# Determination of Key Principles of Sustainability Integration to Building Projects Development in Enugu State, Nigeria

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***Abstract-*** ***The study determined the key principles of sustainability factor variables to be integrated to building projects for sustainable building projects delivery in Enugu State, Nigeria. In order to carry out the study, nine local government areas (three each from the three senatorial zones of the state) were sampled based on urbanization and population of inhabitants in the area. A total of four hundred (400) questionnaires were distributed to stakeholders in the built environment while three hundred and forty four (344) representing 86.0% of the respondents were returned and used for the analysis. The data was analyzed using common size percentage analysis, mean score using five point likert rating scale, severity index/ranking, regression and correlation analysis. The results show key principles of sustainability consists of environmental, economic and social factors. It ranked first with mean score of 4.40 and severity index of 88.1% while the social sustainability factors ranked second with mean score of 4.10 and severity index of 81.9%. the least in the ranking was environmental factors with mean score of 4.00 and severity index of 80.0. The work concluded that key sustainability principles integrated to building projects are design, construction with whole life operation and maintenance would enhance the economic welfare, environmental health and social wellbeing of communities in Enugu State. The study recommends that the integration of key principles of sustainability to building projects would require Government and community participation, in terms of finance, education, training and awareness creation through public private partnership to achieve sustainable building projects delivery and facilitate urban renewal programme in the state.***

***Indexed Terms-*** ***Sustainability, Sustainable Buildings, Sustainable Integration, Economic Sustainability, Environmental Sustainability, Social Sustainability.***

## I. INTRODUCTION

Building sustainability is fundamentally a process of best practices that leads to sustainable outcomes (Muldavin, 2010). Planning process is typically not conducted very well due to its complexity and extra costs that are always associated with it (Mansur, Chewan Putra, and Mohammed, 2003). The planning process does not encourage sustainability matter clearly and limited interactions between various disciplines have hindered sustainable building projects from reaching the expected achievement. There are minimal inputs from Operation and maintenance groups, construction managers and trade contractors or outside stakeholders during the design stage and the planning process which make sustainability principles hard to be incorporated in building projects (Construction Industry Development Board (CIDB), 2003).

The impact of construction activities on the environment is considerable particularly in areas of energy use, soil degradation, loss of agricultural land, forests and wild lands, air and water pollution, and depletion of non-renewable energy sources and minerals (Ametepy, Ansah and Gyadu-Asiedu, 2020). Hence, sustainable development concept should encompass the interdependence between economic development, the natural environment and people inhabiting the environment. Sustainability aims at increasing economic efficiency, protecting and

restoring ecological systems and improving human well-being with a view to minimizing consumption of matter and energy, re-usability and recyclability of material, human satisfaction, minimum environmental impacts and embodied energy. Boroma and Roberts (2017) asserts that it is important to minimize the consumption because as material is consumed its chances for future use are diminishing; hence, its potential utility to future generation is lost. Embracing green or sustainable concept in design is aimed at reducing energy consumptions, operation and maintenance cost, reduce building related illness, increase the productivity and comfort of building occupants, reduce waste and pollution, increase building and component durability and flexibility. There is the need to integrate these at early stages of building, planning and construction process. However, sustainable development for building project delivery needs time, understanding, acceptance, adjustment and implementation. These can be achieved through awareness/commitment both on the part of individuals, community and professionals.

Aluko (2011) stated that, in Nigeria, many laws and regulations were enunciated at Federal, State and Local government levels for proper planning of the environment and building design architecture without integration of sustainability concepts. Most of the building projects are not sustainable which portends danger to the environment by degrading the natural design architecture. Although, the principal indicators for sustainable development are not integrated at the planning stage for most building projects, their execution also lack proper monitoring by the policy makers (Udegbunam, Agbazue, and Ngang, 2017). These led to poor implementation during construction which drastically affects our living environment. For a building development project to be sustainable, it must have the ability to be sustained for a definite period without damaging the environment, or without depleting a resource (Hornby, Gatenby and Wakefield, 2000).

UN Habitat/UNEP report (2008) identified (i) inconsistent government policies on sustainable development of building projects to incorporate critical issues of environmental management and sustainability. (ii) bureaucratic bottleneck during the approval of building design process. (iii) lack of adherence to planning rules and regulations (iv) multiple agencies involved in the approval and monitoring the execution of building projects (v) high cost of land acquisition and processing of certificate of occupancy (vi) distortion in land use management from the original master plan, and future planning not in accordance with the needs and aspiration of the increasing population (vii) indiscriminate felling of trees without replanting, building on water and drainage channels, erosion induced gullies as a result of poor environmental management. (viii) poor road network and infrastructural facilities to existing and new development areas, and (ix) lack of integrity on the part of project participants and individuals entrusted with the monitoring and implementation of the stipulated rules and regulations.

