

Greening of Human Settlements in South Africa: A Case of Ndlambe Village

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Abstract:- In 1994 a new democratic government was ushered in South Africa with the release of political prisoners including Nelson Mandela. The government introduced a strategy of a Reconstruction and Development Programme (RDP). This was a deliberate move of building houses for the previously disadvantaged communities, which were more of a black community of African origin. There are challenges the housing programme is faced with, amongst the challenges is quality of houses, access to basic services of water, sanitation, energy and waste management. The challenges related to climate change and environmental protection by means of reduced material input and lower carbon footprints, as part of the green agenda. Progress in the development of sustainable human settlements especially in regions suffering from inadequate and decaying infrastructure can be achieved best through the integrated application of green technologies based on local and solar resources, appropriate town planning and design of dwellings, oriented towards the benefit of the people, social activities, business development and income generation. The importance of technological innovations in human settlements echoed in the Human Settlements Summit 2017 was the need to upscale innovation and transformative technologies in order to build smart communities for connectivity, resilience, economy, and dignity. Moreover, rapid urbanisation and technology gaps in human settlements could also be managed through innovations in technology. One channel to achieve this is through the formation of strong partnerships between private sector and government, and/or international partnerships on integrated application of green technologies. While South Africa has embraced green economy principles and committed to reducing infrastructural and industrial development actions that are environmentally destructive, still to be seen are tested integrated approaches on coming up with green alternative technology development. Postured to proffer a Green Village Model the study followed qualitative design in which data was collected through document reviews and interviews while examination of technologies was followed applying Cost Benefit Analysis, Capital Cost Analysis and Social Acceptance Modelling. The study proposes a model with relevant variables that need to be considered in terms of designing and implementing a green building project.

Keywords:- *Greening, settlements, technologies, innovations, carbon, buildings, model, sustainable.*

I. INTRODUCTION

Sustainable and green strategies, technologies, designs and processes have gained prominence in many business organisations as well as in some global economies in the past few decades (He, Kvan, Liu & Li, 2018). In the construction industry, sustainable ways of designing, enacting and maintaining building structures have been embraced, especially in the commercial aspects of the economy. Other authorities (Kabisch, Qureshi & Haase, 2014; Tan, Xu & Zhang, 2016) report that increased urbanisation has led to the necessity for the adoption of sustainable approaches in construction and designing both human settlements and commercial structures. The incorporation of green methods in construction is known as green buildings or green construction (Saad, 2018). It is generally accepted that the main cause climate change which is caused by unsustainable way of living and of making business is urbanisation.

Green building incorporates design, construction and operational practices that aim to address the environmental sustainability issues associated with industrialisation and urbanisation trends in recent years (Saad, 2016). Other researchers commonly describe green building as energy saving and the efficient use of resources, not only in the design and construction of the structure, but throughout its entire life-cycle (Ding, Fan, Tamb, Biana, Li, Illankoon & Moon, 2018; Hazan & Zhang, 2016; He et al., 2018). Ding et al (2018) add that the green building must also provide a safe, comfortable and healthy environment for the occupants. It can be deduced therefore that many explanations of what a green building entails hinge on the benefits of the green or sustainable principles and reflect much on the interaction between the humans and the environment.

At a micro level South Africa since 1994 has also not been immune to large urbanization as people decided to live in urban areas some chasing housing, others basic services and some driven by employment opportunities. Owing to the current urbanisation in Africa, it is estimated that the African urban population will comprise approximately one-fifth of the world's total urban population by 2050 (UN-DESA, 2015). It is also important to note that South Africa is one of the most urbanised countries in the sub-Saharan region of Africa. Evidence from UN-HABITAT (2010) suggests that approximately two-thirds (62 per cent) of the South African population is currently urbanised. South Africa, like any other African country, is faced with sustainability challenges in relation to its economic, environmental and social status (Lose & Tengeh, 2015).

The aim of this study was to develop a model or a framework that may provide improvements from the existing models and theories. Thus, this study’s results are valuable to the development of a workable model or a framework that could encourage planning designing and implementation of a green village whilst ironing out some impediments of green construction in a broader view in different organisations. The model will be able to provide a solution for both private and public sector in the construction industry to assist in planning, designing and implementation of sustainable green villages.

