Improvement of Existing Buildings for Sustainability as against Maintenance and Rebuild

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ABSTRACT

Many countries, especially in the developing world, did not meet the UN target of 2002 to achieve sustainable development because the issue of existing buildings which form the bulk of building stock were not adequately addressed. This paper did a literature review on how existing buildings could be sustained through improvement as against maintenance and rebuild; it revealed that the maintenance of unsustainable buildings could at best be returned to their unsustainable original standard at construction, while rebuild is costlier and less environmental friendly. Improvement is noted to be cheaper and more environmental friendly than rebuild, and will also reduce maintenance cost. The paper also reviewed some improvement models that can be applied for elimination of perceived waste and inefficiencies in existing buildings for sustainability.

Key Words: Sustainable Development, Maintenance, Improvement, Demolition, Rebuild, Existing buildings, Waste.
INTRODUCTION

Over twenty years after the Earth Summit (termed Rio + 20); many countries, especially in the developing world are yet to make significant impact in the sustainable development (SD) of their built environments. One of the major reasons attributed to this is the neglect of existing buildings which form the bulk of built assets in cities; they were developed decades ago when sustainability was not a consideration (Miller & Buys, 2008). 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 reported that despite efforts at both the local and international levels toward ensuring SD in Nigeria, “current realities suggest that the goal of achieving sustainability in the country is yet to be realized”. According to Wood (2006), “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.” Therefore, for any noteworthy impact to be achieved by developing nations in SD, it is vital that existing building stock should be given more considerations.

CONCEPT OF MAINTENANCE

The term “maintenance” comes from the French verb "maintenir", which means to hold. BS 3811 (1984) defined building maintenance as “work undertaken in order to keep or restore every part of a building, its services and surrounds, to a currently accepted standard and to sustain the utility and value of the building.” The real problem in defining maintenance therefore is “a lack of universal agreement as to what represents an acceptable condition” (Chanter & Swallow, 2007). This is of course a matter of conjecture and is generally subjective as each owner or tenant will have to establish his own standards based on factors such as usage of building; anticipated life; availability of capital, materials and manpower; changes in usage and personal or business prestige.

![Fig. 1: Concept of Maintenance (Adeyemi, 2010 modified)](image)

Maintenance is the act of maintaining, in which repairs or indeed replacement may well be necessary, but the primary objective of all maintenance procedures is to avoid as far as practicable the need to repair or replace the structure, fittings, services, equipment or furnishings which collectively make up the total environment of any building (Seeley, 1987).

The objectives of building maintenance therefore include:
- To ensure that the building and its associated services are in a safe condition;
- To ensure that the building is fit for use;
- To ensure that the condition of the building meets all statutory requirements;
- To carry out the maintenance work necessary to maintain the value of the physical assets of the building stock; and
- To carry out the work necessary to maintain the quality of the building (Seeley, 1987).

![Diagram of Maintenance Work Classifications](consultations.rics.org, 2012)

Fig. 2: Typical Classifications of Maintenance Work

Maintenance is mainly battles the effects of deterioration and decay, which are mainly responsible for building degradation. Deterioration is where the condition of a structure or a building and/or its components degenerate or become worse, it refers to the cumulative physical distress buildings are subjected to from completion, whereas decay is the condition when a structure or building and/or its components rot, waste or decompose, very often to the point where replacement is the only option or solution. These terms should be differentiated from depreciation, which deals with the gradual loss in monetary terms of the economic value of the building, although they induce the latter.

In as much as maintenance is used to address deterioration and decay, it cannot adequately solve the problems of obsolescence, especially functional and economic obsolescence, as their signs may not be obvious as against physical obsolescence wear and tear thereby making them not addressable through maintenance strategies, but through upgrading only. Rey (2004) noted that buildings are subject to physical and functional obsolescence, however, regular maintenance can slow down this process, but after a certain time larger interventions become inevitable. Obsolescence with regards to building is a relative term and it denotes that a property does not possess any useful life as it stands, inferring that a building can only be regarded as obsolete in the context of one time and place.

**IMPROVEMENT AND MAINTENANCE**

The definition of improvement adopted is “a condition superior to an earlier condition” (AED, 2013). In maintenance, the original standard at construction is restored, while in improvement, the original standard is upgraded; thus maintenance carried out on non-sustainable existing building can at best reinstate it to its original non-sustainable standard. 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. According to Nicholas & Soni (2006), there is need for standards to be continuously revised to keep pace with continuous improvement.

