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Green buildings and water management in Harare, Zimbabwe

Vincent Itai Tanyanyiwa, Olivia Sakhile Juba
Faculty of Science & Technology Zimbabwe Open University, ZW

Highlights

- Buildings consume more than twenty percent of the world's available water
- For water management, redeveloping buildings is more efficient and sustainable than maintaining and refurbishing them.
- Customization of international rating systems in green water management improves water efficiency.
- Green buildings closely emulate the site's natural "pre-development" hence they save the existing natural water cycle
- The water efficiency rating system assists consumers in making informed decisions on choosing water efficient products.

Abstract

Green buildings are structures that use environmentally responsible and resource-efficient materials throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation, and the final demolition. Buildings consume more than twenty percent of the world's available water. The study adopted a qualitative research design to analyse water use in buildings that are owned by Old Mutual Properties in Harare, Zimbabwe. Data were collected through structured and unstructured interviews and observation. Grey water treatment and low flow plumbing fixtures provide opportunities for industry to build high tech, low water demand projects. On average, applying water-efficient designs and products lead to less water and energy use, and a reduction in operating costs. Increased government regulation and the desire to lower energy costs are expected to drive a faster adoption of water efficient products such as ultra-low flush toilets and low-flow shower heads. The use of non-sewage and grey water for onsite uses such as site irrigation will minimize demands on the local water resources in Harare in particular and the entire country in general.

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Email: tanyanyiwavi@yahoo.com
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1. Introduction

Buildings are part of the environmental problem and are responsible for one-third of global greenhouse gas emission. They account for 40% of end-user energy consumption, 40% of solid waste, and 12% of fresh water use worldwide hence the need for green buildings which can be a quick win in mitigating climate change by reducing the energy used in buildings by between 30% to 80%, saving on money, creating jobs, and securing a more sustainable future (Lynch and Dietsch, 2010). Water efficiency rating systems are important and these are a comprehensive mechanism for informing consumers of water efficient products. Strategies such as legislation, regulation, licensing, pricing, awareness generation, behavioural changes to realise water efficiency and conservation are important because treated water is scarce especially in urban areas (Ahn and Pearce, 2007). Stakeholders such as manufacturers, government organisations, sector experts, civil society, and the media should come together to ensure that there is green water management (Gissen, 2003). This paper is based on four buildings owned by Old Mutual Property Zimbabwe (Private) Limited since 1981. The four buildings are Eastgate Complex, Century Towers, Stanley House and Corner House, all in central Harare.

Green Building Practices (GBPs) used in green buildings are environmentally friendly and economically more productive than ordinary buildings (Kaula, 2015). Green buildings are currently getting global recognition and uptake especially in the global north as a climate change mitigating measure. Facilities built according to the GBPs, are assumed to have lower periodical rental premiums, high finished property values and are energy efficient. Little research has been undertaken in Zimbabwe as regards to water use in buildings. This paper explored how water is being used in Old Mutual's Properties in central Harare. Harare's rapidly increasing population and spontaneous urban sprawl outstrip available resources and the capacity of the City of Harare (CoH) to provide a reliable water supply. The increasing consciousness of the international predicament in freshwater supply has led building designers and managers to reduce water use in buildings with additional conserving equipment, rain-water recovery systems, and inventive water technologies (Du Plessis, 2005).