II. LITERATURE REVIEW

A. Background to green building

Climate change is one of the major global challenges of the 21st century (Urri, 2015). Human population growth has led to increased demand for energy and other resources from the environment which subsequent increased carbon footprints and environmental degradation (Barry et al., 2018; Urri, 2015). Ultimately, the combined effect of hazardous emissions and environmental resources exhaustion may be global warming. Global warming causes the sea level to rise and ocean water to become more acidic, thereby affecting the coral reef ecosystem (Barry et al., 2018). For instance, the Pacific Ocean is believed to have become 25 per cent more acidic in the last three centuries and is expected to become 50 per cent to 60 per cent more acidic by the year 2100 (Nordhaus, 2019). These extreme conditions also threaten human health. In all these, the human activities have contributed significantly to global warming and climate change.

B. The concept of green building

There has not been a universally agreed definition of what green building. Scholars, state departments and private initiatives have defined green building according to their differing contexts. According to Hasan and Zhang (2016) a green building is one that optimises energy efficiency and utilises natural, recycled or reclaimed resources in the construction process.

The study made reference to a green village project that is piloted in Kenton-on-Sea at Ekuphumleni Township in Ndlambe Municipality in the Eastern Cape. The green village approach is to mainstream appropriate water, sanitation, energy and alternative building technologies to secure a smart, green and sustainable village in Ndlambe and improve innovative local economic development interventions. This pilot project is also to show case a new innovative model for integrating technologies at a settlement level and to influence policy shift, direction and paradigm of communities, municipalities, stakeholders, government departments and housing entities which should be adopted to attain sustainable green village through multi-stakeholder effort.

Ndlambe Green Village technologies are proposed for water supply and sanitation including grey water recycling, multiple water use, use of waste water ingredients, such as minerals from urine, waste management and renewable solar energy. It consists of two modules, technological and socio-economic related features as depicted in Figure 1 below.

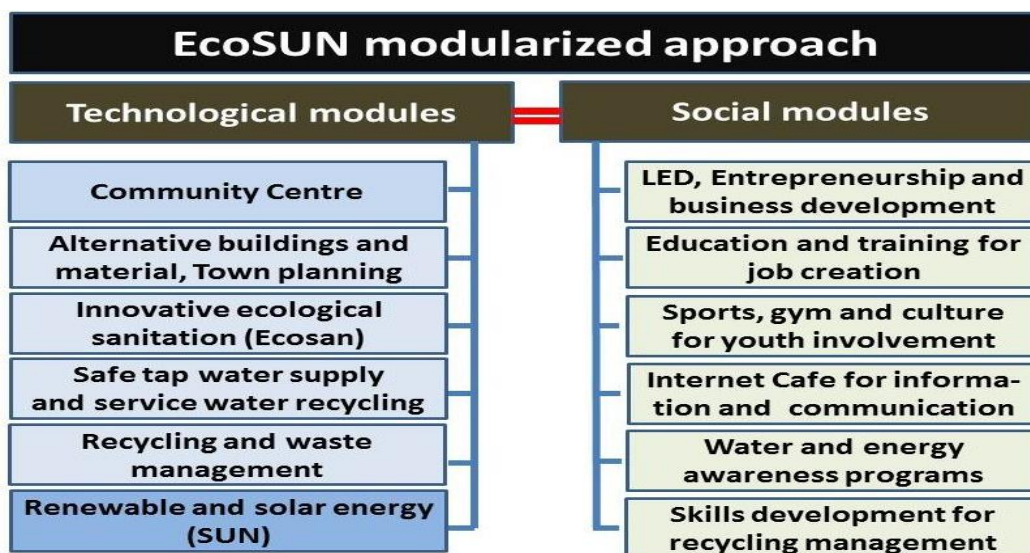


Fig. 1: EcoSUN modularized approach. (Source: Soyez, 2015)

In the Eco Village an Ecosun building housing the modules shown in figure 1 is constructed. The Eco-sun building will be used as a community multipurpose centre, for the community people to use for meetings, education center and a place to showcase their crafts and sell to the holiday makers. The community will use this area like a hall

for functions and other activities that they deem are fit for the purpose. What is of note regarding the building is that it is built based on the concept of the eco-village. All buildings in this green village will be built similarly in that only alternative building technology will be used.



