Criteria for measuring Sustainable Construction Project Performance in Nigeria

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Abstract. Construction Project (CP) in Nigeria is currently still at a rear end as far as sustainable construction is concerned. Consequently, the objective of this study is to identify criteria necessary for measuring sustainable construction project performance and to elicit perceptions of their relative importance. Thorough review of related studies were deployed to generate a set of factors that makes construction project habitable, attractive and liveable, and also, factors for measuring construction project performance. A total of 87 questionnaires were distributed to seven (7) main groups of project participants namely; client, project manager, architect, quantity surveyor, electrical engineer, mechanical engineer and builder/civil/structural engineer who participated on nine (9) case study projects. The survey findings indicate that quality performance and productivity both with 81.6% of importance, innovation with 80.4% of importance, health and safety with 80.2% of importance and client’s satisfaction with 80% of importance are the most important factors to consider while measuring sustainable construction project performance. For a construction project to be habitable, safety and incident risk, acoustic comfort and visual comfort are the most important factors to consider. When considering how attractive construction project should be, art in architecture, unique style, terrain choice and harmonious surrounding are the most important factors to consider. Also, when considering the liveability of a construction project, space efficiency, ventilation and public accessibility are the most important factors to consider. Finally, this research recommended that the factors listed above, are key factors to consider at the design stage of any construction project for both the designer and the regulatory agencies, and these factors are to be monitored throughout the construction process since they are vital in measuring the performance of any sustainable construction project to infer a more desirable and satisfactory sustainable building.

1. Introduction

The global and national search towards sustainable development has placed the construction industry in the spotlight since the industry is the major main consumer of natural resources. Construction projects has fundamental impacts on economic, environmental, social and technical sustainability. In considering these impacts, it is important to measure the performances of product of construction industry which is construction projects. In measuring the performance of construction projects, it is vital to identify criteria needed to assess the performance of the construction projects as this in turn simplify the process of performance measurement of construction projects.

Several construction project performance evaluation techniques or methods are presently in use all around the world; yet some of these methods neglect to incorporate the needed sustainable performance indicators and criteria, hence, the need to identify criteria to consider when measuring
performance of construction project. Also, many criteria are to a great degree complex to make and are regularly scrutinized for disentangling the unpredictable issues of sustainability in CP performance. Today, great deal of effort is being placed worldwide in achieving sustainable performance in construction industry [4]. The sole objectives of these efforts are to regulate the energy consumption and to ensure construction project sustainability in extreme climatic condition and sustainable efficiency design in construction project.

2. Review of Related Studies

Performance measurement is utilized to enhance project execution by taking a gander at the criteria to be estimated and assessed to get the outcomes; this will be a guide for what associations need to design and do later on. Moves ought to be made in view of the after effects of assessment. Criteria measured in the assessment procedure are constituted by inside and outer parts of the organization (Hoque, 2004).

Thought of taking non-monetary measures, for example, consumer satisfaction and occupation fulfilment into account in estimating execution began in the 1990s. After numerous industries uncovered the restriction of money related measures, associations tended to take a gander at non-monetary viewpoints to be estimated and considered in assessing execution of CP. Business pioneers concur that a successful project will better serve its stakeholders by concentrating on the necessities of its clients, workers, providers and the more extensive network [1].

There is a developing mindfulness among organizations in the construction industry that measurement frameworks are vital for checking and controlling their execution and performance. [5] Study concede to a similar thought. They express that performance measurement is creating its way in the industry. There are three reasons. In the first place, the consistent fast improvement of performance measurement in different divisions amid the 1990s made a monstrous enthusiasm for its advancement in the construction industry. The second reason is the expanding intricacy of construction projects requiring proper measurement instruments and models to enhance execution and the third is the advancement and difficulties of project management and in addition building innovation as of late.

Some factors are essential to consider while measuring sustainable construction project performance in order to have a clearer picture of where these types of projects stands as far as sustainability is concerned and according to [8], these factors can be categorised under different phases in the construction process namely; Inception phase, Construction phase, Operational phase and Demolition phase. The following are the factors identified in his study as the most important factors to consider; finance plan, workers’ health and safety assessment, Air pollution assessment, standardization, security consideration, energy consumption, public awareness, re-usable element, local economy, provision of services among others. [15] Study also recognises the impact construction chemical waste and waste disposal could cause throughout a construction project lifecycle. [11] Study emphasizes on occupational health and safety as one of the major benefits of applying sustainability measure in a construction project.