2. Green Buildings

Green development attempts to be holistic and is related to the concept of "sustainability" i.e. meeting present needs without compromising on the ability of future generations to meet their own needs (World Green Building Council, 2013). The Green building concept is part of the current movement towards more sustainable societies (UN-HABITAT, 2010). Green development establishes and reinforces connections, applies ecological thinking by creating places for people to live and work (GBCSA, 2016). Green development is more than individual buildings or their components, it seeks to minimise entire life-cycle impacts by employing resource-efficient, and environmentally and community-sensitive land-use by fitting the site thus using resources efficiently through the provision of a health indoor environment which is adaptable. It is generally accepted that green building refers to both a structure and the use of processes that are environmentally conscious and resource-efficient throughout a building's life-cycle: from setting up, siting to design, construction, operation, maintenance, renovation, and demolition that take into consideration: energy use, water use (16% of water withdrawals are used in the construction sector and 25% in buildings), indoor environmental quality, material section and the building's effects on its surroundings. Green building benefits generally include, energy and water savings, improved building durability, flexibility, improved occupant health, comfort and productivity, reduced maintenance costs, revenue from recycling, and reduced outlays for building materials, conserved natural resources, reduced waste and pollution, anticipating future legislation, by exceeding present building code specifications, reduced health and safety risk and liability reduced maintenance/ replacement costs over the life of the building, lower costs associated with changing space configurations and greater design flexibility (UN-HABITAT, 2010). A green building is one whose construction and lifetime of operation assures the healthiest possible environment while representing the most efficient and least disruptive use of land, water, energy and resources (GBCSA, 2016). Green buildings use environmentally responsible and resource efficient materials depending on their quality, availability, access to water in buildings, design, construction, operation, maintenance, renovation, and demolition as well as all green issues (cradle to cradle approach).

The optimum green design effectively emulates all natural systems and conditions of pre and post de-

veloped sites. GBs are important because they save the existing natural water cycle and design site. GBs closely emulate the site's natural "pre-development" hydrological systems by retaining storm water, on-site infiltration and ground water recharge. This is done through the use of methods that closely resemble natural systems. At the site there is an efficient use of potable water with recycling being enhanced e.g. Harvested rainwater, storm- water, and grey water.

The Green Building Council of Zimbabwe (GBCZ) was launched on the 30th of September 2016 in Harare to spearhead the Green Building concept in Zimbabwe. This council is still in its infancy. The GBCZ advocates for integrated building designs and a multi-disciplinary approach to design, catering for the Planet, People, Productivity (3 Ps) which in essence refers to sustainable green building practices by educating industry players on the best materials to use. The Council intends to train accredited professionals that rate buildings by recruiting members to lobby for by-laws that promote sustainability in the built environment. Most materials that have been used in the Zimbabwean construction industry in the past have not been environmentally friendly. Central to cost-effective green building and site design is a factor of interrelationships and correlated cost and performance trade-offs that exist amid different building systems which call for requisite strategies and technologies.

3. Strategies and Technologies of Green Building Water Management (GBWM)

- The least cost, least time consuming and most environmentally preferable design for site and storm water management is the design and site improvements that respect the prevailing natural flows and topography.
- A comprehensive site evaluation and strategic location of buildings. Site improvements are done to protect key natural hydrological features.
- Excavations are minimised and so is soil disturbance and compaction of existing topsoil.
- Low-impact storm water technologies such as bio-retention, rain gardens, open grassy swales, pervious bituminous paving, pervious concrete paving and walkways, constructed wetlands, vegetated roofs, and all on-site retention and ground water recharge or evapotranspirational technologies are used.
- A design that harvests, processes, recycles and reduces the use of potable water coupled with a water budget is a prerequisite e.g. use of low-flow plumbing equipment, toilets and waterless urinals. Onsite treatment systems encourage the use of gray-water for toilet flushing, rain and storm water for site irrigation.
- Drought tolerant and indigenous trees are important for preserving surface and ground water.

4. Nature of water uses in buildings

There are four main types of water and wastewater categories in residential, institutional and commercial buildings i.e. potable water, grey water, black water and storm water. Potable water is commonly referred to as drinking water, while, grey water is the domestic wastewater from bathroom fixtures (taps, showers and baths), laundry fixtures (washing machines) and kitchen facilities (such as sinks and dishwashing machines). Blackwater contains 'waste discharges from the human body, which is collected through fixtures such as toilets and urinals, while storm water refers to run-off due to rainfall collected from roofs, impervious surfaces and drainage systems (Corr & Adams, 2009). In commercial buildings, water use is related to and governed by the functions of the building as well as the type of equipment installed. The major water guzzlers in the buildings are the restroom plumbing fixtures such as toilets, faucets, urinals and showers, plumbing fixtures account for about 60% of the total water use in office and administrative buildings. Narrowing down to the per capita statistics for water use, a range of 20-40 litres of freshwater per person per day is generally considered to be a necessary minimum to meet needs for drinking and sanitation alone (Gleik, 1997).

