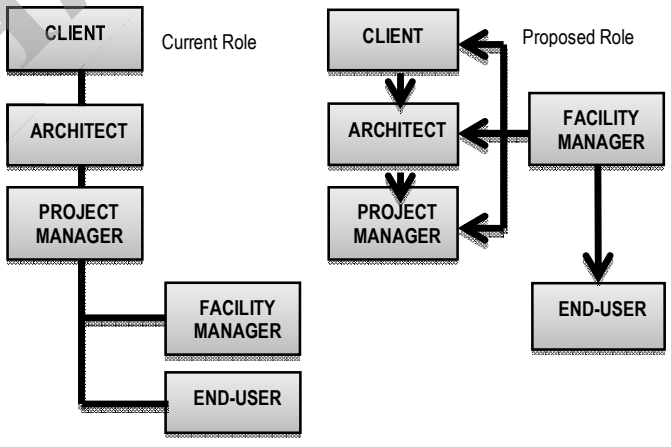

Fig. 3: Role of Facility Manager (Shah, 2007).

physical completion.

As a professional, he will therefore try to ensure that the future is not prejudiced by unwise investment or byfacile solutions, but unfortunately in many developing countries, the facility manager is usually excludedin the development process. However, this paper suggests that he can still find a role in SD; in the improvement of existing building stock. (Fig. 3)

Stone (2005) identified three stages in improvement process, namely: The Analysis, the Strategy and Tactics stages respectively. The analysis of the existing building provides the principles or basis of the argument for the remodeling of a specific place and can generate the strategy and tactics of the redesign. This paper suggests that the facility manager can generate the information needed for the analysis stage whilethe technical details for the latter stages would be provided by other professionals in the built environment, especially the designers – architects and engineers, for the simple reason that they are better qualified to do so. Scott (2008) observed that for any improvementprogramme, the scale and nature of interventions can only be ascertained after gaining detailed knowledge of the host building.

Post-Occupancy Evaluation (POE)

According to Shika et al. (2012), to achieve sustainability objectives in buildings, a coherent strategy and action plan is needed to address occupants' expectations and needs in existing buildings, thus this paper suggests the use of POE. The tool allows for occupants to provide direct feedback on the performance of the building and how it meets their needs. Watson (2003) defined POE as "a systematic evaluation of opinion about buildings in use, from the perspective of the people who use them. POEs are generally aimed at conveying the parameters of buildings that work well and also at focusing on the ones that should not be repeated in future building designs." POE assesses how well buildings match users' needs, and identifies ways to improve building design, performance and fitness for purpose. According to Shah (2007) "The POE is performed using a questionnaire to gain a direct feedback from the occupants, and uses these experiences as the basis for evaluating how a building works for its intended use. It can be used for many purposes, including fine-tuning new buildings, developing new facilities and managing 'problem' buildings." Nawawi & Khalil (2008) observed that POE of buildings is "vitally needed to ensure that building performance of government and public buildings and facilities is sustained." Once occupants' satisfaction and expectancies are known and analyzed, areas to change and those to improve can be identified and subsequently resolved. The three phases in a typical POE include: Preparation; Interviews; and Analysis and Reporting.

RESULTS AND DISCUSSION

Proposed Lean Improvement Strategy for Existing Office Buildings

The proposed model (Fig. 4) took in information from the varied literature review in the following steps:

Step 1: The problem as recognized is "Sustainability of Existing Buildings" with respect to users' facility requirements in terms of a gap between what is and what should be.

Step 2: Determination of recognized users' requirement, using POE tool. Users include occupants and visitors alike. Major steps include identification and selection of participants for questionnaires and interviews, however, the facility manager adds his observation to data collected. Design data collection instruments; collect the data and summarize what you have learned about the variable's effects on the problem; determine what additional information would be helpful at this stage through observation by the facility manager.

