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Green buildings: A Mauritian built environment stakeholders' perspective

Peer reviewed

Abstract

The earth's health is deteriorating and will deteriorate even more rapidly unless people adopt eco-friendly policies. Green building has long been a concept but it has not yet been universally applied in practice. The concept of sustainability emerged in 1713 in Germany and was internationalised in the 1970s and can be associated with the energy crisis and environmental pollution concerns. This research is aimed at comparing 'green' buildings with 'non-green' (traditional) buildings in terms of cost and to determine contractors' and professionals' knowledge of green buildings and materials.

The literature reviewed and results of a survey among professionals and contractors from the island of Mauritius formed the basis of the study. The literature study on green buildings generally revealed that green buildings may be more costly at the outset, but they contribute to long-term savings. This was confirmed by the majority of the survey respondents who stated that green building materials are more durable than traditional materials, resulting in cost savings. Furthermore, the most emphasised advantage is reduced energy and water use. Contractors are more familiar with traditional materials than green materials and professionals do not have sufficient experience in green building materials/concepts, resulting in a low growth rate of green building construction.

The outcome of the study is very important for construction and design team members, clients and environmentalists.

Keywords: Building **c**osts, built environment, green buildings, sustainability

Abstrak

Die toestand van die aarde neem gedurig af en die tempo daarvan sal nie afneem tensy die bevolking meer eko-vriendelike beginsels toepas nie. Die konsep van 'groen geboue' is reeds lank bekend alhoewel dit nog nie universeel toegepas word nie. Die konsep 'volhoubaarheid' het sy oorsprong in 1713 in Duitsland en internasionalisering in die 1970's toe die energiekrisis en kommer oor omgewingsbesoedeling ontstaan het. Navorsing is gedoen om vergelykings

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te tref tussen 'groen' en 'nie-groen' (tradisionele) geboue, in terme van kostes en kennis van kontrakteurs en ontwerpspanlede.

Die navorsing is op 'n literatuurstudie en resultate van 'n opname tussen verskillende professionele konsultante en kontrakteurs in Mauritius gebaseer. Die algemene literatuurstudie toon aan dat 'groen' geboue aanvanklik meer kos as tradisionele geboue, maar meer voordelig is in terme van langtermynbesparings. Dit is bevestig deur die navorsingsrespondente wat aangedui het dat 'groen' boumateriale meer duursaam as tradisionele materiale is met gevolglike vermindering in langtermynkostes. Verder is die laer energie- en waterverbruik van 'groen' geboue baie voordelig. Kontrakteurs is meer vertroud met tradisionele materiale as met 'groen' materiale en professionele konsultante het onvoldoende ondervinding in 'groen' geboue; dit alles lei daartoe dat die groeitempo van groen geboue nie na wense is nie.

Die resultate van die navorsing is van uiterste belang vir alle persone in die bou-omgwing, kliënte en omgewingbewustes.

Sleutelwoorde: Boukostes, bou-omgewing, groen geboue, volhoubaarheid

1. Introduction

For the purpose of this article, the following terminology applies:

Green materials – building materials that are environmentally friendly, renewable, biodegradable and recyclable, e.g. carbon, polyurethane.

Traditional/natural materials – materials that are found naturally in a specific place and used by inhabitants to build, e.g. grass, bamboo, thatch, straw bales, dry stone, mud (plaster).

Conventional materials – materials specified mostly by designers, e.g. brick, concrete, glass, steel.

The concept of green or sustainable buildings is not new, but the technologies associated with the concept have evolved and matured over time (Emmit & Gorse, 2006: 606). "Green building is the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction." This practice expands and complements the classical building design concerns of economy, utility, durability, and comfort. A 'green building' is defined by the Green Building Council of South Africa (GBCSA) as "a building which is energy-efficient, resource-efficient and environmentally responsible" (GBCSA, 2010). Green building is also known as "a sustainable or high performance building" (US Environmental Protection Agency, 2010: online). Van Wyk (n.d.) argues that green buildings are now a universally accepted principle that promotes the construction of environmentally friendly buildings; they can be

defined as buildings that minimise their impact on the environment while improving their indoor environmental quality.

Green buildings have been on the rise in the United States of America, Europe and Australia for a number of years (Department of Environmental Affairs and Tourism, 2009: online). However, in South Africa this is still a relatively new notion. In 2007 and 2008, consciousness of green buildings increased on account of the electricity and water shortages and a growing awareness of global climate changes. These issues all resulted in a demand for green building practice from international organisations.

The way construction is taking place is about to change radically; it "has" to (Freed, 2008: 9). Freed further explains that the majority of modern-day buildings waste energy, water and resources. According to Kennedy, Smith & Wanek (2002: 1, 2), our relationship to buildings began to change during the last few generations. The Industrial Revolution came like a big splash in a little pond. It started in Western Europe, then spread to other parts of the globe. With the industrialisation of buildings, an increase in the amount of construction took place. However, the consequences were not all positive. The effects of extraction, manufacture and the transportation of building materials have contributed to the global environmental problems currently being experienced.