5. Objectives

The study sought to:

- explain some of GBPs by Old Mutual's Properties, Harare;
- explore the uptake rate of GBPs by Old Mutual's Properties, Harare;

- evaluate why GBPs have not been widely embraced in Zimbabwe.

6. Materials and Methods

The study used a qualitative methodology, specifically an exploratory design focusing on key consultations and deliberations with different stakeholders who Eastgate Complex, Century Towers, Stanley House and Corner House in Harare. The design relied on analytical rather than statistical inference. Yin (2003) provides key definitional clarity on the design by outlining that "exploratory research is conducted to provide a better understanding of a situation; in this case how Old Mutual Properties is trying to implement GBPs. Exploratory research is not designed to come up with final answers but some hypotheses could come up from the current situation. Based on the definition above, this study focused on generating evidence on how Old Mutual Property Buildings have tried to go green in water management. Data were collected through semi-structured interviews with occupants of buildings and key informants from Old Mutual Properties. Physical observations were also made to identify green issues in the buildings. The four buildings were selected because Old Mutual Property is the largest property investment manager in Zimbabwe (and specifically in Central Harare) whose portfolio comprise over 500 000m^2 worth at approximately USD $510 million (Old Mutual Property, 2016). The property portfolio's assets span across the Retail, Industrial, CBD offices, Office Parks, Land and Development sectors which are located in more than 30 centres around Zimbabwe. Occupants of the properties are clients from within and outside the Old Mutual Zimbabwe Group.Secondary data were obtained from literature related to green water management. Key informant interviews (KII) were also used to collect data on building materials use, green issues Harare by-laws as well as environmental expectations from the Environmental Management Agency (EMA) and City of Harare (CoH) by-laws. Data from field observation, semi-structured interviews and key informants were analysed through triangulation of theories, concepts, and sources of data. Emerging themes on particular aspects were then recorded as opinions of a particular group (Chambers, 1992).

7. Sampling

The study used purposive sampling which emphasises "the researcher's prior knowledge of potentially helpful respondents" (Yin, 2003). The study used two variants of purposive sampling which are:

- expert Case sampling is where the research team sampled respondents who are known ex-perts in the field of study. This approach facilitated identification of key experts from the EMA and CoHwho gave the most valuable information;
- respondent-driven sampling is where initially identified respondents were requested to provide referrals to a set number of other potentially informative respondents. The ap-proach was used for EMA and related organisations that it works such as COH and Harare Residents Trust.

8. Results and Discussion

CoH is considering a new by-law which will make the use of cheaper and sustainable energy a prerequisite for the approval of any future building plans. In Harare, the 55 000 m2, mixed - use Eastgate Complex, is an example of how he integrated nature and sustainability coexist.

8.1 Challenges in initiating water efficiency reform in Harare's buildings

At Old Mutual the property development department is responsible for the formulation and management of property developments to ensure that projects are delivered as per client's requirements but taking into cognizance international building development. Apart from this, the department is also involved in new developments, building refurbishments, life cycle management and renewal. The Property Services department is tasked with operations management of the physical assets i.e. all aspects of managing a property portfolio, including building maintenance, leasing and rental collection.

The concept of sustainable building incorporates and integrates a variety of strategies during the design, construction and operation of building projects. Green building materials offer specific benefits to the building owner and building occu-

pants, reduced maintenance, energy conservation, improved occupant health and productivity, lower costs associated with changing space configurations and greater design flexibility. There is a need for engineers and architects to design resilient, sustainable and Green Infrastructure so that the same area of land can frequently offer multiple benefits if its ecosystems (World Green Building Council, 2013). Zimbabwe should competently craft policies and strategies to build sustainable human capital capacity in these areas to make our country competitive again. Sustainable engineering infrastructure and services are the basic cornerstones of life, civilisation and economic well-being of communities. Generally, there is a huge deficiency in capacity to understand the need for, how to develop, deliver, maintain and care for Green and Sustainable infrastructure and services.

