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MANAGING THE BUILDING DESIGN PROCESS FOR SUSTAINABILTY AND IMPROVED QUALITY

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ABSTRACT

The essence of building design process and management for building sustainability in the creation and maintenance of a qualitative architectural product is investigated in this paper. The design process, concept of building sustainability and particularly the quality of the built environment are discussed. Akure, a state capital in Nigeria was used as a case study. The principles and indicators for sustainability of buildings and its implications on the quality of the environment are examined in details. Survey findings include the views of the professionals on the clients, perception on the design process as well as management of projects, and the implications on the quality of the ensuring products and the city's environment. The data were factor analyzed using varimax rotation criterion (with Kaiser Normalization). The results revealed that five factors were effective, with one of them exhibiting the greatest variability and individual differences. The variables that loaded on this factor were really the aspects of the process and management relating to the clients. The findings also revealed the professionals' wrong attitude towards design process as shown with a very high degree of variability in the study. The paper concludes by recommending the enactment and enforcement of relevant policies with adequate education of the people and the involvement of all the stakeholders in the management of building projects and environmental programmes for the realization of a qualitative architectural product.

Keywords: design, process, design management, sustainable building, qualitative, architectural product.

INTRODUCTION

The effectiveness of the design process in the building industry has a great influence on the success of subsequent processes in the construction of projects and also on the quality of the environment [1]. Several studies have also pointed out that a large percentage of defects in building arise through decisions or actions taken in the design stages [2]. Hence, poor design has a very strong impact on the level of efficiency during the production stage [3]. It is further noted that, the increasing complexity of modern buildings in a very competitive market–place in recent years has significantly increased the pressure for improving the performance of the design process in terms of time and quality. Despite its importance, relatively little research has been done on the management of the design process, in relation to the research time and effort which has been devoted to production and project management [4]. They also reiterated that the relatively small cost of the design process compared to the production costs probably disguises its true importance in the performance of construction projects. The fact that design management has been neglected is understandable to some extent because, building design is a very difficult process to manage. It involves thousands of decisions, sometimes over a period of years, with numerous interdependencies, under a highly uncertain environment. A large number of professionals are involved, including architects, project managers, structural engineers and service engineers.

The design process therefore needs to be planned and controlled more effectively, in order to minimize the effects of complexity and uncertainty. The lack of adequate design planning results in insufficient information being made available to complete design tasks and inconsistencies within construction documents. Poor communication, lack of adequate documentation, unbalanced resource allocation, lack of coordination between disciplines, and erratic decision making have been pointed out as the main problems in design process management [2, 4]. Despite its importance, relatively little attention has been paid to the design when compared to production and hence the resulting problems and the need for this study. The paper therefore highlights the nature, guidelines and stages of the design process, as well as the essence of the quality and sustenance of building projects. It attempts to analyze the principal factors and the variables

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affecting the design process to reveal the most active ones responsible for the decision making in the study area. Necessary recommendations are thereafter proffered.

DESIGN PROCESS AND MANAGEMENT

Researchers have pointed out that most descriptions of the design process, both theoretical and empirical, recognize two patterns, which include creative and managerial processes [5]. As a creative process, designers are traditionally known for the solutions which they produce, rather than the kind of problems they deal with. The problem is usually poorly defined, with the clients sometimes not being able to make their needs explicit [6, 7]. The solution does not necessarily come directly from the problem. The attention of the designer thus oscillates between the comprehension of the problem and the search for a solution. One of the traditional ways is to quickly develop a potential solution or a group of potential solutions, as a way to define and understand the problem clearly [8]. A number of models of design as a creative process exist. For example, in the model proposed by some researchers, there are four main activities in design namely: analysis, synthesis, evaluation, and decision making/ communication [5].

As a managerial process, design is traditionally regarded as one of the stages of a project in the building industry. In fact, it is one of the most important processes in building projects, since it defines the product to be built and has many interfaces with several other processes, such as production planning, material supply, sales, and building operations. The breakdown of the design process into stages varies considerably across studies both in terms of content and the names given to each stage [8]. In this research work, the design process is divided into the following four stages: (1) inception and brief collection, (2) detail design and working drawings, (3) execution stage, and (4) feedback from operations.