Although not usually a high priority for investors, owners or even tenants, the energy used by buildings is significant and obviously a key concern with regard to global warming (Sayce, Ellison & Smith, 2004: 226). According to Nassen, Holmberg, Wadeskog & Nyman (2006: 1593), the building sector accounts for 40% of the primary energy use and 36% of the energy-related CO_2 emissions in the industrialised countries. These emissions are mainly related to the use phase of buildings, while emissions from the production of building materials, such as concrete and steel, are attributed to the manufacturing industry sector.

The objective of the research was to investigate the concept of green buildings with specific reference to the *cost* of green buildings, the *scarcity* of natural materials in the building industry, the *use* of green materials as opposed to traditional materials, and building professionals' knowledge of green-building practices. The purpose of the literature review was to describe green buildings in general, and the quantitative research was to ascertain the current position in Mauritius only.

2. Review of literature

2.1 The first green buildings

According to Freed (2008: 10), the first truly green buildings dated from AD 1. These were the stone dwellings of the Anasazi Indians (Meinhold, 2009: online). The best examples of these buildings appeared around the 700s and consisted of apartment-house-style villages which had beautiful stone masonry. Freed (2008: 10) mentioned that the reason for considering those buildings as green buildings was that the Anasazi understood the sun and heating, natural ventilation, how to capture water, while the only materials used were stone, mud and wood. It is important to note that the 'Anasazi buildings' were completely free of toxins and were healthy.

2.2 Advantages of green buildings

Srinivas (2009: 791) explains that green buildings have had numerous benefits in India. These benefits range from the tangible to the intangible. Tangible benefits include reduction of power consumption by 20%-40% and reduction of potable water consumption by between 30% and 40%. On the other hand, intangible benefits include the health and safety of the building's occupants, better comfort for the occupants, higher productivity for occupants, and better practices from day one, by having the latest techniques or technologies included.

Furr (2009: 104) states that the benefits of green buildings include reduced capital investments because of available incentives, reduced operating costs through reduced consumptions (energy and water use), reduced personnel costs related to increased productivity and worker health, and increased operating revenue (higher rentals, increased occupancy and net metering).

Green buildings have many advantages pertaining to the environment, as well as costs involved. The most emphasised advantage may be regarded as reduced energy and water use (Srinivas, 2009: 795), while Furr (2009: 104) emphasised the cost advantages.

2.3 Limitations and risks of green buildings

Anderson, Bidgood & Heady (2010: 35) suggest that green building construction is different from that of conventional buildings, but as with conventional construction, claims and disputes also accompany green projects. These authors also warn about possible

'green litigation' because of new inexperienced entrants into the green market and the unknown risks.

Project owners are also faced with risks; there may be a failure to meet the required level of certification (Hancock, n.d., online). This risk may be significant where a large number of projects need to meet sustainability standards. Hancock further explains that in the case where the completed project fails to be accredited as green, there is a further risk that the owner does not meet his loan or incentive programme; the economic implications may be substantial (Anderson *et al.*, 2010: 35).

Bowers & Cohen (2009: online) argue that while many risks of green building are identical to the risks of conventional construction, the addition of sustainability/efficiency benchmarks and the need to attain a certain level of certification change the playing field to some extent. They also emphasise the risks facing design professionals, namely, as Leadership in Energy and Environmental Design (LEED)-accredited professionals, designers are expected to show higher standards of care, while accepting the fact that design failures may result in non-compliance with LEED certification of the project. More importantly, liability may arise from the failure of systems or components to perform adequately over the structure's lifecycle.

Currently, nearly every European country, the United States of America, Canada, Australia, Japan, Hong Kong and South Africa have their own green building rating system/tool. In 2007 the South African Property Owners Association established a Green Building Council of South Africa (GBCSA) to promote environmentally sustainable practices. The GBCSA developed a rating system called the Sustainable Building Assessment Tool (SBAT). It was developed to support the development of a more sustainable built environment within South Africa's developing country context. The SBAT framework includes three sustainability aspects, namely economic (local economy, efficiency, adaptability and flexibility, ongoing costs, capital costs); environmental (water, energy, waste, site, materials and components), and social (occupant comfort, inclusive environments, access to facilities, participation and control, education, health and safety). Building environmental rating systems provide a way of showing a building owner to what extent a building has been successful in meeting an expected level of performance in various declared criteria (Sebake, n.d.: online).

