Full paper

International Journal of Real Estate Studies

INTREST

Implementation of Environmental Sustainability Strategies for Real Estate Development in Developing Nations: An Empirical Study from Ghana

Iddrisu Kasim[1]*, Ibrahim Sipan[2,3], Dzurllkanian @ Zulkarnain Daud[3], Kamalahasan Achu[3], Ebenezer Afrane[1]

[1]*Department of Estate Management, Faculty of Built and Natural Environment, Kumasi Technical University, Kumasi, Ghana*
[2]*Centre for Real Estate Studies, Universiti Teknologi Malaysia, Skudai, Johor, Malaysia*
[3]*Department of Real Estate, Faculty of Built Environment and Surveying, Universiti Teknologi Malaysia, Skudai, Johor, Malaysia*

*Corresponding author's email: iddrisukasim@gmail.com

Article history: Received: *23 November 2019* Received in revised form: *30 August 2020*
Accepted: *18 October 2020* Published online: *21 December 2020*

Abstract

Real estate development is an important physical development activity in every economy. However, conventional real estate development poses multiple threats worldwide to environmental sustainability especially in emerging economies. As a developing country, Ghana is one of countries that did not attain Millennium Development Goals (MDG7 for instance) before the promulgation of Sustainable Development Goals (SDGs). Therefore, this paper examined the main environmental sustainability strategies implemented by real estate developers in Ghana to safeguard the environment. After synthesizing relevant literature on real estate development in the context of sustainability, a conceptual basis for the research was established, then a closed-ended questionnaire was set and used to gather field data from purposively sampled developers from Accra and Tema Metropolitan areas which are noted for active real estate development in Ghana. Using descriptive (frequencies and weighted mean ranking) and inferential (chi-squared) statistics, the field data was analyzed using SPSS v23. The analysis revealed that out of the ESS attributes for real estate development established from the literature, less than 30% were mostly implemented in the country. With a p-value of 0.05 (chi-squared), none of the main attributes of Energy Efficiency (EE) and Water Efficiency (WE) strategies were implemented during the post construction stage of real estate development (RED) process albeit they implemented at the pre-construction to the construction stages. However, except one of the three Sustainable Site Planning and Management (SSPM) strategies which was not implemented in the pre-construction stage, the rest were implemented through the RED process. Hence, the level of implementation of strategies SSPM, EE, WE and construction materials and resources efficiency (CMRE) for real estate development was generally low. As a result, stakeholders in the physical development process of the country need to significantly influence real estate developers to implement more environmentally efficient strategies in real estate development.

Keywords: Environmental sustainability, sustainable development strategies, real estate development, developing country, Ghana

■1.0 ENVIRONMENTAL ISSUES WITH CONVENTIONAL REAL ESTATE DEVELOPMENT

Real estate, sometimes referred to as real property, is defined as "space delineated by man, relative to a fixed geography, intended to contain an activity for a specific period" (Graaskamp, 1981/1992, p. 620). Other academics explain that real estate is land together with any physical improvement affixed to it (Yoegel, 2017). Thus, the term real estate is used thematically to mean tangible assets or structures affixed to land; bundle of rights associated with land ownership and use; and all improvements to land; the industry and or businesses involving appraisals, acquisition, operation and disposition of physical structures and improvements affixed to land (Ling & Archer, 2018; Romero, 2013). Consequentially, real estate development (RED) refers to the construction and management of a physical product resulting from vacant land or improving an existing physical product affixed to land (DeLisle & Worzala, 2012; Nelson, 2014).

Therefore, the real estate industry contributes immensely to the development of nations. Like gross domestic product measures the economic outlook of a nation within its boundaries, real estate measures the real wealth or level of prosperity of a nation in terms of that nation's physical development. Real estate development, in spite of its facilitating role in national development, consumes huge environmental resources, generates huge volumes of waste and high levels of pollution that negatively impact both natural and built environments (Huang et al., 2018; Hussin et al., 2013). This makes real estate development a major environmental threat to sustainability in developing and developed countries (Darko et al., 2018; Mensah et al., 2019; Ratcliffe et al., 2009; UNEP, 2012).

In the United States of America, for example, the Environmental Protection Agency discovers that housing developments account for 43% of construction's industry wastes. Also, the National Association of Home Builders Research Center reports that approximately 8,000Ibs. of physical development wastes are produced from a modest 2,000 square foot residential property (Borgese, 2008; Senick et al., 2011). In terms of aggregates, on the average, real estate development produces 6,860kg of waste per home of which 4480kg are debris from construction and 2,380kg are different types of solid wastes (Hussin et al., 2013). These wastes are generated because of factors including variations in designs, poor quality of materials, contractor's errors, improper site management, errors in procurement, materials unable to meet specifications (Hussin et al., 2013; Lu et al., 2011; Mokhtar & Mahmood, 2008; Wahab & Lawal, 2011). Real estate development, then, remains a primary cause of excessive exploitation of environmental resources for the creation of built environments and thereby contributes to carbon emissions and pollution during extraction of construction materials and erection of structures (Amoateng et al., 2013; Borgese, 2008; Huang et al., 2018; Kheni & Akoogo, 2015; Senick et al., 2011). The huge volumes of environmental resources and materials depleted through the development process cannot be sustained if the renewable capacity of the ecological resources continue to be less than the rate of depletion (Daly, 1990).

As a result, conventional real estate development (CRED), being classical method to property development that views real estate as only valuable till it serves no purpose, demolished and predisposed to pave way for the construction of a new property, has been one of the main causes of soil degradation, deforestation, air and water pollution (Borgese, 2008). This 'disposable' real estate development concept, apart from its immense consumption of building materials, increases the pressure on landfill and dumping sites. CRED, also, promotes development of substandard projects by developers who have no intention to lodge in such properties (Borgese, 2008; Keeping & Shiers, 2004). Yet CRED, despite being environmentally inefficient, remains the most common property development approach in developing countries like Ghana.

Thus, being a key product of town and country planning, real estate development projects have much effect even outside their localities because of the provision of public amenities and infrastructure to support real estate development (Hussin et al., 2013; Senick et al., 2011). In this regard, developing real estate without measures to ensure energy and water conservation as well as other environmental resources would lead to rapid depletion of environmental resources, more carbon emissions and accelerated global warming (Borgese, 2008; Hussin et al., 2013; Keeping & Shiers, 2004). There would be high negative environmental effects should developers treat real estate development particularly the construction phase as provisional activity having a short-term thereby failing to implement environmental strategies to reduce projects' environmental cost (Hussin et al., 2013). In Ghana, the absence of purposed-designed environmental sustainability guidelines for physical development illustrates the severity of the issue of sustainability of the environment in the real estate industry. The problem is exemplified in Ghana's failure to meet MDG Goal 7 which focuses on the importance for the international community of nations to ensure global environmental sustainability as at 2015 (Mensah et al., 2015; Sengupta et al., 2015).

Although following the promulgation of SDGs after the MDGs expired, there is a shift towards sustainability of environment through real estate development in most countries (Du Plessis, 2007; Nelson, 2007), and development of sustainable cities in some developed countries (Abidin, 2009; Abidin et al., 2013; Kibert, 2013; Mensah et al., 2015), real estate development in Ghana remains primary source of environmental destruction (Amoateng et al., 2013; Kheni & Akoogo, 2015; Kwakye, 2010). From the above, implementing environmental sustainability strategies (ESS) in real estate development (RED) to ensure sustainability of the environment in Ghana should be prioritized. However, there is very little information on the kinds of strategies implemented through real estate development to improve environment efficiency of the country. This research fills that gap by exploring the various ESS implemented in RED to conserve environmental resources in Ghana. As a result, the study sought to identify the attributes of ESS implemented by real estate developers in Ghana and how they are being implemented through the development process to help the country contribute to global environmental sustainability efforts.

2.0 ENVIRONMENTAL SUSTAINABILITY IN REAL ESTATE DEVELOPMENT

2.1 Concept of Environmental Sustainability and its Application in Real Estate Development

According to Daly (1990), environmental sustainability relates to renewability and non-renewability of resources and the bearable and unbearable levels of pollution. Regarding resources renewability, sustainability of the environment is attained when the rate of regeneration does not exceed the rate of harvest of ecological resources. Concerning non-renewability of resources, sustainability of the environment is ensured when renewable substitutes of non-renewable resources are developed to prevent the diminution of non-renewable resources. With regards to pollution, the rates at which wastes are generated should not be greater than the assimilative capacity of the environment. In brief, Daly's explanation of environmental sustainability suggests a situation in which consumption rates of renewable resources, levels of depletion of non-renewable resources and levels of pollution generation can be maintained in perpetuity without causing severe negative impacts to the survival of humanity. Thus, environmental sustainability is at critical risk once these rates cannot be sustained. In other words, sustainability of the environment is "a condition of balance, resilience, and interconnectedness that allows human society to satisfy its needs while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity" (Morelli, 2011, p. 23).

From real estate development perspective, DeLisle (2008) refers to sustainability as efficient use of scarce real estate in an equitable and socioeconomically responsible manner such that there is an optimal balance between space users and the space produced for existing but effective demand without compromising the space needs of future generations. The above explanation links with the general meaning of sustainability which is the balancing of needs of current generation without negatively undermining the needs of future generations (Emas, 2015; Nikolova, 2016; Redclift, 2005; WCED, 1987). In line with the above fundamental principles of sustainability, Abidin et al. (2013) argue for a strategic shift from classical approaches to physical development which negatively affect projects' environmental performance to environmentally efficient approaches which improve environmental efficiency of the natural and built environment. To this end, developers together with their consultants need to be encouraged to include environmental and social factors in their key performance indicators (KPIs) for real estate development projects besides cost, quality and time criteria (Siew et al., 2013) to demonstrate strong commitment for environmental sustainability goals (ESGs) for real estate development. Figure 1 below illustrates the concept of sustainability in real estate development.

