Promoting Sustainable Construction through Ecological Economics

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Key words: construction process, ecosystem, green infrastructure, project performance, sustainability

SUMMARY

Ecological economics (EE) is the study of interactions and impact of human activities on the environment, which is an aspect of sustainable concept. To encourage the adoption of EE, this article examined various drivers as well as measures of mitigating environmental impact of construction activities in the South African construction industry. Primary data was collected using well-structured questionnaires that were designed based on information obtained from secondary source, that is, existing literature materials. The questionnaires were administered on contractors, clients and construction professionals in the construction industry. Using convenience sampling approach, 70 questionnaires were distributed to the respondents, 55 were received while 5 of the questionnaires were not properly completed and unfit for analysis. Findings from reviewed literature reveals a low level of awareness and adoption of ecological economics concept in the construction industry. In order to promote and ensure the adoption of this practice, there is a need for the inauguration of EE through communicating new ideas and incentivizing ideas for change relating to greener construction are the major drivers of promoting the concept in the construction industry. These will assist clients, construction professionals, contractors and other stakeholders in overcoming the roadblocks to the adoption of the practice of EE in the South African construction industry. For this reason, stakeholders in the construction industry needs to educate themselves with the knowledge of ecology and information relating to sustainable practices at large. In furtherrance to this study, further specific and detailed research can be conducted to examine the benefits, drivers, barriers as well as the methods of overcoming the roadblocks to to adopting the concept of EE for sustainabke construction.

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1. INTRODUCTION

The relationship between pro-environmental knowledge and its ecological impacts have been highlighted and discussed by various authors. However, Cohen (2006) explains partly the failure and deficiency of the sustainable models use to date. He further added that "Sustainable consumption runs counter to dominant tenets of neo-liberal economics and conventional political objectives" (Cohen, 2006), which neglects the ecology and hinders on the economy in the end. Thus, this research inculcates the assessments of EE as a model to promote sustainability with the construction industry.

Cole (1999); Holmes and Hudson (2000) stressed that the concern about enhancing construction practices as a mean to mitigate their detrimental effects on the natural ecology. Johnson (1993); Cole (1998); Crawley and Aho (1999); Rees (1999) substantiated that the attention of construction professionals across the world have been captured by the ecological impact of the construction industry, green buildings, designing for recycling and eco-labelling of buildings. The construction industry's performance is currently a primary concern of the professionals within the construction industry Ding (2008) mentioned. In addition, Cole (2005); Cooper (1999); Holmes and Hudson (2000) emphasized that ecological assessments have emerged due to major problems in sustainable construction.

According to Cooper (1999), Kohler (1999) as well as Finnveden and Moberg (2005), building designers and professionals have long been concerned about building performance. Thus, encouraging ecological construction and sustainable production are vital for sustainable development, which hinge on attaining long-term economic growth that is uniform in regards to the environment and social needs.

The implementation of EE would bring about environmental programmes that can educate and edify the knowledge of 'green' and environmental sustainability amongst scholars and professionals within the Built Environment. Ruževičius (2009) supported this by mentioning that effective environmental awareness be amended for higher institution students from all disciplines, business enterprises, as well as public sector and government administration institutions. The advantages of ecological development are often not palpable; they are only evident over a long-term cycle with reduced operating costs and a conclusive environmental and social impact on the encompassing community.

2. SUSTAINABLE CONSTRUCTION AND ECOLOGICAL ECONOMICS

Sustainable construction or sustainability in short is a concept created to be the messiah of the slowly deteriorating environment and ecosystem at large. The World Commission on Environment and Development (WCED, 1987) stated that sustainable development is the capacity of making development sustainable to certify that it qualifies with the present needs without neglecting the potentiality of the next generation to cope with their needs. Kates, Parris and Leiserowitz (2005) and, Daneke, Lenox and Hall (2010) commented that the wide usage and citation of this definition has molded sustainable development as being centered on intergenerational equity. Similarly, Pearce (2006) defined sustainability as primarily meaning lasting or perpetual and development without sustainability seems pointless. Despite the fact that the definitions mentioned above fail to emphasize the environment and ecology, a statement in the WCED (1987) referred to that the theory of sustainable development imposed limitations to the modern state of technology and society on environmental resources and the bearing capacity of the ecology to digest human activities on infrastructure development.

