

# Volume 9 Issue 1

ISSN 1994 - 7402

March 2016



# Journal of Construction

On the Department of  
Higher Education list of  
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Official Journal of the  
Association of Schools  
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## AIMS AND SCOPE

The Journal Of Construction (JOC) is the official journal of the Association Of Schools Of Construction Southern Africa (ASOCSA). ASOCSA has committed itself to foster excellence in construction communication, scholarship, research, education and practice and the JOC provides the medium to achieve this commitment. JOC is at this stage a bi-annual refereed journal serving all stakeholders and participants in the building construction and civil engineering sectors.

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## Dear Industry Stakeholder,

Dear Journal of Construction (JoC) Stakeholders  
The first 3 months of 2016 has flown by. I trust that it has been a fruitful time for you either as an academic, consultant or contractor.

Together with JoC becoming fully functional as an Open Access Journal Dr Nishani Hararain has taken over the reigns as new editor. We hope that you are using this opportunity to gain better insight into the research that is current in the sector at this time. Following a workshop recently attended by the new Editor more developments on this front will be taking place.

Our eyes are focused on Nelson Mandela Bay where we will be hosting our 10th Built Environment Conference from July 31 - August 2 this year. With only 2 months to go before the conference we are informing you that the conference is once again accredited by the SACPCMP with 5 points being awarded for attendance of the conference. Professionals registered with the SACPCMP need a total of 32 points over a 5 year period and this conference is highly regarded by the SACPCMP.

I wish you well for the year,

A stylized, handwritten signature in black ink, appearing to be 'F C Fester'.

Ferdinand  
F C Fester  
President ASOCSA  
March 2016

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# JOURNAL OF CONSTRUCTION



## EDITORIAL

The 1st issue of Volume (9) of the Journal of Construction (JoC) comprises four papers which cover various topics in construction and in higher education contributed by authors from Africa.

Firstly, Hoffman and Nkadameng assess the water supply challenges in the Elias Motsoaledi municipality of Limpopo Province, South Africa. Secondly, Ncgobo and Harinarain investigated how expensive sustainable building materials are the primary factor influencing sustainability in the residential sector. Thirdly, Agumba and Musonda determined the perception of gender on the effects of substance abuse on the students' physical, cognitive and affective development at a comprehensive South African university. Finally, Tramontin and Moodley examined the critical relationship between higher education and sustainability, towards improving energy efficiency in buildings through higher education.

Overseeing EDITOR: Prof. Theo C Haupt, University of KwaZulu-Natal, Durban South Africa.

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# INVESTIGATING WATER SUPPLY CHALLENGES IN THE ELIAS MOTSOLEDI MUNICIPALITY OF LIMPOPO PROVINCE, SOUTH AFRICA: A CASE OF MOTETEMA SETTLEMENT

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## PURPOSE:

The study discussed water supply challenges in rural South Africa and evaluated community perceptions of the municipal capacity.

## ABSTRACT

### Purpose

The study discussed water supply challenges in rural South Africa and evaluated community perceptions of the municipal capacity.

### Design/methodology/approach

Municipal planning documents described the targeted study area. Questionnaires by 98 randomly selected community respondents profiled the respondents and evaluated several aspects of water delivery in the community.

### Findings

The results reveal several operational challenges. Water delivery was sporadic and unreliable, the water quality was poor and the breakdowns response time was unacceptable.

### Research limitations/implications

The causes of the water delivery problems were not investigated. The study suggested solutions and was restricted to one municipal area only.

### Practical implications

The local municipality should response should focus on quality control, monitoring, training, funding and capacity building of their service delivery function. More efficient communication with the community is required.

### What is original/value of the paper

Several water service delivery challenges were revealed and will be of value to the municipality to mobilise, plan and structure a proper response to challenges.

**Keywords:** Limpopo, South Africa, Rural areas, Water quality, Water supply

## BACKGROUND

Water is a basic human need, but, it is a limited resource with quantitative limitations and qualitative vulnerability. The World Health Organisation confirms that inadequate access to water or unavailability thereof can seriously impact on human survival or may lead to loss of life<sup>1</sup>. The WHO estimates that more than 700 million people still lack ready access to improved sources of drinking water and nearly half of the estimated number live in sub-Saharan Africa. According to Oumar and Tewari<sup>2</sup> the provision of sufficient drinking water and sanitation services will remain a major international problem in the 21st century. South Africa is a water scarce country and demand for water is fast approaching the levels of supply. Dye argues that decisions by authorities on priority allocations to users of water will become ever more difficult in future, especially in years of drought<sup>3</sup>.

This study will focus on the Motetema Settlement located within Elias Motsoaledi Local Municipality (EMLM) in the Limpopo Province. The Sekhukhune District Municipality has jurisdiction over the area of study as Water Service Authority. EMLM is a water service provider and is faced with severe challenges of supplying reliable water services to its constituents. The EMLM annual report of 2013 confirmed that water supply challenges were experienced<sup>4</sup>The residents in Motetema often go without potable water for days and when the water is available, the quality of the water is often unacceptable. The reasons behind the unavailability and unreliability of water services were explored in this study .

Inability to access sufficient clean water has negative impact on communities. Kayaga et al<sup>5</sup> states that access to improved

service levels of water supply are not only vital for human health but are also necessary for people's convenience and dignity. The White Paper on Water Supply and Sanitation Policy of 1994<sup>6</sup> defines basic water supply as a minimum of 25 litres per person per day or 6000 litres per household of eight people per month within a maximum distance of 200m from dwellings. This study will explore if the water supply to Motetema township falls within these stated guidelines.

## THE STUDY

### Importance of the Study

South Africa is an arid to semi-arid region. Du Plessis<sup>7</sup> confirms that 21% of the country receives an average rainfall of less than 200mm per year with 44% receiving 200-500mm. This rainfall equates to only 60% of the world average. More than 65% of the country receives less rain than is required for dry-land farming. In 1994 the White Paper produced by the DWA already identified that the poor, rural areas of South Africa are particularly vulnerable to suffer from inadequate access to drinking water, especially in times of drought<sup>6</sup>. The EMLM 2013 annual report confirmed that most of the rural areas of the Limpopo Province still do not have access to reliable sources of water and often rely on unclean local rivers and streams for access which can be detrimental to human health due to the bacteria they carry<sup>4</sup>.

Water service delivery in the region has been facing many challenges over a period of time. In 2012 Maponya reported in the Sowetan on the communities of Tafelkop and Motetema that went on a violent protest barricading roads, burning tyres and looting shops belonging to foreign nationals in an attempt to get municipality's attention on water services delivery in their community. The district municipality at the time, confirmed that it was experiencing technical challenges with water supply<sup>8</sup>.

Sporadic water supply has a far more severe effect on poor households connected to a potable water supply than on households depending on natural sources of water. Communities depending on natural water sources, maintain and keep sources safe for human consumption. A 2009 study by Dungamaro found that when potable water service is available, natural sources of water are neglected and they become unsafe for human consumption<sup>9</sup>. The communities of EMLM often have to rely on other methods of water access such as buying or collecting from natural sources such as rivers and streams. In poor households, rivers and streams become the only source of water when the water service delivery is unavailable. If a municipality does not heed to the challenges that communities face as a result of unreliable water supply the result may be negative perceptions in the community about the municipality's capacity to deliver services. If the municipality also ineffectively communicates with communities on water service delivery issues, the negative perceptions in the community will probably be exacerbated. Part of this study was to understand community perceptions in this regard.

### Description of the Study Area

EMLM falls in the Limpopo Province and is the second largest municipality within the Sekhukhune District Municipality. According to StatsSA the geographical area is 3668.33km<sup>2</sup> with a total population size of 249 363 people<sup>10</sup>. EMLM is the Water Services Provider (WSP) in its area of jurisdiction. Motetema settlement is one of the closest settlements to the municipal offices in the municipal area. It is divided into three main settlement types: Motetema urban, Motetema rural known as "Skoti" and the informal settlement known as Shushumela meaning "push yourself in". The population of about 48,600 constitutes 20% of the total municipal population. Motetema Urban is located downstream and closer to the main reservoir,

Shushumela is located further away on hilly area and the rural part of the area is located in a largely flat area.

### The Problem

Motetema is deprived of natural water as the Lepelle River is located 30 km away and cannot be used by the residents as a source of water. The Motetema urban settlement is located the closest to the economic hub of the area and to the site of the municipal offices. The demand for rental property is high in the area and many people cannot afford to rent homes in the urban settlement. People that cannot afford rental stay in Shushumela. Due to the increasing population in the settlement the existing infrastructure is unable to cope with the demand. Dilapidated and fragile infrastructure and inadequate maintenance result in frequent pipe bursts in the area.

The seriousness of the situation is exacerbated by the fact that the municipality does not seem to understand the extent of the challenges that these communities face as a result of the sporadic water supply. This is intensified by ineffective communication between the communities and the municipality. The primary objective of the study is to analyse and describe the water supply and access challenges in the communities of Motetema.

The study is to understand community perceptions in this regard:

- How often is water unavailable?
- How often is water not available to you?
- Is the quality of water supply unacceptable?
- How good is the response to water supply breakdown?

## LITERATURE REVIEW

### International scenario

The United Nations International Conference on Environment and Development (Earth Summit) in 1992 adopted a programme of action to provide the poor with access to fresh water and sanitation for sustainable living. The World Health Organisation in collaboration with the United Nations Children's Fund (UNICEF) set a standard of minimum 25 litres of safe drinking water per day per person and also set the maximum distance to be travelled to a source of water to 200 meters. This water supply standard became the basis for Free Water Policy in South Africa<sup>1</sup>.

Local municipalities in South Africa are tasked with the function of providing water in their areas of jurisdiction. Due to funding and capacity challenges in many rural municipalities supply of sufficient and reliable drinking water is still a challenge. Without sufficient water communities cannot thrive; risk of waterborne diseases becomes high, people migrate to areas where better opportunities are evident, thereby losing skilled people to urbanised areas. As a result rural areas continue to lag behind in development issues.

Van Zyl et al<sup>11</sup> proposed that municipalities as custodians of water services infrastructure in their respective areas should provide an acceptable standard of services to their communities. This requires rigorous planning for municipal infrastructure which follows a life cycle management approach. The important role of municipalities is also highlighted by a study of Bhagwan et al<sup>12</sup>. The study emphasized the very important service delivery function of local government to ensure water security and meeting the water needs resulting from expanding socio-economic growth.

### South African scenario

South Africa has since made significant progress towards ensuring access to water especially in rural areas. In the State

of the Nation Address delivered on 3 June 2009 president Zuma confirmed that access to safe drinking water improved from 62% of the population in 1996 to 88% in 2008. The Department of Water Affairs 2010 Annual report indicated that 97% of the population had access to basic water supply<sup>13</sup>. The African Ministers Council on Water (AMCOW) Country Status Review Report<sup>14</sup> also confirmed that the Millennium Development Goal targets for water supply and sanitation had been met by South Africa.

However, the mere fact of water supply does not ensure quality in water delivery. Majuru et al<sup>15</sup> warns that the existence of water supply infrastructure does not equate to access to safe water, as these systems often do not work. Koestler et al agree and stated that maintenance is a challenge and providing new water supply infrastructure often takes precedence over ensuring continued access to water<sup>16</sup>. The report by DWA Progress Report on Water Access<sup>13</sup> confirmed serious challenges in rural communities relying on communal taps of poor standard. Rietveld et al<sup>17</sup> reported in 2009 on very poor rural water supply due to sub-standard construction.

In 2008 the South African government started the Blue Drop project to address the problem of monitoring and reporting on water service quality<sup>18</sup>. Since inception this initiative experienced problems mainly from rural municipalities that often relied on ad-hoc reporting with very little effect on identifying actual water delivery problems. Rivett et al agreed that rural municipalities often failed to comply to report on the required management of monitoring of water quality and rather reported on water quality alone. Rural municipalities are falling behind the national water service delivery guidelines resulting in a widening gap between water supply quality levels in urban and rural areas<sup>19</sup>. South African water research also revealed a distinct paradigm shift in confirming the changing nature of water supply challenges that confronts the country. A recent study by Siebrits et al<sup>20</sup> indicated that South African water research publications between 1977 and 1991 were dominated by research into technical and engineering solutions. More recent studies were typically on water pollution, water quality, governance and politics in water management. According to the WHO<sup>1</sup> the main causes of not meeting water services delivery targets are lack of priority given to the sector, lack of financial resources and lack of sustainability of water supply and sanitation services.

Mutamba<sup>21</sup> suggest that water demand management and water conservation may offer many benefits to alleviate South Africa's current water supply problems. Benefits may include better efficiency of water infrastructure, cost savings, consistency of water supply, improved water quality and increased income for water service providers. Bhagwan et al<sup>12</sup> also support the potential of water demand management and link this to a recent study of the Water Research Commission regarding the current status of water supply in South Africa.