3. Research Methods

3.1. Research design. The design adopted for this study was survey method (quantitative research). Primary data were collected through questionnaire administered to professionals that participated in the case study projects for this study.

3.2. The Study Area. Nine (9) Construction projects were selected as case study for this research. These construction projects are project registered with a sustainability tool as at the time of construction in Nigeria.
3.3. Study Population, Sample Size and Sample Technique. The projects selected for this study are mainly construction projects constructed to meet sustainable development goals. They are listed below:

1. Nest Oil Tower Project, Lagos
2. The Heritage Place Tower Project, Lagos
3. Nox Building Project, Abuja
4. P & G Nigeria MDO Warehouse Project, Ogun State
5. No 4 Bourdilon Street Building Project, Lagos
6. Convention Centre Project, Uyo State
7. Wing Tower Project, Lagos
8. AfDB Nigeria Field Office Building Project, Abuja
9. Alliance Place Tower Project, Lagos

For One (1) Construction Project, respondent for the study are:

A. Client
   a. Client or Client representative = 1

B. Consultant
   a. Project Manager = 1
   b. Architect = 1
   c. Quantity Surveyor = 1
   d. Structural Engineer = 1
   e. Electrical Engineer = 1
   f. Mechanical Engineer = 1

C. Contractor
   a. Quantity Surveyor = 1
   b. Builder or Civil Engineer = 1
   c. Electrical Engineer = 1
   d. Mechanical Engineer = 1

Therefore, for Nine (9) Construction Projects, number of respondent (R) will be

\[ R = 11 \times 9 \]
\[ = 99 \]

The number of questionnaire distributed for this study are Ninety Nine (99) but not all the questionnaires were returned, Eighty Seven (87) questionnaires were returned in which all were found suitable for the purpose of analysis, this represent 87.87% of the response rate which is adequate for the study.

The technique for sampling respondents for this study is a non-probabilistic sampling technique also termed purposive sampling technique. This is so because these type of projects are not so common in the country, therefore, careful selection of sustainable commercial construction projects in Nigeria was purposively done.

3.4. Data Collection Approach. The collection approach employed for this study includes a well-structured questionnaire self-administered to various professionals that are concerned through direct contact, e-mails, WhatsApp and telegram. The questionnaires were self-explanatory, clear and understandable.

3.5. Data Analysis Techniques. The data collected in this study was analysed with relative importance index and mean item score through SPSS package and Microsoft Excel software.
3.5.1 Relative Importance Index (RII). The criteria for measuring performance of sustainable construction was analysed using Relative Importance Index (RII) to rank the indicators accordingly to their order of importance. A 5-point likert scale was employed for the collection of data, the research employs the formula below:

\[ \text{R.I.I} = \frac{\sum_{i=1}^{5} W}{A \times N} \]  

(1)

Where:
- \( N \) is the total number of responses.
- \( W \) is the weighting given to each factor by the respondents and ranges from 1 to 5 where '1' is 'Not Important' and '5' is 'Most Important',
- \( A \) is the highest weight (i.e. 5 in this case).

3.5.2 Mean Item Score (MIS). Mean Item score was used to analyse criteria for sustainable construction. The sum of FX resulting from the multiplying frequencies of the respondents and ratio of the range of options between 1-5. FX was divided by the total number of questionnaires analysed to get the mean item score used to rank indicators from the highest to the lowest.

