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Green Product Innovation Strategies for Environmental Sustainability in the Construction Sector

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Abstract: *Environmental Sustainability and ecological benefits through green products innovations has recently gained significance due to increase in issues such as global warming, CO2 emissions, increase in waste and other ecological hazards. In the construction sector, green products innovations emphasize upon waste reduction or material recycling, energy conservation and control of pollution. Despite international certifications and LEED ratings, there are still barriers that retard the growth of green product innovation projects. This study investigated green product innovation through a multiple case study analysis of several building projects in three construction firms in the industrial towns of Jubail and Yanbu, Saudi Arabia. The study was carried out around three variables, viz. energy conservation, materials reduction, and pollution control in the project life cycle. In-depth interviews and a study of documentation revealed such dimensions of green product innovation that are essential for a construction company to adhere to. The study also found out barriers that need to be addressed to in order to achieve green Saudi Arabia. Finally, the study suggested developing skills of company personnel and reviewing of the regulations in order to motivate companies to involve themselves more in green projects.*

Keywords: *Green innovation, Construction sector, Regulations, Environmental sustainability*

1. Introduction

There are several companies across the globe that have launched "sustainable," "environmentally friendly" or "ecofriendly" products under the green products innovation schemes (Greenbiz, 2009). For instance, Ford pioneered soy-based seat cushion foam; SC Johnson issued a green list itemizing restricted ingredients to be weeded out; Lipton Tea pledged to source their 100% tea from environmentally sustainable estates only. Such a paradigm shift hints at a kind of positive intent among companies and also suggests that environmental sustainability cannot be acquired only through legislations but also through product innovation measures and introduction of new technologies (Berger et al., 2007). Likewise, the construction industry which has been rated as the largest contributor of greenhouse gas emissions (Truitt,2009) and biggest consumer of natural resources (USGBC, 2012), there is a potential to create benchmarks and achieve environmental and ecological sustainability (UN, 2015) through green product innovation. A strong reason for this this belief is its capacity to adapt to low energy consumption methods and improvising resource efficiency in its working patterns (Kibert, 2016).

The sector can also provide more green job opportunities by incentivizing companies that use technological innovations in their ventures in order to turn them green and cause less production of waste; cause less CO2 emissions and pursue environmental an ecological practices. There are a few

instances of companies that mobilized green design and green innovation projects and exchanged their knowledge of future technologies to collaborate with global companies. The Netherlands, a country known for having world's most innovative construction sectors, has witnessed its suppliers pushing companies to adopt technological innovations and as a result, two-thirds of projects have adopted technological innovations in their operations (Pries & Doree, 2005). Another example of process innovation is Skanska, a construction company in Sweden that has employed uniquely the software tools to eliminate waste and optimize logistics in building construction, particularly those off-site construction centers order to avoid CO2 emission affect the city dwellers. In collaboration with professional organizations while its workforce received skills training. This transformed its employees into a highly committed green and sustainable workforce (Pries & Doree, 2005).

Clark Construction is another US based building and civil construction company that not only emphasized safety standards and community values but also a sustainability strategy in its work manual. It has set up a sustainability department with the primary objective to train its architects and clients for reducing environmental impacts, to coordinate with other departments regarding certification, green building trends, and use of resources. Similarly, another company, Southern Development Homes, built EcoSmart homes known for their energy efficiency and healthy air. Among several other measures, the company is engaged in recycling the construction waste and knowledge transfer through IT database installed within the company (Pries & Doree, 2005).