Guidelines For Determining The Design Process

There are some design tasks which need to be carried out in phases, developing from the general and abstract to the detailed and concrete issues, such as the identification of client needs, land negotiation, selection of construction technologies, market and financial analysis [1]. Due to time pressures, the production stage usually starts before the completion of detail design. Thus, it is necessary to identify which documents or information should be made available at the beginning of the production process and at some important production milestones. At the initial design stages, the level of uncertainty is very high, and only a rough estimate of the duration of each stage is usually made. However there are three main points at the design process in which there is a concentration of efforts for integrating different disciplines. These include the outline, scheme and detail design stages. This integration effort is usually represented as a cycle of activities, performed by the design team, and followed by individual adjustments carried out separately by different designers, with necessary evaluation activity.

Stages in Project Delivery

In discussing the role of design process and management, it is necessary to look at the various stages that a project goes through along the path to completion. When viewed as a system, the project is a dynamic one with changing status from that of an idea or concept through to sketch plan, working drawing, site operations, and final completion. At the inception stage, the client nominates and contacts the architects with his or her intention to carry out the project. The architect here determines the need to involve other members of the design team, after which the acceptance of the commission is made. The plan of work according to the job book can provide a valuable basis for the efficient design and management of the building processes.

Following the agreement of a design baseline, the outline proposal and scheme design will be formulated to develop the design brief, for the approval of the client. The detailed design gives the full design of every part and component of the project, while the total design package is submitted for approval by the authorizing body, after which the project could be implemented. The execution stage commences with the tender action for the selection of the competent contractor, the award of contract, and the project planning activities. Here the nominated contractor programmes work in accordance with the contract conditions and follows the plan to the practical completion of the building. After the completion and necessary rectification of any defect and settlement of final account, the project is adjudged a quality product to be handed over to the client for occupation. The essence of the quality and sustainability of the building project is however paramount and is enumerated below.

QUALITY AND ARCHITECTURAL PRODUCTS

Human thoughts and actions, religion, politics, art, technology, and aspiration, as well as the landscape, geology, and climate of the environment are the ingredients of architecture. It is an art tied to practical purpose and always executed within several practical limits [9]. In practice, architecture is concerned with the pursuit of beauty, functionality, and stability; and has thus helped to make human existence meaningful by gaining the foothold in space and time. It is concerned with the existence of meanings derived from natural, human, and spiritual phenomena and is experienced as order and character. These meanings in spatial forms depict place, path, and domain, which are the concrete structures of human environment [10], and provide the key to the habits, thoughts, and aspirations towards qualitative environment

The architectural profession is continually expressing concern about the quality of new architectural products, which they see as being of fundamental importance. For architects, quality appears to mean 'what' is delivered as the finished products both in terms of its function, aesthetic appeal, and stability. These imaginative uses of space, form, style, and treatment of materials are the criteria upon which designers wish to be judged and the yardstick by which they measure quality. It is one of the essential criteria for project success, which is primarily subjective. This gives rise to varieties of difficulties in ensuring client's satisfaction with the quality of the finished product. Some approaches consider quality as the presence of features of a product, which include fitness for purpose, appearance, maintainability, comfort, discomfort, and ugliness. It was believed that quality is something that cannot be quantified as it encompasses words like 'excellence', 'worth', and 'goodness' and is not a physical property that can be measured [11]. These different views of reality, personal, and professional value system affect Architects' view of quality. Obviously, for quality building and environment to succeed, it must begin with the formation of a coherent project team, design process, and the sustainable parameters in which all are working in the clients' interests.

BUILDING AND SUSTAINABILITY

The building industry bears substantial responsibility in achieving the overall sustainability of the earth, as it concerns human habitations, activities, and nature.

Principles for Building Sustainability

The study of sustainable buildings concerns the issue of what can be sustained in the building sector and contributes to the ecological sustainability of the earth [12]. At local level it involves ecological, economic, social, and cultural sustainability. Ecological sustainability deals with the preparation of proper site planning of projects, correct orientation of buildings, and adequate exposure to sunshine for users. Reductions in the use of non-renewable materials, energy efficiency and waste generations are to be well managed.

Economic sustainability requires treating the depletion and deterioration of natural resources with caution. It also encourages investment in green products, pollution abatement, and capacity building. While social and cultural sustainability encompasses reduction of the social cost for future generations, preservation of cultural diversity, and provision of equal opportunities for all.

Levels of Sustainability

Sustainability can be discussed at different levels such as; the project, building sector, and global levels. The highest level deals with environmental quality such as the global warming, ozone depletion, and pollution. While the local level deals with employment and economic growth, site planning, and impacts of noise and odour on the local environment. The building sector level is concerned with issues such as adaptive use and durability of buildings, reuse and recycling of materials, and efficient use of energy. At the building project level, the indoor environmental health such as ventilation, humidity, lighting, thermal comfort, maintenance, and management patterns affecting the durability of the buildings are paramount.