The integration of key principles of sustainability to sustainable building projects delivery in Enugu State, Nigeria is apt in this era where human related activities, burning of fossil fuel, green house gas emissions, and construction activities had led to variability in rainfall, temperature and other climatic conditions. These have resulted to food insecurity, deforestation, erosion induced gullies, unbalancing of ecosystem, pollution of air, land and water, loss of lives and properties in the state.

## II. LITERATURE REVIEW

2.1 Development Impact of Sustainable Design Sustainable Development Research Network (2002) stated that a successful design development presents various pre-construction and post-construction stages which include;

(a) Planning process consists components of Site selection and planning, Budget planning, Capital planning, Programme planning.

(b).The Design Process consists of Client awareness and global setting, Sustainable visions, project goals and sustainable criteria, Team development, Well-integrated design, Resource management, Performance goals.

(c) The operation and maintenance process consists of Commissioning of building systems, Building operations, Maintenance practices, Renovation, Demolition.

These tasks performed at each stage in the life cycle of sustainable building when properly integrated will result in Human well-being which is dependent on the relationship of environment, economic and social sustainability respectively as explained in Figure 1.

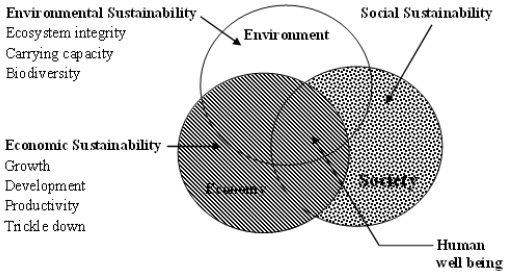


Figure 1: Model of Human Well-being
Source: Sustainable Development and Research Network (2002).

2.1.1 Environmental Sustainability Principles of Buildings

This relates to the matters concerned with planetary protection and maintenance of diverse ecosystems (Sayce, Walker and Mclutosh, 2004). These include;

(i) Optimizing of Materials and Resources Used:- global resource conservation to reduce the material intensity and increase the efficiency of the economy (Akadiri, Chinyio and Olomolaiye, 2012).

(ii). Sustainable Materials and Resources;- concerned with the prudent use of materials to reduce the negative impact to the environment and protect the users in terms of health and long term basis. These include selection, matching the products and the materials to the specific design and site to minimize the overall environmental impact (GSB, 2012).

(iii). Energy Efficient; concerned with renewable energy, reduce carbon (IV) oxide ($CO_2$) emission, building envelop performance and daylighting. Energy consumption has a direct impact on operational costs and exposure to fluctuations in energy supply and prices (GSB, 2009).

(iv). Efficient Water Consumption; in building construction and its operations, extraction, manufacturing and delivering of materials and products to site.

(v). Noise Control; a sustainable building with a comfort, wellbeing, satisfied user and functional excessive noise cause discomfort, is annoying and disruptive to occupants and communities.

(vi). Urban design, visual impact and Aesthetic; sustainability requirements in building urban design, aesthetics and visual impact are considered.

(vii). Site Planning and Management; concerned with on site selection, brownfield development, development density and community connectivity, construction activity pollution control and storm water design.

(viii). Concern on Quality of Land, River and Sea; precipitated by pollution impact by reducing acidification potential and human toxicity potential as well as eco-toxicity potential.

(ix). Transport management; suitable access to a building for both occupants, workers or for delivery goods. The quality of transport and transport access to the site by public and private means are influenced by occupation and ownership.

(x). Air and Emission Quality; include air pollution generated by building use, emission process and traffic emissions and its impact on human life, buildings and crops. These include improving indoor air quality, ensuring clean air, reduce acidification potentials, photochemical ozone creation potential and human toxicity potential.

(xi). Conserving Heritage; conserving heritage and footprint of project in archaeological site reduces energy usage associated with demolition, waste disposal and new construction and promotes sustainable development by conserving the embodied energy in existing buildings. Life cycle analysis of building fabric, structure, envelope, interior elements and systems and ongoing management and use need to be considered as part of the conservation process to achieve optimum energy efficiency outcomes (Rowe, 2009).

(xii). Efficient Environmental Management; in order to identify the environmental risks and formulate and implement primitive actions to reduce adverse environmental impacts such as water, land and air pollution, effective environmental planning, management and control are vital. Conserving existing natural

area and restore of damaged area to provide habitat, promoting biodiversity and maximizing open space by providing a high ratio of open space to development footprint. The promotion of biodiversity is important efficient environmental management strategy.

(xiii). Sustainable Construction Method; Transforming and assembling of resources into physical artifacts is essentially an intensive transformation process in construction. There should be harmonization of building construction with surrounding to minimize depletion of limited resources.