Step 3: The data collected in step 2 and the experience of the end-users is analyzed, documented, and used to determine cause-effect relationship and potential causes of the current conditions. Determine whether more data are needed: if so, repeat step 2. It would afterwards be fed into the BIM and to other members of the design team to consider. The building team will equally incorporate the principles of SD, Green Building and Zero Emission into their designs which are also fed into the BIM.

Step 4: Through the BIM, an improvement strategy is produced that would be used to satisfy users' requirements among other things. From a list of possible strategies, a decision will be taken on which solutions to be tried. Careful assessment of the feasibility of each strategy and potential adverse consequences will be considered also. Reason(s) should be advanced for choosing a particular strategy. Will there be a pilot project?

Step 5: The implementation of the preferred strategy through the activities of the construction team will eliminate waste and inefficient facilities from the building structure for sustainability.

Step 6: Control, to ensure that goal is achieved and sustained (kaizen). The flexible improvement strategy would be used to accommodate feedback through regular POE in step 2 above.

It is necessary that the use is retained for this model to be valid. It was designed to highlight the roles of the end-users and the facility managers in the sustainability of existing buildings through improvement strategy;these two groups of stakeholders have been neglected in the questfor SD. The model had also emphasized the multi-disciplinary role involved in SD.

A benefit of improvement as observed by many writers is that it will appreciably lower maintenance cost. Grigg (1998) observed that buildings steadily deteriorate and are not sustainable because "maintaining infrastructureis a constant and expensive process which often is neglected in favor of more attractive political goals." Kincaid (2002), in one UK study showed improvement of office buildings had lower operating costs than prior to themeasure, while Suzuki, et al. (2010) explained that the principles of sustainable development must take into account and carefully assess the 'operational costs' after construction is completed.

Another perception is that improvement is far cheaper than

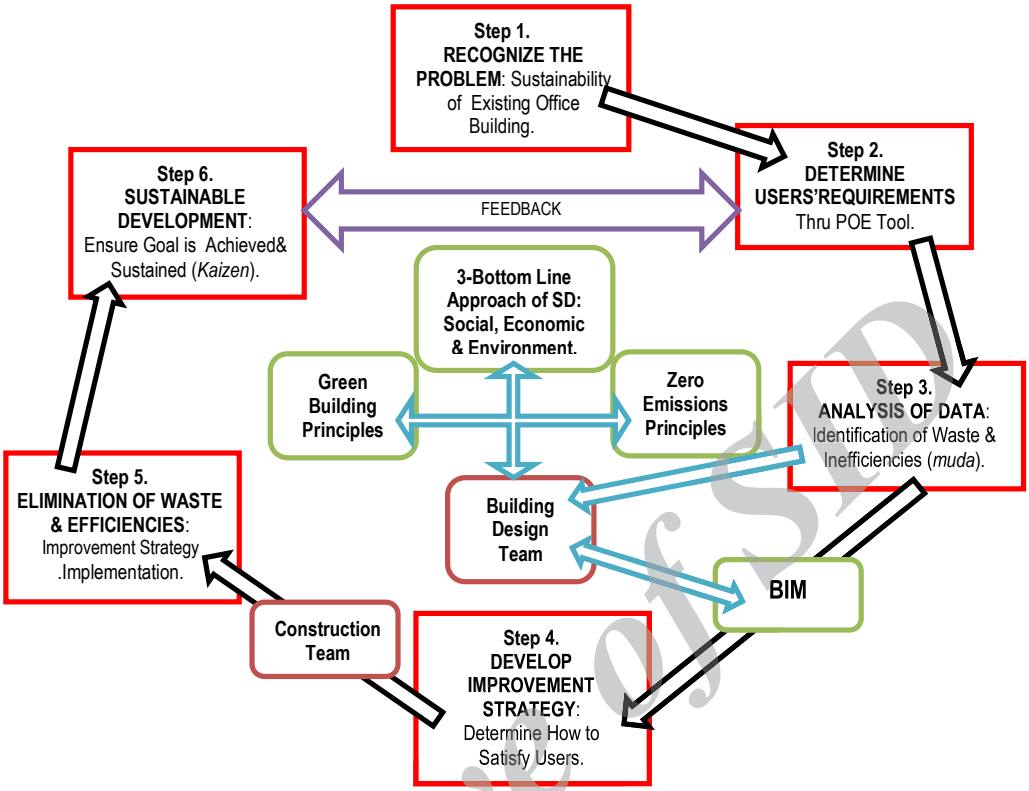

Fig. 4: Proposed Lean Improvement Strategy for Existing Buildings.

