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ASSESSMENT OF REGENERATIVE DESIGN PRACTICES FOR RESIDENTIAL HOUSING: A CASE STUDY IN AWKA, NIGERIA

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The purpose of this study is to assess existing regenerative design strategies applied in neighbourhood designs, with a view to deriving a framework of strategies that can be implemented in related developments across different geographical contexts. A design science research approach was applied, which is fundamentally solution-oriented and multi-stepped, and used mostly in architecture and engineering to define a building or an artefact. The study starts with a review of extant literature, followed by the development of a preliminary framework for proposed strategies. A residential housing neighbourhood was used as context for case study, to analyse the level of regenerative design practice, using the proposed strategies. Results of the case study were used to develop the strategies further, which were then refined and validated by being subjected to evaluation through a survey of construction professionals within the study context. The validated strategies were further tested for significance, as a final step. A key finding is the relative lack of regenerative design practice especially within the study context. However it can be promoted. Though it is a design-related concept and could be viewed as context-specific, findings indicate that some of the existing strategies could be effectively adopted in different geographical locations, irrespective of specific climate and environment. The study suggests a need for greater focus on the ecological implications of sustainable design and construction. The study adds value by organizing notions of relevant regenerative design strategies into a holistic picture, which is validated, in order to highlight the more relevant strategies, and critical aspects to consider in the implementation of regenerative design projects.

Keywords: neighbourhood design, regenerative design, regenerative development, strategies, sustainable design

INTRODUCTION

The connection between the built environment and threats to sustainability of human life and the environment has been established (Younger et al., 2008; Opoku,

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2019). The built environment is noted to have both positive or negative effects on the environment, and simultaneously improving and degrading human health and well-being (Younger et al., 2008; Bartuska, 2011). The outcome in each case depends on choices and actions taken to address needs for enhanced livability and comfort (Bartuska, 2011). Due to limitations in choices and actions, most efforts at conventional and sustainable designs focus on improving the efficiency of components (Zari, 2010; Craft et al., 2017). This focus on 'efficiency' in design is said to be responsible for the separation of humans from nature (Ives et al., 2018). Humans commoditise and exploit the natural systems instead of co-existing with them, which results in deterioration of human and ecological systems (Zari, 2012; Lehmann, 2019; Opoku, 2019). Consequences include poor physical and psychological health, poor human development, and environmental crises (Dias, 2015; Ives et al., 2018). Thus, current sustainable design approaches emerged to address the impact of the hitherto unsustainable development perpetuated by mankind, in order to ensure livelihood for future generations (EPA, 2011; Mang and Reed, 2012b). Therefore sustainable design approach is focused on mitigating existing impacts and sustaining the existing environment, which is already degenerated (Owen, 2009), and to best aim at conservation which is argued as being insufficient to sustain life (Singer, 2010; Conte and Monno, 2016). Apart from concerns for efficiency, existing sustainable design, is said to aim at reconnecting the environment to the socio-political components instead of the ecological concerns (Hodges, 2006; Howard et al., 2008). Other authors point to the weaknesses of current sustainable design approaches (Craft et al., 2017), and persistent negative environmental impact (Axinte et al., 2019), and poor human and natural well-being (Ives et al., 2018). According to (Boehnert, 2019), the main issue is that current sustainable design fails to include ecology in its principles. Ecological inclusion in design offers valuable response to environmental issues where conventional sustainability agendas prove inadequate. The inclusion of ecological principles in sustainable design of the built environment implies the wellbeing of ecosystems and human systems. The scenario can be achieved through the co-evolution of the built, natural and socio-cultural systems as described by authors such as Mang and Reed (2012a); Bartlett and Gauthier (2013); Boehnert (2019); Axinte et al. (2019); Opoku (2019). The concept of regenerative design emerged from the aforementioned thinking (Mang and Reed, 2012b; Axinte et al., 2019). It developed as a necessary advancement in sustainable design with a focus on self-renewing capacities for the constructed human and natural systems (Mang and Reed, 2012a; Axinte et al., 2019). It is a more integrated and comprehensive approach to sustainable design and construction (Trombetta, 2018), which inherently facilitates human reconnection with nature (Ives et al., 2018). In contrast, while sustainable design sustains an already deteriorated environment, regenerative design seeks to regenerate and/or restore the environment by improving the mutual relationships of the building, nature and human development processes within the context of place (Mang and Reed, 2012b; Girardet, 2017; Trombetta, 2018; Axinte et al., 2019).