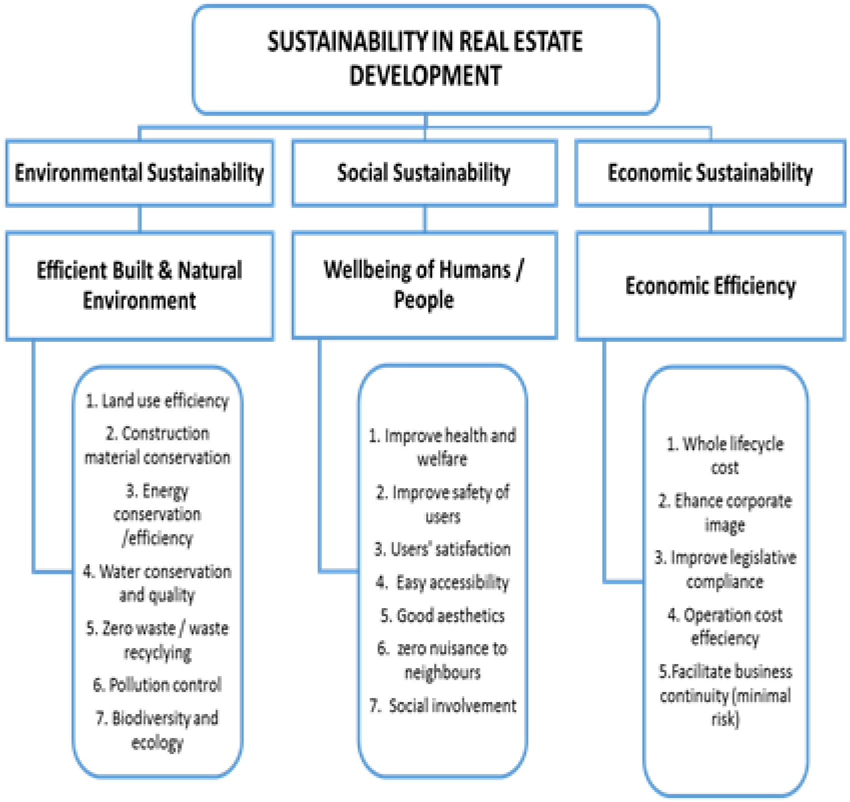

Figure 1 Sustainability dimensions for real estate development
(adapted from Abidin, 2009, 2010; Keeping & Shiers, 2004)

2.2 Developing Environmentally Sustainable Real Estate

A real estate asset is environmentally sustainable when each stage of the development (pre-construction, construction, post construction) improves the environmental impacts of the project over its lifecycle (Ahn et al., 2017; Mensah et al., 2019; Pearce et al., 2017). Thus, developers can contribute to efforts to ensure environmental sustainability by purposefully developing environmentally efficient properties. As a result, an environmentally sustainable real estate development (ESRED) refers to a model of real estate development whereby adverse impacts of the project on the environment are drastically minimized through the development process (Addae-Dapaah et al., 2009; Christensen, 2012; DeLisle et al., 2013; Keeping & Shiers, 2004; Warren-Myers, 2012). The purpose of ESRED is to ensure that the economic motives behind real estate development does not undermine the environmental efficiency of the project through the development lifecycle (DeLisle et al., 2013; Emas, 2015; Nikolova, 2016; Redclift, 2005). Therefore, developers can pursue ESRED by establishing ESGs and implementing the appropriate ESS through the development process (site planning and design stage, construction of physical development stage, operation and management stage) to attain the ESGs set out for the project as exemplified in Figure 2.

2.2.1 Some Environmental Sustainability Goals for Sustainable Real Estate Development

It is beyond the scope of any book to, in great details, discuss or explain all the aspects of environmental sustainability through the phases of real estate development (Ratcliffe et al., 2009). In line with this standpoint, this part of the study highlights some environmental sustainability goals (ESGs) developers may have to achieve through real estate development for environmentally sustainable real estate development. By definition, ESGs are a set of aims for environmental efficiency to achieve throughout the real estate development process. Generally, ESGs for real estate development focus on fresh air, clean land, fresh water, zero waste, acceptable emissions, resource efficiency (Ratcliffe et al., 2009). In spite of different stages of the development process as found in literature, "the pre-construction (site planning and design – SPD)", "construction (construction and physical development – CPD)" and "post construction (operation and management – OM)" stages are the major phases with significant impacts on the environment. Consequently, some common environmental sustainability goals expected at every phase of real estate development process are presented in Figure 3.

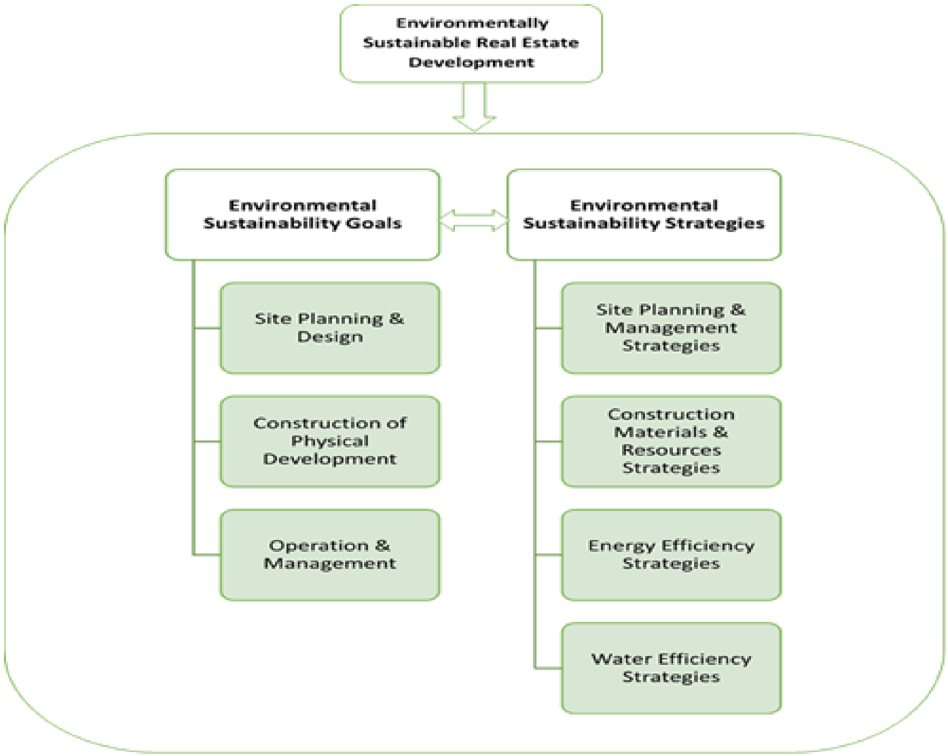

Figure 2 Dimensions of environmentally sustainable real estate development
(Adapted from GBI-Malaysia, 2013; OECD, 2001)

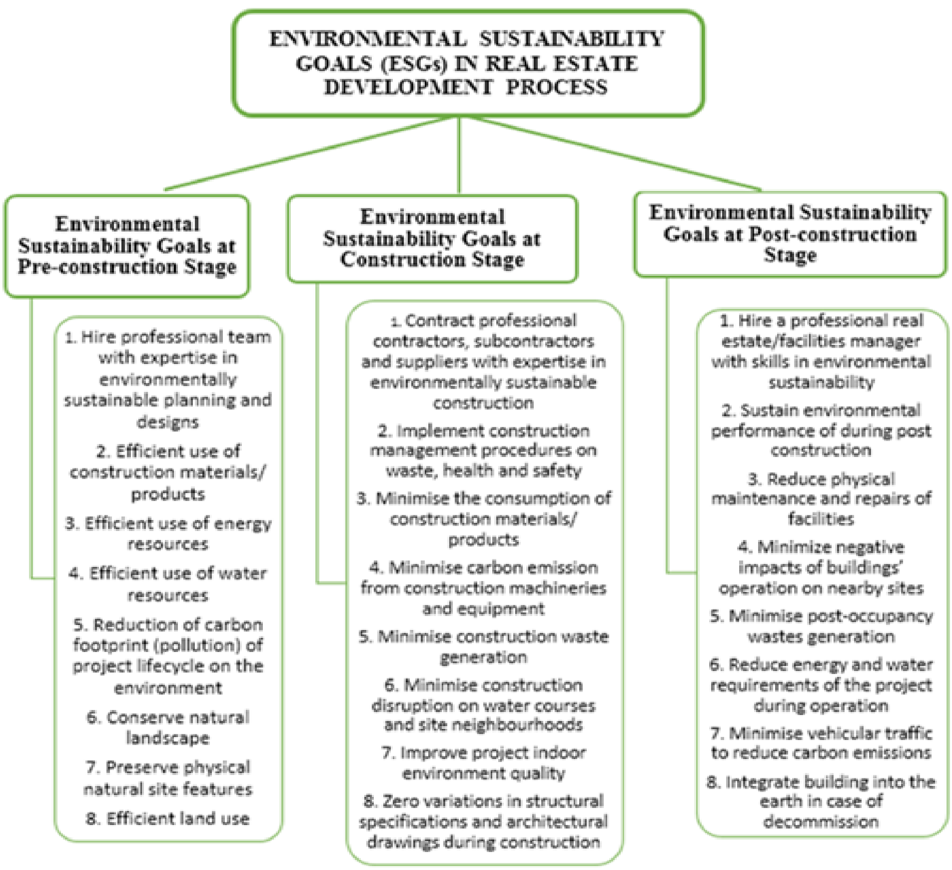

Figure 3 Some ESGs for the three main phases of real estate development process
(Authors' construct based on Table 1 below)

2.2.2 Some Strategies for Developing Environmentally Sustainable Real Estate

Through the real estate development process, creative strategies should be implemented to minimize energy usage, enhance indoor environments for occupation as well as reduce environmental resource consumption. The Organisation for Economic Co-operation and Development – OECD (2001) advocates that sustainable development needs to reflect "the short and long term economic, social and environmental objectives of society – through mutually supportive approaches wherever possible – and manages trade-offs where this is not possible". As a result, the development team under the coordination of the developer or their representative should ensure optimum environmental performance of physical developments by employing sustainable strategies from design to construction through to operation and management (Keeping & Shiers, 2004). The implementation of such strategies would minimize the adverse impacts of built environments on the natural environments.