demolition and rebuilding. Shresthaet al. (2012) reported an improvement research finding in Indonesia revealed that cost is less compared to the cost of demolition and rebuilding. Ma et al. (2012) observed that it is being considered as one of main approaches to achieving sustainability in the built environment at relatively low cost and high uptake rates. According to Bullen, (2007), "Adaptation is inherently sustainable because it involves less material use, less transport energy, less energy consumption and less pollution during construction." Shipley, Utz& Parsons (2006) noted that "It is potentially cheaper to adapt than to demolish and rebuild inasmuch as the structural components already exist".

Improvement strategy is also perceived as environmental friendliness. Itard&Klunder (2007) found from a study that improvement generates less waste, uses fewer materials and probably uses less energy than demolition and rebuilding. Power (2008) argued that, "there are significant economic, social and environmental benefits of refurbishment in comparison to demolition. These benefits include reduced landfill disposal, transportation costs, greater reuse of materials, retention of community infrastructure." Gohardani & Bjork (2012) also observed that building demolition requires higher capital costs, more aggregates and subsequent new build than improvement and further includes embodied carbon inputs, noise and disruption. Moreover, a greater transportation need for materials and waste is observed for building demolition which also involves a polluting impact of particulates.

Notwithstanding the evidences clearly supporting improvement, the decision-making process associated with whether to improve or demolish assets can be exacerbated by an array of interacting variables that converge around financial issues. Gohardani & Bjork (2012) observed that, "Despite the exemplified disadvantages of demolition, avoidance of demolition within the existing building stock is uniformly impractical in certain cases." Douglas (2006), of same opinion wrote that, "Demolition is often selected when the life expectancy of an existing building is estimated to be less than a new alternative, despite any improvements that adaptive reuse may inject."

Despite contribution to the existing body of knowledge, these writers (and studies alike) fail to provide facility managers with

an ideal approach that can determine the desired improvement strategy in existing buildings, especially in the developing world with particular reference to waste and inefficiencies. This paper therefore proposed such model.

With this tool, facility managers are able to resolve the puzzle of which level of improvement they shall consider for a specific building; as a result, they can achieve near-optimal allocation of limited resources spent on building improvement, instead of giving in to different pressures due to intra-organizational politics. To make proper decisions connected with the improvement of office buildings, knowledge is required about possibilities of their conversion so that they meet the expectations of occupiers. It is therefore important to define the flexibility of the building in the sense of possibility of adaptation of the space to different needs.

CONCLUSION

There is difficulty amongst writers in providing a consensus definition for SD; however, there seem to be an agreement that though it is a universal challenge, it cannot be approached in the same way for all nations, but rather practical response can be defined nationally or locally, while emphasis is placed on the multi-stakeholder/interdisciplinary approach by incorporating the views of end-users and property managers to policy making and implementation for the sustainability of existing built assets.

An improved building would have a major impact on productivity, especially in offices. The lean improvement strategy will be cheaper financial-wise than to demolish and rebuild; environmental friendly; and bring about an appreciably reduced maintenance cost. However, despite the exemplified disadvantages of building demolition, avoidance of demolition within the existing building stock is uniformly impractical in certain cases. The concepts of lean thinking, green building and zero emission were identified as having the principles of identification and elimination of waste wherever they appear, and they have been incorporated in the model to achieve sustainability, while the BIM allows each professional to add discipline-specific data to the single shared model.

END NOTES

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