2.4 Uncovering the meaning of sustainability

Sustainable construction, according to Kunszt (2003: 5), may be defined as "the creation and responsible management of a healthy built environment based on resource efficient and ecological principles". Harrison (2000: 8) and the Environmental Stewardship Initiative (2002: online) define sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their needs". This definition can be accepted as the most widely used one, and is contained in the Brundtland Report – World Commission on Environment and Development 1987 (Munier, 2005: 10).

Very often the terms 'green' and 'sustainable' are used interchangeably. However, according to Kibert (2005: 9), the term 'sustainability' addresses the ecological, social and economic issues of a building. This author further relates that in 1994, the Conseil International du Bâtiment (CIB), an international construction research company networking organisation, defined the term 'sustainable construction' as the "creation and operation of a healthy built environment, based on resource efficiency and ecological design". RICS (2010), on the other hand, provides a definition of 'green building' as

> *a sustainable building or green building is an outcome of a design philosophy which focuses on increasing the efficiency of resource use, including energy, water and materials, while reducing building impacts on human health and the environment during the building's life cycle, through better siting, design, construction, operation, maintenance and removal.*

Sustainable development is often confused by some people who think that concepts such as 'sustainable' and 'development' cannot co-exist, while others think that the words 'sustainable' and 'development' contradict each other (Munier, 2005: 16). Munier referred to the term 'sustainable development' as a qualitative change involving not only the economy, but also institutional, social and environmental changes. According to McIntyre, Ivanaj & Ivanaj (2009: 166), there are three pillars of sustainability, namely:

- Economic (growth, market expansion, externalisation of costs);
- Social (basic human needs, equity, participation, social accountability), and
- Ecological (carrying capacity, sustainable yield, resource conservation, biodiversity).

2.5 The issue of costs

There is a perception that green buildings are more expensive than conventional buildings (Kats, 2003: 12). In a report conducted by Berman (2001), it was found that among half a dozen Californian developers interviewed in 2001, green buildings cost 10-15% more than conventional buildings. Morris & Matthiesen (2007: 3) are of the opinion that "there is no significant difference in average costs of green buildings, as compared to non-green buildings".

Srinivas (2009: 795) postulates that the cost of green buildings can be slightly higher than that of conventional buildings. He also stresses that this should be considered by means of a different paradigm; therefore, the use of a baseline cost is required. However, green buildings can result in money savings for companies, developers and end-users – over and above their function in protecting the environment (Oxford Business Group, 2008: 137). The CEO of Emaar Dubai, Richard Rodriguez, corroborates that construction costs can be reduced considerably if best practices are employed.

When considering the cost of green buildings, both tangible and intangible benefits must be considered. The tangible benefits such as the economical advantages are not immediately visible. However, the lifetime payback is much higher compared with that of conventional buildings, which mainly accrues from operational cost savings, reduced carbon emission credits and potentially higher rental or capital values. The intangible benefits such as social advantages are due to the positive impact of green buildings on the neighbourhood environment. Moreover, due to better working conditions, the productivity of occupants increases and health problems decrease. Furthermore, green buildings create a green corporate image; several companies are now viewing Green Building Rating as a tool to enhance marketability (Roy & Gupta, n.d: 7).

2.6 Building materials

Resources, pollution and performance are the most general criteria of building materials (Berge, 2000: 3). Resources used by any construction material include all the raw materials and energy used from its extraction to its disposal. Pollution in the above context refers to all harmful emissions resulting from the production of the material, products used to clean and maintain the material, off-gassing from materials during their lifetime, and final incineration or landfilling. Performance is the criterion for how well the material does the job for which it was produced (Milani, 2005).

Natural materials and processed materials perform differently. Natural materials tend to be more complex and have different positive qualities and, if correctly utilised, can bring a plus to the building industry by enhancing the performance of buildings. When compared to traditional materials, methods and technologies, natural materials can provide energy efficiency in buildings. However, May (2006: online) maintains that not any kind of natural material will suit any situation. Suddell (2008) proclaims that the construction industry is the second largest sector that uses natural material.

According to Albino, Balice & Dangelio (2009: 85), a green material is one that minimizes environmental impact throughout the entire life cycle. However, although Baumann, Boons & Bragd (2002: 415) are of the opinion that there is still confusion on a definition of green materials, Attmann (2009: 118) states that green materials are:

- environmentally friendly;
- renewable;
- biodegradable, and
- recyclable.

Furthermore, Attmann (2009: 118) maintains that green materials can be categorised into:

- biomaterials (biotic materials), e.g. straw, carbon, polyurethane;
- composites, e.g. concrete, brass;
- smart materials, e.g. carbon-fibre, and
- nano-materials, e.g. nano-carbon tubing.

Kelly & Hunter (2009: online) propose the application of the three R's (reduce, re-use and recycle) as being helpful in selecting building materials.