#### EMLM situation

EMLM mission statement included in the annual report focuses on provision of services to communities in a sustainable manner that will promote social and economic development. The Millennium Development Goal (MDG) service delivery targets were access to basic water for all by 2008, access to basic sanitation at the Reconstruction and Development (RDP) level by 2010 and all schools and clinics to have access to water and sanitation by 2007<sup>4</sup>. There are no recent reports in the municipality which indicates whether the municipality was able to achieve its targets or not.

The data collected for the Water and Sanitation Sectoral Plan (WSSP) in 2008 revealed that the provision of free basic services fell below the standard provision for free basic services.

That is, 97.5% of households still fell below the RDP standard level of service. Water services backlog stood at 61.73%. According to the EMLM Annual Report (2012/13), the municipality has a 57% backlog for water services and 84% in sanitation. The report indicates that reliance on other government departments and the District is inhibiting the municipality from achieving success in the provision of water services infrastructure.

EMLM has a total of eleven (11) clinics of which eight are served with water through the borehole system and three (3) are serviced through reticulation and one (1) is serviced through a water tanker. The Municipality boasts 100% coverage in this area. The table below indicates that water backlogs are more prevalent in early learning centres and primary schools.

**Table 1: Access to Water at Institutional Level**

School Type	No. of schools	No. of pupils	RDP standard water, no. of schools	Water shortage, no. of schools
Early learning centres	70	4045	7	63
Primary	78	27951	23	55
Secondary	51	22544	21	30

Source: Elias Motsoaledi Local Municipality, 2008. Water and Sanitation Services Plan.

## METHODOLOGY

### Data Collection and Analysis

Out-dated municipal planning documents were used for planning of data collected and assumptions had to be made in this regard. The study targeted people who have been living in the area for at least 5 years. The data was collected by means of questionnaires through simple random sampling method of selecting respondents at social gatherings, leisure points and at community facilities such as clinics. The research process was explained to respondents to ensure that aspects such as confidentiality and voluntary participation were understood. The data collection process was conducted over a period of three days during December 2014.

A total of 110 questionnaires were distributed and 98 were collected from the respondents - 55 questionnaires were collected from Motetema Urban as the biggest area, 25 from Motetema Rural and 18 from the Informal settlement of Shushumela.

## DATA ANALYSIS

### Respondent profile

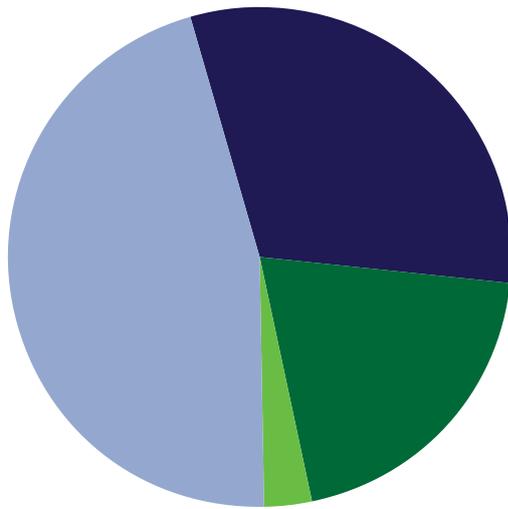
Of all respondents 51% were female and 49% were male. From the discussions and comments with respondents during completion of the questionnaires the women in general were more passionate in their responses than men. This was probably because women carry the responsibility of household maintenance and as such water issues affect them more directly than men. The results reveal that 57% of the households are comprised of between 4 to 8 people, 23% have between 9 to 12 people whilst 20% comprise of between 1 to 3 people. The household average is 5 people per household. The results show that 98% of the total respondents receive portable water from the municipality and 2% don't have access to portable water. It was established that the 2% were mostly from the newly extended formed informal settlement and the municipality was in the process of extending communal taps to that section.

**Location of water supply**

A total of 89% of the respondents receive water in their household or in the yard through a tap whereas 9% receive water through a communal tap. The remaining 2% of the respondents indicated that they receive water through a municipal tanker. In some instances the distance between the communal taps or the municipal tankers may have exceeded the 200m target set by the Water Act. However it can be concluded that water delivery met the Water Act requirement of 200m in at least 89% of cases evaluated.

**Availability**

The availability of water is detailed in Figure 1. 46% Of the respondents receive water less than 9 hours per day, 31% receive water between 9 and 15 hours a day, 20% of the respondents have available water almost always 3% always have water. On average the respondents only have access to water for 40-45% of the day.



- 3% Always ( 24 hours a day )
- 20% Almost Always ( 16-23 hours a day)
- 31% Sometimes ( 9 -15 hours a day )
- 46% Seldom ( less than 9 hours a day )

Figure 1: Water Availability Period

**Water Pressure**

Figure 2 indicated that 73% of the respondents were satisfied with water pressure when water is available, but 19 %, mostly from the informal settlement complained about low pressure while 8% indicated poor or totally insufficient water pressure. It was concluded from the response that the poorer, upper parts of the informal area did not have adequate and efficient water supply.

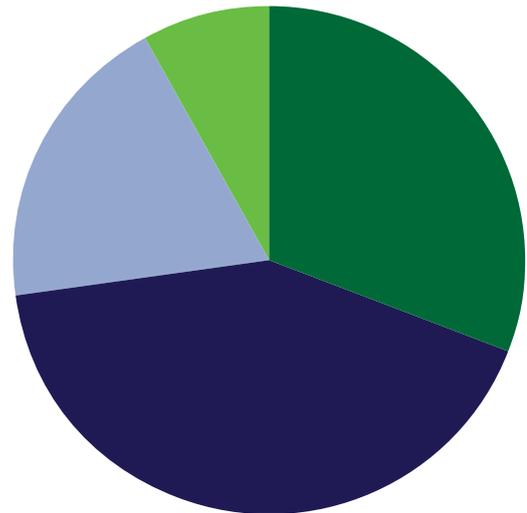
**Volume of water supply**

The Motetema urban respondents received a minimum of 250 litres per day or 7500 litres of water per household per month. Motetema rural respondents receive about 150 litres per day or 4500 litres of water per household per month. The average supply for Motetema rural and the Informal settlement are below the reserve amount of 6000 litres per household per month, as per the basic water regulations.

**Breakdown response time**

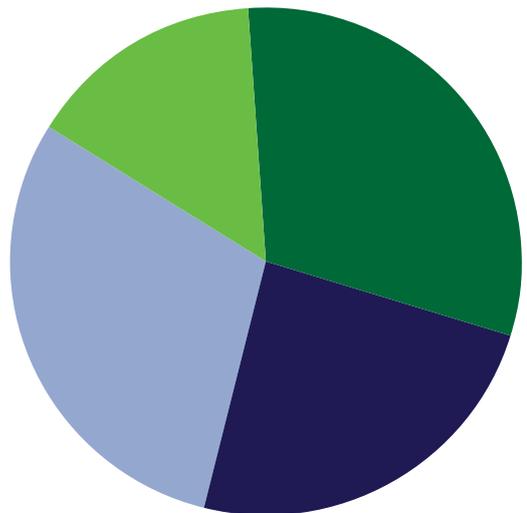
According to Figure 3 a total of 31% of the respondents indicated that it took on average 2-3 days or water supply to be restored after a system breakdown and 54% of the respondents indicated that

it took more than 7 days for the water to be restored. The average time taken to restore water services is between 5 and 14 days).



- 19% Too little, Insufficient
- 8% Poor, Totally Insufficient
- 31% High or more than Sufficient
- 42% Fair or Sufficient

Figure 2: Water Pressure



- 15% 1 day
- 31% 2-3 days
- 24% 7-14 days
- 30% 12.5-14 days

Figure 3: Response time

**Quality of water**

The data from the questionnaires revealed that only 37% of respondents were satisfied with the quality of the water received. 31% Of respondents were dissatisfied stating unacceptable colour, smell and taste as the main reason. A further 26% of respondents cited colour as the main element and 7% cited taste. Most respondents added by saying that the water tasted like mud and that it was often brownish in colour. The overall

opinion on water quality is described by Figure 4 below. It shows that 80% of the respondents regard the quality of the water received as bad. The bad quality of water was confirmed by the health workers at the clinic who referred to frequent outbreaks of diarrhoea in the community due to the unsafe drinking water.

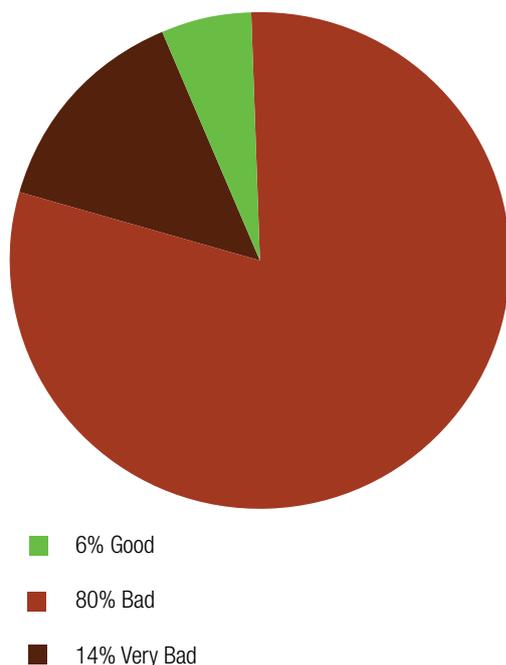


Figure 4: Water Quality

Additional comments to the questionnaires received from respondents indicated that theft of water infrastructure such as taps and valves (indicated 54 respondents) is considered the main cause for water unavailability in the area. Old infrastructure indicated by 28 respondents and inadequate maintenance by 10 respondents as other main causes for water unavailability. When questioned on the technical capacity of the municipal staff a total of 71% of respondents did not have confidence in the municipality's capacity. Comments received in this regard referred to lack of training of municipal officials, slow response to water breakdown complaints, negative attitudes of municipal officials due to lack of management support and lack of suitable training and too few skilled officials.. A total of 64% of the respondents also answered that they did not know how to report water related issues. Reporting water delivery issues is important for record keeping in the municipality and for performance monitoring and evaluation purposes.

## FINDINGS AND DISCUSSION

### Water Supply Challenges

The municipality should be commended for supplying water infrastructure in the community. Only the informal settlement that is expanding rapidly does not have access to water. However, the existing infrastructure has deteriorated and needs urgent maintenance and upgrading. The provision of new water infrastructure without maintaining the existing infrastructure is ineffective management of public assets. Asset management and maintenance plans for water infrastructure in the municipality are urgently needed.

The slow response time to breakdowns also support the finding that maintenance needs urgent management attention. The low pressure/volume of supply suggests that the capacity of the water supply infrastructure may be inadequate. The quality of the water also merits urgent technical and management attention. Various causes may be at the root of this problem. The

study proposes that the population growth in the area may be in part responsible for this problem.

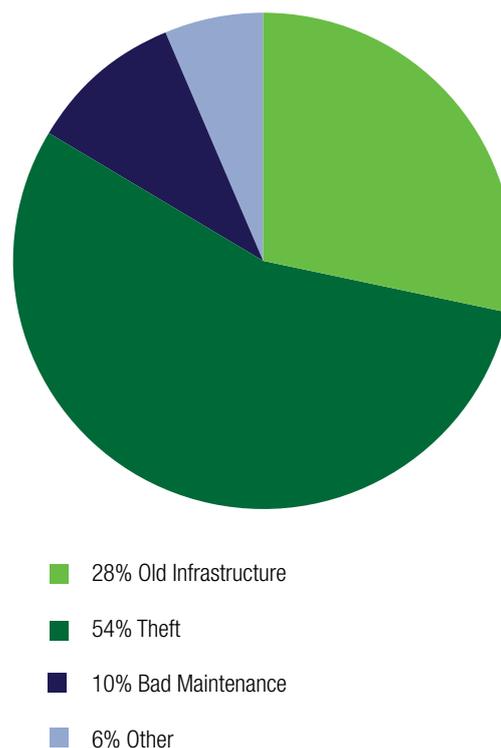


Figure 5: Causes of Water Unavailability

### Efficiency and Reliability of Water Supply

The results from the analysed data indicate that water supply in Motetema is inefficient and unreliable. The quality and integrity of the water supply system are under severe pressure with pipe bursts and leakages common occurrence throughout the settlement. This could become costly in the long run to refurbish should the municipality not take immediate steps in addressing the problems. A substantial number of complaints were received during data collection relating to the persistent unreliability of water supply. As much as 46% of the respondents have access to water for less than 9 hours per day and a further 31% have access for between 9 to 15 hours per day. These results therefore suggest that water supply is irregular and erratic, therefore unreliable.

### Institutional Arrangements

The findings indicate a weak technical capacity in the municipality to sustain water supply to the satisfaction of the residents. A number of respondents specified the lack of technical skills in the municipality. They also reported that the municipal officials have a negative attitude because they are not fully qualified to handle the technical challenges as they arise.

Interpretation of the data from the questionnaires in combination with the additional comments received indicates that significant information gaps seem to exist between end users and the municipality.. It emerged that 64% of the respondents did not know the process to report water challenges including dysfunctional water meters. The results also indicate that 63% of the respondents were not satisfied with the quality of water received. The majority 58% cited colour as their main concern and the negative health effects that untreated water brings. The overall ratings on water quality indicate that 80% of the respondents consider the water to be of bad quality. Municipal health workers also linked the frequent outbreak of diarrhoea in the area to poorly treated water or unsafe drinking water which is a common occurrence.