The research into sustainability is mainly to assess the environmental impact of human activities and to search for options, which could have least negative impact on natural environment. Since the purpose of buildings is to create a human environment, the study of sustainability involves both the natural and human environments created by building activities. However, there is no single strategy for building sustainability. The strategy to be used depends on the objectives and levels of sustainability being envisaged. Hence the paper addresses the sustainability in building design process using a case study carried out in Akure. The findings are analyzed to make appropriate recommendations for the creation and maintenance of qualitative architectural products in the urban environment.

RESEARCH LOCATION AND METHODOLOGY

Akure, the study area, is one of the second generation State capitals and a rapidly growing city in Nigeria, located around latitude $7^o\ 15^1$ North of the equator and $5^o\ 14^1$ East at an approximate altitude of 370m above sea level. It has a population of 190.000 (1991 census) and rose from a rural town to one of the country's urban centers with an estimated population of 246,000 by 2004 using 2% yearly increase. The rapidity of its development within the last twenty-five years stemmed from the political status of the town which was initially a provincial headquarters and later a state capital serving as the seat of both the Local and State Governments since 1976. This accounted for the influx of people to the city for employment and other related reasons, with the attendant sporadic developments devoid of adequate planning and monitoring. The city was investigated to provide data to avert or suppress future eruption of environmental degradations. These are being suffered by bigger cities in the country because of the inadequate planning at the inception of their growth and development. The outcome of its choice will not only be applicable to other cities in Nigeria but also to those in other developing countries.

The data for the study was extracted from a larger research work covering a wide range of issues being investigated on building sustainability in Akure City. Provided in the questionnaire administered is the socio-economic status of the respondents; and issues bordering on the initiation, development, and sustainable management of building projects. The major variables tested in the study are the activities involved in the design process, which include: inception and brief collection; building design, execution, and other management issues. They were rated on the 5 points Likert scale, determined by very high, high, average, low and nil responses.

Research assistants with adequate knowledge of building design and construction were sent to the field to administer the instruments on some professionals in the building industry, working in different private and public organizations in the city. The professionals were randomly selected from the list of members collected from the respective institutes' offices in the city. About 210 questionnaires were distributed; at 35 copies each to members of the six prominent practicing professionals in the city. They include Architects, Planners, Structural Engineers, Quantity Surveyors, Estate Managers, and Building Contractors. One hundred and fifty seven copies, about (74%) of the questionnaire retrieved from the field, tested sufficient for valid assessment.

DATA ANALYSIS AND RESULTS

The data collected were subjected to factor analysis using varimax rotation criterion (with Kaiser Normalization). Principal component method of factoring was used while Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy was applied to test whether the partial correlation among variables is small. The Kaiser-Mayer-Olkin (KMO) and Bartlett's test was used to test for the appropriateness of the sample from the population and the suitability of factor analysis. It also tests for the adequacy of the sample, as a true representation of the population under study. The factor analysis by principal components is adopted in the data analysis for the purpose of partitioning the experimental variables into factors that influence the design process, the purpose being to summarize interrelationships and establish levels of variances in decision variables as they influence the given phenomenon. The following analyses are generated in the factor analysis using Statistical Package for Social Sciences (SPSS).

The descriptive statistics presented in Table 1, gives the mean and standard deviation of the sample population on each decision variable. It also shows sample evidence that hurried and shallow brief collection; inadequate site supervision; pilfering and unpaid fees to consultants and contractors are rated as the highest variables that affect design process management. While inappropriate form of contract and noise pollution impact on buildings, on the other hand seems to be the least important variables affecting design process in the study. The test has shown in Table 2 a chi-square of 776.940 and a significance level of 0.000, which are indications of adequacy of the sample. The KMO test is another measure of sample adequacy and has a value of 0.644, showing that the sample is reasonably adequate. The component matrix is shown in Table 3, which also presents the initial loading as the principal components. It includes the extracted and rotation sums of square loading which specifies the number of factors to be retained.

In order to obtain a meaningful factor loading, the principal component matrix is rotated using Varimax criterion. According to the Social Science rule, absolute values of coefficients with figure less than 0.445 were suppressed and only factor loading of 0.445 and above were assumed to be interpretable. After a careful examination of the results in Table 4, five factor groupings were obtained. It shows that the first four factors have variables that are meaningfully related to the study, while the fifth factor's variables show a level of discord and are not applicable in taking decisions.