The advancement and acceptance of regenerative design facilitated the development of strategies for successful implementation, adoption of the concept, and transition from conventional design approaches to regenerative design methods (Hodge, 2006), and inform the reconnection of humans with nature (Roös

and Jones, 2017). Despite various opportunities in regenerative design practice, the implementation is still limited in contemporary design. A major reason proffered is the nature of regenerative activities which are regarded as contextual. Hence available strategies are contextually bounded in reality while they may be assumed as being applicable to any context (Hodge, 2006), such as different climatic zones/geographical regions. While this notion persists, the extent of the context-specific nature of regenerative design has not been fully explored. Consequently, the extent to which one regenerative design strategy can be applied across geographical regions is not clear. The purpose of this paper therefore, is to assess existing regenerative design strategies, to determine the possibility of adopting them in other geographical regions within a socio-political context. A secondary goal of the study is to identify and highlight possible means of propagating the adoption.

Regenerative design concept, and strategies

Regenerative Design has been defined as a system of strategies and technologies that produces designs to regenerate underlying life supports systems based on the interactions of the ecosystems (Mang and Reed, 2012b). It is a holistic approach that reconnects human needs and cities with life processes and nature, creating enabling conditions for natural and ecological systems (Axinte et al., 2019; Du Plessis, 2012; Mang and Reed, 2012). Regenerative design is based on place and system, and usually focuses on positive results (Svec et al., 2012), which are achieved by harmonizing the building, nature, and people to encourage regeneration of ecosystems (Dias 2015). This is to use the built environment of buildings and cities as the processes that instigates mutually beneficial co-evolution between human and natural systems (Cole, 2012; Reed, 2007). In order to enhance the human and natural ecosystems, the built environment is designed, planned and built in such that it increases the social and ecological health, and well-being (Dias, 2015; Opoku, et al., 2019; Younger et al., 2008).

The early regenerative design strategies such as Robert Thayer (1994), John Lyle (1994) and architect William McDonough (2001), originate from the earlier concepts of sustainable development (Hodges, 2006). Although many of the strategies share some similarities, they looked at different components of the environment while focusing on a distinct geographical and landscape scale, and the issues particularly salient to it. The strategies by John Lyle (1994), that are regarded as basis for several construction methods such as LEED and LCA (Trombetta, 2018), focus on the ecological components of the environment, and the underlying interconnectivity and material flow through the ecosystems. He argues that the community/neighbourhood area should be planned in such a way that it replaces what it uses by its functional processes which include conversion, distribution and other processes. Robert Thayer (1994) focused on the socio-cultural component of the environment with attention on the relationship between nature and technology. When Lyle supports the replacement of used resources, Thayer argues that renewable energy and resources should be optimized, and the basic structure maintained with no ecological or ecosystem destabilization and waste. While Lyle and Thayer focus on ecological and socio-cultural components respectively, McDonough-Braungart (2001) looks at the economic component and the recognition of alternative means. The McDonough-Braungart strategies are applicable at the site level, and their greatest significance is the global market. The

strategy claims that nothing in nature is a waste, and that everything has the potential to bring about a required change in the environment.