## CONCLUSIONS AND RECOMMENDATIONS

The conclusions reached and the recommendations made is done from the following point of departure - a water supply installation is a technical and often complex system requiring the appropriate management skills and maintenance programmes to be sustainable and dependable over the longer term. If such a system has to supply an informal, expanding and unregulated community, the challenge of consistent, high quality water supply becomes a much more complicated task.

### Improving Water Operations

It is suggested that EMLM implement the following strategies to improve water operations:

- Upgrading of water treatment technologies with advanced or alternative treatments to improve the quality of water supplied.
- Implementing pro-active measures or an early warning system to identify changes in the quality and quantity of water supplied.
- Launch a Technical Skills Development Programme, with assistance from state agencies responsible for capacitating local government.
- Effective implementation of water conservation and water demand strategies to reduce losses and wastage.
- Public education or awareness for water conservation and management especially at household level.
- Regular maintenance of water supply systems, including metering equipment, to reduce the level of unaccounted for water.
- Regular monitoring of water source quality and quantity.

### Institutional Arrangements

Water supply management is an integrated process involving different institutions who have to work together in providing a good service. The process should take account of existing arrangements between the municipality and the community and to strengthen those relationships for the benefit of the water service. In order for operations to run smoothly, the municipality needs to recognise the important linkages between the following functions:

- The management of the bulk system,
- The management of the branch and local systems,
- Coordination, both horizontally and vertically,
- Regulatory and operations functions,
- Active multidisciplinary professional support services.

EMLM should strengthen communication channels between the municipality and the residents by establishing water management committees within the different areas to support operations i.e. report water issues as they arise. A clear separation of roles between the WSP and WSA will also improve coordination which is a necessity in operations management.

### Investment in Water Infrastructure

As discussed in the paper, water infrastructure in this settlement is on the verge of collapse. This is evidenced by frequent bursts of water pipes, dysfunctional meters and also visible water leakages throughout the area. The municipality should:

- Address water infrastructure theft.
- Conduct an infrastructure audit to inform the basis for investment in the area.
- Refurbish existing infrastructure to reduce losses and wastage.
- Acquire an accurate database on connections and meters. This database should be linked to the billing and collection database to improve municipal revenue.
- Invest in the development of boreholes and other groundwater sources.
- Invest in an operations and management system, linked to asset management system to prolong the life of the infrastructure.

Similar findings and conclusions were made by the studies of Majuru et al<sup>15</sup> and Hoffman et al<sup>22</sup> in other areas of Limpopo Province which indicate that the above mentioned problems may be wide spread and systemic in many municipalities in the rural areas of South Africa. The Motetema municipality need to consider taking immediate measures to deal with the identified challenges, since the challenges are of an urgent nature. Such interventions will require revising and updating the municipal planning instruments such as the Water Services and Sanitation Plan to ensure sustainable water services supply to the people of Motetema. The suggested interventions are also supported by the findings of a study by Jack et al<sup>23</sup> on emergency response plans for water security in rural areas of three other provinces of South Africa. The study by Jack et al proposes that emergency response plans be in place to identify water delivery emergencies such as unavailability or contamination of water supply, how to communicate such emergencies and how to respond appropriately thereto.

However, it should be noted that the Motetema Municipality will struggle to achieve success if the recommended interventions are not complemented by technical skills development programmes and training at all levels of the municipality. An efficient, effective and reliable water services operation is dependent on mutual cooperation from all involved parties including the private parties dealing with implementation. The Motetema Municipality may benefit to heed the findings of a study by Akinboade et al<sup>24</sup> advising early communication and consultation with the community, prompt action to be taken on justified complaints and to avoid making empty political statements that only serve to fuel unrealistic expectations.

## CONCLUSION

Provision of water and sanitation services remains a key priority for government. Adequate water supply is a prerequisite to sustainable development and for drawing capital investment into areas that require economic development. Supply of clean water is essential for sustaining healthy societies, for human dignity and improved quality of life. This study has established that water supply in the Motetema area is experiencing severe challenges and recommendations have been given for consideration by the municipality in order to effectively deal with the challenges.

The study revealed challenges relating to:

- Overall operational challenges of the supply system which has an impact on the quality of water supplied,
- Technical skills shortages or capacity challenges,
- Inadequate planning and investment into water infrastructure maintenance,
- Inefficient communication channels between the community and the municipality.

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# EXPENSIVE SUSTAINABLE BUILDING MATERIALS: THE PRIMARY FACTOR INFLUENCING SUSTAINABILITY IN THE RESIDENTIAL SECTOR

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**PURPOSE:**  
**Residential sustainable building practices do not only apply to new environmentally orientated construction designs but also to environmental friendly operation and maintenance procedures. The purpose of this paper is to identify the challenges that prevent sustainable building practices in the residential sector in KwaZulu-Natal (KZN).**

## ABSTRACT

### Purpose of this paper

Residential sustainable building practices do not only apply to new environmentally orientated construction designs but also to environmental friendly operation and maintenance procedures. The purpose of this paper is to identify the challenges that prevent sustainable building practices in the residential sector in KwaZulu-Natal (KZN).

### Design/methodology/approach

This was a qualitative study and forms the first part of a national study, the aim of which is to identify whether residential buildings contractors understand and implement sustainable building practices. Data was collected by means of ten telephonic interviews with residential contractors that were purposefully selected from the Masters Builders Association (KZN).

### Research Limitations/implications

This paper forms the first part of a bigger study and therefore a small sample was selected. Consequently the results of this study are indicative of the condition in KZN and cannot be generalised to the rest of South Africa.

### Findings

Issues that affect the sustainable building practices in the residential sector such as high costs of sustainable building materials and lack of education in sustainable building methods are key factors that builders identified as hindrance in achieving sustainability in this sector. Careful selection of environmentally sustainable building materials by architects is the easiest way for architects to start incorporating sustainable design principles in residential buildings. The contractors believe that ultimately it is the client who is responsible for sustainable residential building practices as "they are the ones paying for it".

### Originality/value of the paper

With the emphasis now been placed on sustainable construction and green buildings, this paper highlights the challenges experienced by residential contractors in implementing sustainable practices, the primary challenge been the high cost of sustainable building materials.

**Keywords:** Sustainability, Residential building, Contractors, Sustainable design.

## INTRODUCTION

Sustainable building practices are practices that aim to reduce resource inputs such as energy, water, materials and waste outputs while at the same time improving the liveability of citizens<sup>1</sup>. The ecological damage that transgresses from harvesting natural resources and their conversion into building materials includes loss of wildlife habitat, erosion and water and air pollution<sup>2</sup>. People are in a relationship with the natural world and the two are acutely interdependent in addressing the complex problem of construction and the environmental efforts towards sustainable construction and it is therefore important to put in place practices that restore the balance between the two<sup>3</sup>.

Residential sustainable building practices do not only apply to new environmentally orientated construction designs but also to environmental friendly operation and maintenance procedures<sup>3</sup>. Not only should construction materials and components be produced in a sustainable way but their use must also answer to environmental requirements<sup>3</sup>.

Residential building construction has an important role to play in sustainable development, because constructed houses have

a great influence on the quality of life, comfort, security and health<sup>4</sup>. By creating an airtight envelope, home owners can lower heating and cooling costs by over 50% or more<sup>5</sup>.

Sustainable residential building practices include the in-situ mixing of concrete to reduce the amount of concrete waste that is discharged to landfills<sup>2</sup>. Sourcing locally produced materials also reduces carbon emissions hence using locally produced bricks/blocks and other materials are encouraged in the residential building sector to improve sustainability. Re-using building materials, broken bricks or blocks for filling in required sections can also reduce waste that is taken to dumping sites<sup>2</sup>.

The purpose of this paper is therefore to identify the primary factors that prevent sustainable building practices in the residential sector in KwaZulu-Natal (KZN).

## SUSTAINABLE BUILDING

To sustain means to support, to keep alive and to keep going. Sustainable construction is an integrated process aiming to restore the balance in the natural and the built environment and to create settlements that affirm human dignity and encourage economic equity<sup>3</sup>. There are direct benefits in sustainable building methods which include economies in fuel bills, market advantage and lower long term exposure to environmental or health problems<sup>6</sup>. The risks that are associated with these direct benefits include issues such as the building performance, the cost of green building and the reliability of technology<sup>6</sup>.

The Agenda 21 protocol (which outlined the United Nation's vision for a centrally managed global society) produced a global action plan for sustainable development<sup>3,7</sup>. The Agenda 21 is a charter of 27 basic principles covering rights and responsibilities of states and their citizens, but it is a non-binding agreement. Some of the identified areas include the promotion of sustainable land use, planning management, promoting sustainable energy use and transport systems in human settlements and promoting sustainable construction industry activities.

The overriding assumption is that sustainable building practices costs more or is less profitable but there is pressure to work towards a more sustainable construction industry with better processes and products<sup>8</sup>. There has been a growing trend in recognising waste minimisation and energy efficiency as good practice for sustainability while healthy housing, affordable warmth and clean air are recognised as aspects of social justice that should be available to all. If savings from energy conservation are greater than the increase in the monthly costs of the mortgage or construction loan, the homeowner is literally making money month after month. Energy conservation is not a cost it's an investment that only gets more valuable over time<sup>5</sup>.

Benefits of sustainable building practices include:

- Reduced operating costs;
- Reduced waste;
- Reduced liability in municipal expenses and running cost;
- Enhanced productivity<sup>9</sup>.

### Sustainable Building Materials

Careful selection of sustainable building materials by the architects is the easiest way to start incorporating sustainable design principles in buildings. But in most cases the price of sustainable building materials are a concern when considering

sustainable building practices compared to the similar alternative materials<sup>2</sup>. There is a need to pay attention to the use of modern building materials with reference to energy intensiveness of materials, natural resources and raw materials consumed, recycling and disposal and the impact on the environment<sup>9</sup>. Stabilised mud blocks, compacted fly ash blocks, rammed earth walls and low intensive roofing systems are some measures that the contractors can undertake to achieve sustainable building homes<sup>9</sup>.

There are three phases of building materials that relate to sustainable building practices, these are pre-building phase, building phase and post building phase<sup>2</sup>. The pre-building phase describes the production and delivery process of a material up to but not including the point of installation. This has to do with discovering new materials in nature as well as extracting, manufacturing, packaging and transportation to a building site. The pre-building phase has the most potential for causing damage to the environment. Understanding the environmental impacts in the pre-building phase will lead to a wide selection of building materials by the architects<sup>2</sup>. The architects need to be aware of the procurement of raw materials, methods of manufacturing process and the distance from the manufacturing location to the actual residential construction site. The extraction of raw materials whether from finite or renewable sources can negatively impact the environment. It is not easy to meet the ever growing demand for buildings by adopting only energy efficient traditional materials like mud, thatch and timber hence more innovative methods are needed<sup>9</sup>.

The building phase refers to a materials useful life, this phase begins with materials assembly into a structure and it includes the repair and maintenance of materials and it extends throughout the life cycle of the material within or as part of the building<sup>2</sup>. In the post building phase material usefulness after the building has expired is a key concern as it involves the material re-usability and materials being converted to other products<sup>2</sup>.

The innovation of new building materials and the reduced reliance on energy intensive materials such as cement, steel, aggregates and aluminium can make a huge difference to the global environment<sup>3</sup>. Sustainability as a concept has just been introduced to developing countries and is not yet regarded as a priority. The major challenge for sustainable construction would be to get sustainability to the agenda of the construction industry. In residential homes harvesting rainwater for irrigation and other non-drinking purposes is a must in order to achieve sustainable homes<sup>5</sup>. Tank less water heaters are also an option as they produce warm water as required, low pile and natural fibre carpets are presumed good as they trap fewer allergens, porous pavements and un-compacted gravel, crushed stone and open paving blocks reduce or eliminate runoff and allows water to filter in to the ground. It is therefore important to understand why contractors are not implementing sustainable practices in the residential sector.

## RESEARCH APPROACH

This was a qualitative study that focused on the challenges experienced by residential building contractors in implementing sustainable building practices in KZN.

Data was collected by means of an interview from ten residential building contractors registered with the Masters Builders Association (KZN). The residential contractors were selected via purposive sampling which is a non-probability sampling method<sup>10</sup>. Interviews are used tool to access people, experiences and their inner perceptions of reality<sup>10</sup>. The authors selected interviews because they are more flexible, it's a quick

and cheap method to obtain information, responses can be recorded without causing embarrassment to respondents and the interviewer can explain the requirements more easily<sup>11</sup>. This paper maintained total confidentiality in relation to the data that was collected from residential contractors.

## RESULTS AND DISCUSSION

The transcripts from the interviews were studied to identify different themes which was then used to analyse the data. Of the ten residential contractors sampled for the study, five were owners of a construction firm. The five other people interviewed included a financial director, quantity surveyor, partner, director and a member of the firm. The number of years in the profession of the respondents ranged from two years to 35 years. Nine residential contractors have undertaken some form of sustainable residential building since their companies were incorporated. This indicates that most residential contractors are aware of sustainable residential building practices.