Bullen & Love (2011) stated that, improvement measures “provide the opportunity to link the performance of a building directly to the objectives of sustainability.” While Nelson (2008) also noted 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”.

Improvement entails the upgrading of existing buildings’ original standard at construction, and while many other terms have been used in literature to describe its strategies, such terms have not been used in this paper save in relevant quotations in a bid to produce consistency. Such terms include adaptation, refurbishment, rehabilitation, remodeling, retrofitting, revitalization, among others; they have ambiguous meanings, as observed by some authors. Mansfield (2002) observed that “there is a surfeit of terms used to cover retrofit such as adaptation, refurbishment, upgrade, conversion, renovation and exist in a “state of happy confusion”. Mansfield (2011) noted that, “across the literature there continues to be some confusion regarding the 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.

**IMPROVEMENT OF EXISTING BUILDINGS FOR SUSTAINABILITY**

The rate and scale of improvements needed to existing buildings to “save the planet” are immense and extensive programmes are seen as necessary (Wood & Muncaster, 2012). It would be difficult to achieve SD in our cities if the issue of existing buildings is not addressed since they form the bulk of buildings. Wood (2006) noted that, “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, not only does improvement extend the economic life of existing buildings; it also improves “the living environment, increase property values, reduces the urgency for redevelopment, and enhances public safety and the image of city”.

Much of the building stock for the next century already exist and thus, to make a serious impact on improving sustainability, existing buildings should be more fully considered, so that fewer resources may be consumed by new builds. Stone (2005) observed that improvement of existing buildings is an attempt to preserve our cultural heritage, and thus large numbers of existing buildings are improved in preference to demolition. Also in agreement, Teo & Lin (2011) observed that building improvement finds it significant in “combating building deterioration and delivering building sustainability.” Though they went on to say that the measure a building shall receive always “seems puzzling to property portfolio managers”. 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.”

Many writers have also agreed that increasing the life of a building through reuse can lower material, transport and energy consumption and pollution and thus make a significant contribution to sustainability (e.g. Velthuis & Spennemann, 2007; Power, 2008; Love & Bullen, 2009).

**BENEFITS OF IMPROVEMENT OF EXISTING BUILDINGS OVER REBUILD**

One benefit, as observed by many authors, is that when a building standard is sustainably improved, it is expected that the maintenance cost would considerably reduce. Grigg (1998) had noted that “maintaining infrastructure is a constant and expensive process which often is neglected in favor of more attractive political goals.” Adequate maintenance financing is but one of the major factors affecting the sustainability, because poorly managed infrastructures steadily deteriorate, become congested, or become unsafe and clearly are not sustainable. Douglas (2006) also argued that, compared to newly built, improving existing buildings “would postpone, if not avoid the obsolete process of buildings and it will greatly enhance their performance”. Kincaid (2002), in one UK study showed that post improved office buildings had lower operating costs than prior to the improvement intervention, even if sustainability was not a priority, while Suzuki, *et al.* (2010) advised that “the principles of sustainable development must take into account and carefully assess the costs of sustainable development investments by calculating and considering the ‘operational costs’ after construction is completed. In other words, operating and maintenance costs should have continuity so as not to ‘burden’ in the future.”

Another benefit of improvement of existing stock is a growing perception that the improvement of existing building is far cheaper financial-wise than to demolish and rebuild (e.g. Ball, 2002). Ma *et al.* (2012) observed that improvement is considered as one of main approaches to achieving sustainability in the built environment at relatively low cost and high uptake rates, although the choice of most cost-effective improvement measure for particular projects is still a major technical challenge. Shrestha *et al.* (2012) reported a major research finding in Indonesia that cost of improvement is less compared to the cost of demolition and rebuilding. The
improvement option further saves the cost as it is time saving and the downtime is less. Bullen (2007) also supported this view, that improvement is “inherently sustainable because it involves less resource consumption, less transport energy, less energy consumption and less pollution during construction.”

The relative costs, related benefits and constraints of reuse vs. demolition and new build have received widespread debate, with Hall (1998), Douglas (2006) and Kohler & Yang (2007) also stating that the costs of reusing buildings are lower than the equivalent costs of demolition. Shipley, Utz & Parsons (2006) however advised that it is potentially cheaper to improve than to demolish and rebuild as long as the structural components already exist, and the cost of borrowing is reduced, as contract periods are typically shorter.” Needlemen (1965) once argued that, attention should be directed to improvement than to rebuilding, because rebuilding would normally cost more than renovation, and the rate of rebuilding is relatively slower than improvement in raising the quality of the general housing stock. Sigsworth & Wilkinson (1967) however criticized Needlemen’s model, noting that the “two options should deserve equal attention” rather than only attaching the importance to the option of improvement: improvement should be applied to buildings capable of modernization, while rebuilding is necessary where existing buildings “are too worn out to be renovated.”