Table 1: A comprehensive summary of regenerative design strategies

Strategies	Authors
Attention to the distinctiveness and image of a place	Zari (2010), Haggard (2002), Litman (2009), Du Plessis (2012), Mang and Reed (2012a), Hes-Stephan-Moosavi (2017)
Ecological Inclusion	Lyle (1994), Zari (2010), Litman (2009), Trombetta (2018), Orr (2018), Craft et al., (2017)
Natural systems optimisation and enhancement	Thayer (1994), McDonough-Braungart (2001), McDonough (1992), Orr (2018), Roös and Jones (2017), Hes-Stephan-Moosavi (2017), Trombetta (2018), Craft et al., (2017)
Maintenance of cultural identity	Thayer (1994), Zari (2010), Litman (2009), Hes-Stephan-Moosavi (2017)
Integration of resource, material and landscape scale	McDonough (1992), Litman (2009), Zari (2010), Hes-Stephan-Moosavi (2017), Trombetta (2018), Craft et al., (2017)
Human and natural ecosystems co-evolution and mutual relationship	McDonough (1992), Zari (2010), Lyle (1994), Du Plessis (2012), Roös and Jones (2017), Hes-Stephan-Moosavi (2017), Craft et al., (2017)
Conservation, restoration and recycling	Thayer (1994), Zari (2010)
Multiple pathways, flexibility	Lyle (1994), Gabel (2009), Litman (2009), Roös and Jones (2017), Trombetta (2018)
Application of appropriate technology	Thayer (1994), Gabel (2009)
Support on feedback	Lyle (1994), Zari (2010)
Storage as sustainable	Lyle (1994)
Prioritizing sustainability	Lyle (1994)
Matching technology to need	Lyle (1994), Gabel (2009)
Design with nature	Lyle (1994), McDonough (1992), Zari (2010), Orr (2018), Roös and Jones (2017), Hes-Stephan-Moosavi (2017), Trombetta (2018)
Optimise full product life cycle/ eliminate waste	Thayer (1994), McDonough-Braungart (2001), McDonough (1992), Gabel (2009), Orr (2018), Roös and Jones (2017), Craft et al., (2017)
Diversification of interests	McDonough-Braungart (2001), Zari (2010), Orr (2018), Trombetta (2018)
Whole system design integration	Lyle (1994), Litman (2009), Zari (2010)
Economic enhancement through ecological efficiency	McDonough-Braungart (2001), Gabel (2009), Hes-Stephan-Moosavi (2017)
Intelligent and Integrated design and construction approach	Zari (2010), Litman (2009), Trombetta (2018), Craft et al., (2017)
Integration of project to place	Haggard (2002)
Stakeholdership and community participation and integration	Zari (2010), Haggard (2002), Litman (2009), Gabel (2009), Orr (2018), Hoxie et al., (2012), Mang and Reed (2012a)
Multiple and shared goals	Lyle (1994), Gabel (2009)
Acceptance of design consequences	McDonough (1992)
Create long-term value systems	McDonough (1992), Gabel (2009), Trombetta (2018), Craft et al., (2017)
Understand the limitations of design	McDonough (1992), Hes-Stephan-Moosavi (2017)
Landscape scale and community Integration	Litman (2009), Zari (2010), Trombetta (2018), Craft et al (2017)
World as unit for problem solving	Gabel (2009), Hes-Stephan-Moosavi (2017)
Vision to realty	Haggard (2002), Gabel (2009)
Redundancy and resilience	Gabel (2009), Litman (2009), Orr (2018), Trombetta (2018)
Beauty and affordability	Orr (2018)
Design for disassembly and repair	Orr (2018), Craft et al., (2017)
Awareness, education, and transparency	Gabel (2009), Hes-Stephan-Moosavi (2017), Lyle (1994)

Another principle by McDonough known as Hannover Principles considers the understanding of transformation and growth of human interdependence with nature, and the effects of design on the ecosystem.

The strategy argues that the design of the built assets should support human co-existence with nature to derive creative forces from natural energy flows. This design, McDonough (1992) further states, should be based on Earth, Air, Fire, Water and Spirit, which collectively considers "all aspects of human settlement", and the interactions of people with their built environment. Many of the earlier regenerative design strategies emphasize that nature should be considered as model for planning, designing and constructing the built environment (Lyle, 1994; McDonough, 1992).

More recent strategies include Pedersen Zari (2010); Litmans (2009); and Medard Gabel (2009). Most recently, a few regenerative design and development strategies were presented by authors such as Orr (2018); Roös and Jones (2017); Hes et al., (2017); Plaut et al., (2016); Craft et al., (2017): and Trombetta (2018). A summary of existing regenerative design strategies is presented in Table 1.

Findings from literature, show that existing strategies are contextually limited to a geographical scope and a component of interest. Despite the different contextual inclinations, it is arguable that all the strategies are related in concepts and application. However, there are no generalized strategies of regenerative design practices, for easy adoption and application. Such generic strategies, or wider applicability of existing strategies would arguably benefit developing country contexts in Africa. This is pertinent when considering Africa's growing cities where the demand for development such as residential housing, is a potential threat to environmental sustainability. A case in point would be the West African country of Nigeria. In view of the foregoing, there is a need to determine common strategies that can be operationalized for implementing regenerative design practices. Effort should be made to derive and propose a framework of generally applicable strategies/generalized strategies, which can be implemented in different geographical zones across the country. It would be most viable and beneficial, to physical development programmes, such as residential housing.