However, there are contrary views suggesting that the construction industry is incapable of green innovation and economic sustainability and therefore has failed to achieve economic growth through innovation (Murphy, Perera, & Heaney,2015) due to high cost pressures (Loforte Ribeiro, 2009) long time consuming projects (Ilg, Scope, Muench, & Guenther, 2017) and consumption of chemical products and such mixtures that are hazardous to health and environment. Looking at these uncertainties in the construction sector, the UN also invited proposals of sustainable innovation and setting sustainable development goals (SDGs) from construction companies. In the last two decades Saudi Arabia has experienced rapid infrastructural development in the form of both commercial and residential construction. This has resulted in a heavy increase in energy consumption and CO2 emission (Taleb & Sharples, 2011; SAMA, 2015; Saudi Arabia Sustainable Energy,2015) An estimate reveals that if energy efficiency is not given serious attention to, Saudi Arabia would lose approximately 3 million barrels of crude oil in local consumption only per day (EIA, 2013). Another study (Alrashed & Asif, 2012) also emphasizes upon keeping a check on energy consumption and carbon emissions through construction of energy efficient and sustainable buildings. McKinsey (2008) , however, finds it difficult in the case of Saudi Arabia due to its climate change, over dependence on foreign construction manpower and raw material imports.

1.1. Green Product Innovation

There is still much confusion on what constitutes a green or sustainable product or what green innovation means (Baumann et al., 2002; Berchicci and Bodewes, 2005; Ottman,1997; Peattie, 1995; Roy et al., 1996). Ottman et al., (2006:87) attempts to define it: "the terms 'green product' or 'environmental product' are used commonly to describe those that strive to protect or enhance the natural environment by conserving energy and/or resources and reducing or eliminating use of toxic agents, pollution, and waste." In the construction sector, green real estate projects are defined as projects that are energy efficient, nontoxic, easier to deconstruct and recycle, and have a smaller environmental impact and are economically profitable (UNEP, 2012; USGBC,2015a; 2015b).

Truly speaking green product innovation are significantly improved goods or services that focus on reducing ecological and environmental impact from energy and material resources as well as pollutants and toxic waste (Roy et al., 1996; Dibrell (2011). There are various certification agencies such REACH, Construction Product Regulation (CPR), Building Research Establishment Environmental Assessment Methodology (BREEAM) and Leadership in Energy & Environmental Design(LEED). These regulatory bodies ensue that the construction supply chain complies with legal, technical, environmental requirements of green building.

2. Problem Statement

Growing urbanization has drastically reduced natural resources and led to a deteriorating impact on our planet's natural ecology. The construction of buildings requires a huge amount of raw material and chemicals, which amount to a high release of CO2 emissions, largest (50%) from the construction industry alone. Besides, the constructions sector also requires extraction of concrete, steel, glass and huge soil excavation and their transportation which also consumes a large amount of energy (Wu P et al, 2016). Additionally, the construction waste is diverted to landfills that further destroy the green space (IFMA (2010). Hence, there is an urgent need to find solution and mitigate the impact of construction industry by drawing a balance between climate changes and energy consumption by the industry, it is also important to find out how the construction industry of Saudi Arabia, in particular, could be converted into a leading green sector and whether measures such as product innovation can be useful in accomplishing that task

The research questions that emerge from this problem statement are as follows:

1. What constitutes a green construction sector?
2. How can green product innovation assist in achieving a green construction sector?
3. What are potential barriers hindering the process of green product innovation and how to overcome them?

A study (Glass, 1996) has explored how the construction industry could be created into a green sector through product innovation; however, it has failed to suggest best practices that might be adopted to create a transition mechanism. It is hoped that that the current study highlights such innovative measures that would help companies in the construction sector to initiate the greening process and optimize environmental policies. In addition, the findings of this study will also help legal authorities to legislate schemes and regulations that would pave a way of green innovation in the construction industry.

The next section examines the previous studies followed by a section on the theoretical framework used for this study. Section 5 presents the methodology and section 6 presents findings of the study. The last section concludes the study with suggestions and recommendations.