2.1.2 Economic Sustainability of Buildings focus is on micro and macroeconomic benefit. The microeconomic is concerned with the factors or activities which could level to monetary gains from construction project while macroeconomic relates to the advantages gained by the public and government from the project success (Zainul, 2010a). The project impacts on the economic conditions of its stakeholders and economic systems of local, material and global levels is the focus. The four principles for assessment of economic sustainability are;

(a). Economic Benefits to the Stakeholder; indicate how building project creates wealth and benefit for the stakeholders especially to the owner or occupants of the project. This promotes the utmost efficiency and reduces final costs through integrated design.

(b). Improve Local Market Presence; will generate benefit on the communities and local economies such as through preparation of needs assessment in order to determine infrastructure and other services needed.

(c). Whole Life Cost Efficiency; Sustainable building has long term benefits. Therefore, the life cycle assessment and whole life cost efficiency are essential to be taken into account since the project is designed to incorporate the environment, social and economic aspects on long term basis. Integrating sustainability in building project is not matter of design and construction, but also need whole life thinking including what happens once the building is occupied (Schumann, 2010).

(d). Indirect Economic Impact; Regional economies and local communities are an important part of a project economic influence in the context of sustainable development. Direct economic impacts and market influence focus on the immediate consequences of monetary flows to stakeholders, while the indirect economic impacts include additional impact generated as money circulates through the economy. The positive indirect economic .impacts such as economic impact in improving social or environmental conditions, enhancing skills and knowledge amongst a professional community or jobs supported in the supply chain, job creation and influence indirect positive economy impacts at the regional, national or local level and growth the value of the area surrounding the project.

2.1.3 Social Sustainability Principles of Buildings

Social Sustainability Principles of Buildings is based on the benefits of workers, stakeholders and future users. Social Sustainability is concerned with human feeling, security, satisfaction, safety and comfort and human contributions like skills, health, knowledge and motivation.

The seven significant assessment tools for Social Sustainability of building are adaptability, cultural importance, lovablility and likeability, planning and building regulations, occupation, legislation and locality and working environment quality (Sayce et al, 2004). Labuschagme, Brent and Classen, (2005) summarized that Social Sustainability Project life cycle should include internal human resources aspect, external population, stakeholders' participation and macro social performance aspect. The social dimensions of sustainability is referred to the impacts a project has on the social systems within which it operates surrounding the aspects of (i) employment (ii) labour/management relations, (iii) occupational, health and safety. (iv) training and education (v) fairness (vi) human right performance (vii) society (viii) product responsibility (ix) stakeholders participation and (x) macro social performance.

2.2 Integration of Building Projects into Urban Planning

The ability of cities in the globalizing world to perform their roles is hindered by the prevailing myriads of problems plaguing the system. Weak capacity is aggravated by the traditional colonial heritage of

master planning which is characterized by topdown, rigid and blue print nature. Infective urban planning practice and the search for appropriate planning approach contribute to the enhancement of sustainable urban development. There is overcrowding, poverty and environmental decay compounded by ineffective urban management practices in most Nigerian cities especially in Enugu State. The plethora of problems associated with these centres threatens to poison the promise of urban vibrancy and the challenges seem unmanageable, as most Nigerian cities are no longer living organisms. They are on the verge of death, rather than bubbling with soul, spirit and senses (Omolabi, 2003).

The Federal Government fragmental and uncoordinated intervention in the physical planning activities linked with such factors as globalization and democratization, culminated into various policies, strategies and approaches that have reinforced the role of cities as centres of production, consumption, social and political change. The fostering of sustainable economic growth, promoting efficient urban and regional planning development while ensuring improved standard of living and well-being of the people have failed in our circumstances.

Traditional physical planning approach with blue print (Master plan) created urban physical environment which is unpleasant in aesthetics and inconvenient in use to foster economic development and socio-cultural environment of urban population (Omolabi, 2008). The essence of urban planning to improve welfare of residents by following a logical sequence of problem definition, goal setting, determining the element of a plan, goal achievement determination, evaluation, implementation, and monitoring has failed in reality. It suffered a lot of draw backs in practice because it has not scientifically discovered the best radical solution to be implemented by the planning authority in public interest (Omolabi, 2008).

The traditional master plan as a form of urban planning failed due to excessive rigidity, lack of coordination with sectoral socio-economic and financial strategies for urban development, lack of citizen participation, and its notion as a product rather than process document (Onibokun, 1989; Conyers, 1994; Okpala, 1999). Omolabi (2008) suggested integrated planning approach which is an amalgam of community development and urban planning as an alternative to the traditional master plan approach. The community development refers to those measures, which enable people to recognize their own ability, to identify their problems and use the available resources to earn and increase their income, and build better life for themselves. Community development is a product of many elements like changes in thinking, perception, cultural beliefs, and traditions amongst others.