Fig. 2: Eco-Sun Building. (Source: Mohren, 2016).

C. Conceptual model

The conceptual model development is based on the integration of stakeholders, construction drivers, and environmental drivers. Construction drivers in this case include economic growth, industrialisation, population

growth, income levels and health. In addition, environmental drivers include political influence, the natural environment, as well as social, technological, ecological and legal (legislative) considerations.

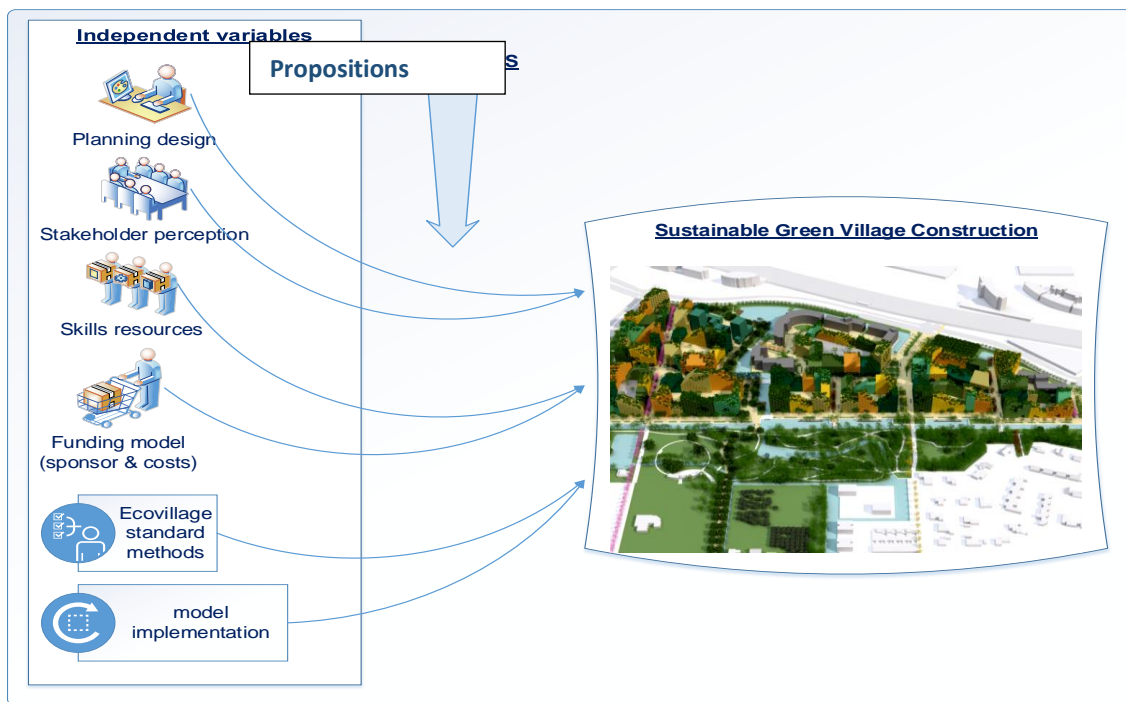


Fig. 3: Conceptual model, (source, own construction) 2020.

Green building, green construction and the transformation of occupants to green users have become a more indirect and effective form of environmental education (Kibert, 2012).The government is an important driver of sustainable development. Most governments globally put their heads together to address this global challenge.The construction industry also plays a crucial role in the South African economy. It does not only avail the required infrastructure but is also the major employer and a major

contributor to the gross national income (Katz, 2013).The role of users in green building is of the utmost importance. Users’ perceptions and expectations of green buildings significantly impact the effectiveness of the green building strategy (Bond & Perrett, 2012; Abdul-Muhmin, 2007).The figure below shows the Ndlambe eco-sun house construction of a Multi-Purpose Community Center(MPCC) utilizing alternative building technology.