3. Literature Review

Several studies have attempted to establish relationship between green innovation and economic sustainability,(Cheng, Chang, & Li, 2013) discussing benefits (Häkkinen &Belloni, 2011; Zuo & Zhao, 2014) as well as barriers that impede or delay the green innovation process (Mirow, Hoelzle, &Gemuenden, 2008) but none of these studies have been able to segregate or identify benefits or barriers sector wise. Hence, it is difficult to determine which factor(s) benefit or cause barrier to a particular industrial sector. Additionally, very little is known about what process is adopted in green product innovation and which technology or raw material are best suited to a particular industry or sector. However studies have unanimously agreed on at least three strategic priorities, viz., energy minimization, materials reduction, and pollution prevention. But, in fact, when applied in the construction sector, these priorities could be seen as prerequisites to the project life cycle and productivity (Schmidt, 1995). These three priorities usually would determine the interaction between green product innovation and sustainability or profitability of a sector. For instance, studies (Choi, Jang, and Hyun, 2009; USGBC, 2015a; Turner Co, 2014) investigated and derived conclusion that there exists a direct and positive relation between green innovation and financial performance of a sector. However, this study focused more on the ecological and environmental benefits rather than financial.

In the constructor sector, an example of environmental benefit is the rise in the number of green labeling or green certification particularly observed in technological advanced new building projects (Harrison,1999). The number of LEED-certified projects, for instance, increased by about 518% between 2009 to 2014 (Turner Co, 2014) which, motivated several companies to adapt to green building business practices. The expenditure on LEED-certified projects also increased from USD 103 billion in 2012 to

USD 288 billion in 2017 (USGBC, 2015a). Philippines has introduced Building for Ecologically Responsive Design Excellence (BERDE) which is a green building rating system developed by the Philippine Government through its Department of Energy. It is a step toward environment sustainability and has laid down certain environmental and building laws, compliance of which is just like following the law of the land. Several construction companies use BERDE as a guide for green building and sustainability while local governments have incorporated BERDE as part of their policy making it mandatory for all projects within their jurisdictions to follow its guidelines.

A study by Lafuente et al (2018) examine a sample of 74 knowledge-intensive Businesses (KIBS) in Costa Rica, known for a strong culturally-driven history of following ecological tradition. It is the only nation that has introduced a green trademark for certifying buildings that have strong sustainability credentials. Costa Rica links green product innovation with corporate social responsibility practices. It is made possible by efficiently managing natural resources viz. the country has a 100% renewable electricity for at least 250 days every year. Other measures include wildlife protection, and carbon neutral environment. The study found out that the sampled KIBS had blended product innovation strategies with learning capabilities and entrepreneurial orientation of their employees. These KIBS units work as strategic business models depicting entrepreneurial intent to achieve sustainability and continuous product innovation.

Another study (Cobuidler, 2018) examines the award winning Norwegian software start-up Catenda the "Green Industry Innovation" programme, which employed technological best practices for construction industry in terms of selecting products that are environmentally friendly. In addition to very large efficiency and cost-saving potentials. Employing the product data sheets, for instance, the company explores how the construction companies can use the product data with the help of design and collaboration software tools or ERP solutions. The study claims that the experiment with technology succeeded as the company was able to establish HUBs for green products and eco-friendly infrastructure at various constriction sites. The company claims to have revolutionized this data-based technology as future of the construction industry. Besides the ecological benefits, the software could also help the construction industry to save time, avoid mistakes and exchange product information across the same network. It would also help the business to streamline its various standards of sustainable construction. It can establish a construction process that can proactively alert construction companies against hazards such as resource depletion, environmental degradation due to some infrastructural defects or erroneous product life cycle. The study claims this technological invention to be a tool for achieving a "greener" environment across all the European construction industries.