From Table 1, the categories of ESS identified together with their attributes for environmentally sustainable real development were sustainable site planning and management (SSPM), construction materials and resources efficiency (CMRE), energy efficiency (EE) and water efficiency (WE). SSPM strategies refer to the various approaches that can be implemented through real estate development to ensure that land use requirements of the real estate project are sustainable. CMRE strategies also includes all efficient ways of ensuring that the materials and other resources used in the construction of real estate so as to effectively reduce the environmental footprints of the real estate asset. EE refers to all environmentally efficient energy approaches applicable in real estate development projects to effectively minimize the energy requirements of the project whereas WE stands for water conservation strategies implementable in real estate development to ensure that the water requirements of the projects do not become wasteful not adversely affect sources of water supply. The various attributes or indicators of each strategy gathered from secondary sources have been presented in Table 1.

Table 1 Some environmental sustainability strategies necessary to achieve environmental sustainability goals in RED

No.	ESS	Attributes	References
A	Sustainable Site Planning and Management (SSPM)	1. Plan and site real estate project to fit into the community's master plan 2. Integrate natural feature in building designs 3. Provide access to public mass transit and, pedestrian and bicycle paths and sidewalks 4. Reuse existing buildings through refurbishment, conversion and adaptation or extension of existing real estate 5. Site real estate development projects close to existing public infrastructure 6. Develop non-arable lands for real estate construction projects instead of fertile farmlands or forest 7. Adopt greener transport policies such as car-sharing schemes for building users, facilities for bicycle users. 8. Use geotextiles and silt fences during construction to prevent erosion and enhance free flow of surface water 9. Use natural drainage systems such as swales, streams 10. Incorporate natural landscape into construction project 11. Restrict amount of soil taken off project site	Akadiri et al. (2012); GBI-Malaysia (2013); GRI (2008); Howe (2020); Keeping and Shiers (2004); Ratcliffe et al. (2009); Wilkinson et al. (2008)
B	Construction and Material Resources Efficiency (CMRE)	1. Use environmentally friendly materials in building design 2. Re-use building materials and products from existing structure on site or from local or regional sources 3. Procure recyclable construction materials 4. Use environmentally efficient materials for maintenance and repair works 5. Use durable construction materials 6. Adopt timber preservation treatments 7. Use non-toxic materials or harmless cleaning fluids, paints and solvents 8. Use native plants and lawns for landscaping instead exotic plants and lawns 9. Order in-demand construction materials only 10. Separate site waste materials for recycling 11. For existing real estate redevelopment, demolish by orderly dismantling recyclable components for reuse.	Akadiri et al. (2012); Asif et al. (2007); GBI-Malaysia (2013); Howe (2020); Keeping and Shiers (2004)
C	Energy Efficiency (EE)	1. Use energy efficient materials and construction devices/machinery 2. Adopt alternative but very low or zero carbon energy 3. Seal and insulate buildings or tighten building envelopes 4. Design low energy intensive transportation 5. Orient buildings to capitalize on passive energy (daylighting) 6. Position buildings to capitalize on 'natural ventilation' 7. Encourage use of energy-efficient lighting devices and appliances 8. Adopt green transport policies such as car-sharing schemes for building users, facilities for staff using bicycles 9. Plant trees at strategic points to reduce heating and cooling 10. Educate building users on simple ways to conserve energy 11. Reduce transportation distance for building materials	Akadiri et al. (2012); GBI-Malaysia (2013); GRI (2008); Howe (2010); Keeping and Shiers (2004); Schimschar et al. (2011); UNEP (2012); US-DOE (2008)

D	Water Efficiency (WE)	1. Protect watercourses within and around the project site 2. Adopt local plants that can thrive in drought conditions for landscape 3. Recycle 'grey water' for irrigation of landscape, car wash 4. Incorporate water-efficient plumbing fixtures (pressing reduction or using low water consumption water closets, urinals, sinks) into designs and construction 5. Integrate dual plumbing system to control portable water usage 6. Adapt rainwater harvesting building design 7. Design low water-demand landscaping 8. Promptly fix plumbing leakages 9. Educate building users on simple ways to conserve water	Akadiri et al. (2012); Asare (2014); GBI-Malaysia (2013); Howe (2010); Ilha et al. (2009); Keeping and Shiers (2004); McCormack et al. (2007); Sev (2009); UNESCO (2003); US-DOE (2008)

2.3 Derivation of Theoretical Framework for ESS Implementation in RED Process

The review identified ESS and their attributes that are can be applied in real estate development. The implementation of these ESS through the real estate development process is theoretically systematic, thus chronological as hypothesized in Figure 4 below. Accordingly, the developer is expected to identify a set of ESGs to achieve and identify the appropriate ESS to implement to achieve those ESGs through the RED process. The level of implementation of ESS in RED contributes to the real estate project's environmental efficiency. The arrows in Figure 4 show the ideal flow of the implementation of ESS in the development process to develop an environmentally sustainable real estate.

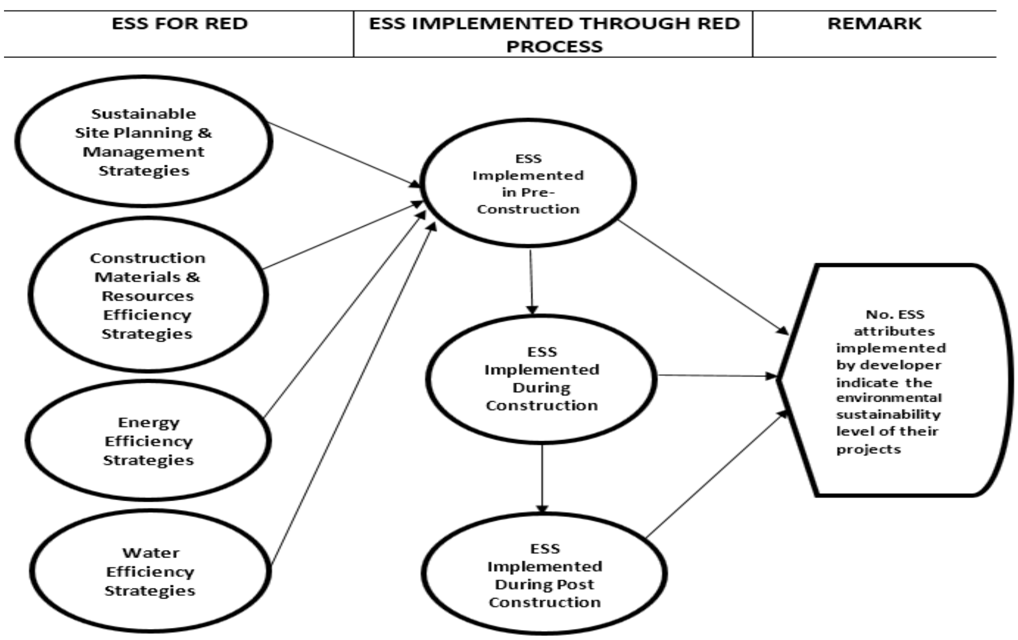

Figure 4 Implementation of ESS through RED process from environmental sustainability perspective
(Authors' construct based on literature review)

■3.0 METHODOLOGY

In the exploration of construction professionals' viewpoints on factors affecting some aspects of sustainable development in construction in Ghana and South Africa respectively, Djokoto et al. (2014) and Smallwood (2015) applied quantitative method. Accordingly, the quantitative research approach of inquiry was employed in exploring the main ESS attributes implemented by Ghanaian real estate developers.

Generally, researchers would apply a methodology that facilitates the conduct of secondary, afterward, apply the knowledge acquired for primary research (Iacobucci & Churchill, 2010). In line with the above, literatures from books, journals, trade and industry magazines, policy documents, reports, news media, unpublished and published theses covering sustainability of the environment in the context of real estate development were reviewed to set a conceptual basis for the primary research. After identifying the attributes of ESS for RED in literature, some real estate developers in Accra-Tema metropolises were asked to identify the ESS attributes they implemented in real estate development. The field data was aided the researchers to answer the research question (Saunders et al, 2009). Thus, the researchers used standardized and pre-designed instruments with pre-meditated corresponding responses based on the research aim (Yilmaz, 2013) to gather the primary data.

Based on Taro Yamane's formula (Yamane, 1967), 114 developers were purposively sampled from Ghana Real Estate Developers Association (GREDA). GREDA has 160 registered members with 95.58% of the members situated and operating from the Greater Accra region of Ghana while 2.94% and 1.47% are located and operated in Ashanti and other regions respectively (GREDA, 2018). The 95.58% of 160 (153) in the Greater Accra region was treated as 100% of developers in the region out of which 114 developers with basic knowledge and experience in sustainability were purposively sampled. The purposive sampling offered the researchers higher degree of freedom to select only respondents who were knowledgeable on the issues being investigated and willing to participate in the research (Singh & Masuku, 2014; Yilmaz, 2013; Saunders et al., 2009). The survey questionnaires were then administered on the field with the help of research assistants.

Field data was descriptively and inferentially evaluated using SPSS v23. The number of questionnaires returned was expressed as a percentage of the 114 population to ascertain the reliability of the survey outcome. Means of the ESS attributes were weighted and ranked to identify the highest and lowest means in order to determine the major ESS attributes based on whether or not they were mostly implemented the developers. According to Business Dictionary (2019), weighting is a statistical approach whereby given data item like an average is highlighted instead of other data items making up a group or summary. That is each data item is given a figure that illustrates its relative significance in relation to the rational for the data collection. A chi-squared test was then conducted to find out the stages of the development process the most prioritized ESS attributes were implemented. Structurally, the methodology applied in the study is depicted in Figure 5.