Fig. 4: Eco- Village Site Construction (Source, own), 2020

The figure below shows the construction site of the eco-sun building.



Fig. 5: Eco-Sun House (Source, Own), 2021.

It must be mentioned that the construction of the ecosun village pilot project has also suffered the challenges mentioned in this study, there was no model that this project was planned, designed and constructed according to hence the need to come up with a model that will guide government officials, architects, planners on planning, design and implementation of alternative green building technologies.

D. Green building in South Africa

In response to the climate change crisis and the effects of increased urbanisation as well as population growth needs, South Africa has joined the rest of the world in the practice of green building. A significant mark/step in this regard was the establishment of the Green Building Council South Africa (GBCSA) in 2008 (Nakumuryango & Inglesi-Lotz, (2016). This was made possible by the involvement of expertise from other countries such as Australia. In 2014, six years' after inception, the GBCSA had certified more than 50 buildings.

The government of South Africa, through the GBCSA, has managed to include public buildings in the green building system. To date, some government buildings have achieved the Green Star SA status. Local municipalities are utilising the Green Building Guidelines or by-laws to enhance the adoption of green building practices in their areas. The guidelines are followed whilst adhering to the national legislation and include South African National Service (SANS) 10400-X and 10400-XA which are centred on environmental sustainability and energy efficiency in buildings respectively.

In 2015 the South African Local Government Association (SALGA) entered into an agreement (Memorandum of Association) with the GBCSA to advance the green building agenda. This partnership has seen all 257 municipalities in South Africa becoming members of the GBCSA, thus fostering the quick legislation, facilitation and growth of green building principles and practices at the local level. The GBCSA has also partnered with ICLEI Africa which works with local municipalities in sub-Saharan Africa to achieve sustainability through urban development and green infrastructure establishment.

E. Challenges of green construction

The adoption of green construction is not without its challenges. These challenges contribute significantly to the pace of acceptance and actual installation or erection of green buildings. Hasan and Zhang (2016) identified the economic aspect of the green construction to involve monetary and time concerns. The foremost challenge is the issue of cost. Hasan and Zhang (2016) warn that the implementation of green construction may require extra capital that is necessitated by the need to install green technologies that will, for instance, save water and energy. The cost may also stretch to the maintenance aspect of the installed green technology.

Another major challenge in green construction relates to the incorporation of green technology. The technology can be installed on an already existing building system (retrofitting) or drafted in the design of a yet-to-be built structure. In both instances, certification is important because the process assesses safety and sustainable issues. However, since green construction is still evolving, a significant passage of time can be expected before certificates are awarded. In addition to this, uncertainty still looms regarding the performance of green technology and equipment. However, this obstacle may be reduced with

time on the basis of the evolvement of green construction. Thus, specifications to fully inform implementation are still a major problem, especially in developing economies that are in the early stages of adopting green construction. The green technology in itself is still limited (Hasan & Zhang, 2016).

Researchers also highlight the difference in perspectives of the construction industry practitioners as a drawback (Powmya & Abidin, 2014). This points to awareness and acceptance; in other words, the benefits and importance of green buildings are yet to be recognised, not only in the industry but in eyes of the public as well.

F. Drivers and motivators of green buildings

The green building programme is restructuring the construction industry and is attracting a significant demand in the property market and industry at large (Ahn, Pearce & Ku, 2011). Altomonte and Schiavon (2013) point out that the techniques and concepts are already there; it is only necessary to unleash the innovative capacity for the green market to grow even bigger. In the following sub-sections, the various drivers to green building are categorised as economic, social, environmental and organisational drivers.



Fig. 6: Drivers of green building. (Source: Own construction), 2020.

The literature suggests that green buildings also contribute significantly to creating and maintaining an environmentally conscious image (Kibert, 2012; Pearce & Ku, 2011). Apart from being a driver of environmental and social progress, the green strategy has an unquestionable impact on economic and organisational facets in different spheres such as; improved employee satisfaction and well-being leading to enhanced morale and ultimately, to improved productivity.