Pearce (2006) noted that sustainability as a value-laden phrase enabled different people defining the term according to their perception of "good world". According to Hall, Daneke and Lenox (2010), they evaluated that sustainable development aims to equate social and environmental objectives with that of the economic objective. Kates, Parris and Leiserowitz (2005) and Pearce (2007) studied that published literature on sustainability has developed concepts under sustainability in place of consolidating a more meaningful treatise.

2.1 The Concept of Green Construction

The idea of green construction arose from the limitation experienced by sustainable construction. According to Hassan *et al*. (2005) and Kolev (2009), elucidated that green construction is construction that is designed in a manner that has a minor impact on the environment compared to that of conventional construction. The principal of 'green' intends to iron out issues related to traditional buildings. Similarly, Bina (2013) speaks of green construction as a movement leading towards sustainability and energy-efficiency of a building or structure throughout its life cycle. For the purpose of this study, green building is comprehended as another form of construction that utilizes resources in energy efficient manner in all areas of the built environment lifecycle.

The benefits of green building and construction are both tangible and intangible relating to the environment. In addition, Nina (2013) observed that the lifestyle and living standards of green building users are far more comfortable due to the adoption of sustainable principles by the concept of green building. LEED (2006) added that people tend to become more productive when they work in greener structures which eventually leads to an economic gain, based on the comfortability of the environment and people being more 'environmentally-friendly.

2.2 The Urgency to Construct Green

Hoffman and Pienaar (2013) studied that in recent years, the construction industry has significantly contributed to the increased energy inefficiency and global climate changes. Through research conducted by Dodge Data and Analytics (2013), he discovered that green construction has kick started ever since the formation of the Green Building Council of South Africa (GBCSA). Furthermore, Dodge Data and Analytics (2013) reported that 51% of all firms in South Africa are anticipated to have larger volumes of green activities incorporated into their construction designs. Similarly, the World Green Building Council (WGBC) (2014) reported that more than 17 countries worldwide including South Africa are registered members of the WGBC.

Recent studies by Windapo (2014) highlighted that the urgency for green construction has been associated with the nimble deteriorating environment in the last decade. The evidence is seen in the liquefying Polar ice caps due to high levels of carbon dioxide emissions from which construction activities contributed roughly 35% amongst other industries that Hassol (2005) revealed.

2.3 Ecological Economic and Sustainable Construction

Ruževičius (2010:717) added that environmental degradation of the environment and ecology can be mitigated through the implementation of different state and public administration brought about EE. The green public procurement promotes environmental policies through the involvement of public administrations using ecological criteria's in their specifications, contributing to an increase in 'green' demand. Calabro (2007) added that the involvement of the public administration in 'green' choices was an effective way of enhancing the demand for green products within the market.

3. RESEARCH METHODOLOGY

This Survey design was adopted for collection of data for this study. The population includes architects, quantity surveyors, engineers, construction project managers, construction managers and other relevant professionals within the built environment in South African construction industry; specifically in the Gauteng region.

The research adopted a close-ended questionnaire based on data obtained from literature review of existimg materials in the area of sustianability, ecology and economics. The questionnaire was designed to explore the awareness level of ecological construction based on various demographic, internal and external factors highlighted from literature. The distribution of questionnaires to respondents was through mainly electronic mail as well as hand delivery and they were retrieved through the same means. Prior to actual distribution, a pilot study was carried out among selected academics and construction professionals to test and improve the instrument. Their comments, observations and views were examined and considered in the preparation of the final instrument for data collection.

The first section of the questionnaire examined the background of the respondents while the second portion explored the awareness level of EE amongst identified construction professionals. The importance of the identified variables were examined based on the level of agreement of respondents using a 5-point Likert scale. The rating were as follows: 1=Strongly disagree; 2=Disagree; 3=Neutral; 4=Agree; 5=Strongly agree. Mean item score (MIS) and standard deviation (SD) were thereafter computed for each of the variables and the values were used in ranking and determining their importance. Cronbach's Alpha test was carried on the group of collected data and a value of 0.701 and 0.714 were obtained for responses in respect of sources of information and reasons for the gap in knowledge. This is acceptable as noted by George and Mallery (2003) as well as Punch (2005) that the value of the Cronbach's Alpha above 0.7 is acceptable.