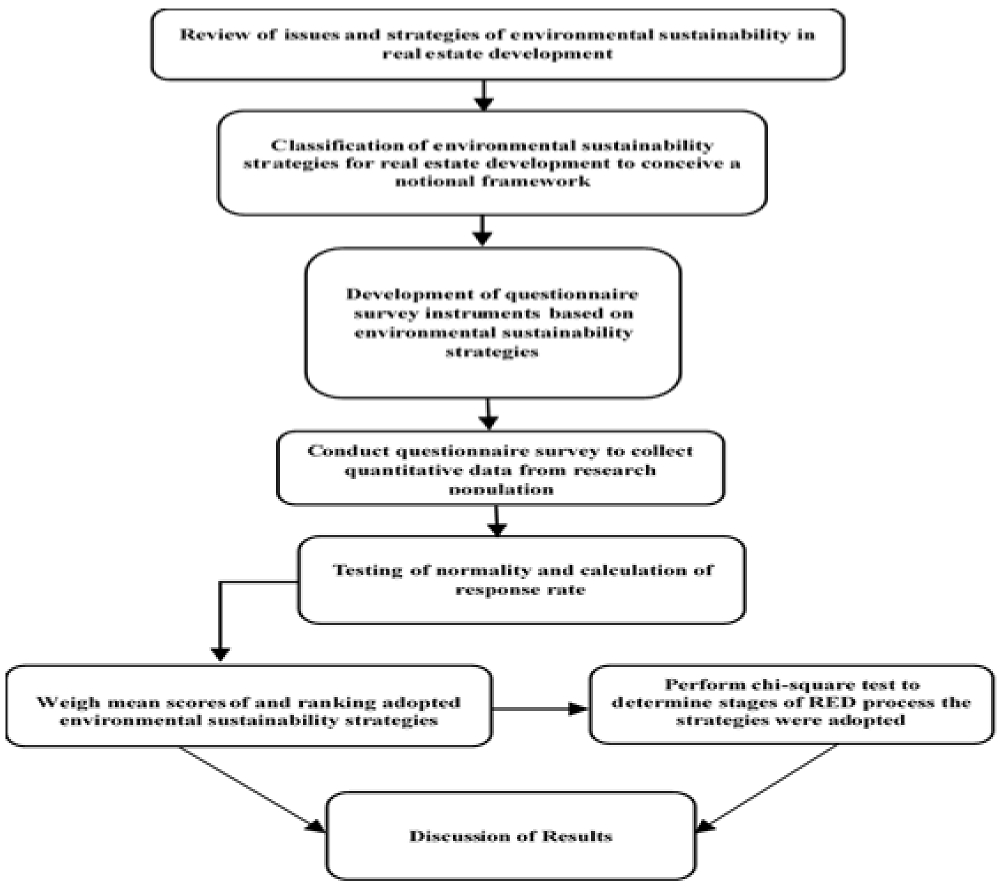

Figure 5 The research process (Authors' construct)

4.0 PRIMARY DATA ON IMPLEMENTATION OF ESS IN RED IN GHANA

4.1 Preliminary Results

The response rate obtained for the study was approximately 84.20% (this is derived from 96 answered and returned questionnaires out of 114 that were distributed). A normality test revealed that the constructs were normally distributed. The values of the variables fell within the range of +2 to -2 (Field, 2016; Hair et al., 2010) indicating the normality of the data (see Appendix B). From same Appendix B, the standard deviations of the mean values of all the measured variables (ESS attributes) were within the acceptable range of ± 2 as reported by Barde and Barde (2012). A Cronbach's alpha value of 0.867 was generated for 56 key items used in the questionnaire survey (see Table 2). Thus, Cronbach's alpha value of 0.867 exceeded Nunnally and Bernstein's (1994) recommended value of 0.6 and was within 0.80-0.89. The reliability of the survey instrument was good (see Table 2) as a response rate of 84.20% was recorded. The results of the survey were, thus, suitable for testing the research objective.

Table 2 Reliability statistics for items of the variables

Cronbach's alpha		**0.867**
Number of items		56
N (sample size)	Valid	91 (94.8%)
	Excluded[a]	5 (5.2%)
	Total	96 (100%)

a. Listwise deletion based on all variables in the procedure

From Figure 6 below, most of the respondents were real estate professionals (66.70%, n=96) and project managers (32.30%, n=96) with over 46.90% (n=96) being postgraduates (see Figure 8). In Figures 7 and 9, 34.40% (n-=96) of the respondents have been in real estate development business for more than a decade and possess more than ten (10) years of experience in sustainable real estate development while 46.9% (n=96) having less than ten (10) years' experience as they have been in business for less than ten (10) years. Nonetheless, all the respondents are aware of environmental sustainability because of Ghana Green Building Council's eco-community national framework launched about a decade ago to promote sustainable community development (Asaase, 2012) as evident in Figure 9. For detailed respondents' profile, see Appendix A.

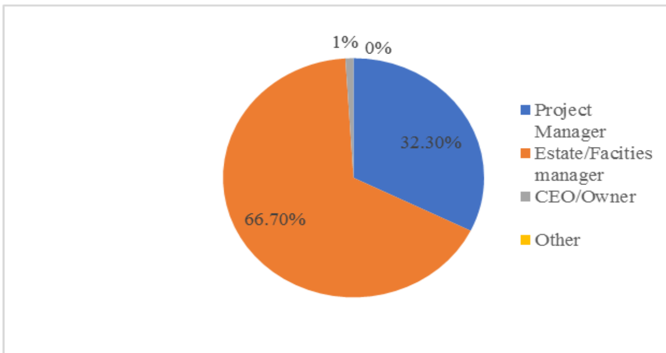

Figure 6 Respondents' roles in the industry

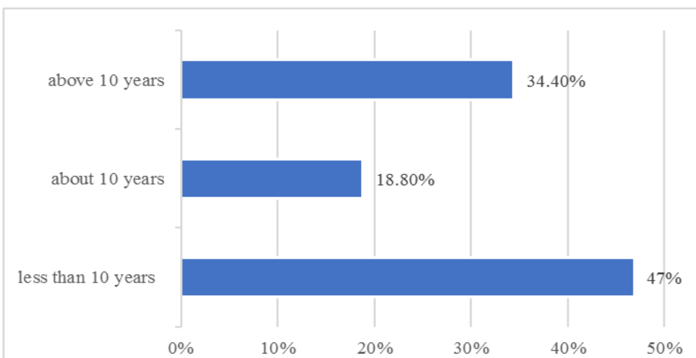

Figure 7 Level of industry experience

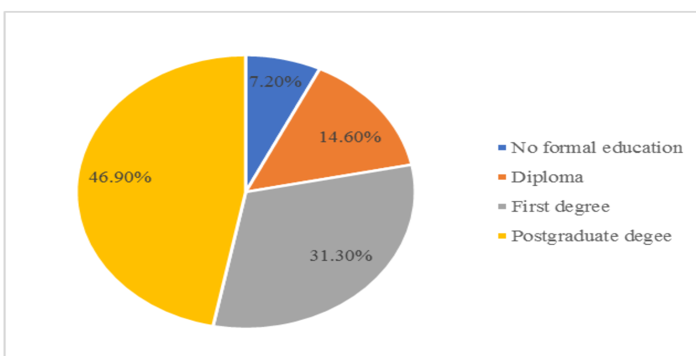

Figure 8 Level of education

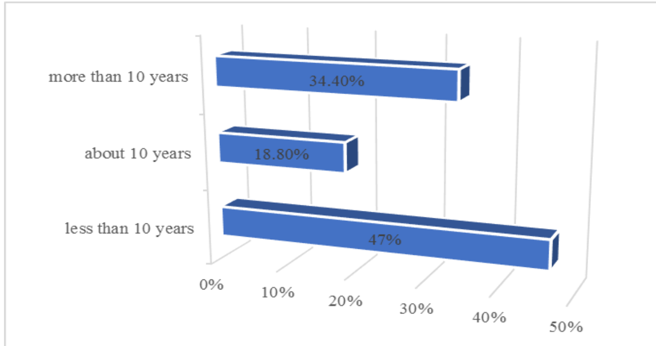

Figure 9 Years of experience with sustainable real estate development

4.2 Major Attributes of ESS Implemented in Real Estate Development in Ghana

The research aim was accomplished through the calculation of mean scores of ESS attributes implemented by the developers and ranking the outcomes per the weight of each score with the proposed mean score criterion adapted from Ibrahim et al. (2015). From Table 3 below, an attribute with a mean score above 4.0 on the scale for level of implementation (1 to 5, where 1 means *not implemented* while 5 means *mostly implemented*) as used in the data collection instrument was deemed as '*major'* since the average mean for the scale was (1+2+3+4+5)/5 = 3.0.

Table 3 Interpretation of mean scores for attributes of ESS (adapted from Ibrahim et al., 2015)

Mean score	Explanation	Comment
Less than or equal to 1	Not implemented	Not applicable
Greater than 1 but less than or equal to 2	Least implemented	Not major
Greater than 2 but less than or equal to 3	Less implemented	Not major
Greater than 3 but less than or equal to 4	Much implemented	Not major
Greater than 4	**Mostly implemented**	**Major**

Based on Tables 3 and 4, major ESS attributes for development of real estate in the country include attributes with mean scores greater than 4.0 (see mean ranking in Table 4). The complete list of all the 42 attributes is found at 'Appendix B' from which Table 4 was extracted. Only 12 attributes representing 28.57% of the 42 ESS attributes were mostly implemented in development of real estate. In terms of categories, only 3 out of 11 "*Construction and Material Resources Efficiency (CMRE)*" attributes were major, likewise "*Sustainable Site Planning and Management (SSPM)*". For "*Energy Efficiency (EE)*" attributes, out of 11 identified from literature, only 2 were mostly implemented in the development of real estate. With respect to "*Water Efficiency (WE)*" strategies, only 1 attribute out of 9 was mostly implemented. From Table 4, the ESS attributes are ranked based their mean scores and in accordance with the priority at which they were implemented for real estate development. Thus, SSPM3, CMRE5, EE5 and WE8 were highly prioritised as ESS attributes for real estate development.