III. METHODOLOGY

A. Research Approach and Design

This research adopted a qualitative methodology since the objective was to gain detailed information regarding green building, its technologies and net-benefits. Also the research suggests using the MCDM to understand the green value creation, the selection of green building technologies and the implementation the green technologies for the establishment of a green village. This type of model requires specific information rather than standardised information.

For purpose of this study, the researcher made use of the qualitative approach. It produces a wealth of comprehensive data on a small sample and the process of data collection is not limited to set categories or themes; instead the themes are extracted from the data itself (Ghelichi et al., 2016; Bryman, 2012; Burns & Bush, 2013). The inherent flexibility of qualitative studies and their potential for illuminating intricacy are predominantly relevant to the current research. Also the current research topic is also complex, hence it requires detailed enquiry.

The case study approach was utilised in conducting this study. According to Leedy and Omrod (2018), case study research is an in-depth study of a specific or distinct individual, programme or event for a certain period of time. Creswell (2014) adds that case study research is a multi-faceted form of qualitative enquiry that allows the researcher to comprehensively and holistically investigate a complex phenomenon in context. It usually comprises numerous variables. Case study research is also fundamentally applied in exploratory and explanatory studies in a bid to gain an understanding of an issue in its real-life circumstances (Yin, 2014).

B. Target Population and Sampling

A research or study population is the total number of units/elements which a research study targets to infer results through examining a small but representative part of it (Groh, 2018) (Leedy&Omrod, 2018). In this study the study population was the total number of designers, contractors, environmentalists, builders and general community members who in one way or another have some stake in green building projects in Ndlambe Village in Eastern Cape, South Africa. This is because the research study aims to collect data on the design, planning and implementation of green building practices in the Ndlambe Village.

Palinkas et al. (2013) point out that purposive sampling is widely used and seems more appropriate to the information-specific context needed in these situations. However, the researcher had to minimise errors and bias that are inherent in using judgemental selection. In achieving this, purposive sampling was only employed after grouping the target population into clusters representing their roles in the research topic of green building. Using the purposive sampling technique explained earlier, the study collected data from a sample of a total of 34 individuals. The individuals were categorised into focus groups which were interviewed during data collection.

C. Data Collection

The categories of the sample given in Table 1 were used as the focus groups for data collection. Focus groups consist of a small number of people between five and ten, who are deliberately selected so that their opinions may be studied to project the characteristics of a bigger population or phenomenon (Groh, 2018). Focus groups thus allow an effective moderator to be a proxy for the users of the results of the research (Oltmann, 2016). In this study, the use of the focus groups was coupled with a semi-structured questionnaire that comprised open-ended questions.

Table 1: Sample profile of respondents

Group	Number
Community members (users)	12
Designers/contractors/builders	8
Environmentalists	8
Government officials	8
Total	36

In addition to the use of focus groups as a data collection method, this study also employed document analysis as a qualitative technique. Document analysis is defined by Oltmann, (2016) as a social research method that is an invaluable in triangulation in the study of particular phenomenon. Documents used in this study include municipal strategic plans, international reports on green initiatives, engineering articles and government policy documents among several others.

Field observation is also among the research methods employed in this study. By definition, “field observation is a data collection method, by which you gather knowledge of the researched phenomenon through making observations of the real life phenomena” (Smulowitz, 2017:28). The primary focus of observations was to capture changes that took place in the research phenomenon under study during interactions with humans.

D. Data Analysis

The thematic analysis technique was adopted in this research because this research follows a qualitative study, which collects narrative data through group and individual interviews. The motivation for using thematic analysis stems from various advantages that it offers in terms of understanding and interpreting data. In terms of flexibility, thematic analysis tends to be a relatively easy technique to learn and quick to implement. Moreover, it does not require the researcher to look for experts of data analysis who do not have a theoretical foundation of the objectives research.