On average the residential construction firms have been practising for 5.4 years, with nine respondents having completed at least two sustainable residential buildings.

All residential contractors do believe that the living conditions of the occupant can be improved by using sustainable residential practices, however one respondent stated that:

*“they can improve residential living conditions if the materials are available at reasonable prices”.*

Nine residential contractors believe that the oil spills from plant that contaminates the soil is very minimal in residential projects. Another respondent highlighted the fact that:

*“labourers are well aware on how to deal with oil spills on site”.*

All respondents do believe that the finished product of the landscaped areas will be in perfect condition if there was minimal or no oil spillage at all.

All the respondents believe that using sustainable building materials made from recycled glass tiles, insulation and dry wall can improve the sustainable building practices. There are however challenges with sourcing these materials as one respondent highlighted that:

*“small scale hardware's where they procure materials do not stock these type of materials most of the time because they are hardly purchased because they are expensive”.*

Eighty percent of the residential contractors believe that the materials that the professional team and architects prescribe are easy to understand and obtain but it was also stated that:

*“the specifications are easy to understand but not easy to obtain. The materials may be obtained easily in small quantities, but at later stages of the project, the materials might have to be imported from far away as the demand might be too much for local suppliers to produce and supply and some are specialised materials that local producers cannot produce”.*

The majority of the residential builders outlined that in professional team meetings the materials are clarified and recommendations of suppliers who supply those materials are given or suggested to the builders but the long lead time that it takes suppliers to bring materials to site is another challenge that residential contractors face.

Minimisation of waste is also a major concern in the residential building industry, the respondents agreed that waste minimisation is always prioritised on site as it positively impacts the environment.

Seventy percent of the respondents believe that it is not the role of the residential contractors to drive sustainable residential building practices. One respondent went as far as saying :

*“it is the architect's responsibility to design sustainable homes and its onus is on the owner to choose a sustainable home, the contractors simply follow the architects design instruction”.*

Another respondent stated that *“the home owner is the one who is responsible as they have the final say as to what should go in the construction of their houses”.*

A further respondent highlighted that *“the awarding of the work only happens once the design, bill of quantities and necessary documents are all completed and they only receive the tender documents to tender for the job and there is very little that they can do to influence the design or project at this stage”.*

Only three respondents believe that the residential contractors can be key drivers on residential projects as *“they drive the project and are aware of benefits – it is to their advantage”.*

One respondent highlighted that *“residential contractors have leverage as they can influence the choice of material that the client wants as the projects progresses”.*

The third respondent stated that *“with the experience in the residential building sector they understand it more and they can influence the client but the client should be willing to opt for it”.*

All the respondents believe that recycling materials on site can benefit the contractor in cost savings and it can benefit the environment. Most respondents argue that wastage is always kept minimal. One respondent highlights that:

*“the contractor can benefit from recycling materials in that he would save on transporting new materials to site, which cuts fuel cost and buying new materials”.*

The majority of the respondents highlighted that there are major cost savings as less material will be procured. One respondent highlighted that :

*“using different skips for non-reusable materials and one for re-usable materials such as steel off cuts, planks etc. is a good practise”.*

All respondents agree that the use of modern lighting systems such as compact fluorescent light bulbs reduces energy consumption and impacts positively on the environment. One residential contractor stated that:

*“incandescent light bulbs produce light from heat which makes them consume more energy as compared to fluorescent light bulbs which consume less energy”.*

Seventy percent of the builders believe that regulations from the National Home Builders Registration Council (NHBRC) are in favour of sustainable residential building practices but the emphasis is more on energy efficiency. One respondent went so far as saying:

*“yes it is incorporated but not in finer details, there are lot of grey areas”.*

The three residential contractors who believe that the NHBRC guidelines are not in favour of sustainable residential practices mentioned issues such as:

*“they are not in complete favour of residential sustainability building practices as they do not impose strict compliance with sustainability practices”.*

One respondent mentioned that *“should the municipalities put all the residential building practices to its bylaws and have strict measures in place the clients and contractors will comply, the NHBRC guidelines are general basic building codes”.*

Eighty percent of the respondents are positive that if they are involved in planning stages of residential projects they can add more value. One respondent stated that *“residential contractors are more hands on, they have experience and they also know what is capable and possible”.*

Another respondent argued that *“residential contractors input is vital in early stages as the contractor understands site conditions better than most people who are involved in the project”.*

Some of the respondents do believe that they can add value if they were to be involved in early planning stages however it is highly unlikely since they only get involved in later stages. The two residential contractors that believe it is not possible for residential contractors in early planning stages to add value on the project mentioned that :

*“typically builders are not always included in initial planning or design stages, they are only appointed after these have been finalised and a quantity surveyor has created a bill of quantities based on the completed design”.*

The other respondent highlighted that *“even if builders add input or suggest certain aspects the clients call the shots and they have a final say”.*

All the respondents believe that sustainable residential building materials inflate building costs. One respondent highlighted that *“the market is a niche market and therefore highly priced”.*

The other respondent mentioned that *“the sustainable building materials are expensive and often discourage owners or clients from opting to use sustainable building materials. The materials increase the cost of construction because they cannot be found locally and have to be imported from neighbouring towns”.*

Another respondent pointed out that the *“residential sector is a different sector; the sustainable materials are ordered in low volumes and this leads to higher prices unlike in other sectors of construction where they can order in bulk”.*

Some respondents went as far as highlighting that the cost of sustainable building materials do inflate building cost *“but you do find clients that are prepared to pay the premium so that they can see savings in water bills and electricity in the long run”.*

The respondents do believe that there are savings in the long run if the home owner opts for sustainable building practices. One respondent claims that:

*“there will be savings in the long run for the home owner, but the current costs of sustainability building practices becomes too much for the owner to adhere to such”.*

Some respondents recommended that *“lower energy costs equates to lower maintenance in the long run”.*

Another respondent pointed out that *“harvesting rain water for irrigation and outdoor use benefits the owner in water bills and there are major savings in electricity”.*

In general some residential contractors believe that *“for the home owners and contractors to be able to adhere to sustainable building practices, the current cost of implementing sustainability needs to be affordable and there must be future benefits that will exceed the cost of implementing sustainability”.*

Another respondent believes that *“the government needs to subsidise this industry as there is no competition at all and prices are way too inflated”.*

## CONCLUSION

This study has established that residential contractors are aware of sustainable residential building practices but they do experience challenges in its implementation. The challenges experienced by the residential contractors are that they have to pay high prices to procure materials as they buy them in small quantities, architects do not always design sustainable options, they are not involved in the early stages of the design process where they can have a say and overall they believe that clients are responsible for sustainable residential building practices as they are the ones paying for it. A recommendation would be for government departments or even the Construction Industry Development Board (CIDB) to conduct awareness programmes for the clients informing them about the green building products and sustainable building practices. Continued education programs for professionals and technicians as well as concerted public education programmes is also important.

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# PERCEPTION ON THE EFFECTS OF SUBSTANCE ABUSE IN A COMPREHENSIVE UNIVERSITY: A CASE OF GENDER

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## PURPOSE:

**Substance abuse has been identified to interfere with the students' physical, cognitive and affective development. The main aim of this study was to determine the perception of gender on the effects of substance abuse on their physical, cognitive and affective development.**

## ABSTRACT

### Purpose

Substance abuse has been identified to interfere with the students' physical, cognitive and affective development. The main aim of this study was to determine the perception of gender on the effects of substance abuse on their physical, cognitive and affective development.

### Methodology

The research philosophy adopted was positivism and the approach was deductive. A self-administered questionnaire containing items developed from literature review was administered to 199 built environment and civil engineering students at a South African university. The data was analysed using the Statistical Package for the Social Sciences (SPSS) version 21. Cronbach alpha was used to achieve the reliability for internal consistency of the measured constructs i.e. physical, cognitive and affective development. Item correlation identified the correlation of the measures of physical, cognitive and affective development. T-test was further conducted to test gender perception on the effects of substance abuse on the physical, cognitive and affective development.

### Findings

The measures of physical, cognitive and affective development had a strong relationship and were reliable measures. Furthermore, the results suggest that there was no statistical significant difference on the perception of the effect of substance abuse on cognitive development as informed by male and female students. However, there was a significant difference on their perception on substance abuse on physical and affective development.

### Limitation(s)

The respondents were from one comprehensive university, therefore the findings cannot be generalized for all the tertiary institutions in South Africa.

### Value

It is recommended that the scale of physical, cognitive and affective development can be used in future studies in other tertiary institutions. These scales are reliable and the measures have strong relationship. Furthermore, male students should be informed of the effects of substance abuse on their physical and affective development.

### Keywords

Effects, Engineering, Gender, University, Substance Abuse

## INTRODUCTION

Parents expect a university to provide a nurturing environment for their children which would be conducive to studying. It is expected that a university should provide a safe, enriching and rewarding educational experience for a student. This will ensure that students would develop their social and intellectual skills without any hindrances. However, every university in South Africa faces challenges and students ought to be aware of these challenges. Students should not be deceived into thinking that they have entered an ideal educational environment which is free from the influences of drugs and alcohol abuse and similar vices<sup>1</sup>. One challenge indicated in South Africa is that university students are using bursary money to buy alcohol<sup>2</sup>. It is probably uncontroversial to indicate that most university campuses struggle with containing and controlling alcohol and drugs consumption by their students. It can therefore be suggested that substance abuse is a problem in higher institutions of learning<sup>3</sup>. This sentiment is supported by many other authors<sup>1, 4, 5, 6, 7</sup>.

Furthermore in the United States, alcohol use on college campuses has been documented in at least 50 years. The recent concerns have centered on heavy episodic drinking, a potentially dangerous practice often termed "binge drinking," and usually defined as consuming five drinks or more in a row for men and four drinks or more in a row for women<sup>8</sup>.

It is indicated that alcohol consumption has been described as a core component of student culture and is seen as a defining feature of tertiary education lifestyle<sup>9</sup>. Substance indulgence has prompted students to lose focus on their primary reason for embarking on higher education. They further indicated that a place of learning should never allow students to indulge in alcohol consumption. Universities need to take a firm stand to ensure their campuses are alcohol free zones. A stance against alcohol on campus requires regular policing. This will ensure the safety and success of our future generation. However, they indicated that alcohol is still freely available on campus in South Africa<sup>1</sup>. Contrary to this finding, a survey conducted in Purdue University showed a sharp drop in drinking among students from 48% in 2006 to 37.3% in 2009. Much of this success is attributed to a new trend in alcohol free events on or around campus grounds<sup>10</sup>. In order to further stifle the consumption of alcohol among students, One centre developed a comprehensive approach to assist students with alcohol use. They addressed the issues not only through educational channels but also by bringing about change at the institutional, community, and public policy level. The premise of this approach is grounded in the principle that people's attitudes, decisions, and behaviour and those that relate to alcohol use are shaped by the physical, social, economic, and legal environments. This Centre argues that many aspects of this environment can be shaped by universities and government officials<sup>11</sup>.

Students normally enter university to further their studies and acquire knowledge so that they can improve their chances of entering the job market. These students would expect to have a positive experience that will contribute towards successfully completing their studies. They believe that higher education is a genuine place for one to enjoy academic bliss<sup>1</sup>. However, these outcomes are not fully achieved because students abuse of drugs and alcohol in the universities and prevent them from attending classes and make them perform poorly academically<sup>6</sup>. In a South Africa found that alcohol abuse led to female students being raped on campus<sup>1</sup>. This is a worrying factor that would lead parents and guardians to be fearful of sending their female children to further their studies at higher institutions of learning in South Africa.

Substance abuse could be exacerbated with the age at which students first enter such institutions<sup>6,1</sup>. This is an age of freedom and experimentation, where young students have the opportunity to test the limits previously set by parents and schools<sup>1</sup>. Furthermore, it has been found that male students consumed/abused alcohol more than female students in South Africa<sup>6</sup>. However, in a study conducted in Canada female consumption of alcohol was increasing relative to their male counterparts. Furthermore, non-binge drinkers and binge drinkers did not show significant difference in relation to cognitive and behavioural impairment<sup>12</sup>. This study should be enhanced by comparing the effects of substance abuse on the cognitive and behavioural impairment in male and female students.

It can be inferred that students who have experimented on substances such as tobacco, alcohol eventuates in compulsive patterns of use characterized by psychological and physical dependence<sup>13</sup>. However, there is paucity of study in South Africa to compare the perception of gender on the effects of substance on their physical, cognitive and affective development. Hence,

this paper examines the perception of student gender on the effects of substance abuse, on their- physical, cognitive and affective development. This paper is guided by a number of research questions and hypotheses:

- What is the reliability of the measures of physical, cognitive and affective development?
- What relationship exists between the measures that measure the physical, cognitive and affective development?
- Do male and female students differ on the effects of substance abuse on their physical, cognitive and affective development?