9. Solutions to Green Building Water Management Growth (GBWMG)

In modern day designs, the engineers' job is not only to provide designs but tokeep water usage savings in mind (Lynch, & Dietsch, 2010). In Harare, there is need to mobilise additional water resources e.g. Kunzvi Dam and the use of high efficient plumbing fixtures. Kunzvi Dam was planned as far back as the 1990s. It is located along the Nyaguwe River in Murewa to serve Harare and its satellite towns. It was predicated that Lake Chivero, Manyame Dam, Harava and Seke dams would not meet the demand for water in Harare due to increasing population. Completion of Kunzvi Dam is still a pipe dream; government appears to be indecisive and to ensure that Harare gets another reliable water source. The city has been grappling with the water crisis for many years, water-borne diseases e.g. dysentery, diarrhoea and cholera killed 4500 people in 2008 during the worst hyperinflationary year in the history of Zimbabwe.

Currently in all the four buildings that were studied, there is need for retrofitting i.e shifting from building green buildings to greening existing buildings e.g. A dual flush toilet is an efficient, it uses less water by offering a low volume flush (liquids) and a full volume flush (solids). The efficiency of these toilets is enhanced by a large trap way which minimises clogging. Retrofitting the dual flush functionality onto an older style toilet helps in saving water, a process currently in progress at the Old Mutual Properties. In addition to fixing leaks and replacing existing fixtures with low-flow options, energy use was reduced. Retrofitting is important because it increases the building value and at the same time indoor environmental comfort, increased rent premiums, low occupancy costs for tenants and therefore fewer vacant buildings. Green buildings are not exclusively successful in achieving water and energy saving targets. To improve water management targets, there is need to encourage occupants to adopt water-saving behaviour in addition to the use of green building materials. To date, water saving has not been fully embraced by occupants / tenants in all the four buildings. There are strategies that include raising education awareness on water efficiency among the building occupants, water saving commitments, and to have an active building manager responsible for all water management related matters.

Retrofitting also leads to improved public relations and marketing values of a building in addition to reduced ownership risk. Use of renewable forms of energy e.g. solar or wind to pump water will contribute to green growth / sustainable buildings The use of use of GIS / telesurveillance in monitoring pipes / water flow will go a long way in monitoring the efficient use of water in buildings the Harare water billing system needs to review to promote user pays for actual cost / polluter pays. Green or living Roof are not only technically efficient are friendly nature because, besides aesthetic appeal, a living roof reduces heating, by adding mass and thermal resistance through evaporative cooling. In addition, they increase wildlife habitat in built-up areas and reduce storm water run-off and filters pollutants and carbon dioxide out of the air. Rainwater harvesting is currently being implemented on top of roofs or below the ground. Rainwater harvesting is important because it diverts storm rainwater. Insulating return piping also ensures that warmer water will be supplied back to the hot water plant, thus reducing the energy demand at the heating plants in the building (Gilmer and Hughel, 2008). In all the buildings there is regular 6-month interval of leak-proofing / leak repair. This is done for the reason that leaking pipes can go unnoticed. Cooling towers remove heat from a building's air conditioning system by evaporating some of the condenser water. Occupants of the building are educated on the need to conserve water is a prerequisite for the sustenance of life on earth. While the supply may seem abundant, water is a finite resource, i.e. Fresh potable water

is necessary for survival hence the need for green design and construction (Kibert, 2008). Education involves publicity of the use of the new smart water metering old mutual properties assesses the economic and environmental performance of buildings over their full life cycle by looking at description and portrayal of energy /water characteristics of buildings, incorporation of sustainable design and construction. The aspect of resilience is also important in water management.

Resilience relates to the design, construction, and operation of buildings and infrastructures that are resilient to natural and man-made disasters including flooding in the case of buildings. Buildings designed for resilience can absorb and rapidly recover from such a disruptive event. Continuity of operations is a major focus of resilience. The National Response Framework presents guiding principles that enable all response partners to prepare for and provide a unified national response to disasters and emergencies. The resilience of critical infrastructure must also be considered; infrastructures include water and wastewater, energy, among others. Vulnerability, risk and resilience assessments must be done and mitigation options evaluated in concert with resource restraints in all the buildings owned by Old Mutual Property.