SUMMARY

Factor analysis by principal component was adopted in identifying the variables that affect the design process and the management of sustainable building in Akure. The variables were partitioned into factors and the aggregate influence of the factors gave the following four principal factors as effective.

Table 1. Descriptive Statistics

	Names of Factor	Mean	Standard Deviation
hbc	Hurried and shallow brief collection	5.23	4.35
iss	Inadequate site supervision	5.23	4.35
puf	Pilfering and unpaid fees to consultants and contractors.	5.23	4.44
pep	Promotion of equal opportunity to all	5.23	4.47
mep	Maintenance and estate management patterns	5.23	4.42
pmc	Inadequate planning and management of activities	5.20	5.45
aub	Adaptive use of building materials	5.20	4.87
sfg	Social cost for future generation	5.17	5.36
pes	Promotion of employment and services	5.17	3.71
dfr	Disclosure of financial resources/materials	5.17	4.28
isc	Inappropriate selection of sub-contractors	5.17	5.05
nrd	Natural resource depletion	5.13	5.11
ddt	Delayed tendering and cost increase/abandonment	5.13	4.31
dne	Depletion of natural resources	5.13	4.28
unr	Unclear responsibility and risk allocation	5.13	3.94
mcr	Many changes in requirements	5.13	4.97
ipf	Investment in pollution abatement	5.10	4.05
lwg	Level of waste generation	5.10	3.82
phc	Preservation of heritage and local materials	5.07	3.92
apc	Appointment of consultants, skill etc	4.93	4.81
ifc	Inappropriate form of contract	4.77	4.40
npb	Noise pollution impact on buildings	4.30	3.91

Source; Authors' field survey 2005

Table 2. KMO and Bartlett's Test of Sample Adequacy

Kaiser-Mayer-Olkin Measure of Sampling Adequacy		.644
Bartlett's Test of Sphericity	Approx. Chi- Square	776.940
	df	231
	Sig.	.000

Table 3. Extracted and Rotation Sums of Loading

Compo-nent	Extraction Sums of Squared Loading			Rotation Sums of Squared Loading		
	Total	Variance %	Cumula-tive %	Total	Variance %	Cumulative %
1	11.386	51.671	51.671	5.078	23.080	23.082
2	3.602	16.374	68.004	4.879	22.177	45.260
3	1.631	7.415	75.459	4.031	18.323	63.582
4	1.241	5.643	81.102	2.930	13.317	76.900
5	1.010	4.592	85.695	1.935	8.795	85.695

Extraction Method: Principal Component Analysis

Factor 1- Inception Stage and Brief Collection

The variables that load significantly high on this factor are mostly the issues that deal with the clients' unclear responsibilities and risk allocation. This has a loading of 0.856. Each of the variables that load on the factor has correlation (r): $0.711 \leq r \leq 0.856$. That this factor accounted for 23%, the highest proportion of variances is not by accident, because the normal practice usually at the inception of a project is for client to employ the services of the consultants, and provide them with adequate information for their services.

Factor 2- Ecological, Social and Cultural Factors in Design

This accounted for 22% of the total variance explained. Five of the variables deal specifically with economic, social, and cultural factors in building design. The sixth variable deals with the level of waste generation, which has a correlation of 0.641. This has shown the importance of the professionals who are appointed because of their special expertise in their fields and the ultimate aim of producing cost-effective designs. However in the country, it has not always been satisfactory because of the shallow and hurried ways the consultants are briefed by the client and the consultants' interpretation of their client's brief, without ascertaining their financial capabilities.

Factor 3- Execution of Building Projects

The total variance explained by factor 3 is 18%. All the variables on the factor are concerned with the execution of building projects. Delay in tendering decision has a correlation of 0.854 with the factor, while pilfering and unpaid fees, inadequate management, and site supervision have 0.820, 0.803, and 0.760 correlations respectively. This is in line with the view that the appointment of the contractors by the client and the execution of project without adequate sources of finance and design information has led to delay in project completion, budget deficit and abandonment of project [13]. Contractors are also fraught with unrealistic tendering; inadequate management; lack of competent participants; poor communication; inadequate supervision; poor installation; and low quality of testing and commissioning.

Factor 4- Consideration for Sustainability at Building Sector Level

This factor explains 9% of the total variance in the analysis. Three variables loaded on the factor with correlation of 0.774, 0.758, and 0.645 within the building design requirement criteria, while the fourth variable has a correlation of 0.711. This implies that the variables have contributed barely to the consideration of sustainability at the building sector level.