Douglas (2006) is of same opinion, he wrote that, demolition is often selected when the life expectancy of an existing building is estimated to be less than a new alternative, despite whatever improvement may inject. Dong (2002) conducted a detailed comparison of the options of improvement and rebuilding, and contended that improvement outweighed rebuilding in terms of a lower cost and higher resource efficiency, “while rebuilding had advantage in reducing the impacts of global warming potential.” On the contrary, Bullen (2007) believes that since new build is comparatively more straightforward, then costs are often lower than improvement.

A third benefit of improvement is its environmental friendliness. The weight of enlightened opinion favours improvement of existing buildings because it offers a more efficient and effective process of dealing with buildings than demolition. It is deemed to be a safer strategy as it reduces the amount of disturbance due to hazardous materials, contaminated ground and the risk of falling materials and dust. In particular, site work is also more convenient as the existing building presents a work enclosure that reduces downtime from inclement weather. According to Itard & Klunder (2007), “demolition should be regarded as being an environmentally unfriendly process.” They found from a renovation study that improvement of buildings generates less waste, uses fewer materials and probably uses less energy than demolition and rebuilding. Evidence clearly suggests that the opportunities created by improvement measures outweigh those presented by demolition and rebuilding (e.g. Douglas, 2006; Bullen & Love, 2010).

Power (2008) argued that, “there are significant economic, social and environmental benefits” of improvement in comparison to demolition. “These benefits include reduced landfill disposal, transportation costs, greater reuse of materials, retention of community infrastructure and additional benefits of local economic development and neighborhood renewal and management.” Gohardani & Bjork (2012) also observed that, “building demolition requires higher capital costs, the need for more aggregates
and subsequent new build than refurbishment 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.”

Finally, improvement is considered by many writers to be an effective SD implementation tool for existing buildings (Brand, 1994; Pickard, 1996; Ball, 1999; Kohler, 1999; Latham, 2000; Cooper, 2001; Kohler & Hassler, 2002; Douglas, 2002; Gregory, 2004; Langston et al., 2007). 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.

**FACTORS AFFECTING IMPROVEMENT IMPLEMENTATION**

Notwithstanding the evidences clearly suggesting that improvement has significant long-term benefits to offer, the decision as whether to improve or demolish can be exacerbated by an array of interacting variables that converge around financial issues. Accordingly, when considering a building for improvement, it is essential to also examine the following issues as noted by Shipley et al. (2006), Itard & Klunder (2007), and Bullen & Love (2010):

- building’s structural layout and its capacity to accommodate required spaces and functions;
- energy efficiency of the building’s walls, windows and roof;
- building’s potential for meeting building, health, safety and accessibility requirements;
- condition of mechanical, plumbing and electrical systems and their capacity for modification;
- the presence of hazardous materials;
- ability of the building and site to provide a safe and secure environment; and
- convenience and safety of the building’s location.

![Diagram](image)

Fig. 4: Key Elements Influencing Building Improvement Strategies (Ma et al., 2012).

According to Ma et al. (2012), some key elements affecting the success of building improvement strategies are shown in Fig. 4 above. Gohardani & Bjork
(2012) thus rightly observed that, “Despite the exemplified disadvantages of building demolition, avoidance of demolition within the existing building stock is uniformly impractical in certain cases.” Arge (2005) also observed that the type of property also influence the nature of interference.

**SUSTAINABLE IMPROVEMENT MODELS**

Three models were examined during the literature review that mainly deal with sustainable improvement; they are: (1) **Lean Thinking**, (2) **Zero Emissions** and (3) **Green Building**. They promote elimination of waste and inefficiencies for sustainability.