Table 4 Summary of mean ranking of ESS attributes for sustainable real estate development

ESS Categories	Code	ESS Attributes	Mean	Ranking within Groups	Ranking of All ESS
Sustainable Site Planning and Management	SSPM3	Incorporate natural landscape into construction project	**4.32**	**1**	3
	SSPM1	Plan and site project in community's master plan	**4.19**	**2**	6
	SSPM2	Integrate natural feature in building designs	**4.01**	**3**	12
Construction Materials and Resources Efficiency	CMRE5	Use durable construction materials	**4.47**	**1**	1
	CMRE7	Use non-toxic materials or harmless cleaning fluids, paints and solvents	**4.40**	**2**	2
	CMRE9	Order in-demand construction materials only	**4.30**	**3**	4
	CMRE6	Adopt timber preservation treatments	**4.15**	**4**	8
	CMRE1	Use environmentally friendly materials in building design	**4.11**	**5**	1
	CMRE4	Use environmentally efficient materials for maintenance and repair works	**4.10**	**6**	10

Energy Efficiency	EE5	Orient buildings to capitalise on passive energy – daylighting	**4.23**	**1**	5
	EE6	Position buildings to capitalise on 'natural ventilation'	**4.17**	**2**	7
Water Efficiency	WE8	Promptly fix plumbing leakages	**4.08**	**1**	11

4.3 Major Attributes of ESS Implemented through the Development Process

A chi-squared test was performed to find out the stages the major ESS attributes were implemented. The summary of the results from chi-squared contingency table in Appendix C is found in Table 5 below. For the 12 major ESS attributes implemented, SSPM3 and SSPM1 were implemented through the development process while SSPM2 which implemented in the construction and post construction stages only. Also, only CMRE5, CMRE6 and CMRE1 out of six CMRE attributes were implemented through three stages of the development process. For EE and WE attributes, none was implemented through all the stages of the development process. Thus, EE5, EE6 and WE8 were all implemented only at the pre-construction and construction stages of the development process.

Table 5 Attributes of ESS implemented at stage of the development process

ESS Categories	Code	ESS Attributes	Pre-CS	CS	Post CS
Sustainable Site Planning and Management	SSPM3	Incorporate natural landscape into construction project	√	√	√
	SSPM1	Plan and site project in community's master plan	√	√	√
	SSPM2	Integrate natural feature in building designs	*X*	√	√
Construction Materials and Resources Efficiency	CMRE5	Use durable construction materials	√	√	√
	CMRE7	Use non-toxic materials or harmless cleaning fluids, paints and solvents	√	*X*	√
	CMRE9	Order in-demand construction materials only	*X*	√	*X*
	CMRE6	Adopt timber preservation treatments	√	√	√
	CMRE1	Use environmentally friendly materials in building design	√	√	√
	CMRE4	Use environmentally efficient materials for maintenance and repair works	√	*X*	*X*
Energy Efficiency	EE5	Orient buildings to capitalise on passive energy – daylighting	√	√	*X*
	EE6	Position buildings to capitalise on 'natural ventilation'	√	√	*X*
Water Efficiency	WE8	Promptly fix plumbing leakages	√	√	*X*

Note: ***Pre-CS – Pre-Construction Stage;*** ***CS -Construction Stage;*** ***Post CS – Post Construction Stage;***
√– Implemented; ***X – Not Implemented***

■5.0 DISCUSSION

RED is a business venture requiring huge sums of capital. As a result, analysis of the developers' profile revealed that most developers have less than ten units of developments with less than ten years' experience in environmentally sustainable real estate development. Overall, the developers demonstrate a high level of awareness of environmental sustainability though over half of them had started business a decade and more before Ghana Green Building Council established its eco-community national framework to facilitate development of environmentally sustainable communities (Asaase, 2012). In line with Keeping and Shier (2004) recommendation that developers should involve professionals in RED, most developers in the study area engaged real estate professionals especially in the operation and management phase of the development process.

5.1 Major ESS Implemented in Real Estate Development in Ghana

The study revealed that out of 42 attributes of ESS implementable in RED as established from literature, just 28.57% (12) were prioritized by Ghanaian real estate developers. Thus, ESS implementation in real estate development in the country was largely insignificant. The low level of implementing ESS reflected the law enforcement regime for physical planning and development in Ghana as only one (1) respondent indicated that one of his/her projects had been disapproved because of environmental concerns. Hence, it sufficed to say that most real estate developments in the country conformed with the country's environmental laws and physical development regulations albeit the environmental efficiency level of GREDA projects was very low. This supported the assertion that in developing countries, sustainable real estate development remains insignificant (Du Plessis, 2007; Hussin et al., 2013) because of socio-economic challenges confronting the real estate sector (Djokoto et al., 2014; Kheni & Akoogo, 2015). Figure 10 illustrates in terms of priority, the major attributes of each ESS that were implemented in the country.

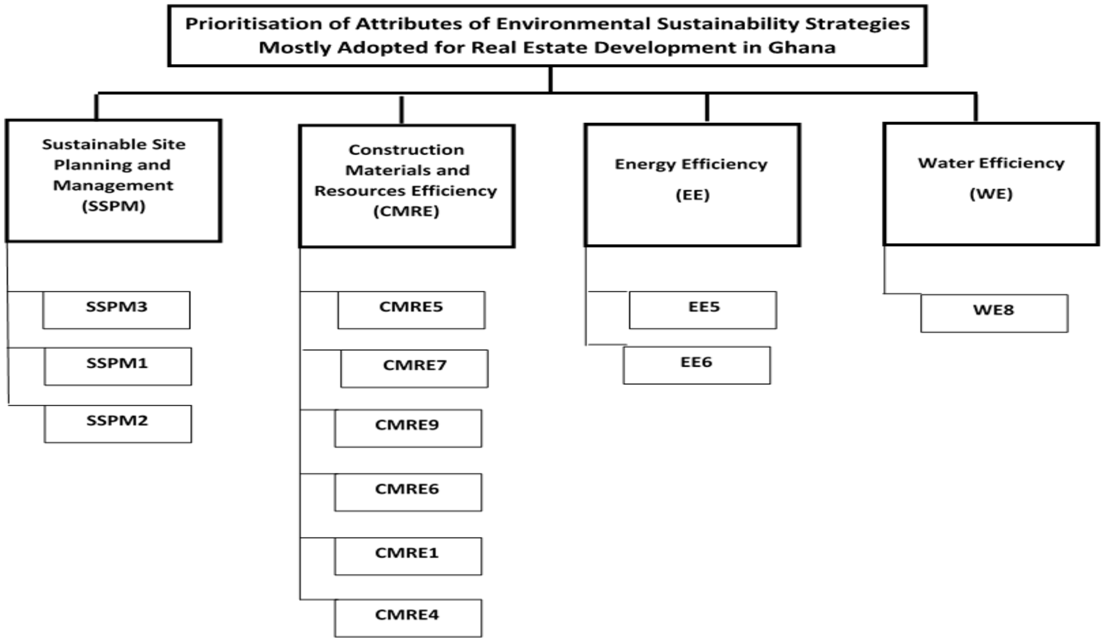

Figure 10 ESS attributes implemented in RED in Ghana

From Figure 10 above, only three (3) of SSPM attributes were mostly implemented in RED in the country. These 3 major SSPM attributes were planning and siting of real estate projects within master plans of communities (SSPM1), integrating natural site features (SSPM2) and incorporating landscape into real estate project design and construction (SSPM3). Three (3) out of eleven (11) SSPM attributes implemented for RED in the country point to the fact that there are challenges with efficient use of land in the country which is a threat to sustainable land use notwithstanding it being a means to addressing rapid uncontrolled urbanization worldwide (Akadiri et al., 2012; Howe, 2010). The low level of implementation of SSPM creates urban sprawl in the country resulting in critical pressure on social amenities due to congestion and its consequences such as vehicular traffic, poor management practices, pollution (Yankson & Bertrand, 2012). Incidence of car dependency is high because of lack of pedestrian and bicycle paths and walkways (Howe, 2010). Akadiri et al. (2012) suggested reuse of existing buildings and recycled resources to minimize use of fertile farmlands for physical construction projects. However, use of non-arable lands for RED (SSPM) was minor in the country depicting the extend of depletion of environmental resources and the pollution associated with their extraction.

With respect to implementation of CMRE attributes, six (6) out of eleven (11) were implemented by developers. To reduce excessive consumption of earthly material resources during construction (Howe, 2010), developers used durable construction materials (CMRE5). Non-toxic materials or harmless cleaning fluids, paints and solvents (CMRE7), timber preservation techniques (CMRE6) to reduce if not eliminate incidences of sick building syndromes (Akadiri et al., 2012). Environmentally friendly materials (CMRE1) were building design specifications whereas use of environmentally efficient materials for maintenance and repairs (CMRE4) were implemented to reduce pollution and carbon emissions (Keeping & Shiers, 2004). Developers also procured only in-demand construction materials (CMRE9) to minimize construction waste and leftover materials at construction sites (Keeping & Shiers, 2004). However, Ghanaian developers failed to prioritise the implementation of reuse of real estate sites, debris from demolished buildings for new projects which is the cause for uncontrolled urban sprawl resulting in excessive demand for arable lands. Lack of recycling of old construction materials means over reliance on the environment for new construction materials and this does not contribute to safeguarding the environment (Howe, 2010).