The following null hypotheses were tested:

- (Ho1) The measures measuring affective, cognitive and physical development are not reliable;
- (Ho2) There is no relationship within the measures that measure substance abuse effect on physical, cognitive and affective development; and
- (Ho3) There is no significant difference on the perception of the effect of substance abuse on physical, cognitive and affective development between male and female students.

## LITERATURE REVIEW

### The Effects of Substance Abuse

The effects of substance abuse on the development of students can occur in the following areas:

- Their physical development; and
- Psychological development i.e. cognitive and affective development.

### Effects of substance abuse on students' physical development

Physical development of a person concerns the growth of the body. This entails changes in the proportions between different parts of the body and changes in the internal structure and functioning of the body<sup>14, 15</sup>. Substance abuse has, amongst other, the effects on the physical development of the student. Smoking drugs such as marijuana causes various respiratory problems and diseases such as daily coughing, acute chest illness and risk of lung infections<sup>16, 17</sup>. Furthermore, smoking can aggravate asthma and prevent enough oxygen and nutrients from nourishing the skin, giving rise to bad skin and a disease called psoriasis<sup>18</sup>.

Furthermore, continued smoking causes breakdown of lung tissue and clogging of the air sacs<sup>19</sup>. Based on the aforementioned discussion the researchers infer that student will be less active in sports performance. The student will suffer from increased heartbeat, poor blood circulation and shortness of breath making it difficult for him to engage in activities that students of his age group engage in.

Drug abuse may make the student giddy, stagger, lose balance and will affect his motor co-ordination<sup>17</sup>. Motor dysfunction (especially dysfunction regarding fine motor co-ordination as required for articulation, writing and eye movements) may cause students to experience speaking, writing and reading difficulties<sup>20</sup>. Substance abuse robs the body of essential vitamins and minerals and interferes with the digestion of food<sup>17</sup>.

### **Effects of substance abuse on students' psychological development**

Psychological development refers to the development of mental characteristic or attitude of a person with specific emphasis on those factors affecting behaviour in a given context<sup>21</sup>. Health issues that interfere with good health are heavy drinking, drug use, and stress. The major causes of death among college students are auto accidents and suicides. In a high percentage of cases, alcohol use is involved with both causes of death<sup>22</sup>. Therefore, the psychological development of the student will be discussed by distinguishing between the cognitive and affective aspects.

### **COGNITIVE DEVELOPMENT**

The term cognitive development refers to the continuous and cumulative development of the intellect and has to do with thinking skills, creatively, perception, conceptualization, insight, knowledge, imagination and intuition<sup>20</sup>. It can be inferred that secondary school learners display different characteristics during their cognitive development. The authors believe that these characteristics will also be experienced by university students. The student will have a conscious focus on the world and acquires knowledge of the world in a cognitive and formal manner. They acquire further new skills in calculation of mathematics, physics and also incorporate new concepts in his knowledge structure. Furthermore, the student is expected to remember information and apply the information when solving problems and be able to reproduce it a later stage<sup>15, 23</sup>.

The student can communicate effectively and his vocabulary is large enough to follow teaching. Perceptually, the student can assign meaning to sensation and can recognize, memorize, integrate, differentiate and imagine. The student learns by personal experience and by active participation. His attention span improves and he is able to concentrate for longer periods. The student is capable of devoting himself seriously to his tasks and completing them properly. Furthermore the student is willing, eager and ready to learn<sup>20</sup>.

### **Effects of substance abuse on students' cognitive development**

Substance abuse can affect the cognitive development of the students. This can occur when substance being abused interferes with a good nutrient supply to the brain and may result in brain damage, which is done in a cognitive and formal manner. Excessive alcohol use causes the brain to age prematurely. Brain disorders commonly associated with alcoholism are Weenicke's Syndrome, Koraskoff's Psychosis and Marchiafava's Disease<sup>24</sup>.

The use of addictive substance for example marijuana over a long period of time may impair the memory and problem solving abilities of the student<sup>16</sup>. This has serious consequence on academic achievement as well as appropriate life decisions that a student has to make.

Furthermore, it erodes the self-discipline necessary for learning. The student may experience problems with reading, calculating, writing and incorporating new concepts into his knowledge structure. Ultimately, the student may experience falling grades and may drop out of school<sup>20</sup>.

The student who abuse alcohol finds it more difficult to be cautious and to use good judgment to protect him/herself. They find it more difficult to think clearly because the more they drink, the more slowly their brain works<sup>18</sup>. This in turn can lead to difficulty in reading, calculating and writing skills.

Marijuana smoking may result in the loss of short-term memory and impairs a person's ability to learn and concentrate, which

in turn affects his problem solving abilities and the ability to reproduce information at a later stage. The marijuana user experiences a lack of initiative, motivation and concern about the future<sup>16, 25</sup>.

### **AFFECTIVE DEVELOPMENT**

The affective development is an emotional development concerned with emotions, feelings, passion, moods, sentiments and whims and determines the students' personality<sup>26</sup>. The students emotions are aroused by internal rather than external factors. The student shows a greater understanding for the feelings of others and simultaneously displays a greater degree of empathy and sympathy. They also express, control, suppress or hide emotions according to social rules thus meeting the requirements of his cultural groups, his peer group and his community. The students express aggression (anger, rage, stubbornness) becomes more refined and he/she uses the social skills that he/she has acquired to cope, i.e., communication and co-operation. Anger and rage make him moody and he/she will sometimes tend to use force to solve his/her problems or relieve his frustrations<sup>20</sup>.

Happiness and cheerfulness is expressed within the confines of his peer group to which he constantly strives to be accepted. The student often prefers to gloat at a friend's defeat rather than express happiness outwardly for social reasons. They understand moods and mood changes and the positive and negative feelings with which they leave him. Furthermore the student learns to suppress his emotions leading to stress, depression, feelings of discontent and bad moods. They also learn to rid themselves of unpleasant feelings by having a good cry, doing rigorous exercise or having a good laugh<sup>20</sup>.

### **Effects of substance abuse on students' affective development**

The following are some of the effects that substance abuse may possibly have on the affective development of the students: Alcohol intake can lead one being talkative and friendly or aggressive and angry. It can also alter emotions, movement, vision and hearing. In addition to this it can make people do embarrassing things like throwing up or urinating on themselves<sup>27</sup>.

Furthermore, alcohol intake causes a student to become more angry and stubborn or get into a rage without much provocation. The student has not learnt to express control, suppress or hide his emotions in line with expectation of his peer group, his cultural group and his community. Substance abuse can weaken a person's inhibitions, dull the common sense, brings out sexually aggressive behaviour and make the student more egocentric<sup>28</sup>.

Students sometimes attempt to hide feelings and emotions by abusing substances. The "high" that the substance abuser experiences can be a very happy or "spaced out" feeling or a feeling that he has special powers like the ability to fly or get rid of all his problems<sup>29</sup>. Since substance abuse has interfered with the students' ability to suppress his emotions, the student may display anger, rage, stubbornness and jealousy in an open and less refined manner<sup>20</sup>.

Marijuana use has been noted for blunting emotions and for making the student paranoid. The student will most probably end up becoming suspicious and fearful of the people around him causing him to bed-wet, stammer, boast, be anxious or engage in noisy behaviour, which are symptoms of suppressed fear<sup>30</sup>. Jealousy may be displayed by anger, rage and the use of force rather than by teasing, lying and bullying.

Substance abuse and addiction may cause stress and anxiety, which in turn may cause the user to increase the substance dosage to cope with the situation. When this fails, the individual may suffer from uncontrolled depression and may commit suicide<sup>28</sup>. Once the student becomes psychologically dependent on drugs and alcohol they find it difficult to stop with 90% experiencing some degree of relapse<sup>24</sup>. Even if the student wishes to stop they will not know how to because they have relied on the substance to resolve problems and escape from the reality. The student may become less co-operative, less friendly and less sensitive to others who may want to assist him.

## RESEARCH METHODOLOGY

The research philosophy of the study was positivism adopting a deductive approach. Based on the research philosophy and approach adopted in this study the review led to the identification 23 items measuring three constructs i.e. physical, cognitive and affective depicting the effect of substance abuse on students. The use of structured questionnaire survey in an in-depth exploration of the constructs underlying the subject matter of the research was used.

A survey can be described as a quantitative or numeric description of some fraction of the population – the sample, which enables researchers to generalize their findings from a sample of respondents to a population within the limitations of the sampling method<sup>31</sup>.

A purposive sample was used where the researchers selected sample members to conform to some or other criterion in this case university students. The respondents were reading for the qualifications on Baccalaureus Technologiae (BTech) Civil Engineering, Construction Management or Quantity Surveying programs. Furthermore, those who were reading for National Diploma in Civil Engineering and Building were also included. A total of 199 usable questionnaires were gathered of which 51 were reading for National Diploma in Civil Engineering, 137 pursuing National Diploma in Building and 11 were reading for BTech in Construction Management, Quantity Surveying and Civil Engineering. This sample size was sufficient to meet the statistical test requirements for group statistical testing. As part of the delimitation of this research, few respondents reading for BTech in quantity surveying, civil and construction management did not complete the questionnaire. This limits the generalization of the sample.

Purposive sampling is a non-probability method of sampling it is impossible to evaluate the extent to which such samples are representative of the relevant population<sup>32</sup>. In some respects purposive sampling gives the research qualities of a case study<sup>31</sup>. These problems with generalizing from the sample to the whole population of built environment and civil engineering students are limitations of the research design and fully acknowledged in this research.

The questionnaire surveys were administered under controlled lecture room conditions to ensure the standardization of data gathering, to decrease non-response errors and to increase response rates<sup>33</sup>. The data was gathered using self-administered questionnaires<sup>34</sup>. Furthermore, as the questionnaires were completed anonymously, the collection of the data and the presentation of this report cannot harm the respondents or their organization in any way.

The structured questions were analyzed using the Statistical Package for the Social Sciences (SPSS) version 21. This resulted in the computation of frequencies, parametric statistics in the form of independent sample t-test to test the hypotheses of gender perception on the effects of substance abuse. The mean scores of the male and female students in the t-test were interpreted using the bands; strongly disagree (1.00-1.80); disagree (1.81-2.60); uncertain (2.61-3.40); agree 3.41-4.20; and strongly agree 4.21-5.00.

The reliability for internal consistency of the constructs of physical, cognitive and affective development was determined using Cronbach's alpha test<sup>33</sup>. A cut-off value of 0.70 and above is deemed as sufficient in achieving internal consistency of a construct<sup>35</sup>. This cut-off value was adopted for this present study.

## RESULTS AND DISCUSSIONS

The demographic result indicates that majority, i.e. slightly over 61% of students were male and 38 % were female. This is an indication that gender transformation is taking place in the faculty of the built environment and engineering. It can be indicated that this particular university is adhering to the South Africa government policy of allowing female to pursue built environment and engineering qualification. Furthermore majority of the students were Blacks (92.0%), Whites (5.0%), Indians (1.5%) and Coloureds (1.5%). As per the qualification 25.6% of the students were pursuing National Diploma in Civil Engineering, 68.8% pursuing National Diploma in Building and 5.5% were reading for Baccalaureus Technologiae (BTech) in Construction Management, BTech Quantity Surveying and BTech Civil Engineering. The result also suggests that slightly over 40 percent of students in this university are not aware of the substance abuse policy in the university. This might be the reason why students are abusing substance in the campus.

The results in Table 1 indicate the reliability of the effects of substance abuse. The results found that the measures of physical development were reliable, as the group Cronbach alpha was greater than 0.70 at 0.86. The result also found that cognitive and affective development measures were reliable as the Cronbach alpha was above 0.70 as advocated by Hair et al.,<sup>35</sup>. The Cronbach alpha was 0.91 and 0.92 respectively. These results do not support the null hypothesis (H1).

Table 1 Reliability statistics of the substance abuse factors

Variables	Cronbach alpha	Cronbach alpha based on standardized measures	Number of measures
Physical development	0.864	0.866	6
Cognitive development	0.913	0.914	8
Affective development	0.920	0.920	9

It is ideal to analyze and report the mean inter-item correlation when the measures of each construct is less than 10 items<sup>36</sup>. The physical, cognitive and affective development measures had less than 10 items. The result in Table 2 suggests that physical development attained mean inter-item correlation value of 0.513 with values ranging from 0.348 to 0.661. This indicates a strong relationship between the measures measuring physical development. Cognitive development attained mean inter-item correlation value of 0.57 with values ranging from 0.413 to 0.703. This indicates a strong relationship between the measures measuring physical development. Lastly affective development attained mean inter-item correlation value of 0.562 with values ranging from 0.364 to 0.744. This indicates a strong relationship between the measures measuring physical development. The null hypothesis (H2) is not accepted.

The result in Table 3 indicates that the physical development construct was measured using six items. The measures were reliable and can be reused in other similar studies. A t-test was therefore conducted to compare the physical development scores of male and female students. There was significant difference in scores for male students ( $M=3.18$ ,  $SD=1.05$ ) and female students ( $M=3.52$ ,  $SD=1.07$ ,  $t(169)=2.00$ ,  $p=0.05$ , two tailed). Therefore, rejecting the null hypothesis (H3) stated. Male students were highly uncertain than female students on the effect of substance abuse on their physical development. Female students agreed that substance abuse affects their physical development. The groups mean score was 3.52 for female students and 3.18 for male students. In relation to this finding male students might be in denial that substance abuse affects their physical development.