2.7 Professionals and contractors involved in green buildings

Regarding sustainable development, Strong & Hemphill (2006: 6) comment that built environment professionals are faced with the challenge of meeting the needs of people and the growing economy, while simultaneously maintaining the nature, character and posterity of the natural environment. Furthermore, they stress that no one profession is more important than the other; instead, good teamwork is required.

According to the Associated General Contractors of America (2007: online), contractors are important for the success of green projects.

Some contractors may be involved in the design process; however, contractors' involvement in implementing a project is often limited by the project-delivery system and the contract specifications. The Association further stresses that contractors can add expertise if they are included in the design process. Among others, the contractor's role on a green project can be to:

- Recycle and re-use construction and demolition debris;
- Limit the use of hazardous materials on the jobsite;
- Protect existing vegetation, donate cleared trees or mulch for use on site;
- Make environmentally friendly purchasing decisions, and
- Procure and install more energy-efficient mechanical and electrical systems.

However, Braganca (2007: 14) indicates that designers and contractors tend to favour straightforward solutions. Despite the fact that construction has contributed to global environmental problems (Kennedy *et al.*, 2002: 1, 2), buildings are still being erected without taking the climatic consequences into account. This can possibly be attributed to a lack of knowledge or secondly, to satisfy the main human needs; people prefer simple and cheaper buildings.

2.8 Green-building trends

According to Kibert (2008: 12), the trend towards green buildings is as follows: there is rapid penetration of the LEED-green building rating system, as well as increased US Green Building Council (USGBC) membership, private and public incentives, strong federal leadership and an expansion of state and local green building programmes, thereby capitalising on green building benefits and achieving advances in green building technology. Furthermore, Kibert (2008: 12) explains that similar to trends in green building, there are also barriers such as financial discrepancies, insufficient research and the lack of awareness.

The company Frost and Sullivan's (2010: online) recent analysis of the South African green building market found that this market is still in its infancy, but it has great potential for growth. It states that the Green Building Council of South Africa (GBCSA) has experienced an average growth of 100% per annum in its membership subscription since 2008; this is significantly faster than the growth rates experienced at the inception of the Green Building Council of Australia, on which the GBCSA is modelled. In addition, to date the GBCSA has had over 2000 attendees (most of whom are built-environment professionals)

at their Green Star SA Accredited Professional course. Four buildings have achieved certification under the Green Star SA rating system, with another twenty-four registered for certification. Growth in membership and participation rates indicates that the South African market is responding well to green-building initiatives.

2.9 Green building in Mauritius

The Republic of Mauritius is a group of islands in the South West Indian Ocean, consisting of the main island of Mauritius, Rodrigues and several outer islands located at distances greater than 350km from the main island. The population, estimated at 1.3 million, comprises Indo-Mauritians, people of mixed European and African origin, and Sino-Mauritians. The islands of Mauritius and Rodrigues, with a total area of 1.969 square kilometres, have an overall population density of 652 persons per square kilometre. About 43% of the area is allocated to agriculture, 25% is occupied by built-up areas and 2% by public roads. The remaining area consists of abandoned cane fields, forests, scrubland, grasslands and grazing lands, reservoirs and ponds, swamps and rocks. The biggest greenhouse gas emission product is carbon dioxide from fossil fuels and in 2010 this amounted to 3365 gigagram (Gg), with a major impact on the environment. The energy industry (1997Gg), manufacturing (352Gg), transport (845Gg) and residential (123Gg) sectors are the main contributors to the carbon dioxide emission. This has led to greater emphasis on designing green buildings (Central Statistics Office, 2009: 2).

Building-construction methods for residential buildings include mainly buildings with concrete block walls and concrete roofs (86%), concrete block walls and iron/tin roofs (4%), iron/tin walls and roofs (8%), wood walls and iron/tin or shingle roofs (1%) or 'other' (1%). The following 'traditional' materials are still used to some extent: straw (used mostly in hotel roofs for aesthetics); stone (commonly used for aesthetics such as garden walls and balustrades of open terraces, and for hardcore filling); timber planks produced locally, and crushed stoned (as a replacement for sand because of environment protection laws).

The following 'conventional' materials are also used in the construction industry: blocks made of fine stone (instead of bricks), cement (imported) and imported iron sheets (called profilage). Most of the internal finishes consist of marble, vinyl flooring, parquet wood flooring (all imported) and locally produced paint.

Since Mauritius is a tropical island, even in winter it receives enough sunshine to favour the use of solar energy (e.g. solar water heaters instead of electrical geysers) as a form of 'green building' product.

3. Research methodology and findings

The research is descriptive in nature. A quantitative research method was employed, described by Borrego, Douglas & Amelink (2009: 54) as good for deductive approaches, in which a theory or hypothesis justifies the variables, the purpose statement, and the direction of the narrowly defined research questions. The hypothesis being tested and the phrasing of the research questions all govern how the data will be collected, as well as the method of statistical analysis used to examine the data.