Fodor (1999) surmises that a sustainable community is one that lives in harmony with its local environment and does not cause damage to distant environment or other communities now or in the future. This is where achievements in social, economic and physical development are made last, and where a lasting supply of natural resources depends on the development. This culminate into community planning process of formulating policies and making decisions about the future development of a community. The issues concerned with community planning range from simple and little issues like provision of leisure activities, neighbourhood security, inadequate social services and infrastructure and quality of life among others.

Community planning affords the people the opportunity to have input into designs, implementation policies and proposals that affect them at conceptual levels based on their available resources (Reid, 2000). Community planning consider issues like neighborliness, anti-social behavior, crime, infrastructure related issues like drainage, electricity supply, energy, roads, water supply and service provision like community centres, entertainment facilities, libraries, schools, parks, public gardens and health facilities. It can also consider socio-economic issues like culture, employment, housing, as well as architecture, arts, townscape, town planning, urban design, and environmental protection (Wates, 2000).
Elimination of poverty, sustained improvement in the standard of living, enhancement of human dignity, protection of the environment, respect for culture and social cohesion addresses the basic human need for a sustainable urban development. The conditions necessary are the people that provide water bodies, good climate, capital-money, machinery and basic infrastructure. These are desirable social and

economic process that improves quality of life at various levels such as personal, neighbourhood, community, national and international. Other issues are;

(a). An enabling environment of peace and security
(b). Increasing realization of ability of people to successfully operate a multitude of social institutions
(c). Long term strategic needs of the city for sustainable development, and property, and need for participation of citizens at all
(d). Horizontal integration of government with civil society and business with vertical integration of action and policy between the levels of neighbourhood, city, urban region and nation.
(e). Broadened scope which takes into account political, social, physical and economic factors in an integrated manner for effectiveness
(f). The need to recognize and integrate socially, economically and environmentally sustainable urban development
(g). Creation of local financing mechanism for service provision and local projects.
(h). Concerns of 'brown agenda' as well as the 'green agenda' in environmental aspects (Omolabi, 2008).

## III. METHODOLOGY

The research study adopted a descriptive survey design approach. This is to prevent ambiguity and inconsistency in responses. The descriptive survey approach describes the characteristics of existing situation and provides insight into the research problems by describing the variables of interest in order to achieve the aim and objectives of this research study (Mugenda and Mugenda, 2003). The population of Enugu State was projected to be 5,441,900 as at 2023 based on the last census of 2006. The sample study was carried out from Nine local government areas which comprise Awgu, Enugu East, Enugu North, Enugu South, Igbo Etiti, Igboeze North, Nsukka, Oji River, and Udi of the state with a total projection population of 3,672,971 as at 2023 (NBS 2023). The study adopted the stratified random sampling techniques. This is because different disciplines of registered professionals were sampled who had varied knowledge, experience, exposure and interest based on their occupation. Sixty percent (60 %) of the sample was randomly selected using a sample frame while forty percent (40 %) will be randomly selected from each of the professional disciplines in the built environment.

Nine local government areas (three each from the three senatorial zones of the state) were sampled based on urbanization and population of inhabitants in the area. A total of four hundred (400) questionnaires were distributed to stakeholders in the built environment while three hundred and forty four (344) representing 86.0% of the respondents were returned and used for the analysis (See table 1). The primary data was collected through questionnaires while secondary data was obtained from journals, textbooks, seminar papers and occasional publications. The data was analyzed using common size percentage analysis, mean score using five point likert rating scale, severity index/ranking, regression and correlation analysis. The sample population for the study comprised prospective estate developers, stakeholders in the built environment in both public and private sectors.

## IV. RESULTS AND DISCUSSION

Results:

4.1. Analysis of Questionnaire Distributed and Category of Respondents

Table 1: Questionnaire Distributed and Retrieved

| S/N | Senatorial Zone | Number distributed | | Number Retrieved | | Number not returned | Percentage not returned (%) |
|---|---|---|---|---|---|---|---|
| | | | % | | % | | |
| A | Enugu East Senatorial Zone | | | | | | |
| (i). | Enugu North LGA | 54 | 13.5 | 49 | 90.7 | 5 | 9.3 |
| (ii). | Enugu East LGA | 53 | 13.25 | 43 | 81.1 | 10 | 18.9 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (iii). | Enugu South LGA | 53 | 13.25 | 45 | 84.9 | 8 | 15.1 |
| B | Enugu West Senatorial Zone | | | | | | |
| (i). | Oji River LGA | 40 | 10 | 32 | 80.0 | 8 | 20.0 |
| (ii). | Udi Local Government Area | 40 | 10 | 35 | 87.5 | 5 | 12.5 |
| (iii). | Awgu LGA | 40 | 10 | 33 | 82.5 | 7 | 17.5 |
| C | Enugu North Senatorial Zone | | | | | | |
| (i). | Nsukka LGA | 40 | 10 | 36 | 90.0 | 4 | 10.0 |
| (ii). | Igbo-Eze North LGA | 40 | 10 | 34 | 85.0 | 6 | 15.0 |
| (iii). | Igbo-Etiti LGA | 40 | 10 | 37 | 92.5 | 3 | 7.5 |
| Total | | 400 | 100 | 344 | 86.0 | 56 | 14.0 |