**Table 2** Mean inter-item correlation for substance abuse factors

Variable	Mean	Minimum	Maximum	Range	Maximum/minimum	Variance	Number of measure
Physical development	0.518	0.348	0.661	0.312	1.898	0.005	6
Cognitive development	0.570	0.413	0.703	0.290	1.702	0.005	8
Affective development	0.562	0.364	0.744	0.381	2.046	0.008	9

The result in Table 3 further indicates that the cognitive development was measured using eight items. The measures (items) for cognitive development are reliable and hence reused in other similar studies. Furthermore, an independent sample t-test was conducted to compare the cognitive development scores of female and male students. There was no significant difference in the mean scores of female students ( $M=3.48$ ,  $SD=1.02$ ) and male students ( $M=3.20$ ,  $SD=0.98$ ;  $t(165)=1.78$ ,  $p=0.08$ , two tailed) as the p-value was greater than 0.05. Therefore, accepting the null hypothesis (H3) stated. This is an indication that the effect of substance abuse on cognitive development of the students was not different. However, the groups mean score for female and male students was 3.48 and 3.20 respectively. These mean scores suggest that the female students agreed that substance abuse had an effect on cognitive development, whereas male students were uncertain. Male students need to be more informed of the effects of substance abuse on their cognitive development.

Finally, the result in Table 3 indicates that the affective development construct was measured using nine items. The measures (items) for affective development are reliable and can be reused in other similar studies. An independent sample t-test was conducted to compare the affective development scores of male and female students. There was significant difference in scores for female students ( $M=3.25$ ,  $SD=1.02$ ) and male students ( $M=2.92$ ,  $SD=0.99$ ;  $t(165)=2.06$ ,  $p=0.04$ , two tailed). Therefore, rejecting the null hypothesis (H3) stated and accepting the alternative hypothesis. However, both female and male students were uncertain on the effect of substance abuse on the affective development of students abusing substance. These finding suggests that both male and female students should be informed of the effects of substance abuse on their affective development.

**Table 3** T-test of gender on the physical, cognitive and affective development

Variable	Items	Levene test of equality of variances	t-value	Sig.(p)
Physical development	6	0.68	2.00	0.05
Cognitive development	8	0.88	1.78	0.08
Affective development	9	0.81	2.06	0.04

## CONCLUSIONS

The research established that measures for physical, cognitive and affective development were reliable and had strong relationship. Female students perceived that substance abuse affected their physical and cognitive development. However, male students were uncertain of the effects of substance abuse on their physical and cognitive development. Both male and female students were uncertain in relation to the effects of substance abuse on their affective development. It is interesting to note that despite the uncertainty male students were less uncertain than the female students.

It is recommended that the scale of physical, cognitive and affective development can be used in future studies that will include all the universities in South Africa in the department of construction management and quantity surveying. These scales are reliable and the measures have strong relationship. The researchers further recommend that this university and others in South Africa should develop a policy to inform students of the dangers of substance abuse on their affective, physical and cognitive development. If the university has already developed the policy they should always remind students of the dangers of substance abuse on their affective, physical and cognitive development.

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# SUSTAINABILITY AND EDUCATION: TOWARDS IMPROVING ENERGY EFFICIENCY IN BUILDINGS THROUGH HIGHER EDUCATION

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## PURPOSE:

**This paper examines the critical relationship between higher education and sustainability, particularly energy efficiency, through the investigation of the challenges for relevant undergraduate programmes at the University of KwaZulu-Natal (South Africa) in preparing future design team members to implement energy efficiency requirements in buildings.**

## ABSTRACT

### Purpose

This paper examines the critical relationship between higher education and sustainability, particularly energy efficiency, through the investigation of the challenges for relevant undergraduate programmes at the University of KwaZulu-Natal (South Africa) in preparing future design team members to implement energy efficiency requirements in buildings.

### Design/methodology/approach

A mixed method design was adopted. Questionnaire-based surveys were used to investigate the perception of built environment professionals and academics. Semi-structured interviews with Programme Coordinators expanded on the results and strengthened their interpretation.

### Research limitations

The context of the investigation was limited to the Province of KwaZulu-Natal in South Africa, and particularly to the relevant undergraduate curricula at the University of KwaZulu-Natal with regard to the academic environment.

### Findings

The findings showed that professionals believed that a more in-depth focus of undergraduate education on sustainability and energy efficiency in buildings would be beneficial for their practice. Certain programmes faced challenges in embedding these aspects into their curricula, especially due to a lack of awareness as well as programme constraints.

### Practical Implications

The outcomes of this study could aid in reviewing and developing undergraduate curricula on building design and construction in South Africa in order to face, more effectively, the contemporary challenge for a sustainable built environment.

### Value

Advanced competencies and behavioural changes are necessary steps to ensure a sustainable future. The role of education in sustainability is critical towards this aim.

### Keywords

Sustainability Education, Energy Efficiency in Buildings, Higher Education.

## INTRODUCTION

Regulations and strategic objectives within the building industry have evolved significantly over the past decade with regard to recent sustainability and energy efficiency requirements <sup>1</sup>. In developing countries, creating a sustainable built environment requires a different and more sensitive approach from that taken by developed nations <sup>2</sup>. Also, recent research highlighted the need for a more holistic and human-centred approach to energy studies <sup>3</sup>, which looks at the human and social dimension of energy challenges and not only at their technical paradigm.

Together with the increasing awareness of the sustainability issues, the need for education towards the sustainable development is becoming more evident<sup>4</sup>. Competencies and behavioural changes towards sustainability should be firstly acquired through education. Higher education, in particular, plays a key role in preparing future built environment professionals to implement sustainability and energy efficiency requirements in buildings and to embrace the challenge of leading the construction industry towards sustainability targets and resource efficiency principles. Previous studies <sup>5</sup> highlighted the need for sustainable design to become a priority in higher

education curricula to achieve this aim. Also, the results of a report of the United States National Council for Science and the Environment marked the very limited information about the status of sustainability education and practice in any nation. Reasons were primarily related to the lack of surveys across building technology degrees <sup>6</sup>.

South Africa has recently addressed the challenge for a sustainable built environment through the implementation of energy efficient principles for buildings. The national regulation on energy usage in buildings came into effect in late 2011 (SANS 10400-XA). In order for the country and the construction industry to advance towards a more sustainable future, proper education of built environment professionals in energy efficiency is therefore required. Previous studies identified the lack of capacity of the construction sector to implement sustainable practices as a major barrier to sustainable construction in developing countries <sup>7</sup>. In South Africa, this possible gap is emphasized by the local limited research production about green building. The Province of KwaZulu-Natal, in particular, has few certified green buildings, corroborating the limited local experience in the design, construction and relevant training oriented to create a green and energy efficient built environment.

The rationale of this paper is therefore to address the issue of education as a possible barrier to implementing energy efficient principles in buildings in the context of a developing country such as South Africa, with a specific focus on the Province of KwaZulu-Natal. The study aimed at investigating whether the undergraduate curricula at the University of KwaZulu-Natal (UKZN) focusing on building design and construction prepare future members of the design team to adequately implement the new energetic requirements in buildings in KwaZulu-Natal. The main related objectives included: to investigate the design team professionals' perception of the level of undergraduate education on the topic of energy efficiency in buildings; to find possible gaps and identify relevant causes with regard to the integration of energy efficiency within relevant UKZN curricula; to provide recommendations of improving education on this topic.

The study adopted a mixed approach. A survey based on an online questionnaire was conducted amongst built environment professionals located in KwaZulu-Natal. On the basis of the results, a second survey was conducted amongst academics of the main UKZN programmes related to building design and construction (Architecture, Mechanical Engineering, Property Development and Housing). Semi-structured interviews with Programme Coordinators aided in investigating the problem on a deeper level and helped strengthen the interpretation of findings.

The following section provides a critical review of the literature on the topic of education for green and energy efficient buildings. Then the methodology is explained in detail, followed by the presentation and discussion of the main results. Finally, conclusions and recommendations are proposed based on the main findings.

### **The key role of education for improving energy efficiency and sustainability in the built environment**

The Green Building Council of South Africa defines a green building as a building that:

*"incorporates design, construction and operational practices that significantly reduce or eliminate its negative impact on the environment and its occupants"* <sup>8</sup>.

Building green therefore is:

*"an opportunity to use resources efficiently while creating healthier environments for people to live and work in"* <sup>8</sup>.

Energy efficiency, resource efficiency and environmental responsiveness are therefore core components of green buildings. In particular, improving the energy efficiency of the built environment is a critical step towards a more sustainable development, because buildings globally represent the largest energy-consuming sector in the economy. In 2010, the building sector accounted for 35% of final energy consumption and about 50% of final electricity consumption <sup>9</sup>.

Energy efficiency is primarily achieved by introducing energy saving measures when buildings are designed and built. With the current best practices in green building design, it was observed that in South Africa energy efficiency savings of around 40% to 50% could be obtained in new buildings in the commercial sector and around 30% to 40% in the residential sector <sup>10</sup>. However, the implementation of the measures for designing and constructing energy efficient buildings requires specific competencies from the stakeholders responsible for the relevant phases of the construction process, particularly the design team.

Previous studies observed that the development and operation of such buildings are complex tasks which require the combined effort of architectural and engineering designers with different skills in the development of the projects, and also the participation of building operators capable of maintaining the building in its best energy performance behaviour <sup>11</sup>. Also, the contemporary challenges related to the sustainability of the built environment must be addressed by multiple perspectives, including various and conflicting viewpoints <sup>11</sup> which require a more holistic and integrated approach to construction, greater sensibility to sustainability issues, strong critical thinking and problem solving. This principle was applied in this study by looking at different perspectives of the problem and by engaging with various stakeholders involved in the process of improving and applying energy efficiency in buildings, from the learning process through education to the practical application through the professional practice in the built environment.

One of the major barriers to sustainable construction was identified to be the lack of capacity of the construction sector and relevant stakeholders to implement sustainable practices <sup>7</sup>. Therefore, it is evident that education plays a key role towards the transition to a more energy efficient built environment. A previous study observed that :

*"a lot of today's world vices can be eliminated if certain targeted modules and adapted curricula are introduced in the schooling system. One of these vices is energy squandering with all its negative consequences for the planet"* <sup>12</sup>.

Also, looking at energy efficiency and sustainability targets might strengthen the role of education from a "social reform perspective" <sup>13</sup> aimed at learning that could promote a better society and contribute to more environmentally and socially responsible citizens.

South Africa has committed to foster the country to improve energy efficiency through "awareness campaigns, demonstration programmes, audits and education" <sup>14</sup>. It is acknowledged that furthering the education of scholars and professionals would lead to an increase in the number of qualified professionals for the design, construction and management of green buildings, which in turn would lead to an improvement of the energetic quality of the built environment.

Before 2011 South Africa had no mandatory regulations

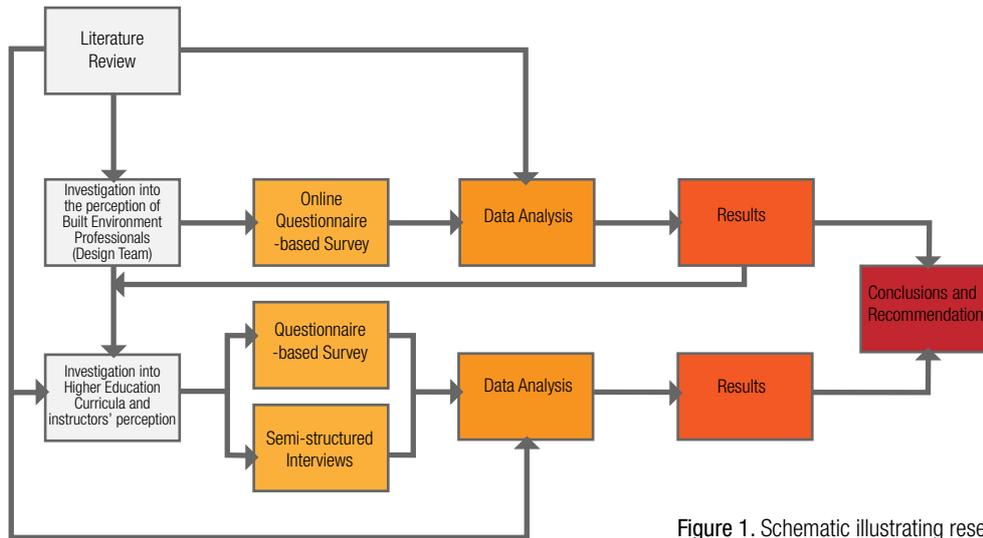


Figure 1. Schematic illustrating research design and methods

governing the use of energy in buildings. The regulation on energy usage in buildings came into effect in late 2011 as the first part of the environmental sustainability section of the National Building Regulations. SANS 10400-XA provides deemed-to-satisfy requirements for compliance with part XA (Energy Usage in Buildings) of the National Building Regulations<sup>15</sup>. The other regulation on energy efficiency in buildings, SANS 204<sup>16</sup>, is currently a voluntary standard, but under certain conditions and approaches is complementary to SANS 10400-XA for the compliance with specific requirements (e.g. fenestration design if the prescriptive route is followed). SANS 204 standard is more comprehensive than SANS 10400-XA and generally the requirements are more stringent. For this reason, SANS 204 standard is used as basic minimum within the Energy category for the certification of green buildings through the Green Star South Africa rating system adopted by the Green Building Council of South Africa. Both SANS 10400-XA and SANS 204 aim to reduce the energy consumption of buildings. The key sections affecting the use of energy in buildings in accordance with the mentioned standards are site and building orientation, building design with specific regard to the building envelope, relevant materials and assemblies, and building services.