Table 4. Rotated Component Matrix[a] Using Varimax

Item Component	1	2	3	4	5
Factor 1-Inception Stage and Brief Collection					
Uur- Unclear responsibility and risk allocation	.856				
Dne- Depletion of natural resources	.815				
Mcr- Many changes in requirements	.784				
Apc- Appointment of consultants, skill etc	.767				
Dfr- Disclosure of financial resources/materials	.739				
Hbc- Hurried and shallow brief collection	.711				
Factor 2- Ecological, Social and cultural Factors in Design					
Phc- Preservation of heritage and local materials		.922			
Nrd- Natural resource depletion		.893			
Ipf- Investment in pollution abatement		.813			
Pes- Promotion of employment and services		.785			
Sfg- Social cost for future generation		.756			
Lwg- Level of waste generation		.641			
Factor 3- Execution of Building Projects					
Ddt- Delay decision to tendering and cost increase/abandonment			.854		
Puf- Pilfering and unpaid fees to consultants and contractors			.820		
Pmc-Inadequate planning and management of activities			.803		
Iss- Inadequate site supervision			.760		
Factor 4- Consideration for Sustainability at building sector level					
Pep- Promotion of equal opportunity to all				.774	
Npb- Noise pollution impact on buildings				.758	
Ifc - Inappropriate form of contract				.711	
Mep- Maintenance and estate management patterns				.645	
Factor 5- Discordant factor 1: Sustainability at execution of building project level					
Isc- Inappropriate selection of sub-contractors					.818
Aub- Adaptive use of building materials			.574		.606

Extraction Method: Principal Component Analysis
Rotation Method: Varimax with Kaiser Normalization
[a] Rotation converge in 8 iterations

Factor 5- Discordant Factor: Sustainability at Execution of Building Project

The last factor 5 accounted for 9% of the total variance in the data, at the building sector level. The variables are loaded at correlation 0.818 and 0.606, and in discord with the factor, since they have either loaded on previous factors or are not applicable in taking decisions concerning the issues on the management of the design process.

CONCLUSION

Design process and management of sustainable building are essential components of the management of the urban environment, especially in developing countries. Often times, professionals attempt to propose projects that would enhance the comfort and satisfaction of the people as well as promoting qualitative environment. However the process is not strictly followed due to a number of factors within and outside their control. The study has analyzed these factors influencing the design process and management of sustainable building in Akure, Nigeria. The variables were partitioned into factors and the aggregate influence of these factors determined. From the results of the study, the following four principal factors affect the design process in the city.

1. The inception and brief collection stage, which contributes 23%.
2. The ecological and socio-cultural factor in design has a contribution of 22%.
3. Execution activities of the building project team contribute 18% .
4. Consideration for sustainability at the building sector level has 13% contribution.

However the other factors comprising variables of sustainability at the building sector level which are the discordant factors have 9% contribution and they are not applicable in taking decision concerning the design process issues. The study has therefore revealed that, of the five factors, factor 1 exhibits the greatest variability and individual differences. The variables that load on this factor are really the client's aspects of the process. This factor and the rest three need to be seriously focused for the effective provision of qualitative urban environment.

The findings also revealed the professionals' wrong attitude towards design process as shown with a very high factor loading in the study. Furthermore it was established that there were significant differences in the success of the design process and management of sustainable building during the execution of building projects. Of the four variables that dominate the factor, only three are common to the analysis. Though with various degrees of significance, tendering decision, payment of fees to consultants, contractors, and adequate management of activities; have strong influence on the sustainability of buildings.

RECOMMENDATIONS

If the developing countries desire qualitative architectural products in the urban environment, all the factors that influence the design process and sustainable management of buildings should be properly addressed and improved upon. On the basis of the findings in the study, the following are recommended:

- All stakeholders involved in managing the design process should be made to know and understand in details their roles and responsibilities in the bid to increase the transparency and improve the communication between the actors. Adequate publicity and education, mounted to enlighten the populace, most especially the respective developers, clients, and professionals on design process and time management could achieve this. Effective teaching, research and continuous professional training are also essential.
- Design control needs to go beyond concerns with the external appearances of development and embrace social, cultural, functional and environmental aspects of design, and address issues related with the quality of development projects.
- The information needed to perform all the necessary activities in the different stages have been formerly established and should be enforced and made effective. This will improve the quality of the design and the production of sustainable projects. Furthermore the existing policies could be reviewed where necessary to meet the current levels of technological development to enhance effective professional practice and sustainable development.
- Appropriate authorities should involve the professional associations, communities, and non-governmental organizations (NGO) in all their building and environmental programmes; from the planning and design, through the implementation to maintenance stages.

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