Source: Researcher Field Survey Report (2022)

From Table 1, a total of four hundred questionnaires were distributed to the respondents in the area of study. The selected local government areas and senatorial zones were shown in Table 1 indicated the questionnaires distributed and their percentages according to the various local governments in the sample survey. The total number retrieved/not retrieved and their respective percentages were also shown in Table 1. A total number of three hundred and forty-four (344) questionnaires were retrieved representing eighty six percent (86%) of the total number administered to respondents.

Table 2: Category of Respondents

| S/N | Characteristics | Frequency | Percentage (%) |
|---|---|---|---|
| (a). | Construction Professionals | | |
| (i). | Builders | 22 | 6.4 |
| (ii). | Architects | 36 | 10.5 |
| (iii). | Quantity Surveyors | 18 | 5.2 |
| (iv). | Land Surveyor | 9 | 2.6 |
| (v). | Estate Surveyor | 16 | 4.7 |
| (vi). | Town Planners | 27 | 7.8 |
| (vii). | Geography and Meteorologists | 14 | 4.1 |
| (viii). | Environmental Engineers/Managers | 12 | 3.5 |
| (ix). | Engineers | | |
| | Civil/Structural Engineers | 25 | 7.3 |
| | Electrical Engineers | 12 | 3.5 |
| | Mechanical Engineers | 10 | 2.9 |
| | Geotechnical Engineers | 6 | 1.7 |
| | Total | 207 | 60.2 |
| (b). | Building and Civil Engineering Contractors | 21 | 6.7 |
| (c). | Manufacturers and suppliers of Building Materials/Products | 62 | 18.0 |
| (d). | Others | 54 | 15.7 |
| | Total | 344 | 100 |

Source: Researcher Field Survey Report (2022)

In Table 2, the Category of Respondents includes all professional in the built environment in order to benefit from their expertise on perspective of sustainable building projects delivery in Enugu State. A total of two hundred and seven (207) professional in the built environment responses were retrieved which represents 60.2% of the respondents. The Building and

Civil Engineering Contractors were twenty-one (21) representing 6.7% of the respondents. The total number of respondents for Manufactures and Suppliers of Building Materials/Products were sixty-two (62) representing 18.0% of the respondents and others which include Policy Makers, interest groups, developers etc. have a total number of fifty-four (54) respondents representing 15.7%.

4.2 Analysis of Determination of Key Principles of Sustainability Integration to Building Projects Delivery in the Study Area

The responses of the respondents on the integration of the key principles of sustainability to building projects delivery in the study area as stated in Table 3 shows that the respondents agreed that the key principles of sustainability consists of environmental, economic and social factors with mean score value of 4.40 and severity index of 88.1%.

Table 3: Perception of Respondents on the key principles of sustainability integration of building projects delivery in Enugu State

| S/N | Item | SD | DA | UD | A | SA | $\sum Fx$ | mean | S.I.% | Rank |
|---|---|---|---|---|---|---|---|---|---|---|
| A. | The key principles of sustainability consists of Environmental, Economic and Social factors | – | – | 29 | 147 | 168 | 1515 | 4.40 | 88.1 | |
| B. | The environmental sustainability principles that are integrated in the planning and construction of building projects in Enugu include: | | | | | | | | | |
| 1. | Optimization of materials and resources | – | 4 | 114 | 139 | 87 | 1341 | 3.90 | 78.0 | 10th |
| 2. | The use of sustainable materials and resources | 14 | 58 | 103 | 74 | 95 | 1210 | 3.52 | 70.4 | 11th |
| 3. | Use of energy efficient products to reduce high cost of energy consumption. | – | 57 | 48 | 105 | 134 | 1348 | 3.92 | 78.4 | 9th |
| 4, | Efficient water consumption in construction, operations extraction, manufacturing and delivery of materials and products to site. | – | 18 | 83 | 117 | 126 | 1383 | 4.02 | 80.4 | 5th |
| 5. | Efficient noise control materials use for comfort of occupants. | – | 11 | 104 | 137 | 92 | 1342 | 3.90 | 78.0 | 10th |
| 6. | Sustainability requirements in building urban design aesthetics and visual impact. | – | 23 | 61 | 113 | 147 | 1416 | 4.12 | 82.3 | 3rd |
| 7. | Site selection, brownfield development, development density and community connectivity, construction activity pollution control and storm water design. | – | 22 | 72 | 96 | 154 | 1414 | 4.11 | 82.2 | 4th |
| 8. | Concern on quality of Land, River and Sea. | – | – | 83 | 118 | 143 | 1436 | 4.17 | 83.5 | 2nd |
| 9. | The quality of transport and transport access to site by public and private means for occupants, workers or delivery of goods. | – | 39 | 50 | 123 | 132 | 1380 | 4.01 | 80.2 | 6th |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 10. | Air pollution and emission quality by building users, traffic emission and its impact on human life, buildings and crops. | – | – | 72 | 115 | 157 | 1461 | 4.25 | 84.9 | 1st |
| 11. | Conserving heritage and footprint of project in archeological site | – | 30 | 85 | 104 | 125 | 1356 | 3.94 | 78.8 | 8th |
| 12. | Efficient environmental planning, management and control. | – | – | 94 | 116 | 134 | 1416 | 4.12 | 82.3 | 3rd |
| 13. | Use of appropriate sustainable methods to achieve sustainable buildings. | – | 48 | 52 | 103 | 141 | 1369 | 3.98 | 79.6 | 7th |
| Grand Mean | | | | | | | | 4.00 | 80.0 | |