10. Sustainability for Buildings in Zimbabwe

Currently, in Zimbabwe, there is no clear focus on the issues of sustainability in terms of buildings because sustainable building because issues on how the buildings are designed; constructed; operated; renovated and demolished, bring in evaporative cooling, reduce storm water run-off and filters pollutants and carbon dioxide out of the air are not included in the construction industry as well as the effects of building on wildlife habitats. Although the GBCZ was launched in September, 2016 not much has been done in this direction and at the time of writing it is not very clear whether the council has the backing of the government. These issues are covered cursorily during the environmental impact assessment (EIS), mandatory for prescribed activities such as the construction of high-rise buildings. If this done for large buildings in the CBD, the effect of the 'heat islands' is reduced e.g. the roof of the parking area in Nelson Mandela Square, the library at Stellenbosch University, South Africa.

In Zimbabwe, the Eastgate Mall (Fig 1 below) in Harare is a good example of a green building which has a Bio mimicry technology. The mall uses strategies used by termites in termite mounds for temperature control, the ventilation system operates like a termite mound i.e. Outside air drawn in, and is warmed or cooled by the building mass, depending on which is cooler or warmer, the building concrete or the air. The air is then vented into the building before exiting via chimneys at the top. The building also allows in local breezes. Double thickness walls in the exterior walls moderate extreme temperature. Plants on the sides of the building help in cooling it down while a glass roof help in dragging heat out. Eastgate Mall Building uses 41 % less water and 35% less energy when compared to conventional buildings (Old mutual, 2016). As opposed to cradle to grave design, the Eastgate Mall is based on a closed loop nutrient cycle found in nature, in which there is no waste (cradle to cradle approach). This would use materials designed as nutrients that would biodegrade safely and restore soil after use. Such buildings function more like trees, they make oxygen, sequester carbon, fix nitrogen, distil water, provide habitat for thousands of species and change with seasons.

Compared to South Africa Zimbabwe is doing badly because the Green Buildings Council of South Africa (GBCSA) has so far awarded 50 buildings with green star certification. New city by-laws to use cheaper and sustainable energy have to be included in Harare's by-laws to enhance sustainability.

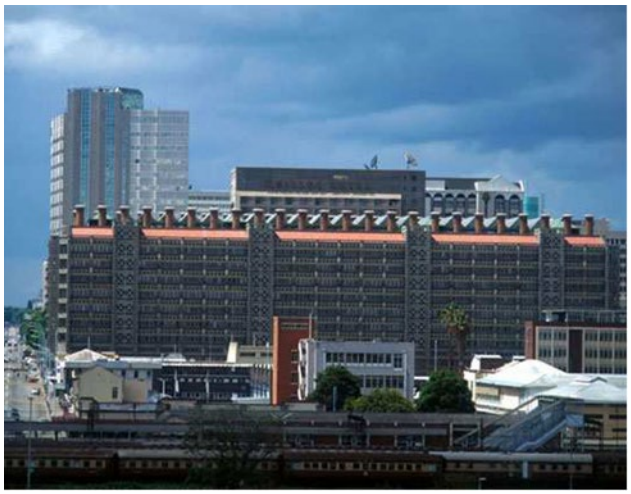

Figure 1: The Eastgate Shopping Mall, Harare, Zimbabwe. *Source: Tanyanyiwa, 2018*

But what is the situation in Zimbabwe in general, and in Harare specifically? Are we going green? The challenges for not going green include but are not limited to the following.