4. FINDINGS AND DISCUSSION

4.1 Background Information

Finding revealed that 38% of the respondents are engaged in contracting firms, 40% worked for Consulting Firms, 4% worked for Developers, 14% worked for Project Management Firms and 4% selected others, which included tertiary institutions and commercial banks. Further results showed that 52.08% of the respondent's companies works for the private sectors, 12.50% works in the public sector and 35.42 companies operates both in the private and public sector. Findings relating to respondents' current position in the company showed that 8% are architects, 40% are quantity surveyors, and 12% are engineers. Also, 14% are project managers, 8% were construction managers or site engineer/agent, 14% were construction project managers, and 4% selected others, which included facility manager amongst others.

4.2 Drivers of Ecological Economics Principles in Construction

Table 1 reveals the various ways that could encourage the adaptability of EE amongst professionals in Gauteng, South Africa. It revealed that communicate new ideas (environmental campaigns, conferences, etc.) was ranked first with an MIS of 4.18 and SD of 0.774; incentivize ideas for change relating to greener construction was ranked second with an MIS of 4.06 and SD of 0.767; amending a minimum percentage legislation of sustainability within a design ('green construction') was ranked third with an MIS of 4.06 and SD of 0.818. Similarly, the table showed that advertising (through media promoting the use 'green' products and buildings) was ranked fourth with an MIS of 4.04 and SD of 0.755; voluntary labelling (using third-party rating systems to assist consumers recognize the value of green buildings.) was ranked fifth with an MIS of 3.90 and SD of 0.863. In addition, the table continued to reveal that combining policy instruments (combine energy, waste, transportation instruments into one policy) was ranked eighth with an MIS of 3.80 and SD of 0.782; Change bidding process to require green features was ranked ninth with an MIS of 3.78 and SD of

0.996 and resource constraints (apparent limits on resource availability and waste absorption capacity) was ranked last with an MIS of 3.78 and SD of 0.996.

Table 1: Ways to Encourage Adaptability of Ecological Economic

Variables	SD	MIS	R
Communicate new ideas (environmental campaigns, conferences, etc.)	0.77	4.18	1
Incentivize ideas for change relating to greener construction	0.77	4.06	2
Amending a minimum percentage legislation of sustainability within a design('green construction')	0.82	4.06	3
Advertising (through media promoting the use 'green' products and buildings)	0.76	4.04	4
Voluntary Labelling (using third-party rating systems to help consumers recognize the value of green buildings.)	0.86	3.90	5
Reducing exemptions to environmental taxes	0.92	3.82	6
Corporate reporting (Informing consumers of their social and environmental value of individual products)	1.09	3.80	7
Combining policy instruments(combine energy, waste, transportation instruments into one policy)	0.78	3.80	8
Change bidding process to require green features	1.00	3.78	9
Resource Constrains (perceptible limits on resource availability and waste absorption capacity)	1.00	3.78	10

SD = Standard deviation; MIS = Mean Item Scores; R=Rank

4.3 Ecological Economics as a Sustainable Construction Tool

Table 2 shows how ecological economics can reduce the impact that building construction has on the environment in Gauteng, South Africa. Imposing pollution taxes directly to the producer was ranked first with an MIS of 4.16 and SD of 0.842; having environmental programmes as part of educational curriculum was ranked second with an MIS of 4.14 and SD of 0.756; prescribed limits on the level of pollution allowed was ranked third with an MIS of 4.08 and SD of 0.778. In addition, the table continued to reveal that amending environmental programmes on 'green' construction to business enterprises was ranked fourth with an MIS of 4.04 and SD of 0.727; innovation from construction institutions and organizations was ranked fifth with an MIS of 4.04 and SD of 0.947; suggesting a fixed percentage on the incorporation of 'green' in infrastructure designs. (Renewable energy, use of low carbon cement and other greener material) Was ranked sixth with an MIS of 3.94 and SD of 0.890. Moreover, the table concluded that amending environmental programmes on 'green' construction to public sector participants was ranked seventh with an MIS of 3.92 and SD of 0.829; social responsibility (site hygiene) was ranked eighth with an MIS of 3.86 and SD of 0.990 and the outright ban on the manufacturing of potent emission producing materials that are used by companies was ranked last with an MIS of 3.76 and SD of 0.981.