METHODOLOGY

The research design adopted for the study is the design science research method, used in architecture and engineering to define an artefact, and basically tends towards solving a problem, (Weber, 2010). Design research is inherently pragmatic, focused on solutions, and mostly using a multi-step approach. The research process includes a review of extant literature, to identify and assess strategies for regenerative design. The identified strategies were also assessed through deductive logical comparison, to test for consistency, reliability and generalisation. Residential housing development was chosen as an ideal case study area of physical development, involving substantial amount of human occupancy. Awka which is the growing capital city of the relatively young Anambra State of Nigeria was selected as context. A prominent residential housing development called Ngozika Housing Estate of Awka was specifically chosen as the project to study. An analysis of the housing estate neighbourhood was conducted via case study, which

involved direct observations and the administration of survey questionnaires. Direct observations focused on a regenerative design evaluation of existing physical conditions of the estate. The questionnaire was used to assess the experience of the occupants. A final step using another survey of construction professionals within the geographical context of the study, was used to refine and validate the final set of selected strategies, and determine avenues for promoting their adoption.

For the surveys, the population of occupants (households) of Ngozika Housing Estate, according to the housing units is (1000). Similarly, the number of registered construction professionals in the host state was 240 for the practitioner survey. A combined simple random sampling size of (377) participants comprising (150) construction professionals, and (285) households from the estate was derived, using Yaro Yamane's formula (Israel, 2013). Considering that the sample size for the registered professional gives proportionately more information for a small specific location in the state, Cochran's equation was also used to generate the sample size for the specific study area (Israel, 2013). The questionnaire was administered in person. From a total of 377 questionnaires that were distributed, 207 complete responses were retrieved. Construction professionals accounted for 62 responses while Ngozika Housing Estate residents accounted for 145 responses. The combined responses amount to a response rate of about 55 percent, which is acceptable in the field of organisational research, according to Bryman and Bell (2003). The two survey instruments shared commonalities substantially. A combination of multi-choice, closed ended, and open-ended questions were used, in addition to likert-type ranking questions to provide rating data in some instances. However, the questionnaire for construction professional differed in having a section for evaluating selected strategies and the proposed framework. Completed questionnaires were retrieved and analysed using descriptive analysis with percentage rating, mean score and ranking in order to identify the set with the highest mean value, and relative importance index to rank the strategies based on importance. The selected key strategies were finally tested for significance using the z-test. The results are presented according to specific aspects investigated in the walkthrough and surveys.

RESULTS

Results of analysis are presented according to the following objectives derived from the study purpose: To determine existing Regenerative design strategies, and a frame work of generic best practices for adoption; to assess the level of regenerative design implementation in projects; to determine key regenerative design strategies and their applicability beyond the study context; and to find out possibilities for promoting regenerative design.

Regenerative design strategies and practices and framework of generic best practices

The identified strategies were further categorized into six themes: environmental, cultural, social, experiential, and educational and economic, as described in Hodges (2006). Table 2 shows the comparative summary of the identified strategies analysed under related thematic areas to enable a comprehensive evaluation of the specific regenerative design strategies.

Table 2: Regenerative design best practices from literature

Strategies	Categories	Number of citations from literature	Remarks
Attention to the distinctiveness and image of a place	Environment	6	Selected
Optimise and enhance natural systems and environment		8	Selected
Conservation, restoration and recycling		2	
Prioritising sustainability		1	
Design with nature		7	Selected
Integrate/ maintain cultural identity	Cultural	4	Selected
Human and ecological co-evolution		8	Selected
Understand the limitations of design		2	
Stakeholders and community participation and collaboration	Social	7	Selected
Integrate and utilise the natural systems and landscape		6	Selected
Landscape and community integration	Experiential	5	Selected
Create systems of long-term value		4	Selected
Dissemination of information and feedback	Educational	5	Selected
Appropriate technological selection		2	Selected
Encourage awareness and education of developers and users		3	Selected
Promotion of diversity and flexibility	Economic	7	Selected
Matching technology to need		2	
Encourage natural storage mechanism		1	
Optimise full product life cycle/ eliminate waste		7	Selected
Intelligent and integrated design and construction		6	Selected
Multiple and shared goals		2	
Redundancy and resilience		4	Selected

From Table 2, the strategies were analysed on the bases of content and similarities. Similar strategies were merged, while the nature of the content was used to classify them under various themes. The popularity and application of strategies reflects in the frequency of citations from the extensive review of extant literature. Table 3 presents a framework of selected best practices from the preceding analysis.