1. Perceived high cost of building design and construction if one goes the sustainable development route. Where it is not perception one finds out that the actual cost of building in Zimbabwe is one of the highest in the Southern Africa region (SADC). Many reasons contribute to this, the chief reason being the high input costs of building (labour, materials, cost of regulatory approvals etc.). This also complicated by the multi-currency regime prevailing especially the use of the US Dollars which continues to firm against other currencies. What then happens is that where budgets are tight the green issues are normally the first to be sacrificed. Professionals in the industry should educate themselves and their clients on the benefits of incorporating green initiatives as an upfront investment in construction projects. This is with a view to significantly reduce operating cost over the lifetime of a building, while contributing positively to the environment and the people who use the building. There is sufficient proof to show that "green" sustainable building projects do not have to be cost-prohibitive. There is in most cases unwillingness by the project teams to venture out of the comfort zone of "old tried and tested methods of construction". At colleges and universities, green issues are not given prominence they deserve. Emphasis is on other design subjects. However, this is changing, but rather slowly. More lobbying and support is required towards this realisation.
2. Lack of adequate training for green practitioners in institutions of higher learning especially in universities and polytechnics in Zimbabwe. The lecturers are few and most lack experience, the most experienced lectures left Zimbabwe during the hyperinflationary period which began around 2008. The students they then produce cannot, with conviction challenge the status quo. When a design guide produced in 1982 is thrown on a desk by a Senior Engineer, for example, the poor chap follows it religiously yet it does not accurately cover issues of sustainable construction. Recommendations to update design guides and design codes and specifications have been made but the question of who will fund the exercise arises. There is depressed construction activity which has meant that the opportunities to go green on building projects have been few and far between. This, then ultimately leads to a situation in which there are few experienced professionals on green buildings.
3. In some countries closer to Zimbabwe e.g. South Africa there is the Green Buildings Council which lobbies for and promotes sustainable construction but in Zimbabwe, the council is in its infancy or non-existent. Rewards and recognition for projects that incorporate sustainable development can help increase awareness. The most celebrated green project is the Eastgate Complex but how many local wards have it on? Most of the awards are by foreign bodies. The government needs to lead by example in this regard, rather than passing laws determining what the private sector can do. Government agencies must incorporate sustainable strategies into their own projects. Policies on greening construction / buildings should be introduced with the government championing implementation. Such policies could include energy and water efficiency, environmental quality of building materials and resources, indoor environmental quality and innovation in design. A certification process such as the Leadership in Energy and Environmental Design (LEED) ratings could be introduced, with attractive incentives for compliance by the private sector. However, the proliferation of foreign project promoters, especially the Chinese who do not subscribe to Engineering Act nor are they forced to register with local professional bodies. In most cases, these foreign project promoters have the project finance and one dares not question their design. Can the same government that allows these foreign developers to build anyhow then enforce the local engineers, architects and planners to go green? Food for thought.
4. Use of old design standards and building codes which do not promote green buildings in both local and central government and by consultants. Design guides for urban water and sewer as well as roads were developed in 1982 when green issues were not as topical as they are now.
5. Some influential people in the political arena even tell that "Green concepts are being pushed to stifle the development of African nations". When the industrialised nations where developing they were not applying sustainable development concepts and it helped

them develop. EMA (2002) appears more hell bent on punishing rather than educating and encouraging stakeholders to be more inclined towards sustainable construction. They have a long list of requirements which are good for the environment but for most it's an exercise to tick a box rather than owning the whole exercise. For a monetary fine, part of it should go into assisting improve the project.

6. Lack of planning in infrastructure development e.g. people are settled on land before services are in place when it should be the reverse e.g. in the high-density suburbs of Eastview, Epworth, Hatcliffe and Southerly Park trying to then introduce sustainable solution becomes a challenge and sometimes is met with stiffresistance due to inefficiencies in the water, energy and transportation systems, as well as in waste management in the aforementioned suburbs.

11. Conclusion

The impending water crisis in Zimbabwe in terms of declining rainfall calls for the need to devise and operationalise water reform for water using fixtures. There is need to introduce a system that would rate water using fixtures for their efficiency. There is a need to customise international rating systems in green water management and related protocols to suit the Zimbabwean context by involving all stakeholders. Focus should be on; what should be rated? What should be the unit of efficiency? What should be the testing protocols? And what should be the inspection systems? (Gleick, 1996).

12. Recommendations

Strategies such as legislation, regulation, licensing, pricing, awareness generation, behavioural changes can be utilised in different ways to realise water efficiency and conservation. Stakeholders such as manufacturers, government officials, organisations, sector experts, civil society, and media is need to be involved to improve water efficiency. For Old Mutual Property to develop technological capacity and knowledge focus should be on:

- quality engineering, architectural and real estate education and training for sustainable designs by an educated and skilled population is mandatory;
- economic incentive and institutional regime through a regulatory and economic environment that enables the free flow of knowledge, and support investment in ICT, entrepreneurship and infrastructural development;
- innovation systems through that can tap into the growing stock of global knowledge, assimilate and adapt it to local needs, and create new knowledge which is relevant to the Zimbabwean context;
- the green building impetus should take centre stage in Zimbabwe through professional training programmes towards a green economy and sustainable growth.

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