Since the topic of energy efficiency in buildings has been addressed in South Africa only recently and the standards are relatively new, it is likely a challenge for higher education curricula in building design and construction addressing the required topics on energy efficiency requirements for buildings. On the other hand, the issue of education as a barrier to implementing energy efficient strategies should be addressed as one of the first targets in the process of implementing sustainable practices in the South African context.

The inclusion of principles of sustainability and energy efficiency in higher education curricula has been proved by several studies to be challenging and not without barriers for academic systems<sup>17,18,19</sup>. Previous research highlighted that curricula were extremely crowded to consider the inclusion of additional modules and there was little institutional motivation and dedication to the work that goes into reviewing the curricula. These new topics furthermore required additional knowledge and skills development from academics<sup>20</sup>. Other studies observed that educational institutions had unsuccessfully communicated a thorough analysis of sustainability and were ignoring the more holistic aspects of the topic, concluding that these information gaps proceeded to create and give rise to an increase of infrastructure problems and perceived obstacles to sustainable development<sup>21</sup>. Some researchers outlined possible ways of overcoming these barriers in higher education. For example,

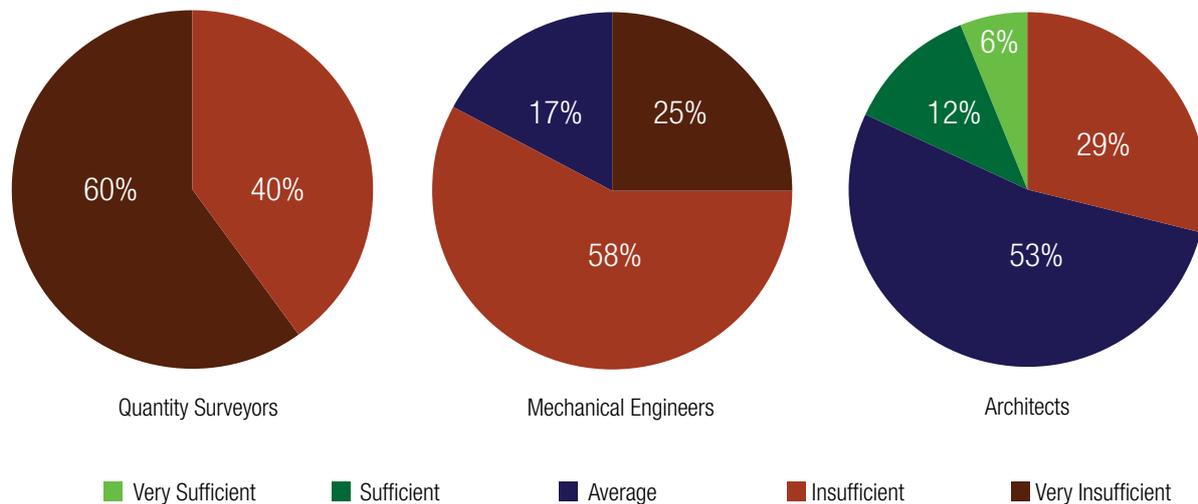
cooperation and backing from university leadership, protection of lasting monetary resources, advancement of suitable managerial capabilities and the integration of courses in sustainability and energy efficiency in present curricula were observed to be important aspects for the short and long-term ecological advancement of disciplines<sup>19</sup>.

In the light of the critical role of education for energy efficiency and sustainability and the possible barriers to its implementation in higher education curricula, this paper provides a contribution to this debate by investigating the topic in the South African province of KwaZulu-Natal, and particularly by looking at the undergraduate curricula offered by the higher education institution with the highest enrolment for contact learning, namely the University of KwaZulu-Natal. The focus on the Province of KwaZulu-Natal is justified by the consideration of the local embryonic development of green construction. Despite being the second most populated province of South Africa, KwaZulu-Natal counts only 12 out of the 99 Green Star South Africa certified projects of new buildings in the country<sup>22</sup>. Since some of these projects relate to the different types of certification (design and as-built) for the same building, the figures reduce to 9 certified buildings in the province. These data make evident the need in this province for skilled professionals and supporting education in sustainability that can improve the environmental and energetic quality of the local built environment.

## RESEARCH APPROACH AND METHODS

The objectives of the study were pursued through a mixed design method, combining qualitative and quantitative research. The combination of both approaches has in fact the potential to intensify the in-depth understanding of the problem<sup>23</sup>, particularly for a transdisciplinary topic such as the sensitive relationship between sustainability and education. Qualitative research is dynamic and interactive in nature, and was favoured as main approach while collecting data in order to emphasise personal experiences and descriptions of participants<sup>24</sup>.

This approach also follows the recommendations provided by previous research, which highlighted the need for more studies investigating the social dimension of energy-related problems on the basis of a human-centred approach<sup>3</sup>. The quantitative approach was adopted through questionnaire-based surveys and to quantify the results from investigative research (surveys and interviews). This aided in analysing and interpreting the results and drawing conclusions. Figure 1 shows a schematic illustrating the research process and relevant methods adopted for this study.



**Figure 2.** Opinions of professionals on the level of undergraduate education to effectively implement energy efficient strategies and comply with the requirements of the new regulation (percentages indicate the percentages of respondents for each group of professionals)

The data was collected primarily through desktop studies, questionnaires and interviews. A comprehensive literature review was conducted investigating the required knowledge and skills to implement energy efficiency in buildings, and possible gaps in higher education identified in other parts of the world. This information was used to design the main research tools in the form of survey questionnaires and semi-structured interviews.

Two surveys were then conducted. An online survey questionnaire was created and submitted to a sample of design firms and in particular to their current practicing design teams. The research sample was selected through purposive sampling oriented to focus on a group of professionals that was most likely to provide significant and appropriate data in terms of relevance and depth in the local context investigated<sup>25</sup>. Within the selected group of professionals of the built environment, a cluster random sample of fifteen Architectural firms, fifteen Mechanical Engineering firms and five Quantity Surveying firms was selected within the KwaZulu-Natal area as a minimum sample size requirement. The questionnaire contained mainly multiple choice and declarative questions aimed at investigating the professionals' perception of the importance of the topic of energy efficiency in buildings and related regulation within their common practice, their perception of the standard of their undergraduate tertiary education in this topic, with regard to UKZN graduates, and their opinion about the importance of integrating this topic within university curricula.

The results of this first survey were quantified by means of graphs and tables and were used as a preamble to the following phases of the research, as they reinforced the problem statement that gave reasons to the study. The subsequent step of the research involved the selection of Programme Coordinators and lecturers in undergraduate curricula of Architecture, Housing, Mechanical Engineering and Property Development at UKZN, through purposive sampling on the basis of the relevance of the topic of energy efficiency in buildings to their curriculum and related specific modules. A survey questionnaire was created based on the findings of the literature review and the previous phase of the research, using a combination of open, dichotomous, multiple-choice and declarative questions, and submitted to the lecturers of relevant subjects. A similar survey method was successfully conducted by other researchers in Australian engineering curricula<sup>6</sup>.

The questionnaire aimed primarily to gain insight about the relation of the modules with and their coverage of the topic of energy efficiency in buildings and related new SANS regulation, and to understand the effort from academics and the Institution into reviewing and developing the curricula to support education in such a sensitive topic. The outcomes were interpreted and compared to the findings from the literature, in order to find possible gaps. The quality of the information and data gained was enriched through face-to-face semi-structured interviews, mainly based on open ended questions, conducted with the Programme Coordinators of the above mentioned relevant programmes. The aim was to gain an in-depth understanding of the problem from a leadership and coordination perspective in the various curricula, investigate possible causes for the gaps emerged and outline potential solutions.

Finally, on the basis of the findings of the previous phases and the review of the literature in the international context, conclusions and recommendations for possible ways of improving higher education in energy efficiency in buildings in KwaZulu-Natal were proposed.

Ethical aspects were carefully treated while conducting the research. The participants were previously informed about the nature and the aim of the study, the contents of the surveys and interviews through an informed consent form. The participation in the study was on a voluntary basis and the responses were kept confidential and disclosed as group data.

## RESULTS AND DISCUSSION

### Survey of Design Team Professionals

The first phase of the study focused on investigating the perception of Built Environment professionals of the design team. This phase supported the research by reinforcing the hypothesis that professionals need an improved higher education to effectively implement energy efficiency and green strategies in the building industry. Furthermore, the survey helped assess the areas of higher education that were considered to be lacking and indicated whether or not the respondents furthered their education in energy efficiency and how. The graduation year of the respondents helped to understand the relevance to the

group of professionals who has been most likely to be affected by past recent or current education system.

Within the 35 firms selected to which the questionnaire was sent, 55 professionals responded. Only the UKZN graduates were selected, reducing the sample to 41 individuals (17 Architects, 15 Mechanical Engineers and 9 Quantity Surveyors), of whom 59% graduated after 2006. Therefore, a large portion of the participants have developed their professional expertise in a period when sustainability and energy efficiency had already become global issues for the contemporary society.

The majority of the respondents declared that they were dealing in their practice with energy efficiency requirements in accordance with SANS 10400-XA and SANS 204 regulations (88% of Architects, 80% of Mechanical Engineers and 89% of Quantity Surveyors). However, their understanding of the subject was relatively lacking: apart from Architects, who mostly declared a sound understanding of the topic, most Mechanical Engineers and Quantity Surveyors declared to have an understanding between average (53% and 67% respectively), poor (27% and 22% respectively) and very poor (11% of Quantity Surveyors).

Results also indicated that, although most participants declared that they had learnt about green buildings and energy efficient strategies during their undergraduate degree, most of them described the level of the education as inadequate (figure 2) to effectively implement the strategies and comply with the requirements of the new regulation (53% of Architects and 17% of Mechanical Engineers declared “average”; 29% of Architects, 58% of Mechanical Engineers and 40% of Quantity Surveyors stated “insufficient”; 60% of Quantity Surveyors and 25% of Mechanical Engineers declared “very insufficient”).

It was found that most of the professionals who declared that they were not taught these topics (only Mechanical Engineers and Quantity Surveyors) did not further their education on the subject after graduation. This might be seen as a misstep and a hindrance to implementing the energy efficient strategies in building projects. Considering the relevance and critical importance of these topics for the contemporary society and the future of the built environment, Professional Councils should be proactive in promoting compulsory Continuing Professional Development training on this area.