Source: Researcher Field Survey Report (2022)

The information in Table 3 indicates that, under environmental sustainability principle "Air pollution and emission quality by building users, traffic emission, and its impact on human life, buildings and crops" has the highest mean score value of 4.25 and 84.9% severity index. This is evident on the environment which could be the reason respondents ranked it first. The next is on item 8 i.e. "the concern on quality of land, river and sea" with mean score value of 4.17 and 83.5% severity index."Sustainability requirements in building urban design aesthetics and visual impacts, and efficient environmental planning, management and control" have the mean score value of 4.12 severity index of 82.3% each respectively. The least mean score values of 3.52 and severity index of 70.4% is on the "the use of sustainable materials and resources" for responses of respondents on their perception the key principles of sustainability integration of environmental sustainability to building projects delivery in the study area. The grand mean score of 4.00 and severity index of 80.0% indicated that all the variable factors under environmental sustainability with rating above 3.25 as stated should be integrated for sustainable building projects delivery in Enugu State.

4.3 Analysis of the Regression Function on the Information in Table 3

The mean score ratings were plotted against the Integration of Environmental Sustainability principles on Table 3 to determine the regression functions in a graph as shown in Figure 2

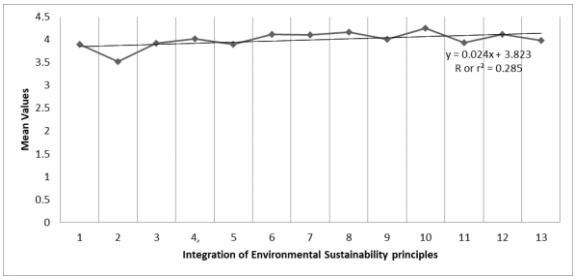


Figure 2: Mean values against Integration of Environmental Sustainability principles

In Figure 2, the graphical estimation shows that, Y = 0.024x + 3.823 and R or $r^2$ = 0.285. The coefficient of correlation, $r = \sqrt{R} = \sqrt{0.285} = 0.5339$. The critical value of r at 0.1 level of significance and degree of freedom ($d_f$) = 24 from the Correlation coefficient table is 0.2598. The result shows that since critical value of the coefficient of correlation (r) = 0.2598 is less than the computed value of r = 0.5339, from the regression function all the variables associated with environmental sustainability principles should be integrated for sustainable building projects delivery in Enugu State.

Table 4: Perception of Respondents on the key principles of economic sustainability integration on building project delivery

| S/N | Item | SD | DA | UD | A | SA | $\sum Fx$ | Mean | S.I. % | Rank |
|---|---|---|---|---|---|---|---|---|---|---|
| C. | Economic Sustainability Principles include; | | | | | | | | | |
| 1. | Economic benefits for stakeholders (owners or occupants) | – | 2 | 70 | 144 | 128 | 1430 | 4.16 | 83.1 | 1st |
| 2. | Whole life cost efficiency considerations. | – | 54 | 42 | 129 | 119 | 1395 | 3.91 | 78.2 | 4th |
| 3. | Improve in local market presence by preparation of needs assessment on infrastructure and other services needed. | – | 13 | 86 | 112 | 133 | 1397 | 4.06 | 81.2 | 2nd |
| 4, | Indirect economic impacts such as additional impact generated as money circulates through the economy, etc. | – | 34 | 67 | 125 | 118 | 1359 | 3.95 | 79.1 | 3rd |
| Grand Mean | | | | | | | | 4.02 | 80.4 | |