A similar study (Niero, et al.,2016) explains how SETAC, a not-for-profit, professional organization in Belgium utilized the Product Life-cycle assessment method to judge the environmental and social performance of a construction business in order to create a "sustainable" society using the innovative technologies, SETAC too devised new technological tools for environmental improvement. It provided a forum of research and development in the fields of ecological risk assessment, product life cycle assessment, chemical minimization, and regulation of natural resources for social efficacy as well as financial; sustainability. Sustainability, in other words, has become the main driver of business and technological innovation. A recent survey of McKinsey (2017) on corporate sustainability revealed that 70% of the surveyed companies practiced sustainability governance merging corporate goals with business operations, mostly which claimed increasing operational efficiency through green innovations. Such innovation can rightly be called sustainability oriented innovation, employing organizational or technological resources to get value-added, sustainable innovative products. This is yet another example of product innovation in a knowledge-based economy through entrepreneurial and organizational renewal.

In a qualitative survey of construction organizations, Ilg (2018) found a virtuous circle hanging around the construction industry wherein the green innovation is driven in order to generate and sustain economic growth. This results in stronger self –efficacy of or organizations increase in their core competences. Such organizations are also able to cope up with such barriers like huge costs and complex processes involved in the construction business. The author suggests that this could happen

only due to the pull effect of green leaders who are able to monitor the financial and environmental benefits of green project through developing awareness among consumers and investors and knowledge transfer between stakeholders. Similar studies (OECD, 2017; Dibrell, 2011) provide evidence of a low impact on environment due to the firm innovativeness resulting in ecological benefits and increase in the demand for green buildings.

Last but not the least, there is an interesting study that recommends a business model for green projects in construction of buildings. This business model comprises elements such as health of the building occupants, indoor air quality, employee productivity and employee satisfaction (Turner Co, 2014). Similarly, employees of LEED certified construction companies show lower absenteeism and tardiness (UNEP, 2012). Such elements have paved the way for green construction replacing the conventional construction (USGBC, 2015a), it has been reported that Turner Construction generated more than half of their revenue (USD 5 billion in 2014) from green infrastructure projects adopting this business model.

4. Theoretical Framework

The framework for this is derived adapted from Dangelico & Pujari, 2010, a pioneering work on green product that emphasizes eco product innovation through developing a product with low input of material, energy with less pollution during the product life cycle. Originally designed for the manufacturing process, this framework can also be applied to the construction process which shall be attempted in the current study. In the construction companies, for instance, the utilization of resource in material and energy should aim at minimization of waste through the use of recyclable and nontoxic material, which also helps in reducing pollution. Energy efficiency can be accomplished during the construction process by implementing such methods that reduce the energy usage or operates on renewable energy resources. This study emphasizes that green product innovation in construction sector is also multi-faceted process like any other sector having raw material, energy, and pollution making a major impact on the environment at various stages of the product's (building) life cycle. Hence, if a construction company utilizes material produced worth green product technology, consumes energy through renewable energy resources and implements a cleaner pollution technology in the building process, it is quite likely that the construction process will not make any impact on the environment.

5. Methodology

This study adopted a qualitative approach in order to examine green product innovation principles practiced in the sampled organizations. The three sampled companies were based in the industrial towns of Saudi Arabia, Jubail and Yanbu. These companies were chosen because of their accessibility, and the commitment they had shown towards ecological and environmental sustainability as was evident from their winning environmental awards or having environmentally-specific policies in force. The data was collected through in-depth interviews with the top management responsible for framing policies and strategies, company documentation and published data sources (Patton, 1990; 2002; Yin, 1981,1989). A multiple case study methodology Yin (2003) was adopted to examine the extent to which each company practiced green measures or new product innovation. Since it was a challenge to examine the interrelationship between raw material, energy, and pollution - the three variables of the study, in the construction industry, the case study method was preferable to a quantitative analysis (Gerring,2004). The unit of analysis in this study was therefore green product innovation projects. This helped the researcher to examine the extent to which construction companies engaged in green product innovation, or addressed to the sustainability issues involving , material, energy and pollution

6. Findings and Results

Stake (1995; 2005; 2010) and Yin (2014), advocate the use of categories to describe the multiple case studies, for a simultaneous generalizability of constructs and themes (Creswell, 2009). As a result, such

causal patterns would emerge in all documents and interviews transcripts that would help identify and cohesively present the green product innovation strategies followed in each case organization. The researcher was hence able to integrate all these constructs and patterns with one another and develop a meaningful, sequential and explanatory framework of study (Miles and Huberman,1994). Literally speaking, this study began with the selection of the sampled organizations and a data collection procedure after conducting data collection for one case study, the researcher made an interim analysis of the contents of the data with respect to the research questions of the study. Such type of analysis allowed the researcher enough time to modify the approach or change the data collection protocol before marching on to the next set of case studies (Miles & Huberman, 1994).