The review of the literature resulted in the formulation of the following three main research questions, namely built environment stakeholders' (i) perception on whether green buildings are more expensive than conventional buildings; (ii) their familiarity with green concepts, and (iii) preference of green *versus* traditional building projects. The survey instrument used to obtain the primary data for addressing the research questions consisted of a structured questionnaire circulated to a randomly selected sample of fifty quantity surveyors, engineers, construction managers, architects and contractors in Mauritius. A response rate of 62% was achieved and this formed the basis for data analysis and the subsequent conclusions. Moyo & Crafford (2010: 68) state that contemporary built-environment survey response rates range from as little as 7% to as much as 40% in general. As such, the above response rate of 62% can be regarded as very high. The response group included quantity surveyors (23%), engineers (16%), construction managers (16%), architects (29%) and contractors (16%). Questionnaires were completed anonymously to ensure a true reflection of the respondents' views and to meet the ethical criterion of confidentiality. It was assumed that the respondents were sincere in their responses as they were assured of their anonymity.

Responses were evaluated on a perceived level of agreement with statements based on a 5-point Likert scale where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, 5=strongly agree. Once the questionnaires were returned, the responses were electronically captured using a Microsoft Office Excel spreadsheet to calculate percentages and mean scores (MS); as indicated in the tables.

4. Results and findings

4.1 Built environment stakeholders' perception on whether green buildings are more expensive than conventional buildings

The questionnaire survey explored the perceptions of Mauritian built-environment stakeholders in terms of the cost of green buildings compared to that of traditional buildings.

The responses are summarised in Table 1.

Table 1: Cost of green buildings compared to that of conventional buildings

Statement	*Response (%)*						*MS*
	Unsure	*1=Fully disagree, 3=Neutral, 5=Fully agree*					
		1	*2*	*3*	*4*	*5*	
Green building design decreases operational and maintenance costs	3.2	6.5	35.5	25.8	29.0	0.0	2 83
Green building materials are more durable than conventional materials resulting in cost savings	0.0	3.2	9.7	29.0	38.7	19.4	3 65
Green buildings use less energy resulting in cost savings	3.2	0	9.7	25.8	41.9	19.4	3.77
Green buildings have less waste disposal resulting in cost savings	6.5	3.2	12.9	35.5	32.3	9.6	3 38
Green buildings use less water resulting in cost savings	6.5	0.0	9.7	29.0	38.7	16.1	3 69
Green buildings use technology that is cheaper than conventional buildings	0.0	6.5	38.7	22.6	29.0	3.2	2 87
Green buildings cost less than conventional buildings	0.0	12.9	32.3	29.0	22.6	3.2	2.74
						Average	3 28

Although the majority of the respondents (35.5%) 'disagreed' on whether green-building design decreases operational and maintenance costs, the majority (38.7%) 'agreed' that green-building materials are more durable than conventional materials which should result in lower maintenance costs. Regarding the use

of energy, water and waste disposal, the majority of the respondents also 'agreed' that green buildings use less energy (41.9%) and water (38.7%) while the majority were 'neutral' (35.5%) on whether there is less waste disposal, resulting in cost savings. The Table also shows that respondents are not convinced that green buildings use cheaper technology than conventional buildings (MS=2.87).

The literature review indicated that the cost of green buildings can be slightly higher than that of conventional buildings. This was confirmed by the majority of the survey respondents (32.3%) as they 'disagreed' that green buildings cost less than conventional buildings.

Although the overall MS of all aspects indicates a higher 'neutral' MS of 3.28, leaning slightly more towards the 'agree' range, the outcome that green buildings cost less than conventional buildings can possibly be attributed to savings occurring during the project's life cycle.

Property developers are often more concerned with initial construction costs when deciding whether to continue with a construction project whereas the life-cycle cost of the development should be a more important factor in decision-making. When green buildings are constructed, the life-cycle cost of the building will result in bigger savings than when conventional materials are used.

4.2 Awareness of green-building concepts

The questionnaire survey also explored the awareness of built-environment stakeholders with respect to various aspects of green buildings. The responses are summarised in Table 2.

Table 2: Awareness of green building concepts

Statement	*Response (%)*						*MS*
	Unsure	*1=Fully disagree, 3=Neutral, 5=Fully agree*					
		1	*2*	*3*	*4*	*5*	
I am familiar with the Environment Conservation Act	0.0	0.0	9.7	38.7	48.4	3.2	3.48
I am familiar with the National Environment Management Act	0.0	0.0	12.9	38.7	38.7	9.7	3.48
I am aware that natural materials are scarce	0.0	0.0	0.0	9.7	74.2	16.1	4.10
I am aware that the environment is degenerating	0.0	0.0	0.0	0.0	70.9	29.1	4.32

Statement	*Response (%)*						*MS*
	Unsure	*1=Fully disagree, 3=Neutral, 5=Fully agree*					
		1	*2*	*3*	*4*	*5*	
I am aware of the benefits that green buildings have on the environment	0.0	0.0	0.0	9.7	83.9	6.4	4.00
The above benefits are substantial	0.0	0.0	0.0	6.5	54.8	38.7	4.35
I am aware of my firm's impact on the environment	0.0	0.0	9.7	38.7	48.4	3.2	3.48

The majority of the respondents (48.4%) 'agreed' that they are familiar with the Environment Conservation Act while the majority of the respondents were either 'neutral' or 'agreed' (38.7%) that they are familiar with the National Environmental Management Act.