In terms of implementation of EE attributes in Ghana, developers prioritized only orientation of buildings to utilize passive energy (EE5) and natural ventilation (EE6) to minimize the lighting and cooling requirements of buildings as energy saving mechanisms. The other nine (9) EE attributes for RED referenced from empirical studies were not prioritized for RED in the country. For instance, using energy efficient construction devices and materials, building envelope insulation, energy efficient deconstruction designs, energy efficient transportation designs to effectively reduce energy consumption through RED were not mostly implemented. Invariably, this accounted for the low level of environmental sustainability of real estate projects in Ghana.

Implementation of Water Efficiency (WE) attributes in RED was the least prioritized since only (1) WE attribute namely promptly fixing plumbing leakages (WE8) was mostly implemented by developers in Ghana. The other eight (8) WE attributes were not giving priority in RED in the country. With only WE8 implemented as water conservation strategy, it implies that Ghanaian real estate developers have paid less attention to concerns by UN over rapid depletion of potable water resources and the likelihood of the world facing worldwide water crisis in the near future (Akadiri, et al., 2012; UNESCO, 2003). This is because water conservation strategies like rainwater harvesting for "collect rainwater for flushing toilets, washing clothes, watering the garden and washing cars" were not giving priority. Identifying and protecting wetlands to secure the ecosystem for plants and aquatic lives (Akuffobea-Essilfie et al., 2020) as well as using efficient plumbing fixtures and equipment to minimize water resources wastage (Akadiri et al., 2012) were not mostly implemented by the developers.

5.2 Implementation of ESS through RED Process in Ghana

The specific stages of the development process these ESS were implemented was investigated. The outcome of the study as captured in Figure 11 below reveals that incorporation of natural landscape into real estate project development (SSPM3) was prioritized through the development process likewise planning and siting projects within master plans of communities (SSPM1). However, developers failed to integrate natural features in actual building designs (SSPM2) during pre-construction. With regards to construction materials, developers prioritized the use of durable construction materials (CMRE5), implementation of timber preservation methods (CMRE6) and use of environmentally friendly materials (CMRE1). The use of environmentally efficient materials for planned and corrective maintenance (CMRE4) was poor as it was only a design requirement but not implemented during construction and post construction stages. This affirmed the view that due to socio-cultural constraints, financial and market challenges, developers generally fail to implement ESS thoroughly through the development process (Mensah et al., 2016; Djokoto et al., 2014; Ofori, 2012). Developers also positioned buildings to reduce energy requirements for lighting and ventilation (EE5 and EE6 respectively). Fixing plumbing problems promptly (WE8) was prioritized but only during construction. Post construction, plumbing issues were not promptly addressed.

The failure to implement the few ESS attributes (12 out of 42) through the stages of the development process confirms the conclusion reached by Hussin et al. (2013) that majority of real estate developers do not view RED process as a cycle. This CRED view of the development process makes most developers treat the post construction stage as temporary too albeit it is the longest phase of the development process and to ensure environmental sustainability of a real estate project, all ESS implemented at the previous phases of RED must be sustained and managed through the development cycle to ensure that real estate project's environmental qualities are maintained (Borgese, 2008). Yet, real estate developers in the country failed to holistically implement ESS in the RED process as recommended by Akadiri et al. (2012).

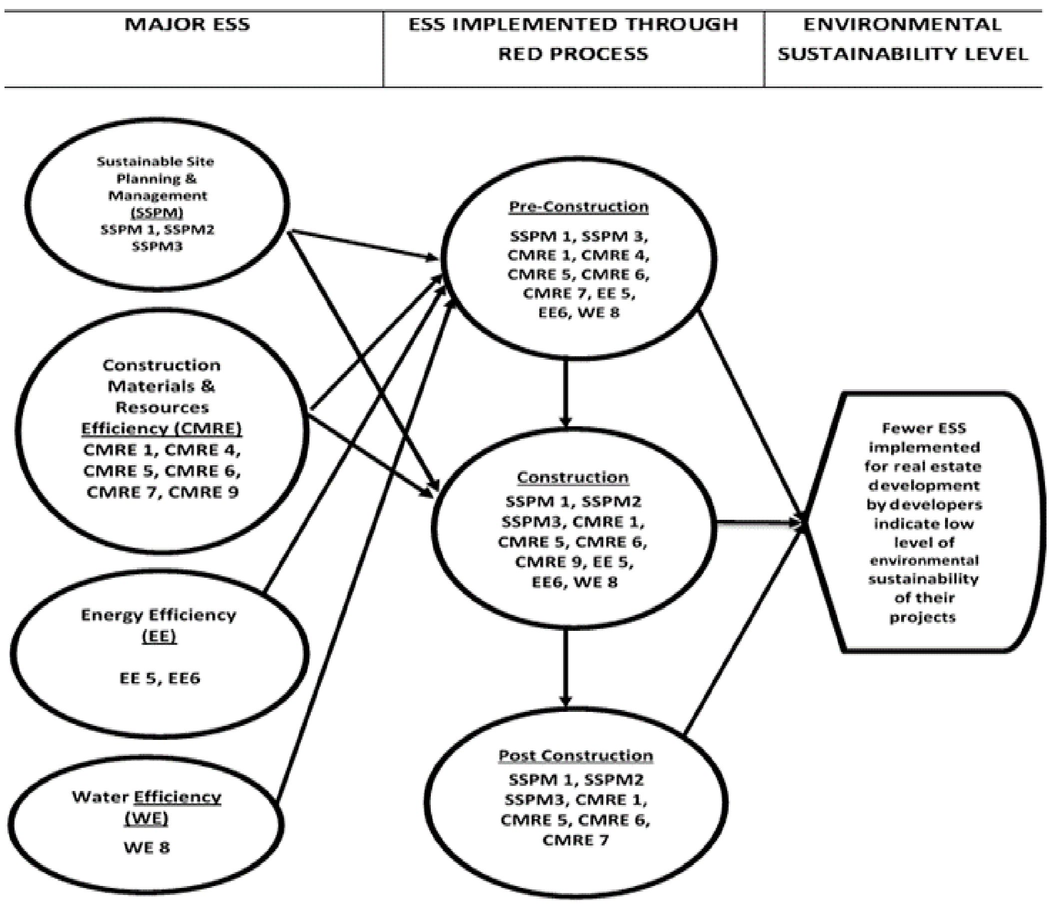

Figure 11 Major attributes of ESS and stages they were implemented in the development process

6.0 CONCLUSION

The object of the study: major attributes of ESS implemented in real estate development in Ghana was achieved by ranking the mean scores of ESS implemented by developers and the stages they were implemented were identified through chi-square test. The ESS were categorized into sustainable site planning and management, construction materials and resources efficiency, energy efficiency, and water efficiency. Out of 42 attributes of the ESS for RED established from literature, only 12 were implemented as major in Ghana and only 4 out of the major attributes were implemented throughout the main phases of the development process. The 28.57% rate of implementation of attributes of ESS of which only 4 were thoroughly implemented through RED process indicate very low level of priority giving to environmental sustainability in real estate development in Ghana. The findings from this study can be generalized for Ghana because over 84.20% of the respondents are headquartered in and operated across the entire country from Accra-Tema metropolitan areas. The major limitation was the use of proxy responses. This limitation is common with studies on real estate development as the development process involves many professionals. As a result, majority of the respondents were developers' employees (representatives) as indicated in Figure 6 (32.3% - project managers and 66.7% - estate/facilities managers). Nonetheless, this limitation does not negatively affect the outcome of the study because real estate sector, characteristically, involves a lot of professional agency services due to the complexity of activities in the industry.

The research findings can be used to aid environmental policy formulation and advocacy to encourage a change in attitude towards environmental sustainability in real estate development. The findings could also influence teaching and practice of sustainable real estate development. However, further research could be conducted to ascertain the various stakeholders influencing the implementation of ESS for RED as well as the challenges preventing developers from prioritizing the implementation of more ESS for RED in the country. Such a study could lead to development of an implementation model to promote integration of ESS in RED, especially in developing countries.

Acknowledgement

This research is extracted from the first author's MSc project report submitted to Faculty of Built Environment and Surveying, Universiti Teknologi Malaysia. We thank Kumasi Technical University for partially funding the postgraduate studies of the first author.

References

Abidin, N. Z. (2009). Sustainable construction in Malaysia – Developers' awareness. *Proceedings of World Academy of Science, Engineering and Technology, 41*, 807-814.

Abidin, N. Z. (2010). Investigating the awareness and application of sustainable construction concept by Malaysian developers. *Habitat International, 34*(4), 421-426.

Abidin, N. Z., Yusof, N. A., & Othman, A. A. E. (2013). Enablers and challenges of a sustainable housing industry in Malaysia. *Construction Innovation, 13*(1), 10-25.

Addae-Dapaah, K., Liow, K. H., & Neo, Y. S. S. (2009). Sustainability of sustainable real property development. *Journal of Sustainable Real Estate, 1*(1), 203-225.

Ahn, Y., Shin, H., Jeon, M., & Jung, C. (2017). Construction process framework for a green building projects. *International Journal of Sustainable Building Technology and Urban Development, 8*(4), 349-364.

Akadiri, P. O., Chinyio, E. A., Olomolaiye, P. O. (2012). Design of a sustainable building: A conceptual framework for implementing sustainability in the building sector. *Buildings, 2*(2), 126-152.

Amoateng, P., Cobbinah, P. B., & Owusu-Adade, K. (2013). Managing physical development in peri-urban areas of Kumasi, Ghana: A case of Abuakwa. *Journal of Urban and Environmental Engineering, 7*(1), 96-109.

Akuffobea-Essilfie, M., Williams, P. A., Asare, R., Damman, S., & Essegbey, G. O. (2020). Promoting rainwater harvesting for improving water security: Analysis of drivers and barriers in Ghana. *African Journal of Science, Technology, Innovation and Development, 12*(4), 443-451.

Asaase, N. (2012, April 19). Ghana Green Building Council (GHGBC) launches the eco communities national framework. *Modern Ghana*. Retrieved on 13 April 2018 from https://www.modernghana.com/news/390230/1/ghana-green-building-council-ghgbc-launches-the-ec.html.