Table 3: First derivation of framework of regenerative design best practices from Table 2

Environment	Cultural	Social	Experiential	Educational	Economic
Attention to the uniqueness and sense of a place	Human and ecological co-evolution	Stakeholders and community participation and collaboration	Create systems of long-time value	Dissemination of information and Feedback	Eliminate waste
Optimise and enhance natural environment	Integrate/ maintain cultural identity and image of a place	Integrate and utilize the natural systems and landscape	Landscape and community connectivity	Encourage awareness and education of developers and users	Integrated and Intelligent design & construction
Design with nature					Promotion of diversity/ Flexibility Redundancy and resilience

Contextual assessment of the implementation of regenerative design in projects – the case study

Ngozika Housing Estate which was selected as case study for this research, is one of the neighbourhoods in Awka capital city of Anambra State in Nigeria. Awka is one of the major communities and ranks as one of the oldest formal settlements in Igboland with a population above one million as at NPC (2006). It lies between latitude 6.22oN and longitude 7.07oE (Iloeje, 2001), and is situated within the flood plain of Udi escarpment (Iloeje, 2001). Nigeria is found in West Africa, within the latitudes 4° and 14° N of the Equator and longitude 2° 2' and 14° 30' E of the Greenwich Meridian (Helmer and Hespanhol 1997). It is made up of 36 states including Anambra state, located in the south-eastern region. The case study involved a walk-through survey of the neighbourhood and its immediate environs, and a survey by questionnaire. Respondents for the questionnaire were people residing in the Ngozika Housing Estate, at the rate of one response per household.

Walkthrough survey results

Ngozika Housing Estate is situated along Enugu-Onitsha express way and covers about 141.9 hectares with a total of about 961 plots. The estate is divided into 3 phases; I, II, and III. Phase 1 consists of 441 plots, phase II has 71 and phase III has 449 plots, and about half of the estate is surrounded by gully erosion. Another important feature of the estate is the subdivision into different sizes for different economic classes. It comprises one bedroom, two bedroom and three bedrooms, for low and middle classes, while duplexes and luxury duplexes for the high class and the elites. Figure 4 below illustrates the layout plans for the phases I, II, and III of the Ngozika Housing Estate. The growing city of Awka is already host to many such residential neighbourhoods, such as Ahocol Housing Estates, Udoka Housing Estate, Commissioners Quarters, Esther Obiakor Housing Estate, G. R. A. Agu-Awka. there are some environmental features distinct in the neighbourhood area. From the walkthrough, the estate has facilities such as open spaces, churches, schools, major and minor roads, 2 main access routes. In terms of environmental features that can be harnessed for regenerative design, it has a nearby stream which serves as landmark and boundaries between each phase. Other natural features include

rocks and trees, and other more negative factors such as erosion sites. The water body is the most distinct feature, followed by trees, gully erosion and others.

Following the walkthrough observations, the surveys were administered. One was to the occupants as part of the case study and the other was to construction professionals as the last step in the methodology. The results have been merged were the objectives and questions are the same. The sections addressed by construction professionals exclusively are presented separately.

Knowledge and awareness of regenerative design – combined survey results (occupant & professionals)

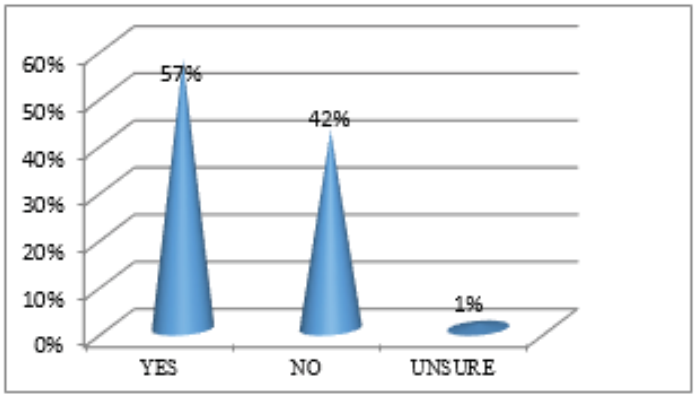

Figure 1: Understanding of regenerative design

From the analysis on the regenerative design awareness on Figure 1, about 57 percent accepted that they have adequate understanding of the regenerative design practice, 42 percent said that they are not well grounded on the practice, and while 1 percent agreed that they are not sure about the practice.