Source: Researcher Field Survey Report (2022)

The information in Table 4 indicates that, the highest mean score value of 4.16 and severity index of 83.1% is on "economic benefits to stakeholders (owners or occupants)" while "improve in local market presence by preparation of needs assessment on infrastructure and other services needed" has a mean score value of 4.06 and severity index of 82.1%.The least mean score on variable factors under economic sustainability integration of 3.91 and severity index of 78.2% is on the "whole life cost efficiency consideration" for responses of respondents on their perception on the key principles of sustainability integration for economic sustainability to building projects delivery in the study area. The grand mean score of 4.02 and severity index of 80.4% clearly shows that integration of economic aspects of sustainability is very necessary for building projects delivery in study area.

The information in Table 4 was represented in the graph on Figure 3

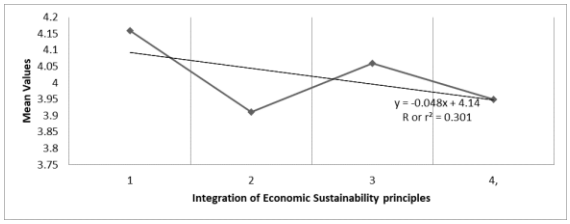


Figure 3: Graph of Mean values against Integration of Economic Sustainability principles

In Figure 3, the graphical estimation shows that, Y = -0.048x + 4.14 and R or $r^2$ = 0.301. The coefficient of correlation, r = $\sqrt{R} = \sqrt{0.301} = 0.5486$. The critical value of r at 0.1 level of significance and degree of freedom ($d_f$) = 6 from the Correlation coefficient table is 0.5067. The result shows that since critical value of the coefficient of correlation (r) = 0.5067 is less than the computed value of r = 0.5486, from the regression function, economic sustainability principles need to be integrated in sustainable building projects delivery in Enugu State.

Table 5: Respondents' Perception on the key principles of social sustainability integration on building project delivery in Enugu State

| D. | Social sustainability principles include: | SD | DA | UD | A | SA | $\sum Fx$ | mean | S.I % | Rank |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Employment benefits | – | – | 85 | 114 | 145 | 1436 | 4.17 | 83.5 | 3rd |
| 2. | Labour/management relations | – | 13 | 87 | 106 | 138 | 1401 | 4.07 | 81.5 | 5th |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 3. | Occupational health and safety | – | 20 | 76 | 117 | 131 | 1391 | 4.04 | 80.9 | 7th |
| 4, | Training, Education and Awareness | – | 5 | 63 | 128 | 148 | 1451 | 4.21 | 84.4 | 2nd |
| 5. | Fairness to provide access and facilities for disabled, equality of remuneration, distribution and opportunity etc. | – | 46 | 37 | 119 | 142 | 1389 | 4.04 | 80.8 | 8th |
| 6. | Human right performance through decision, action, operations, interaction and relationship with others. | – | 31 | 58 | 124 | 131 | 1387 | 4.03 | 80.6 | 9th |
| 7. | Social performance impact of the project with other social institution like public involvement, monopoly practices, compliance with laws and regulations etc. | – | 30 | 53 | 132 | 129 | 1392 | 4.05 | 80.9 | 6th |
| 8. | Product responsibility of the project on users. | – | 32 | 62 | 136 | 114 | 1364 | 3.97 | 79.3 | 10th |
| 9. | Stakeholders' participation, information, community forum and users' participation in planning and development process. | – | – | 78 | 113 | 153 | 1451 | 4.22 | 84.4 | 1st |
| 10. | Macro social performance on environmental and financial performance of a region or nation. | – | 8 | 71 | 121 | 144 | 1433 | 4.17 | 83.3 | 4th |
| Grand Mean | | | | | | | | 4.10 | 81.9 | |

Source: Researcher Field Survey Report (2022)

The information in Table 5 indicates that, the highest mean score value of 4.22 and severity index of 84.4% under integration of social sustainability is on "stakeholders' participation, information, community forum and user's participation in planning and development process. This is followed by "Training, education and awareness" with mean score value of 4.21 and severity index of 84.4% while employment benefits" and "macro social performance on environmental and financial performance of a region or nation" have mean score value of 4.17 and severity index of 83.3% simultaneously. The least in the mean score value of 3.97 and severity index of 79.3% is on the "product responsibility of the project on users". The grand mean score of 4.10 and severity index of 81.9% indicated that the integration of social sustainability principles factor variables are important for building projects delivery in study area.