Asif, M., Muneer, T., & Kelley, R. (2007). Life cycle assessment: A case study of a dwelling home in Scotland. *Building and Environment, 42*(3), 1391-1394.

Barde, M. P., & Barde, P. J. (2012). What to use to express the variability of data: Standard deviation or standard error of mean? *Perspectives in Clinical Research, 3*(3), 113-116.

Borgese, A. P. (2008). Materials re-use & materials conservation. Retrieved on 2 March 2019 from http://www.integrata-ac.com/materials-re-use-resource conservation.

Business Dictionary. (2019). Weighting. Retrieved on 10 March 2019 from http://www.businessdictionary.com/definition/weighting.html.

Christensen, P. (2012). *Key strategies of sustainable real estate decision-making in the United States: A Delphi study of the stakeholders* (Doctoral dissertation). Clemson University, Clemson, SC. Retrieved on 8 April 2018 from https://tigerprints.clemson.edu/cgi/viewcontent.cgi?article=2073&context=all_dissertations.

Daly, H. E. (1990). Toward some operational principles of sustainable development. *Ecological Economics, 2*, 1-6.

Darko, A., Chan, A. P. C., Yang, Y., Shan, M., He, B.-J., & Gou, Z. (2018). Influences of barriers, drivers, and promotion strategies on green building technologies adoption in developing countries: The Ghanaian case. *Journal of Cleaner Production, 200*, 687-703.

DeLisle, J., Grissom, T., & Högberg, L. (2013). Sustainable real estate: An empirical study of the behavioural response of developers and investors to the LEED rating system. *Journal of Property Investment & Finance, 31*(1), 10-40.

DeLisle, J. R. (2008, February). What is sustainable development? Benefits & opportunities for developers and communities. Paper presented at the Green Building Summit - The Seminar Group, Seattle, WA. Retrieved from http://jrdelisle.com/presentations/JRD_GreenBuildVBWNew1.pptx.

DeLisle, J. R., & Worzala, E. M. (Eds.). (2012). *Essays in honor of James A. Graaskamp: Ten years after*. New York, NY: Springer.

Djokoto, S. D., Dadzie J., & Ohemeng-Ababio, E. (2014). Barriers to sustainable construction in the Ghanaian construction industry: Consultants perspectives. *Journal of Sustainable Development, 7*(1), 134-143.

Du Plessis, C. (2007). A strategic framework for sustainable construction in developing countries. *Construction Management and Economics, 25*(1), 67-76.

Field, A. (2016). Exploring data: The beast of bias - Discovering statistics. Retrieved from http://www.discoveringstatistics.com/docs/exploringdata.pdf.

Emas, R. (2015). The concept of sustainable development: Definition and defining principles (Brief for GSDR 2015). Retrieved on 5 April 2018 from https://sustainabledevelopment.un.org/content/documents/5839GSDR%202015_SD_concept_definiton_rev.pdf.

Green Building Index Malaysia (GBI-Malaysia). (2013). GBI residential new construction (RNC) tool v3.0. Retrieved on 5 March 2019 from http://new.greenbuildingindex.org/Files/Resources/GBI%20Tools/GBI%20RNC%20Residential%20Tool%20V3.0.pdf.

Global Reporting Initiative (GRI). (2008). A snapshot of sustainability reporting in the construction and real estate sector. Retrieved on 8 April 2018 from www.globalreporting.org.

Graaskamp, J. A. (1992). Fundamentals of real estate development. *Journal of Property Valuation and Investment, 10*(3), 619-639. (Original work published 1981).

Ghana Real Estate Developers Association (GREDA). (2018). Who we are. Retrieved on 2 May 2018 from http://www.gredaghana.org/whoweare.htm.

Hair, J. F., Jr., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis: A global perspective* (7th ed.). Upper Saddle River, NJ: Pearson.

Huang, L., Krigsvoll, G., Johansen, F., Liu, Y., & Zhang, X. (2018). Carbon emission of global construction sector. *Renewable and Sustainable Energy Reviews, 81-2*, 1906-1916.

Howe, J. (2010). Overview of green buildings. National Wetlands Newsletter, 33(1), 3-14. Retrieved on 2 July 2018 from https://sallan.org/pdf-docs/CHOWE_GreenBuildLaw.pdf.

Hussin, J. M., Rahman, I. A., & Memon, A. H. (2013). The way forward in sustainable construction: Issues and challenges. *International Journal of Advances in Applied Sciences, 2*(1), 31-42.

Iacobucci, D., & Churchill, G. A. (2010). *Marketing research: Methodological foundations* (10th ed.). Mason, OH: South-Western Cengage Learning.

Ibrahim, W. N. A., Bakar, A. R., Asimiran, S., Mohamed, S., & Zakaria, N. S. (2015). Impact of entrepreneurship education on the entrepreneurial intentions of students in technical and vocational education and training institutions (TVET) in Malaysia. *International Education Studies, 8*(12), 141-156.

Ilha, M. S. O., Oliveira, L. H., & Gonçalves, O. M. (2009). Environmental assessment of residential buildings with an emphasis on water conservation. *Building Services Engineering Research and Technology, 30*(1), 15-26.

Keeping, M., & Shiers, D. E. (2004). *Sustainable property development: A guide to real estate and the environment*. Oxford: Blackwell Science.

Kheni, N. A., & Akoogo M. A. (2015). Determinants of sustainable construction practices in Ghana using Structural Equation Modelling. *Journal of Sustainable Development, 8*(3), 67-78.

Kibert, C. J. (2013). *Sustainable construction: Green building design and delivery* (3rd ed.). Hoboken, NJ: John Wiley & Sons.

Kwakye, E. (2010). *Barriers and opportunities to the adoption and implementation of sustainable construction techniques and practices in Ghana* (Unpublished master's thesis). University of Portsmouth, Portsmouth, United Kingdom

Ling, D. C., & Archer, W. R. (2018). *Real estate principles: A value approach* (5th ed.). Dubuque, IA: McGraw-Hill Education.

Lu, W., Yuan, H., Li, J., Hao, J. J. L., Mi, X., & Ding, Z. (2011). An empirical investigation of construction and demolition waste generation rates in Shenzhen City, South China. *Waste Management, 31*(4), 680-687.

McCormack, M., Treloar, G. J., Palmowski, L., & Crawford, R. (2007). Modelling direct and indirect water requirements of construction. *Building Research and Information, 35*(2), 156-162.

Mensah, S., Ayarkwa, J., & Nani, G. (2015). Towards enabling construction organizations' adaptation to environmental sustainable construction in developing countries. *Advances in Social Sciences Research Journal, 2*(10), 84-100.

Mensah, S., Ayarkwa, J., & Nani, G. (2016, July). Barriers against contractors' adaptation to environmentally sustainable construction processes. In *Proceedings of the Doctoral workshop on sustainable infrastructural delivery for economic growth in Africa* (pp. 75-87). Accra: ARCOM.

Mensah, S., Nani, G., & Ameyaw, C. (2019). Breaking contractors' socio-cultural barriers inhibiting adaptation to environmentally sustainable construction. *International Journal of Management and Applied Science, 5*(5), 48-54.

Morelli, J. (2011). Environmental sustainability: A definition for environmental professionals. *Journal of Environmental Sustainability, 1*(1), 19-27.

Nelson, A. C. (2014). *Foundations of real estate development financing: A guide to public-private partnerships*. Washington, DC: Island Press.

Nelson, A. J. (2007, November). *The greening of U.S. investment real estate – Market fundamentals, prospects and opportunities* (RREEF Research Report No. 57). San Francisco, CA: RREEF.

Nikolova, M. (2016). Scientific research basis for sustainable development of the mountain regions: Main concepts and basic theories. In G. Zhelezov (Ed.), *Sustainable development in mountain regions: Southern Europe* (pp. 3-8). Cham: Springer.

Ofori, G. (2012). *Developing the construction industry in Ghana: The case of for central agency*. Singapore: National University of Singapore. Retrieved on 12 April 2018 from https://ghanatrade.com.gh/old/file/Developing%20the%20Construction%20Industry%20in%20Ghana%20BUILDING.pdf.

Organisation for Economic Co-operation and Development (OECD). (2001). *The DAC guidelines: Strategies for sustainable development: Guidance for development co-operation*. Paris: OECD. Retrieved on 15 August 2018 from https://www.oecd.org/dac/environment-development/2669958.pdf.

Pearce, A. R., Ahn, Y. H., & HanmiGlobal. (2017). *Sustainable buildings and infrastructure: Paths to the future* (2nd ed.). London: CRC Press.

Ratcliffe, J., Stubbs, M., & Keeping, M. (2009). *Urban planning and real estate development* (3rd ed.). London: Routledge.

Redclift, M. (2005). Sustainable development (1987–2005): An oxymoron comes of age. *Sustainable Development, 13*(4), 212-227.

Siew, R. Y. J., Balatbat, M. C. A., & Carmichael, D. G. (2013). A review of building/infrastructure sustainability reporting tools (SRTs). *Smart and Sustainable Built Environment, 2*(2), 106-139.

Romero, A. R. (2013). *Property law for dummies*. Hoboken, NJ: John Wiley & Sons.

Saunders, M. N., Lewis, P., & Thornhill, A. (2009). *Research methods for business students* (5th ed.). Harlow: Pearson Education.

Schimschar, S., Blok, K., Boermans, T., & Hermelink, A. (2011). Germany's path towards nearly zero-energy buildings – Enabling the greenhouse gas mitigation potential in the building stock. *Energy Policy, 39*(6), 3346-3360.

Senick, J., Gonchar, M. A. G., & Akhtar, S. H. (2011). The financial benefits of green building. Retrieved on 5 April 2018 from https://www.greenbaumlaw.com/media/publication/10_Financial.pdf.

Sengupta, D., Mukherjee, R., & Sikdar, S. K. (2015). Environmental sustainability of countries using the UN MDG indicators by multivariate statistical methods. *Environmental Progress & Sustainable Energy, 34*(1), 198-206.