Table 2: Mitigating Environmental impact of building construction activities

Measures	SD	MIS	R
Imposing pollution taxes directly to the producer	0.84	4.16	1
Having environmental programmes as part of educational curriculum	0.76	4.14	2
Prescribed limits on the level of pollution allowed	0.78	4.08	3
Amend environmental programmes on 'green' construction to business enterprises	0.73	4.04	4
Innovation from construction institutions and organizations	0.95	4.04	5
Suggest a fixed percentage of the incorporation of 'green' in infrastructure designs. (Renewable energy, use of low carbon cement and other greener material)	0.89	3.94	6
Amend environmental programmes on 'green' construction to public sector participants	0.83	3.92	7
Social responsibility (Site hygiene)	0.99	3.86	8
The outright ban on the manufacturing of potent emission producing materials that are used by companies.	0.98	3.76	9

SD = Standard deviation; MIS = Mean Item Scores; R=Rank

4.4 Discussion of Findings

The findings of this study were analogous to findings by OECD (2008) which revealed through literature that communicating new ideas, advertising and voluntary labeling were the leading methods of adaptation. Similarly, findings by OECD (2010); Rubik *et al*., (2009); Jackson (2005); Jackson and Michaelis (2003) revealed that combining policy instruments was ranked the least. Also, the findings also agreed to Diyana & Abidin (2013) and Häkkinen & Belloni (2011) relating to subsidies and incentives as a highly recommended method of better promoting the adoption of sustainable methods within various industries. Choi (2009) and Rustom (2014) who cited Reed and Gordon (2000) through literature ranked the changing of the bidding process to require green features as the least factor that could aid in promoting the adoption of EE.

The results on the usefulness of EE for sustianable construction were in agreement with the findings in the study by Ruževičius (2009) of having environmental programmes as part of the educational curriculum and amending environmental programmes on 'green' construction to business enterprises were discovered to be among the highly ranked measures of mitigating environmental impact caused by the construction industry. In addition to this, Barker (2013) results revealed that imposing pollution taxes directly to the producer and prescribed limits on the level of pollution allowed were studied as the most effective measures of mitigating environmental impact caused by the South African construction industry. Similarly, the current study agrees with the results of Grossman & Krueger (1995) and Romeiro (2012) of Innovation from construction institutions and organizations as being a relatively effective measure too.

Nevertheless, the finding were not in conjunction with the study of Ruževičius (2010) and Calabro (2007) where amending environmental programmes on 'green' construction to public sector participants was identified by the current findings as one of the least effect measures that can be implemented. Moreover, in a study by Barker (2013), it was discovered that the most highly ranked measure of mitigation was the last ranked measure of the current study that indicated a disagreement.

5. CONCLUSION AND RECOMMENDATIONS

The current study indicates findings of the methods that can be implemented to encourage adaptability of EE in Gauteng, South Africa. Moreover, the study explored how EE can help mitigate the environmental impact of the construction industry. Findings from the empirical study revealed that there are various methods that EE can bring about in the quest of mitigating environmental impact in Gauteng, South Africa.

Findings from the questionnaire survey results collected from the respondents revealed that, communicate new ideas, incentivize ideas for change relating to greener construction, amending a minimum percentage legislation of sustainability within a design, advertising, voluntary labelling, reducing exemptions to environmental taxes, corporate reporting, combining policy instruments, change bidding process to require green features, resource constraints were the most dominate methods of adopting EE by the professionals in the Built Environment in Gauteng, South Africa.

From the questionnaire findings collected from the respondents, it was concluded that imposing pollution taxes directly to the producer, having environmental programmes as part of educational curriculum, prescribed limits on the level of pollution allowed, amending environmental programmes on 'green' construction to business enterprises, innovation from construction institutions and organizations, suggest a fixed percentage on the incorporation of 'green' in infrastructure designs, amending environmental programmes on 'green' construction to public sector participants, social responsibility, the outright ban on the manufacturing of potent emission producing materials that are used by companies were measures of mitigating environmental impact. Therefore, the research objective was achieved from both literatures and the questionnaire of the current study.

The construction industry and the professionals within the Built Environment should exercise the measures of mitigating environmental impact caused by the construction industry such as: imposing pollution taxes directly to the producer, having environmental programmes as part of educational curriculum, and prescribed limits on the level of pollution allowed. Also, innovation from construction institutions and organizations and amending environmental programmes on 'green' construction to business enterprises.

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