Mean score equation used for the calculation:

\[ \text{MIS} = \frac{5(FX_5) + 4(FX_4) + 3(FX_3) + 2(FX_2) + (FX_1)}{X_5 + X_4 + X_3 + X_2 + X_1} \]  

(2)

Where:
- MIS = mean item score
- \( X = \) range 1 – 5 with 5 being the highest and 1 being the lowest
- \( F \) = Frequency of respondent in each factor

4. Data Analysis and Result

Table 1. Demographic Information

| Categories         | Classification       | Number | %    |
|--------------------|----------------------|--------|------|
| Professional       | Client               | 9      | 10.34|
|                    | Project Manager      | 8      | 9.20 |
|                    | Architect            | 9      | 10.34|
|                    | Quantity Surveyor    | 15     | 17.24|
|                    | Civil Engineer       | 6      | 6.90 |
|                    | Structural Engineer  | 4      | 4.60 |
|                    | Electrical Engineer  | 16     | 18.39|
|                    | Mechanical Engineer  | 15     | 17.24|
|                    | Builder              | 5      | 5.75 |
| Year of Experience | 6 – 10 years old     | 47     | 54.00|
|                    | 11 – 15 years old    | 17     | 19.50|
|                    | Less than 5 years old| 15     | 17.20|
|                    | 16 – 20 years old    | 5      | 5.70 |
|                    | More than 20 years old| 3     | 3.40 |
| Participation in SCP| Yes                  | 78     | 89.70|
|                    | No                   | 0      | 0.00 |
|                    | Missing              | 9      | 10.30|
|                    | Total                | 87     | 100.00|
From Table 4.1, respondents who were involved in filling of questionnaires and answering of interview questions are Clients or Client representative, Project Managers, Architects, Quantity Surveyors, Structural Engineers, Electrical Engineers, Mechanical Engineers, and Builders who actively participated in the construction projects selected as case study for the purpose of this study. Respondents whose years of experience are between 6-10 years are at the majority as they dominate 54% of the total population while respondents with 11-15 years of experience have 19.50%, those respondents who have less than 5 years of experience have 17.20. The respondents with years of experience of over 20 years are very limited as they are only 3.40% fraction of the entire populace, and thereafter followed by the number of respondents with 16-20 years of experience with a fraction of 5.7% of the entire populace. This reveals that as much as the idea gotten from this research is distributed among different age bracket of experience, there seem to be a larger turn out from the middle aged professional in the construction industry to participation in Sustainable Construction in Nigeria. The result gotten from the respondents shows that about 90% have well participated in Sustainable Construction project while none claim to have not participated in Sustainable Construction projects, at the same time, about 10% of the respondents left their opinion blank.

Table 2. Factors that makes Construction projects habitable.

| Criteria for Habitable Projects | Descriptive Statistical Values |
|---------------------------------|--------------------------------|
|                                 | Mean   | Ranking |
| Safety and Incident risks       | 3.56   | 1       |
| Acoustic comfort                | 3.44   | 2       |
| Visual comfort                  | 3.09   | 3       |
| Indoor air quality              | 2.94   | 4       |
| Outdoor building related qualities | 2.94 | 5       |
| Influence of the user           | 2.86   | 6       |
| Aesthetic comfort               | 2.67   | 7       |
| Thermal comfort during dry season | 2.48 | 8       |
| Thermal comfort during rainy season | 2.47 | 9       |

From Table 2 above, Safety and Incident risks with mean score of 3.56 has the 1st rank when comparing several criteria that makes habitable construction project. This rank was then followed by Acoustic comfort coming 2nd with a mean score of 3.44, thereafter Visual comfort with 3.09 mean and 3rd in ranking. This is not surprising as safety and comfortability of users of any construction project is maximally important which have been demonstrated in Table 2 above as the most important criteria to consider when measuring the habitability of a construction project. Thermal comfort during rainy season and during dry season has the lowest rank on the table with 9th and 8th ranking and mean value of 2.47 and 2.48 respectively. This also can as well be interpreted thus; that in considering how habitable a construction project can be, these factors are less important compared to the other factor mentioned earlier above.