IV. MAIN FINDINGS OF THE STUDY

The section on key findings discusses the Vithi model as created by the author based on the results of this study. The Vithi model as depicted in Figure 7 below is made up of six stages. The first stage includes the inputs consisting of political considerations, specialists and capital investment. The second stage is the activity consideration, the third stage is the activity processes, the fourth stage is the critical success factors, and the last is the output agenda. The figure below shows the Vithi Model developed for this study.

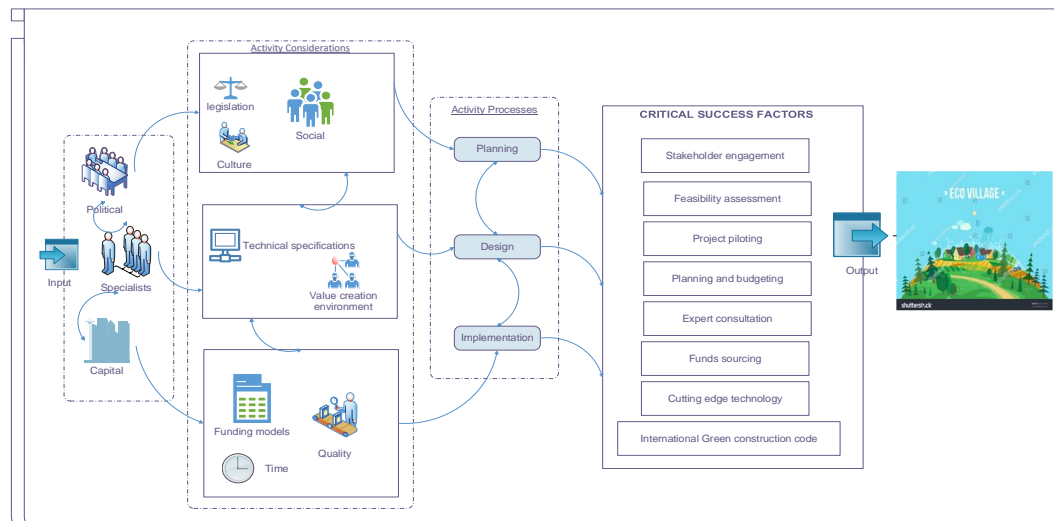


Fig. 7: VITHI Model (Source, Own), 2021.

Based on this research there is not a green village which fully utilises alternative technologies in South Africa. This study introduced a model for implementing green villages in the RDP construction scheme, for low cost house under human settlement.

A. Critical Success Factors

➤ Stakeholder engagement

Engagement with stakeholders is crucial for the successful implementation of projects. There exists no doubt that community and senior political principals have to support the idea of the ecosun village. Community and political support will only take the projects to greater heights. The research is reflective of more than eighty per cent buy in from communities. The group that was consulted was seen to have a good understanding of a sustainable ecosun village.

➤ Feasibility assessment

Prior to the launching of the Green Village initiative, it is essential for the project leaders to carry out extensive feasibility analyses. Feasibility analysis must be carried out on broad fronts, including physical, technical and financial aspects. Physical feasibility assessment seeks to determine whether it will be possible to execute the project, having taken into account the topography, climatic conditions and size of the selected land area. Technical feasibility analysis encompasses such aspects as the required type of technology, specialised skills and the information needed in building the green village. A project cannot be executed if the required capital outlay has not been determined. Preliminary discussions and meetings must assess the possibility of meeting the required capital outlay.

➤ Project piloting

The green village concept, though it has been implemented elsewhere, remains an alien and radical form of innovation for South Africa. Owing to the intricacy of the endeavour and the peculiarity of the technical knowhow required, there is a need for testing the concept prior to the mass rollout. Piloting is widely applied when dealing with projects that entail cumbersome details. It helps in accurately projecting the project costs and identifying

potential challenges and risks inherent in carrying out the project. The Ndlambe Green village initiative needs to be piloted on a small scale, employing expert project evaluation expertise before the actual project is put in place.