Table 4: Perceived relationship between the estate design and surrounding environmental features

Relationship	Degree of rating in percentage				Mean score	Rank
	1	2	3	4		
Influence on estate planning and space	66	12	12	10	1.14	3
Ordinary estate character	66	10	12	12	1.70	2
Influence on road construction and drainage	40	28	12	21	2.16	1

1 – No relationship 2 – insignificant relationship 3 – Slight relationship 4 – Good relationship

The relationship between the existing features and the estate design in table 5 was analyzed using a four-point scale, where 1 = no relationship, 2 = significant relationship, 3 = slight relationship, and 4 = good relationship. From the analysis there is little or no relationship between the neighbourhood design and its natural environment, which goes against regenerative design.

Application of regenerative design – combined survey results (occupant & professionals)

Further analysis of the incorporation of available natural systems supports the indication that the neighbourhood/estate design did not consider the use of existing natural systems. The optimization of renewable energy and material resources was not considered.

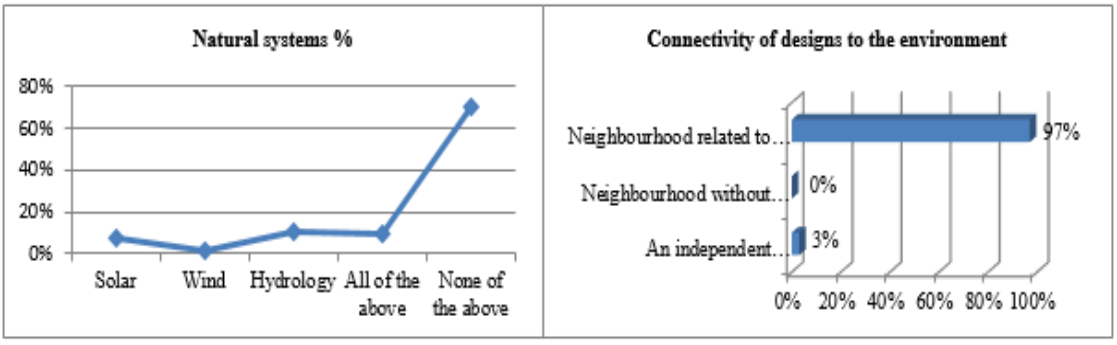

Figure 2: Use of available natural systems and the need to connect designs with the environment

Figure 2 also agrees with the results in Table 4. It also shows that respondents understand and agree with the need to reconnect the neighbourhood design with nature. This indicates an agreement that designs should not be independent of the natural systems that form an image of a place.

Questions specific to construction professionals

The remaining results of analysis focus on critical questions which were addressed to construction professionals in the second survey. The questions are about co-evolution design, promotion of regenerative design for adoption, and an evaluation of the proposed framework of best practices that can be implemented beyond the study context. Table 5 relates to the co-evolution of humans and nature. This question was only answered by the construction professionals within the study area. From the analysis, respondents strongly agreed with the idea of co-evolution of humans and nature.

Table 5: The need to facilitate for co-evolution of humans and nature in the study area

Options	Response in Numbers	Response in Percentage
Strongly Agree	55	89
Slightly Agree	3	5
Disagree	2	3
Strongly Disagree	2	3
Total	62	100

Table 6 relates the possible ways to promote the adoption of the regenerative design concept in the study area. This question applied to the construction professionals only. The respondents were asked to rate in a four-point scale, methods to promote regenerative design. From the analysis, awareness and education ranked the highest, followed by the collaboration between stakeholders and communities, then incorporation as an approval process and last is the change of assumptions and behavior. In table 7 below, a framework of selected strategies for adoption of regenerative practice is presented. The strategies were ranked on the basis of responses, using the Relative importance index (RII). All strategies examined were found to be important and worthy of adoption.