The majority of the respondents also 'agreed' that they are aware:

- that natural materials are scarce (74.2%);
- that the environment is degenerating (70.9%);
- of the benefits of green buildings on the environment (83.9%);
- that the advantages are substantial (54.8%), and
- of their firm's impact on the environment (48.4%).

The above results are a clear indication that Mauritian built-environment stakeholders are fairly familiar with most green-building concepts and related Acts. It is thus important to determine why so few green buildings are being built, especially because the majority of the respondents indicated that they were aware of the benefits of green buildings (MS 4.0) and that these are 'substantial' (MS 4.35). The next section shows the results of respondents' views on their preference in using conventional *versus* green buildings.

Respondents were requested to state their views on the use of green versus conventional buildings by indicating to what extent they agreed with the following statements (Table 3):

4.3 Preference: Green versus conventional buildings

Table 3: Green versus conventional buildings

Statement	*Response (%)*						*MS*
	Unsure	*1=Fully disagree, 3=Neutral, 5=Fully agree*					
		1	*2*	*3*	*4*	*5*	
Professional firms prefer using conventional materials over green materials or products	0.0	3.2	19.4	25.8	45.2	6.4	3.35
Contractors prefer the use of conventional materials over green materials or products	0.0	6.4	12.9	25.8	48.4	6.5	3.39
Contractors are more familiar with conventional materials	0.0	3.2	12.9	19.4	54.8	9.7	3.58
Building professionals are experienced in green-building concepts	0.0	3.2	41.9	32.3	22.6	0.0	2.78
Contractors understand the nature of green materials or products	3.2	6.4	32.3	32.3	25.8	0.0	2.79
Green materials and methods are still new concepts in the construction industry	0.0	3.2	45.2	25.8	22.6	3.2	2.81

The results indicate that the majority of both professional teams (45.2%) and contractors (48.4%) 'agree' with the statement that they still prefer to use conventional materials over green materials or products. This may be because the majority of the respondents (54.8%) indicated that contractors are more familiar with conventional materials and therefore refrain from using green materials.

However, the majority of the respondents (41.9%) indicated that they 'disagree' with the statement that professionals are experienced in green-building concepts. This may be one of the reasons why there is not really a growth in green buildings being built. If professionals do not have sufficient experience in green-building materials/ concepts, they may be hesitant to specify them. The majority of the respondents also indicated that they 'disagree' (32.3%) with the statement that contractors understand the nature of green materials or products, whereas 32.3% of the respondents were 'neutral' regarding this statement. From the results it is also clear that the majority of the respondents (45.2) do not believe that green materials and concepts are still new to the construction industry.

The above results indicate that there is still a tendency not to use green materials or products. This could be because professionals and contractors are not fully familiar with such materials and therefore are hesitant to specify or use them. Clients, however, are becoming more aware of green buildings and materials and may insist that professionals and contractors specify and use such materials. This is also obvious in the following results.

4.4 Prospects of green buildings

Table 4 summarises the respondents' views on the prospects of green-building construction in Mauritius.

Table 4: Prospects of green buildings in Mauritius

Statement	*Response (%)*						*MS*
	Unsure	*1=Fully disagree, 3=Neutral, 5=Fully agree*					
		1	*2*	*3*	*4*	*5*	
Green building construction is at its infancy	0.0	3.2	29.0	29.0	35.5	3.3	3.06
Green buildings have a high growth potential	0.0	0.0	6.5	19.4	64.5	9.6	3.77
Clients are interested in green buildings	0.0	0.0	3.2	25.8	67.7	3.3	3.71
I promote green-building practice among my colleagues	0.0	0.0	9.7	38.7	48.4	3.2	3.45

The results indicate that the majority of the respondents (35.5%) 'agree' that green building is still at its infancy, and 64.5% of the respondents 'agree' that green buildings have a high growth potential. The results also indicated that 67.7% of the respondents 'agree' that clients are interested in green buildings, and 48.4% of built-environment stakeholders promote green-building practice among their colleagues. These findings are similar to what was previously discussed in the literature review. It is thus clear that the prospects of green-building construction are very positive. All stakeholders should thus minimise any barriers to ensure growth in green-building developments.