➤ Planning and budgeting

Planning is a fundamental step in project management. It determines how all other subsequent steps should be carried out. Beyond the role of guiding activities and processes, planning helps in setting targeted objectives and the desired level of outcome. Planning is inseparably related to budgeting; they are both carried out during the primary phase of project formulation. Budgeting on the other hand serves an important role in determining how the available resources and the expected resources will meet the set objectives. Although financial budgeting exists as the common type of budgeting, time and resources budgeting are also some of the overlooked budgeting typologies. The ability to accurately estimate costs needed to complete a project over a defined period of time is essential in the green village initiative. The panel members involved at the planning phase must be carefully selected and each must possess expert knowledge in their respective field areas.

➤ Expert consultation

Municipalities in South Africa often do not have sufficient project management expertise. For larger and more complex projects, it is not unusual for the municipality to require outside assistance throughout project planning and implementation. Highly complex projects such as the Ndlambe Green village require specialists in environmental management, biotechnology science, civil engineers and electronic technologists. Albeit the numerous benefits yielded by expert consultation, however it has various disadvantages. The potential pitfalls to consider before investing in an outside knowledge expert include the high cost in addition to the risk of sharing confidential project details with outsiders. Furthermore, there exist potential risk of conflicts between consultants and the internal project leaders.

➤ *Funds sourcing*

Multiple funding sources considering this element, mean initially looking at who benefits. Indications are that the benefit is for many stakeholders. The national, provincial, and municipality government spheres have a direct benefit. The private sector has an indirect benefit. The largest part of it is their carbon print can be offset by funding green villages. Green villages have trees that we know and have been proven to absorb carbon dioxide at night. Industry is known for polluting the air with the large scale of manufacturing and doing business. These structures should start funding the green village. The funding of green villages in South Africa could also be sourced from the environmental levy. All the funds that are charged from different companies for environmental degradation should be channeled to green villages.

➤ *Cutting edge technology*

The fourth industrial revolution is the new reality and every aspect of human life has been revolutionised, including construction technologies. Modern houses are getting smarter, with the implementation of automated technologies, and commercial buildings are following suit. Compared to ancient buildings, modern buildings are intelligently built, with electronic systems rendering data analytics smarter through centralized operations. The constructors of the green village have at their disposal plenty of cutting edge technologies, including drones. Construction companies pilot drones during various phases of a construction project. Drones are useful when gathering information about the construction site and its surroundings.

➤ *International Green Construction Code*

Standards are sets of guidelines and criteria against which a product's ability to meet quality requirements can be evaluated. There exists a proliferation of standards, rating, and certification programmes in the marketplace which are widely employed in project management. The evolution of the green concept brought with it new standards used in manufacturing, service provision as well as in the construction industry. Green building rating systems are some of the tools that are currently used when evaluating the performance of a building and its impact on the environment. The International Green Construction Code (IGCC) provides minimum requirements for safeguarding the environment, public health, safety and general welfare of humans. Compliance with IGCC standards is imperative for the reduction of negative effects and the promotion of positive externalities from the village construction.

V. RECOMMENDATIONS

The results of this study affirm that this research has implications for all the stakeholders to the green building project, particularly the construction industry, the government and the community members/possible users. This study further contributes immensely on the basic services that the municipality is supposed to plan for in the municipality IDP. The national government also has a large portion to take cognisance off in this study and implement the recommendations of this study on funding models, and implementation of green villages at large. The main

recommendations were subdivided to target three main groups as discussed below.

A. *Construction Industry*

This study was focused on greening the Ndlambe Village by developing a model that can help the effective implementation of green building practices. In this regard, the study advocates for the adoption of sustainable building practices in the pursuit of environmental sustainability goals. The multi-criteria decision model answers the need for a holistic approach to the design, enactment and final use of green building facilities. The study also found that an extended skill set was necessary that relates to the use of green technologies in construction. Furthermore, safety and security aspects of the built environment were emphasised in the results to this study. The findings reported that every green building project has to go through the certification process that is set by the GBCSA. Subsequently, green building practices require collaboration between the construction professionals and other stakeholders such as environmentalists, communities and the government.