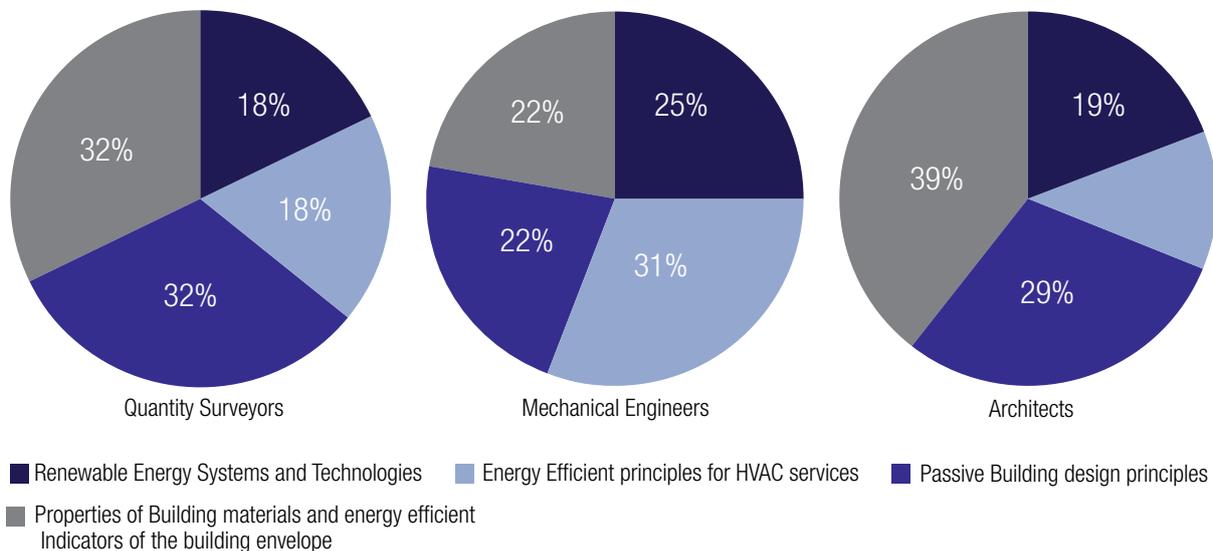


Figure 3. Main topics not addressed within undergraduate curricula according to the perception of the professionals participating in the study

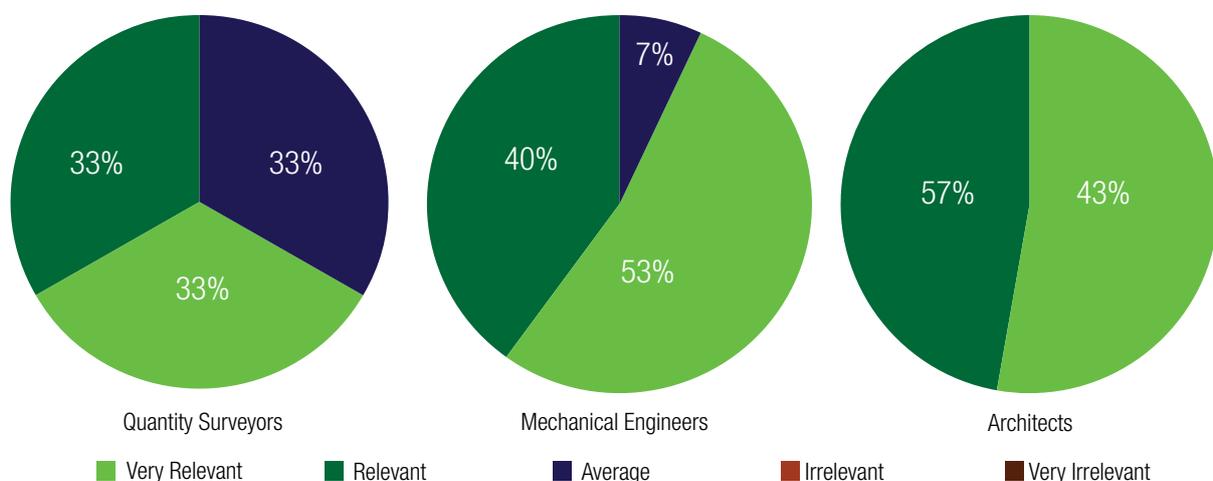


Figure 4. Opinions of professionals on the importance of the inclusion of green building topics in undergraduate curricula (percentages indicate the percentages of respondents for each group of professionals)

With regards to the subject matter within higher education curricula, the topic concerning the properties of building materials and the energy performance indicators of the building envelope seemed to be the most lacking amongst the three disciplines investigated (figure 3). The survey also showed that all the respondents believed that the inclusion of the topics of green building and energy efficiency are rather significant in the preparation of design professionals for industry and that suitable learning on these topics should be provided in undergraduate curricula of higher education (figure 4).

Also, two thirds of the respondents supported that specialist postgraduate courses on green building topics should be offered by the institution, but as consolidation of previous general understanding provided by undergraduate courses.

### Survey of higher education curricula and instructors

The results of the first survey informed the subsequent phase of the research which looked in detail at the UKZN curricula. A second survey was conducted to establish whether the UKZN courses focusing on building design and construction were addressing the topics of energy efficiency related to the SANS 10400-XA and SANS 204 requirements and to determine what lecturers believed can be done to improve the embedding of these topics into relevant UKZN curricula. Following the purposive sampling method described in the methodology, 22 questionnaires were eventually submitted, of which 15 completed were received (response rate of 68%) and used for the data analysis.

The education in energy efficiency in buildings seemed to be taught mostly at third year level during the undergraduate programmes. This suggested that the topic requires a certain level of maturity that follows the foundational concepts taught in first and second year. Compulsory courses on Building Science in Architecture and elective courses within the Mechanical Engineering discipline seemed to be the most focused on the topic. However, compulsory courses would likely better prepare students for implementing energy efficient design and construction principles in buildings during their employment after graduation.

The majority of the courses (53%) had only been offered for a period of 5-10 years and 74% the courses had renewed their curriculum in the last five years. This could mean that these courses, related to buildings and energy efficiency, have been taught at UKZN as a component of recent curricula advancement as result of changing legislation, new technologies, adaption to the continuously evolving dynamics of the industry<sup>26</sup>, and transition towards the new "Learning Paradigm"<sup>27</sup> for higher education which has affected the educational strategies of the University in the last decade. This new paradigm is related to the evolution of the function of universities from institutions for teaching to institutions for learning, which includes both teaching and research<sup>28</sup>. Consequently, greater emphasis might have been given to topics which are also important for the advancement of research in the disciplines.

The delay in the implementation of the legislation on energy efficiency and the recent nature of the topic in South Africa could be a cause for the lack of students understanding of the relevance and importance of energy efficiency in buildings. Lecturers emphasised that awareness is key amongst students within the discipline. It was apparent that many of the courses (73%) dealt, to a greater or less extent, with aspects of SANS 10400-XA regulation. However, just half of the lecturers believed that their course dealt with practical aspects that help students implement energy efficient strategies in buildings

as professionals. For around 40% of the courses that were investigated, energy efficiency in buildings was viewed as a "minor component" (<5% of the overall content) of the module. The extent of the education in energy efficiency in buildings within the surveyed sample seemed to be lacking and many of the concepts and principles were not addressed in detail.

With regard to the social aspects of sustainability and energy efficiency, and relevant role of education for producing more socially and environmentally responsible citizens<sup>13</sup>, the degree to which the surveyed courses were lacking in education on the awareness of energy efficiency in buildings, relevant roles and responsibilities and its value for the society was even greater (only 18% of the courses covered these aspects in detail). Required and optional readings on energy efficiency in buildings were generally not a favoured approach used by instructors (almost half of the modules did not have required readings and 87% did not have optional readings on this topic). Most lecturers (80%) believed that their courses cover the topic sufficiently and those who did not, indicated that improvement can be made in areas of fundamental principles and base theory, information and application of theory. Heads of school seemed to be playing a part from lecturers' perspective in encouraging the inclusion of the topic. However, the university's dedication was found to be "average" in their opinion in terms of depth and level of commitment to the integration of these sensitive topics in education.

### Interviews with Programme Coordinators

The interviews with the Programme Coordinators of the investigated disciplines provided a more in-depth understanding of the opinion and the perception on the problem of expert academics with capacity of leadership and coordination. The results of the interviews suggested that a main concern amongst all areas of interview topics was "awareness" amongst academics. A minority of the Programme Coordinators believed this topic was more of a bonus topic than a necessary core component. Curricula shortfalls were generally believed to be a combination of issues relating to programme structure, funding, awareness and lack of research.

The majority of interviewees reinforced the idea that the undergraduate degree is responsible for adequately preparing students to implement energy efficient strategies and principles in buildings after graduation. However, there was mention that only a basic level should be addressed in the undergraduate degree.

Programme Coordinators showed to be open to improvement should opportunities and infrastructural support come along to develop their curricula. The biggest change that interviewees believed UKZN could become involved with is the education of allied disciplines on the topic of energy efficiency in buildings. This could require large scale programme curriculum review which might be costly and a demanding process, as well as specific training of academics on this field. Lecturers' opinions on improvement from their side were increasing awareness and dedicated annual renewal of course material. These small changes were considered doable for lecturers and could greatly improve course content over the years. International methods of improvement reported in the literature<sup>6</sup>, including case study development, frequent auditing and awareness raising, were generally considered adaptable to the UKZN context. According to a list of possible resources gained from the investigation of the literature, which could be used to further develop education in energy efficiency, Programme Coordinators rated "special guest lecturers" as the most effective method, followed by the provision of specific readings, case studies and notes (Table 1). This may suggest that Programme Coordinators

**Table 1:** Possible complementary resources to foster higher education in energy efficiency in buildings, according to the opinions of Programme Coordinators (lowest scores indicate the resources that were considered the most effective)

Resource	Overall Score
A set of case studies on energy efficiency examples in engineering/architecture	4
List of related documentaries/TV episodes etc. and their sources	7
A list of key energy efficiency textbooks and references for engineer/architects	8
A customised set of readings on energy efficiency for engineers/architects generally	4
Lecture notes on key energy efficiency issues and solutions for engineers/architects	4
A set of mini-lectures ( i.e. lecture guides and study materials) on various energy efficiency topics.	5
Special guest/expert lectures on energy efficiency	3
Lecture notes on energy efficiency opportunities, specifically by technology	5
A customised set of readings on energy efficiency, relevant to BE and engineering discipline/s	5
Lecture notes on energy efficiency opportunities, specifically by sector.	7

are open to outside expertise and are willing to utilise their knowledge to improve learning on these topics at UKZN.

## CONCLUSIONS AND RECOMMENDATIONS

This study aimed to investigate the barriers and challenges in relevant undergraduate higher education curricula to adequately prepare future professionals of the built environment to implement energy efficiency requirements in buildings in KwaZulu-Natal, particularly in relation to the new South African legislative framework. Two surveys were conducted to analyse the problem from multiple perspectives of the various stakeholders involved in the process of improving the energetic quality and the sustainability of the built environment, firstly into the professions relative to the design team and subsequently into the academic environment and relevant curricula at the University of KwaZulu-Natal.

Professionals of the built environment revealed that their level of understanding of the topic is quite average amongst Mechanical Engineers and Quantity Surveyors. Architects reported to have a better understanding amongst the professions, probably since they are forthwith obliged to deal with these aspects to obtain approval of their projects from local Councils. However, although the professionals generally observed they have touched on these topics during their undergraduate studies, their perception was that the topics on energy efficiency were not covered in sufficient detail for an effective practical application in their profession. One of the possible reasons might be related to the recent new regulation for the South African context, whose effects on the building industry need time to be fully understood and to be consequently integrated within higher education. However, a more in-depth learning of some core concepts of energy efficiency in buildings (e.g. thermal properties of construction materials, energy performance parameters for building elements and particularly for the building envelope, energy efficient principles for HVAC services) emerged as critical gaps that professionals would need from undergraduate tertiary education.

The survey conducted within the academic environment revealed that there is room for curricula improvement within the analysed disciplines to foster learning on sustainability and energy efficiency in buildings, in order to produce high-skilled

and internationally competitive professionals on these topics, and more environmentally and socially responsible citizens promoting a real sustainable development of the South African built environment. In particular, general awareness amongst students and academics on the importance of these topics for the future of the country and a more in-depth equipment of learners with practical skills to effectively implement energy efficient strategies in buildings as professionals should be promoted, as well as greater emphasis of these topics within the content of undergraduate curricula. A greater institutional commitment towards the integration of these sensitive topics into education might increase general awareness and help provide strategic measures for improvement.

Rigid structure of programmes, demanding process for curriculum review and development, lack of research on this topic also emerged as possible other barriers to fostering education in this field. An overall belief of low funding from the university was apparent which, if available, could permit the hiring of experts and the training of academics on energy efficiency and sustainability to improve education and curricula.

On the whole, it was established that there are challenges faced by the undergraduate programmes to adequately prepare professionals to implement energy efficiency requirements in buildings. Possible solutions deriving from the investigation within the academic environment were identified in the gradual and continuous curriculum review, special guest lecturing, information and awareness raising campaigns, supporting specialised learning material as notes and case studies. However, it is a firm belief of the authors that sustainability and energy efficiency should not be addressed only as supplementary topics, but the core subjects in the disciplines related to building design and construction should necessarily incorporate the contemporary requirements for sustainability and energy efficiency, and investigate how these requirements affect the evolution of the subject itself. In line with this vision, curricula should be holistically reviewed to embrace the challenge of developing high professionalism able to ensure a more sustainable future.

Also, a closer discussion between the academic environment and professional councils about the topic of energy efficiency in buildings and the sustainability of the built environment could

improve the curriculum development in the light of the shortfalls highlighted by the professionals. Promoting this discussion would have positive impacts both on academia and industry, on academia and industry, on the South African society and on the development of the South African environment towards principles of sustainability.

## ACKNOWLEDGMENTS

The authors would like to thank all the firms, instructors and Programme Coordinators at UKZN that participated in the study. This research is based on the development of a study presented by the same authors at the 9th Built Environment conference.

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JOURNAL OF CONSTRUCTION  
2016**

**1. Submission of manuscripts**

Authors should submit their papers electronically to the Editor at [joc@asocsa.org](mailto:joc@asocsa.org). ( Click to email Editor ).

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Table 1 : Component of expenditure

<b>Component</b>	<b>Expenditure (%)</b>
Cleaning Works	40.9
Mechanical Services	37.7
Building Works	13.6
Civil Works	7.8
<b>Total</b>	<b>100</b>

Source<sup>1</sup>

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[1] Bon, R. (1997) "The future of international construction." *Building Research and Information* 25, 137-41.

[2] Stone, P.A. (1980) *Building Design Evaluation: Costs-in-use*. E & FN Spon, London.

[3] Barrett, S. (1981) "Implementation of public policy." *In Policy and Action*, Barrett, S. and Fudge, C. (eds), Chapman & Hall, London, 1-33.

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