Interviews with company officials allowed a better understanding of the motivational aspect that influenced companies to go 'green' and adopt green practices. Compliance to regulations and usage of technology were the strongest priorities. At all companies, the researcher discovered restriction on CO2 and the usage of certain hazardous substances along with reducing waste. Besides, the regulations too compelled the sampled organizations to green their construction processes; however, in the case of a few projects, environmental regulations do not present a few constraints for companies such as economic losses or risks of a breakdown. However, on the contrary, a variation emerged from discussions with the interview informants. A few admitted that the compliance with environmental regulations rather helped in the risk minimization and increase of revenue. Regulations also often proved an opportunity to create new business.

It was also observed that all companies under study had aligned green product innovations and environmental sustainability with their business policies and strategies, a common phenomenon in manufacturing organizations (Porter and Reinhardt, 2007; Aragon-Correa and Sharma, 2003; Dyllick and Hockerts, 2002; Sharma and Vredenburg, 1998). The company informants also unanimously agreed that the adoption of green products innovations strategies improved the company's reputation and led to a competitive advantage It was also suggested that, in a fast developing country like Saudi Arabia with extreme climatic conditions, the adoption of green product innovation strategies would create more growth opportunities.

One of the reasons why green product innovation is found slow in several sectors including the construction industry is the lack of adequate technology and high production costs. Companies find it difficult to compete with brands and their business rivals as they lack technological knowhow as it was highlighted by several informants in this study. The insufficient technological tools and equipment resulting in high production cost in projects also discouraged companies and individuals to participate in green product innovations. Another key issue observed in this study was the lack of awareness about green products' benefits. Many companies owing to petty labor issues, climatic conditions and other priorities fail to understand the value added to product sustainability due to green product innovation strategies. Due to the awareness about eco-design advantages, or waste reduction, these companies often face difficulty in availing the competitive advantage even in domestic projects.

Some of the informants also opined the barriers in the construction of green buildings in Saudi Arabia, among which lack of skilled labor and eco-friendly regulations were the most significant ones. In addition, issues such as poor project management, incompatible designs, and skills deficiency are a few other challenges that construction companies face in green product innovations (McKinsey Global Institute, 2017). Other documents (Larsson & Clark, 2000) reveal issues of assembling techniques, higher costs for material testing and insufficient monitoring as other barriers to green innovation.

These findings are consistent with (Rahbar,2006;Ottman,et al., 2006; Greenbiz: 2009; Pujari, et al, 2003;2004; 2006;) who advocated green innovation for environmental sustainability, minimization of energy consumption and carbon emissions, reduced operation costs and social benefits like health and good living conditions; with (Mosly, 2015).who emphasized Saudi Arabia should work towards energy efficiency and sustainable buildings; with Rahman & Khondaker (2012) who insisted for such initiatives like reduction of greenhouse gas emissions and access to appropriate technology with a supportive legislation.

7. Conclusion

It is evident from the findings of this study that construction companies are although motivated to develop green products but fails to accomplish any benefits due to several barriers. Our results also show that environmental regulations prove both constraints as well as opportunities for risk minimization and cost benefits or new business opportunities. The results also highlight that environmental sustainability can be aligned with business strategies in order to increase efficiency in the use of resources, material and energy conservations. It is suggested that construction companies should focus on skills enhancement of their employees through trainings and might also initiate a few pilot projects in order to initiate a culture of green innovation and monitor the introduction of new technology.

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