B. *Government*

The study found that the government is in fact a crucial partner in establishing green building practices and the utilisation of eco-centric resources. Findings confirmed that the government plays an important role in setting out an environment and standards for the implementation of sustainable building practices. This may be because the community has some kind of trust in the processes of government which facilitate the acceptability of the green building ideology. Environmentalists and other professionals who were interviewed indicated that the certification of green building designs and final facilities remains the responsibility of the government. This process of certification in essence ensures the adherence to carbon emissions standards as well as the maintenance of health and security quality.

The government's support of the green building agenda may not be limited to policy making and enforcement but may also encompass the provision of enabling and remedial measures to challenges in the process. The Kenton EcoSun village in Ndlambe seeks to pilot government investment initiative and in turn responds to the challenges of housing in the area. Included in the EcoSun green village is the strategy to focus on the development of self-sustaining human settlements instead of houses only, for an example the integration of community centers, children's playgrounds, and business and income generation opportunities for the people.

C. *Users / communities*

More awareness may drive better acceptability and ultimately, a strong social reputation. More awareness may also trigger the demand for green building facilities which may be significant for the social agenda of being eco-centric through less use of resources for energy. As was reported in the methodology chapter, community members were contacted to participate in the study. Significantly, the ordinary community members seemed knowledgeable on the issue of green building. This may discourage the

marginalisation of community members in decision making. The findings to this study established that green building utilisation comes with benefits that include low maintenance costs through energy saving and less water consumption. These benefits may accrue to community members who end up using the green building facilities. Communities can also be seen as clients for the green building projects as they make demands that may change overtime as their perspectives of their interaction with the environment become more informed and refined. Wang et al. (2018) agree that clients' needs are constantly changing as a result of factors that are not limited to their interaction with the environment and other players in the economy. As such, research that includes the perspectives of community members concerning green buildings may be regarded as being important in updating the needs' list. Lastly, the employment opportunities and enhancement of skills sets are likely to accrue to the benefit of the community members.

The socio-economic focus is on creating social change by consideration of the real needs of the people under the given economic constraints. Essential features are public participation, technology and knowledge transfer as part of education and training, development of business opportunities including service teams for maintenance and improvement of the existing demonstration units and its rolling out in other Municipalities. Privacy and dignity of people and their life are high ranking goals, as well as principles of African culture such as Ubuntu principles of cooperation and neighborhood, or the Zenzele principle of self-reliance, self-help and self-confidence (Dewar, 2015), both to get people involved in all steps of the process. Moreover, the demands will be met of better resource economy and the usage of local or regional material and energy resources, as well as a smaller carbon footprint for improved climate protection.

Through the use of innovative sanitation technologies for RDP houses and settlements the fresh water demand as well as the waste water disposal are both covered at the highest sanitary level. With respect to this the water consumption will be reduced in a sustainable way and the reuse of valuable components of waste can be organized ecologically as well as economically. In addition, using renewable stocks will create a cost-efficient and sustainable way to provide energy to the people. This, as well as the design of the houses and the settlement, adapted to the predetermined local environment, will improve the overall living conditions. The development of an upgraded version of the low-cost houses will open the programme for higher income groups who do not qualify for RDP level, such as teachers, business people or administrators, and for whom until now offers are lacking.

VI. CONCLUSION

This study has suggested and validated the Vithi model, which has been conceptualised by the author from the existing theories to assist preconstruction and post-construction planning decisions. The concept of the Vithi model helps pre-project planning teams and decision makers to understand the synergy across the key stakeholders, activities, and resources to ascertain financial logic through the lenses of environmental sustainability, technical complexity, socio-value, economic value proposition, and the legal framework. The outcomes of this research will assist pre-project planning teams and decision makers to assess the alternatives and select the choice(s) most applicable to the profitability of construction businesses and green building projects at large.

Apart from being a decision tool, the Vithi model will also help to direct green building decisions and will be a tool to monitor technological decision before and during construction as well as throughout the period within which the buildings are used in order to capture and document green building performance dynamics to identify inefficiencies and shortcomings. Likewise, the research added to the green building construction industry, the value attached to an understanding of the legal space in the light of green building regulations, policies and possible disputes.

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