5. Conclusions and recommendations

The characteristics of green buildings are energy-efficient, resource-efficient and environmentally responsible. The primary concern is to protect our planet with the aim of creating a better and healthier environment for people. The results of this research indicated that various authors pointed out that green buildings may be more costly at the outset, but they contribute to long-term savings. This was confirmed by the majority of the survey respondents who stated that green building materials are more durable than conventional materials, resulting in cost savings.

The literature pointed out that green buildings have many advantages pertaining to the environment, as well as costs involved; the most emphasised advantage may be regarded as reduced energy and water use – this was confirmed by the survey respondents. The survey results also showed that the prospects of green buildings are positive. Although green buildings are not regarded as a totally new concept in the construction industry, both contractors and professionals indicated that they still prefer conventional methods over green building materials.

Furthermore, although the survey results provided a clear indication that built-environment stakeholders are fairly familiar with most green-building concepts and related acts, the results showed that contractors are more familiar with conventional materials than green materials, and that professionals do not have sufficient experience in green-building materials/concepts. It is therefore recommended that:

- Contractors familiarise themselves better with green materials;
- Professionals gain more experience in green-building concepts;
- Tertiary institutions or other service providers provide green-building training opportunities for all built-environment stakeholders, and that
- Built-environment stakeholders familiarise themselves with the Building Sustainability Index (BASIX) introduced by the government of New South Wales, Australia, to regulate the energy efficiency of new buildings. It offers an online assessment tool for rating the expected performance of residential developments in terms of water efficiency, thermal comfort and energy usage. Furthermore, professionals and contractors should consider implementing the Sustainable

Building Assessment Tool (SBAT) rating system developed by GBCSA.

The results of this survey are based on perceptions of built-environment stakeholders in Mauritius and may differ somewhat from respondents elsewhere in the world. This creates an opportunity for further research to obtain a wider perspective on the issue of green buildings worldwide.

Global climate changes require that all people, especially built-environment stakeholders, become more aware of the benefits of green buildings to, among others, ease the burden on electricity and water shortages and thereby ensuring a better life for future generations.

References

Albino, V., Balice, A. & Dangelio, R.S. 2009. Environmental strategies and green product development: An overview on sustainability-driven companies. *Business Strategy and the Environment*, 18(2), pp. 83-96.

Anderson, M.K., Bidgood, J.K. & Heady, E.J. 2010. Hidden legal risks of green buildings. *Florida Bar Journal*, 84(3), pp. 35-41.

Associated General Contractors of America. 2007. Talking points on green construction. [online]. Available from: <http://www.agc.org/galleries/advy/GreenConstructionTalkingPoints.pdf> [Accessed: 6 June 2010].

Attmann, O. 2009. *Green architecture-advanced materials and technologies*. New York: McGraw-Hill.

Baumann, H., Boons, F. & Bragd, A. 2002. Mapping the green product development field - engineering, policy and business perspectives. *Journal of Cleaner Production*, 10(5), pp. 409-425.

Berge, B. 2000. *The ecology of building materials*. Oxford: Architectural Press.

Berman, A. 2001. Green buildings: Sustainable profits from sustainable developments. An unpublished report by Tilden Consulting.

Borrego, M., Douglas, E.P. & Amelink, C.T. 2009. Quantitative, qualitative and mixed research methods in engineering education. *Journal of Engineering Education*, 98(1), pp. 53-66.

Bowers, K. & Cohen, L. 2009. The green building revolution. Environmental law & policy clinic: Havard Law School, 10 March.

[online]. Available from: <http://www.mgkflaw.com/Green%20Building%20Revolution.pdf> [Accessed: 10 June 2010].

Braganca, L. 2007. *Cost C16 - Improving the quality of existing urban building envelopes: Facades and roofs.* Amsterdam: IOS Press.

Central Statistics Office. 2009. Republic of Mauritius – Mauritius in figures. Mauritius: Ministry of Finance and Economic Development.

Department of Environmental Affairs and Tourism. 2009. Green building in South Africa – Emerging trends. [online]. Available from: <http://soer.deat.gov.za/Green_Building_in_South_Africa_Emerging_Trends_GyzKE.pdf.file> [Accessed: 7 June 2010].

Emmitt, S. & Gorse, C. 2006. *Barry's Advanced construction of buildings*. Singapore: Blackwell Publishing Ltd.

Environmental Stewardship Initiative. 2002. Sustainability definition. [online]. Available from: <http://www.p2pays.org/ref/38/37967.pdf> [Accessed: 8 June 2010].

Freed, C.E. 2008. *Green building & remodelling for dummies*. Indianapolis: Wiley Publishing, Inc.

Frost & Sullivan. 2010. *Market research reports*. [online]. Available from: <http://www.frost.com/prod/servlet/frost-home.pag> [Accessed: 11 June 2010].