**Concept of Lean Thinking:**

Lean thinking has the underlying philosophy that, by identifying and eliminating *muda* (Japanese word for waste), quality can be improved and costs reduced (Kempton, 2006). According to Averill (2011), Lean thinking is an improvement model that emphasizes continuous minimizing (or ultimately eliminating) all types of waste (*muda*) and non-value-added activities, and the delivery of high quality products at the lowest possible cost. It has its origin in the philosophy of achieving improvements in most economical ways with special focus on reducing *muda* (Womack & Jones, 1996). The concept of *muda* (seen as the opposite of value) became one of the most important concepts in quality improvement activities primarily originated by Taiichi Ohno’s famous production philosophy from Toyota in the early 1950s. Ohno (1988) classified these wastes into seven categories namely: *muda* of transportation, *muda* of motion, *muda* of inventory, *muda* of over-processing, *muda* of waiting, *muda* of overproduction, and *muda* of defects; many have however added the eighth - *muda* of “unused human talent” (e.g. Womack & Jones, 1996; Bicheno, 2004; and Liker, 2004). This Toyota production system in Japan later metamorphosed into what is now branded as lean production and lean thinking by Womack et al. (1990).

According to Nicholas & Soni (2006), the two overarching philosophy of lean thinking for sustainability are “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”, while Jylhā & Junnila (2014) defined it as the effort for perfection which is never reached, but creates the urge to make improvements: there is no end for waste elimination. *Kaizen* works by utilizing everyone’s knowledge to identify and implement improvements quickly and without significant cost (Askin & Goldberg, 2007). The concept also emphasized that value is defined by the customer (i.e. the end-user).

Nicholas & Soni (2006) went on to say that the concepts of lean production applies to a vast range of operation and processes in widely differing industries, offices, health care, etc. with only “tweaking of details”. Thus, varying industries have since adopted the concept, including the construction industry from whence terms such as “lean construction”, “lean design” and “lean management” emerged. The substantial argument was the claim that the approach had delivered large improvements in manufacturing, in particular the motor vehicle industry, and where already applied in construction.

**Concept of Green Building:**
According to Nwokoro & Onukwube (2011), SD gave rise to green buildings, because a primary goal of sustainability is to reduce humanity's environmental or ecological footprint on the planet. The concept of green building is also an improvement strategy just like lean thinking as observed by Averill (2011) that: “There is a natural connection and synergy between lean production and energy conservation programs: both disciplines are dedicated to limiting waste and increasing process efficiency.”

The US office of the Federal Environmental Executive defined green buildings as “the practice of increasing the efficiency with which buildings and their sites use energy, water and minerals; and reducing building impacts on human health and the environment” (www.ofee.gov in Shah, 2007). “In 1993, US President Clinton announced plans to make the White House ‘a model for efficiency and waste reduction’ and within three years, the numerous improvements led to $300,000 in annual energy and water savings, while reducing its atmospheric emissions by 845 tons of carbon a year (Shah, 2007). Fig. 4 illustrates some key components of Green Building.

![Green Building Components](www.aranovus.com, 2010)

**Concept of Zero Emissions**

The Zero Emissions concept was postulated by Gunter Pauli in 1994, it advocates for complete elimination of waste, termed “zero waste” by converting waste in value as an improvement strategy (Pauli, 1998). It derived its motivation from the ecosystem in which nothing in nature is a waste, but rather what is waste for one is food for another (zeri.org, 2013). According to Pauli (1998), “Sustainability can only be achieved if the final target is Zero Emissions”. The three main objectives of Zero Emissions are 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” (www.zeri.org, June, 2013).

These models can be applied and used for the improvement of existing buildings’ standards in our cities for sustainability: whilst there are a number of components that can impact the sustainability of existing buildings, this paper promotes the identification and eventual elimination of perceived waste and inefficiencies in
existing building stock for sustainability. Bootle & Kalyan (2002) claimed that UK businesses are throwing away £18 billion a year through the inefficient use of space.

CONCLUSION

World Commission on Environment and Development WCED (1987), set up by the United Nations General Assembly 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”. In order for the needs of the present to be met in the built environment, there is urgent need to address the issue of existing buildings through feasible improvement, thereby conserving resources simultaneously; whereby we do not ‘steal’ from future generations by spending more resources than necessary today (Wood 2006). One of the ways of achieving this is by improving the standards of existing buildings for sustainability through the identification and eventual elimination of perceived waste and inefficient facilities in the design and layout. There is no doubt that there are a number of other factors and barriers that affect our ability to make existing building stock more sustainable. However, until these two major issues of ‘waste’, and ‘inefficient facilities’ are addressed in built assets, the pace of SD in the developing countries may remain slow. This also creates an opportunity for the facilities manager to be involved in the multidisciplinary/multi-stakeholder approach in built environment in which each would contribute his own expertise or discipline-specific data to SD.

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