Table 3. Factors that makes Construction Projects attractive

| Criteria for Attractive Projects | Descriptive Statistical Values |
|----------------------------------|--------------------------------|
|                                  | Mean   | Ranking |
| Art in Architecture              | 3.64   | 1       |
| Unique style                     | 3.62   | 2       |
In the attempt to identify what makes Sustainable construction Project attractive, it was found that one of the most important criteria to consider is the Art in Architecture of the given project which ranked 1st and has a mean value of 3.64; thereafter, we can consider the uniqueness of the sustainable project’s style as this ranked 2nd with a 3.62 mean value. Another criteria to consider when proposing an attractive sustainable construction project is the terrain choice where the sustainable construction project will be situated, this factors is ranked 3rd with a mean value of 3.57. The least of the criteria to consider for attractive projects have mean value of 2.06, 2.99 and 3.10 and they are size, cultural identity of the structure and acceptability by the public with 9th, 8th, and 7th ranking respectively. From the analysis, even though these three criteria happen to be the lowest ranked, it does not mean they really do not matter, as two out of these criteria has a mean rank well above average; which means that they are as well important even if not as important as other with higher ranking.

| Criteria for Liveable Projects | Descriptive Statistical Values |
|-------------------------------|--------------------------------|
| Space efficiency              | 3.94                          |
| Ventilation                   | 3.92                          |
| Public accessibility          | 3.54                          |
| Shopping facilities           | 3.45                          |
| Vehicle comfort               | 3.37                          |
| Outdoor building related qualities | 3.24                        |
| Capability of conversion      | 3.16                          |
| School facilities             | 3.09                          |
| Aesthetic                     | 2.92                          |

In the quest of finding out what makes construction project liveable, one of the most important reasons why construction building project are always embarked upon was found to be space efficiency with ranking 1st with a mean score of 3.94. This criterion happens to be very scarce to find in places like Lagos state Nigeria, where construction projects are being managed on the little land mass available due to scarcity of land in the area. Ventilation is also a very paramount criterion with 2nd rank and a mean rank of 3.92, as it is very essential for construction project especially building project to be well ventilated for the comfort and healthy living of the users. Public accessibility and shopping facilities are also a key criteria to consider in a construction project. In considering how liveable a construction project can be, all the criteria mentioned in Table 4 above should be well satisfied as they all ranked well above average which makes them all important in the life of a construction project.

| Criteria for Measuring SCPP | RII | % of Importance | Ranking |
|----------------------------|-----|-----------------|---------|
|                            |     |                 |         |
Table 6 shows that the two most important criteria for measuring sustainable construction project performance is quality performance and productivity of the project which both have a relative importance index of 0.816 and ranked 1st. Innovation with a relative importance index of 0.804 with 3rd ranking is also another important criteria for measuring sustainable construction project performance with a very high importance index. Health and Safety and Client’s satisfaction are other cogent factors that needs to be taken seriously, as the relative importance index of these factors are 0.802 and 0.800 respectively with 4th and 5th ranking on the table. [11] presented health and safety as one of the major benefit of applying sustainability to construction project. The least of the factors listed in Table 5 above is partnering with 18th ranking and an importance index of 0.626, followed by Leadership with 16th ranking and an index of 0.646. Other factors which are low on the table includes but are not limited to Training and Development, Growth, Stakeholder’s Satisfaction and Information Analysis which are all of indexes 0.646, 0.674 and 0.676, 0.676 with 16th, 15th 13th and 13th ranking respectively.

Table 6. Criteria for measuring Sustainable Construction Project Performance (Cont’d)

| Criteria for Measuring SCPP     | RII  | % of Importance | Ranking |
|---------------------------------|------|-----------------|---------|
| Profitability                   | 0.766| 76.6%           | 9       |
| Cost performance                | 0.766| 76.6%           | 9       |
| Team work                       | 0.752| 75.2%           | 11      |
| Risk Management                 | 0.740| 74.0%           | 12      |
| Information Analysis            | 0.676| 67.6%           | 13      |
| Stakeholder’s satisfaction      | 0.676| 67.6%           | 13      |
| Growth                          | 0.674| 67.4%           | 15      |
| Training & development          | 0.646| 64.6%           | 16      |
| Leadership                      | 0.646| 64.6%           | 16      |
| Partnering                      | 0.626| 62.6%           | 18      |