Furr, J.E. 2009. *Green building and sustainable development: The practical legal guide*. Chicago: American Bar Association Publishing.

GBCSA. 2010. What is a green building? [online]. Available from: <http://www.gbcsa.org.za/about/about.php> [Accessed: 17 May 2010].

Hancock, D. n.d. Boston's green building requirements. [online]. Available from: <http://www.naiopma.org/dv/pages/images/Permitting/HANCOCK_GREEN_BUILDING.pdf> [Accessed: 10 June 2010].

Harrison, N.E. 2000. *Constructing sustainable development*. New York: State University of New York Press.

Kats, G. 2003. Benefits of green buildings: A report to California's sustainable building task force, pp. 12-19, October.

Kelly, J. & Hunter, K. 2009. Life cycle costing of sustainable design. [online]. Available from: <http://www.rics.org/site/download_feed.aspx?fileID=5512&fileExtension=PDF> [Accessed: 4 December 2010].

Kennedy, J.F., Smith, M.G & Wanek, C. 2002. *Natural building-design, construction, resources*. Canada, Gabriola Island: Trans-continental Printing.

Kibert, C.J. 2005. *Sustainable construction: Green building design and delivery*. New Jersey: Wiley & Sons, Inc.

Kibert, C.J. 2008. *Sustainable construction: Green building design and delivery*. 2nd ed. New York: Wiley & Sons, Inc.

Kunszt, G. 2003. Sustainable architecture. *Periodica Polytechnica Civil Engineering*, 47(1), pp. 5-10.

Morris, P. & Matthiesen, L.F. 2007. Cost of green revisited: Re-examining the feasibility and cost impact of sustainable design in light of increased market adoption. Davis Langdon, Inc., pp. 3-12, July.

May, N. 2006. Traditional materials and energy efficiency. [online]. Available from: <http://www.natural-building.co.uk/PDF/art_Traditional_Materials.pdf> [Accessed: 11 June 2010].

McIntyre, J.R., Ivanaj, S. & Ivanaj, V. 2009. *Multinational enterprises and the challenge of sustainable development*. New York: Edward Elgar Publishing Limited.

Meinhold, B. 2009. Co-Op Canyon: Ecotopia inspired by Anasazi cliff dwellings. [online]. Available from: <http://www.inhabitat.com/2009/06/08/revision-dallas-honorable-mention-inspired-by-anasazi-indians/> [Accessed: 8 June 2010].

Milani, B. 2005. Building materials in a green economy. Unpublished PhD Thesis, University of Toronto, Canada.

Moyo, A. & Crafford, G.J. 2010. The impact of hyperflation on the Zimbabwean construction industry. *Acta Structilia*, 17(2), pp: 53-83.

Munier, N. 2005. *Introduction to sustainability-road to a better future*. Dordrecht: Springer.

Nassen, J., Holmberg, J., Wadeskog, A. & Nyman, M. 2006. Direct and indirect energy use and carbon emissions in the production phase of buildings – An input-output analysis. *Energy*, 32(9), pp. 1593-1602.

Oxford Business Group. 2008. The Report: Dubai 2008, pp.137-138.

RICS. 2010. Global glossary of sustainability terms. [online]. http: http://www.rics.org/site/download_feed.aspx?fileID=6914&fileExtension=PDF [Accessed: 13 June 2011].

Roy, T. & Gupta, A.K. n.d. Greenomics: Cost efficiency of buildings in India. [online]. <http://www.joneslanglasalle.com/ResearchLevel1/research_greenomics_cost_ efficiency_of_green_buildings_in_india.pdf> [Accessed: 8 June 2011].

Sayce, S., Ellison, L. & Smith, J. 2004. Incorporating sustainability in commercial property appraisal: Evidence from the UK. *Australian Property Journal*, 38, pp. 226-233.

Srinivas, S. 2009. Green buildings – Benefits and impacts Proceedings of World Academy of Science, Engineering & Technology, 19-21 March.

Strong, W.A. & Hemphill, L.A. 2006. *Sustainable development policy directory*. Oxford: Blackwell Publishing.

Suddell, B.C. 2008. Industrial fibres – Recent and current developments. *Proceedings of the Symposium on Natural Fibre*, Rome, 20 October, pp. 71-82.

US Environmental Protection Agency. 2010. Basic information – Definition of green building. [online]. Available from: <http://www.epa.gov/greenbuilding/pubs/about.htm> [Accessed: 5 May 2010].

Van Wyk, L. n.d. Mauritius Green Building Handbook Volume 1: Sustainable building versus ecological building. [online]. Available from: http://researchspace.csir.co.za/dspace/bitstream/10204/4965/1/Van%20Wyk10_2010.pdf? [Accessed: 8 June 2011].