Sev, A., (2009). How can the construction industry contribute to sustainable development? A conceptual framework. *Sustainable Development, 17*(3), 161-173.

Simpeh, E. K., & Smallwood, J. J. (2015, December). Factors influencing the growth of green building in the South African construction industry. In J. Gibberd & D. C. U. Conradie (Eds.), *SASBE 2015. Proceedings of the smart and sustainable built environment conference* (pp. 311-319). Pretoria: CIB & CSIR.

Singh, A. S., & Masuku, M. B. (2014). Sampling techniques & determination of sample size in applied statistics research: An overview. *International Journal of Economics, Commerce and Management, II*(11), 1-22.

Mokhtar, S. N., & Mahmood, N. Z. (2008). *Approach in construction industry: A study on prefabrication method as a tool for waste minimization*. Paper presented at the International Conference on Environmental Research and Technology, Penang, Malaysia.

Nunnally, J. C., & Bernstein, I. H. (1994). *Psychometric theory* (3rd ed.). New York, NY: McGraw-Hill.

United Nations Environment Programme (UNEP). (2012). UNEP annual report 2012. Retrieved on 15 August 2018 from https://www.unenvironment.org/resources/annual-report/unep-2012-annual-report.

United Nations Educational, Scientific and Cultural Organization (UNESCO). (2003). *Water for people, water for life. The United Nations world water development report*. New York, NY: Berghahn Books.

U.S. Department of Energy (US-DOE). (2008). *Annual energy outlook 2008: With projections to 2030*. Washington, DC: Energy Information Administration. Retrieved from https://www.hsdl.org/?abstract&did=232934.

Wahab, A. B., & Lawal, A. F. (2011). An evaluation of waste control measures in construction industry in Nigeria. *African Journal of Environmental Science and Technology, 5*(3), 246-254.

Warren-Myers, G., (2012). Sustainable management of real estate: Is it really sustainability? *Journal of Sustainable Real Estate, 4*(1), 177-197.

Wilkinson, S., & Reed, R. (2008). *Property development* (5th ed.). London: Routledge.

World Commission on Environment and Development (WCED). (1987). *Our common future*. Oxford: Oxford University Press.

Yamane, T. (1967). *Statistics: An introductory analysis* (2nd ed.). New York, NY: Harper and Row.

Yankson, P. W. K., & Bertrand, M. (2012). Introduction: Challenges of urbanisation in Ghana. In E. Ardayfio-Schandorf, P. Yankson, & M. Bertrand (Eds.), *The mobile city of Accra: Urban families, housing and residential practices* (pp. 25-46). Dakar: CODESRIA.

Yilmaz, K. (2013). Comparison of quantitative and qualitative research traditions: Epistemological, theoretical, and methodological differences. *European Journal of Education, 48*(2), 311-325.

Yoegel, J. A. (2017). *Real estate license exams for dummies with online practice tests*. Hoboken, NJ: John Wiley & Sons.

APPENDIX A

Summary of Respondents' Characteristics (N = 96, 100%)

Variable	Categories	Frequency	%
Level of education	No formal education	7	7.30
	Diploma	14	14.6
	First degree	30	31.3
	Postgraduate degree	45	46.9
Role or position in company	CEO/Owner	1	1
	Project manager	31	32.3
	Estate/facility manager	64	66.7
	Other	0	0.00
Level of experience in sustainable real estate development, years in development business and units of developments	a. Less than 10	45	46.9
	b. 10	18	18.8
	c. More than 10	33	34.4
Real estate sector	a. Residential (housing)	46	47.9
	b. Commercial (offices & stores)	1	1.00
	c. Residential & commercial	49	51.0
	d. Other	0	0.00
Number of projects disapproved by planning authorities for environmental concerns	a. Zero	86	89.6
	b. One	10	10.4
	c. Two	0	0.00
	d. Three	0	0.00
	d. More than three	0	0.00
Environmental sustainability level of GREDA projects	a. Do not know	6	6.30
	b. Very low	6	6.30
	c. Low	46	47.9
	d. High	38	39.6
	e. Very high	0	0.00

APPENDIX B

Normality Test Results for Items (N=96)

Variable	Item	Mean	Standard Deviation	Skewness	Kurtosis
Sustainable Site Planning & Management Strategies (SSPM)	SSPM1	4.19	.837	-.368	-1.481
	SSPM2	4.01	.589	-.002	-.031
	SSPM3	3.52	.711	-.075	-.190
	SSPM4	3.30	.872	-.634	.935
	SSPM5	3.34	.816	-.156	-.622
	SSPM6	3.34	.559	-.091	-.719
	SSPM7	2.92	1.262	-.129	-.739
	SSPM8	3.95	.605	.021	-.202
	SSPM9	3.70	.835	-.708	.031
	SSPM10	3.82	.740	-.660	.629
	SSPM11	3.80	.854	.395	-1.521
Construction Materials & Resources Efficiency Strategies (CMRE)	CMRE1	4.11	.694	-.157	-.891
	CMRE2	3.72	.970	-.535	-.630
	CMRE3	3.43	.611	1.132	.268
	CMRE4	4.10	.447	.478	1.718
	CMRE5	4.47	.710	-.968	-.377
	CMRE6	4.15	.870	-.877	.189
	CMRE7	4.40	.607	-.456	-.632
	CMRE8	4.32	.589	-.220	-.612
	CMRE9	4.30	.756	-.568	-1.031
	CMRE10	3.17	.914	-.340	.581
	CMRE11	3.75	1.016	-.092	-1.223
Energy Efficiency Strategies (EE)	EE1	3.90	.864	-.395	-.495
	EE2	3.06	.646	.421	.798
	EE3	3.83	.735	-.376	.133
	EE4	3.26	.849	-.214	1.032
	EE5	4.23	.747	-.402	-1.101
	EE6	4.17	.804	-1.059	1.201
	EE7	3.96	.780	-.742	.653
	EE8	2.94	1.014	-.059	.325
	EE9	3.75	1.196	-.631	-.394
	EE10	3.71	.939	-.159	-.877
	EE11	3.79	.905	-.094	-.957
Water Efficiency Strategies (WE)	WE1	3.94	.539	-.055	.503
	WE2	3.83	.842	-.322	-.446
	WE3	3.23	.905	-.479	.818
	WE4	3.60	.492	-.433	-1.852
	WE5	3.44	.612	1.086	.169
	WE6	3.50	1.095	-.270	-.177
	WE7	3.89	.905	-.292	-.826
	WE8	4.08	.749	-1.058	1.797
	WE9	3.97	.839	-.595	-.056

APPENDIX C

Summary of Chi-Squared Test for Implementation of ESS Attributes through RED Process

Development Process	Major Attributes of ESS Adopted	Crosstab Statistics				Remark
		Chi-square Test		*Symmetric Measures*		
		Pearson Value	Sign. (2-sided)*	Phi & Cramer's V	Approx. Sig.*	
PRE-CONSTRUCTION STAGE	***SSPM Strategies:***					
	SSPM1	7.675	**.022**	.283	**.022**	Implemented
	SSPM2	20.497	**.000**	.462	**.000**	Implemented
	SSPM3	5.190	.075	.233	.075	Not Implemented
	CMRE Strategies:					
	CMRE7	33.927	**.000**	.594	**.000**	Implemented
	CMRE5	10.684	**.005**	.334	**.005**	Implemented
	CMRE9	.238	.888	.050	.888	Not Implemented
	CMRE6	16.094	**.001**	.409	**.001**	Implemented
	CMRE1	8.018	**.018**	.289	**.018**	Implemented
	CMRE4	14.562	**.001**	.389	**.001**	Implemented
	EE Strategies:					
	EE5	11.116	**.004**	.340	**.004**	Implemented
	EE6	15.743	**.001**	.405	**.001**	Implemented
	WE Strategies:					
	WE8	28.614	**.000**	.546	**.000**	Implemented
CONSTRUCTION STAGE	***SSPM Strategies:***					
	SSPM1	19.202	**.000**	.447	**.000**	Implemented
	SSPM2	32.942	**.000**	.586	**.000**	Implemented
	SSPM3	15.034	**.001**	.396	**.001**	Implemented
	CMRE Strategies:					
	CMRE7	28.823	**.000**	.548	**.000**	Implemented
	CMRE5	5.805	.055	.246	.055	Not Implemented
	CMRE9	43.844	**.000**	.676	**.000**	Implemented
	CMRE6	26.475	**.000**	.525	**.000**	Implemented
	CMRE1	10.707	**.005**	.334	**.005**	Implemented
	CMRE4	3.933	.140	.202	.140	Not Implemented
	EE Strategies:					
	EE5	30.919	**.000**	.568	**.000**	Implemented
	EE6	14.779	**.002**	.392	**.002**	Implemented
	WE Strategies:					
	WE8	46.884	**.000**	.699	**.000**	Implemented
POST CONSTRUCTION STAGE	***SSPM Strategies:***					
	SSPM1	7.713	**.021**	.283	**.021**	Implemented
	SSPM2	27.214	**.000**	.532	**.000**	Implemented
	SSPM3	12.452	**.002**	.360	**.002**	Implemented
	CMRE Strategies:					
	CMRE7	8.586	**.014**	.299	**.014**	Implemented
	CMRE5	14.951	**.001**	.395	**.001**	Implemented
	CMRE9	.243	.886	.050	.886	Not Implemented
	CMRE6	10.305	**.016**	.328	**.016**	Implemented
	CMRE1	26.796	**.000**	.528	**.000**	Implemented
	CMRE4	2.593	.273	.164	.273	Not Implemented
	EE Strategies:					
	EE5	5.623	.060	.242	.060	Not Implemented
	EE6	6.666	.083	.264	.083	Not Implemented
	WE Strategies:					
	WE8	2.673	.445	.167	.445	Not Implemented

Note: * $p < 0.05$