Table 6: Possible approaches to promote regenerative design concept within our communities

Ways	Rating in percentage				Mean score	Rank
	1	2	3	4		
Through change of assumptions and attitude	28	23	33	16	2.37	4
Through awareness and adopting it as an integra part of education	18	22	22	38	2.80	1
Through collaboration of stakeholders and participation of communities	21	25	21	33	2.66	2
Incorporating them as part of the approval process	25	18	28	29	2.61	3

– Strongly disagree 2 – Disagree 3 – Agree 4 – Strongly agree

Table 7: Respondents evaluation of selected framework of regenerative design best practices

Strategies	Rating in number			Mean score	RII	Rank
	1	2	3			
Attention to the uniqueness and sense of places	0	14	48	2.77	0.92	9
Optimise and enhance natural environment	0	3	59	2.95	0.98	2
Design with nature	0	3	59	2.95	0.98	2
Human and ecological co-evolution	2	10	50	2.77	0.93	7
Integrate and maintain cultural identity and image of a place	7	10	45	2.61	0.87	14
Stakeholders and community participation and collaboration	2	10	50	2.77	0.93	7
Integrate and utilize the natural systems and landscape	0	12	50	2.81	0.95	4
Create systems of long time value	2	19	41	2.63	0.88	13
Landscape and community connectivity	0	10	52	2.84	0.95	4
Dissemination of information and Feedback	2	7	53	2.82	0.94	6
Encourage awareness and education of developers and users	0	1	61	2.98	1.00	1
Eliminate waste	3	12	47	2.71	0.90	10
Integrated & Intelligent design & construction	0	19	43	2.69	0.90	10
Promotion of diversity/ Flexibility	2	15	45	2.70	0.90	10
Redundancy and resilience	9	24	29	2.32	0.79	15

- Unimportant 2 – Unsure 3 – Important

From the ranking in Table 7, educating developers and users ranked highest, followed by utilize and enhance natural environment. Others according to ranking are: integrate and utilize natural systems; dissemination of information and

feedback; collaboration/ stakeholders' participation; communities and socio-ecological unit integration; etc. Clearly knowledge and awareness are highly favoured as the first and most important to take. Considering the proposed framework of strategies, there is obvious applicability beyond the study context. This framework could function in a generic sense, outside limitations by context. Even where the strategy refers to existing natural and human systems, it is still generic in description, and therefore can be interpreted to accommodate the vagaries of each context when applied.

FINDINGS AND CONCLUSION

From the analysis above, inadequate sensitivity to natural and human systems is demonstrated in the residential neighbourhood design. As such there is a failure to use design to reconnect the user with nature. In this case the built asset essentially exists independent of the landscape as highlighted by Ives et al., (2018), and in the analysis Table 3 and Figure 2. This approach is noted as contributing to degenerating effects on human and natural systems, and environmental well-being (Lehmann, 2019; Opoku, 2019; Zari, 2012). There is an agreement among participants, of the need to reconnect human activities with nature and co-evolution. This result highlights the underlying connectivity with the environment which helps in building the sense of place. An implication is that ecological components which support regeneration of life support systems should be considered in designs. Another insight from the study is that irrespective of contextual inclinations, there is some level of relativity in all identified strategies. This creates an opportunity for comparative analysis of such strategies, under related themes, from which a framework has been proposed. In addition, the study shows that there is still need for awareness and education in order to achieve good dissemination and ease of transition for the regenerative design practice. The awareness level would influence the level of regenerative design interpretation, stakeholder and community participation, and collaboration. Other ways to promote the concept include the incorporation of regenerative design as part of the approval process. Furthermore, from the comparative analysis of strategies in the study, a framework of some strategies of regenerative design was presented, which could be adopted across many contexts, irrespective of the specific climate and environment. The framework includes education and awareness, and other identified factors which will develop positive attitudes towards the transition of designs and the desire of the stakeholders to participate in the regenerative design activities.

In conclusion the current study shows that regenerative design practices may be in very poor implementation, especially in the study context and related cases. However, the proposed framework of strategies can be adopted to promote regenerative design, regardless of the location. It is important that designs should encourage the co-evolution of nature and humankind in order to revitalize the environment. For the adoption of regenerative design and development, designs should be sensitive to the need for ecological inclusion to sustain life supporting systems. The transition to regenerative design practices can be facilitated by adopting quality awareness and education as major factors; encouraging collaborative actions and community participation to sustain regeneration; incorporating regenerative design practice as part of the approval process for

quality installations. Finally, as an initial road map towards achieving more regenerative design in projects, the generic framework of selected strategies should be adopted for easy implementation, in various contexts, beyond the current study. Considering the key limitation of generalizability in the study, there will be need for further refined instruments, larger and wide reaching survey samples, and the use of a wider spread of multiple cases.

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