5. Discussion of Findings

Safety and Incident risks is the most important factor to consider that makes construction project habitable. Acoustic comfort and Visual comfort are as well considered important in making a construction project habitable. This is not surprising as safety and comfortability of users of any construction project is maximally important. Thermal comfort during rainy season and during dry season has the lowest negligible importance in considering how habitable a construction project can be, these factors are less important compared to the other factor mentioned earlier above. It was explained that to enhance safety practices, it is imperative to enhance professional’s interest in safety management and also increased awareness [16]. Visual comfort is a relatively important criteria
which includes provision of natural light, external views and reduction of glare among others. This is also used as a factor by Building Research Establishment Environmental Assessment Method (BREEAM) assessor to assess a sustainable construction; likewise acoustic comfort which includes overcoming the noise nuisance which may have negative effect on health and quality of life. An example by Design Building of the United Kingdom is the ability to hear the occupants of a neighbouring house through the walls of the building.

In the attempt to identifying what makes Sustainable construction Project attractive, it was found that the most important criteria to consider is the Art in Architecture of the given project, thereafter, we can consider the uniqueness of the sustainable project’s style. Another criteria to consider when proposing an attractive sustainable construction project is the terrain choice where the sustainable construction project will be situated. The least of the criteria to consider for attractive projects are size, cultural identity of the structure and acceptability by the public respectively; even though these three criteria happens to be the lowest ranked, it does not mean they really do not matter. Art in architecture can be termed the expression or application of creative human imagination and skill in a visual form to be appreciated for their beauty and emotional power. Therefore whether the primary purpose of art in architecture of any construction project is to achieve beauty or to organize space in a strategic way is completely up for discussion [2].

In the quest of finding out what makes construction project liveable which is one of the most important reason why construction building project are always embarked upon, it was found that space effic iency is the most important criteria to consider. This factor happens to be very scarce to find in places like Lagos state Nigeria, where construction project are being managed on the little land mass available due to scarcity of land in the area. Ventilation is also a very paramount criterion, it is very essential for construction project especially building project to be well ventilated for the comfort of the users. Public accessibility and shopping facilities are also a key criteria to consider in a construction project. In considering how liveable a construction project can be, all the criteria mentioned above should be well satisfied as revealed in this study, as they are important in the life of a construction project. This result agrees with Physical planning division of the government of the commonwealth of Dominica who considers space, light and ventilation as the key criteria for a liveable and habitable construction project.

Two of the most important criteria for measuring sustainable construction project performance is quality performance and productivity of the project which both have a relative importance index of 0.816. It was opined that for quality performance in any construction project to be achieved, there is need for contractors to give a greater preference to the use of quality materials to improve project cost, time and quality [8]. (Patience, 2014; Liu, 2014) and Arora (2014) also justifies quality performance as a crucial measure of project performance. Innovation as a factor is also another important criteria for measuring sustainable construction projects. Safety and Client’s satisfaction is another cogent factor that needs to be taken seriously. The least of the factors is Partnering, followed by Leadership. Other factors which are low on the table includes but are not limited to Training and Development, Growth and Stakeholder’s Satisfaction [4][10].

6. Conclusion and Recommendation

Several criteria that makes habitable construction project among others are Safety and Incident risks, acoustic comfort and visual comfort. This is not surprising as safety and comfortability of users of any construction project is maximally important. In the attempt to identifying what makes Sustainable construction Project attractive, it was found that the most important criteria(s) to consider are the harmonious surrounding of the given project, the uniqueness of the sustainable project’s style and design, and the terrain choice where the sustainable construction project will be situated. In the quest of finding out what makes construction project liveable, some of the most important reasons why construction building project are always embarked upon was found to be space efficiency, ventilation,
and public accessibility and shopping facilities. Some of the most important criteria for measuring sustainable construction project performance is quality performance and productivity of the project. Also, there is need for contractors to give a greater preference to the use of quality materials to improve project cost, time and quality. Generally, it will be important to understand that the quality performance of the criteria necessary in achieving habitable, liveable and attractive construction project should be highly regarded and incorporated into other factors used when measuring the performance of sustainable construction project.

Finally, this research recommended that the factors listed above, are key factors to consider at the design stage of any construction project for both the designer and the regulatory agencies, and these factors are to be monitored throughout the construction process since they are vital in measuring the performance of any sustainable construction project to infer a more desirable and satisfactory sustainable building.

7. References

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