The information in Table 5 was represented in the graph on Figure 4

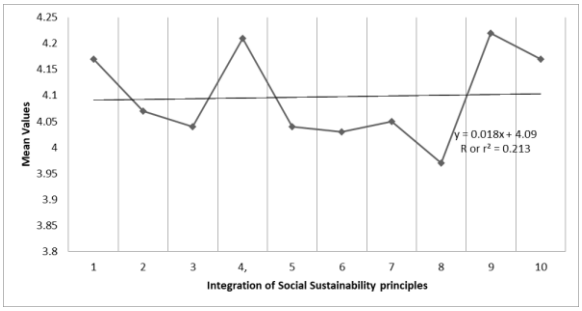


Figure 4: Mean values against Integration of Social Sustainability principles

In Figure 4, the graphical estimation shows that, Y = 0.018x + 4.09 and R or $r^2 = 0.213$. The coefficient of correlation, $r = \sqrt{R} = \sqrt{0.213} = 0.4615$. The critical value of r at 0.1 level of significance and degree of freedom ($d_f$) = 18 from the Correlation coefficient table is 0.2992. The result shows that since critical value of the coefficient of correlation (r) = 0.2992 is less than the computed value of r = 0.4615, from the regression function, social sustainability principles need to be integrated in sustainable building projects delivery in Enugu State.

Table 6: Summary of Respondents' Perception on Integration of Key Sustainability Principles in building projects delivery

| S/N | Sustainability Principles Integration Factors | Grand mean score | Severity index (%) | Rank |
|---|---|---|---|---|
| A | Key principles of sustainability consist of Environmental, Economic and Social factors | 4.40 | 88.1 | 1st |
| B | Integration of Environmental Sustainability factors | 4.00 | 80.0 | 4th |
| C | Integr1ation of Economic Sustainability factors | 4.02 | 80.4 | 3rd |
| D | Integration of Social Sustainability factors | 4.10 | 81.9 | 2nd |
| Overall Grand Mean | | 4.13 | 82.6 | |

Source: Researcher Field Survey Report (2022)

The information in table 6 indicates that the respondents responses that the key principles of sustainability consist of environmental, economic and social factors has the highest mean of 4.40 and severity index of 88.1%. The social, economic and environmental integration have grand mean of 4.10 and 81.9% severity index; grand mean of 4.02 and 80.4% severity index; and grand mean of 4.00 and 80.0% severity index respectively. The overall grand mean is 4.13 and severity index of 82.6%. This result shows that the key sustainability principles should be integrated in the sustainable building projects delivery in Enugu State.

4..4 Analysis of the Regression function of the information in Table 6

The grand mean score values were plotted against the integration of sustainability principles factors in Table 6 to determine the regression function in a graph as shown in Figure 5.

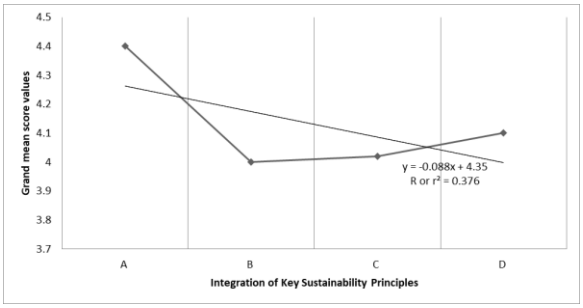


Figure 5 Grand mean score values against integration of Key sustainability principles

In Figure 5, the graph of the regression function of grand mean score values against sustainability integration factors to sustainable building project delivery is a linear relationship which shows the line of best fit at Y = -0.088x + 4.35. The estimation of the graphical function for the coefficient of determination (R or $r^2$) = 0.376. The coefficient of correlation (r) which is the positive square root of the coefficient of determination is calculated as = $\sqrt{r^2 \; or \; R}$ = $\sqrt{0.376}$ = 0.6132. The critical value of r at 0.1 level of significance and degree of freedom ($d_f$) = 6 from the correlation coefficient table of values is 0.5067. The results show that the total variation in the values of mean score ratings is explained by the variation on Integration of Key Sustainability Principles. Also since the critical value of the coefficient of correlation (r) = 0.5067 is less than the computed value of r = 0.6132, obtained from the regression function, the key sustainability principles need to be integrated in sustainable building projects delivery in study area.

## V. CONCLUSION AND RECOMMENDATION

i. The sustainable development concepts applied to design, construction, operation and maintenance with whole life assessment of buildings would enhance the economic welfare, environmental health and social well-being of communities in Enugu State. This is apt in this era of climate change when sustainable development emerged most strongly in the environmental, economic and social points of view which made the concept a driving force.
ii. The key sustainability principles of environmental, economic and social factors would require the effort of government and people inhabiting the area in terms of finance, active participation,

education, training and awareness to achieve the desired goal.

iii. The Enugu state government should encourage public private partnership to fast-track urban renewal programme for sustainable building projects delivery and have legislation to back up all the proposals recommended for proper enforcement in the study area.

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