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Investigating Factors Influencing Building Materials Selection in Nigerian Construction Industry

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Abstract A building is a complex system and selecting appropriate building materials for a building project will have significant impact on the overall performance of building throughout its life cycle. This research therefore aim is to deepen the knowledge of building materials selection within Nigerian building sector, a task which is traditionally performed by architects. The research approach comprised of a questionnaire survey of the registered architects practicing in Nigerian construction industry. Purposive sampling techniques using maximum variation strategy were adopted for selecting the target survey respondents. The factors used to measure the selection of building materials are client's demand, overall cost, climatic compliance, and maintenance demand. The Predictive Analysis Software (PASW) Statistics 17.0 (formerly SPSS statistics) was employed to analyse information from the survey. Empirical results indicate that maintenance demand is the most important factor that determines the selection of materials irrespective of the choice of client and climate. However, cost occupies a prominent role in the decision process. It also shows that most architects are not fully aware about the role of climate in determining the life cycle of materials in tropical environments. The compliance of materials to ever-changing climate does not constitute a major factor in the selection of materials in Nigeria.

Keywords: *building materials selection, architects, cost, climate, maintenance demand, Nigeria*

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1. Introduction

The building industry plays a vital role in the economic development of many countries but has a significant impact on the environment. Building life cycle through its construction, fit-out, operation and ultimate demolition is a huge factor of human impact on the environment both directly (through material and energy consumption and the consequent pollution and waste) and indirectly (through the pressures on often inefficient infrastructure). The materials from which a building is constructed make a significant contribution to its overall impact on the environment.

One of the most important tasks in the design development stage of building design is the selection of the appropriate building assemblies to be used in the various elements of the building, a task which is the traditional responsibility of architects. Literatures abound of the use of specification act as a solution to environmental problems in the construction industry. In the words of Atkinson and Collins [1], 'suitable arrangement of the specification for building materials should help to minimize demolition and construction waste'. This statement was also supported by Oyedele and Ajayi [2] that the use of specification can increase the use of recycled and reuse materials. Often times, this looks like a relatively straight forward activity, but the type of decision to be made and issues to be considered made it an enormous task.

Material selection is a complex process, influenced and determined by numerous preconditions, decisions, and considerations of building material options [3]. Decisions are even made difficult because of the involvement and influence of other parties involved in the design process such as the client, quantity surveyor, civil engineers, consultants, contractors, and the government department responsible for building legislation. This is in addition to the enormous number of materials available, each with a range of different properties and behaviors. New materials are also constantly being developed with enhanced properties, expanding the list of options available to architects [4]. This decision will have a significant impact on the performance of the building with respect to the various design criteria, the characteristic behavior of such materials and their compliance with the environment.

The construction procurement in Nigeria involves the use of traditional arrangement characterized by the architects been the major specifier. According to Akadiri [5] and Emmitt [6], correct selection of building materials, components and products is the core of good architectural design. Correct selection will have an enormous influence on overall cost of maintenance, appearance, function, durability, quality and its performance [7]. However, despite the knowledge of material specification among practitioners, the act of specification is rarely followed

because of the difficulties involved in separating the architects design aim from building materials. Often, materials selection are largely based on trusting experience rather than using a numerical approach and technical details. This is adhered to in order to save time and minimize exposure to risk. This is in tandem with Franken et al., [8] who submit that several decisions are taken in the building industry to minimize risk. In his book about new materials and methods in 1933, cited in Emmitt and Yeoman [9], architect Chermayeff emphasized the need to select building materials that best solves the problems of purpose, money and time, a sentiment that still hold true today. Therefore, there is high possibility that architects are more likely to select materials that are perceived as being most sympathetic to their design values according to Emmitt [6].

The uncertainties that could result from decisions based on wrong selection criteria and factors could be more than imagined. Traditionally, the factors affecting choice of building materials have been the characteristics of the products, its cost and its availability. However, Emmitt [6], listed other factors that are beginning to influence material selection decision making to include safety of the product, its estimated durability in use, its embodied energy, building legislation and environmental impact.

Research in the selection of building materials are relatively new in Nigeria. This research aims to fill that gap by investigating the factors that influence decision making in the act of building material selection in Nigerian construction industry.

2. Research Methodology

A quantitative research was adopted as the epistemology underpinning the conduct of this study. This approach offers an objective, formal, systematic process in which numerical data are used to quantify or measure phenomena and produce findings. The approach utilised a questionnaire survey of Architects in the Nigeria construction Industry, registered with the Nigerian Institute of Architects (NIA). A total of 490 questionnaires were mailed out to participants for completion in December 2017. Responses were received accordingly, including incomplete responses. After removing the invalid ones, 245 effective responses were received giving a response rate of 50 per cent.

The survey first sought the background information of respondents and their organizations. Thereafter respondents were thus asked to rate the level of importance of the derived factors based on a scale of 1-5, where 1 is “least important”, 2 “fairly important”, 3 “important”, 4 “very important” and 5 “extremely important”. To ensure a better understanding of the factors, definition of each factor was clarified and guidance on completion was given in the questionnaire. The constructs used are as follows: F1 = reason for selectin is due to demand of clients, F2 = reason for selection is due to cost consideration, F3 = reason for selection is due to climate compliance, and F4 = reason for selection is due to knowledge about maintenance demand of materials. The frequency tables were run through the Predictive Analysis Software (PASW) Statistics 17.0 (formerly SPSS statistics) which was also employed to analyse the information from the survey. F4 was used as the dependent variable against F1, F2, and F3 while calculating the multiple regressions.

3. Results and Discussion

The results derived from the analysis of empirical questionnaire survey were cross-referenced to the published literature wherever appropriate and to complement each other for validation. The individual regression analysis result in Table 1 show that the variables F1, F2, and F3 at $p < .05$ are all significant on the maintenance demand of building materials, which constitute the greatest factor on which architects base their decision. This is supported by the importance given to maintenance concern by 72% of respondents from very important to extremely important as a principal factor in deciding materials to select for building projects. Table 2 also shows an importance rating of 51.1% for climatic consideration. This indicate that climatic condition which has been noted by other researchers [5,10,11] as a crucial factor in material selection was not considered by Nigerian architects compared to maintenance demand even though Nigeria is in tropical hot climate. Akadiri [5] suggest that building materials selection should depend on the climate zone in which the material will be applied. This is also reaffirmed by Marsono and Balasbaneh [11] that the consideration of the climatic condition of a region in building material selection will lead to improvement in the building construction process and will induce extensive social, financial, economic, and environmental benefits.

The current outcry about climate change requires that building materials should respond to the climatic condition where they are being used. According to Akadiri [12], buildings must supply a healthy and comfortable indoor climate to the people using it which can be achieved by taking the climatic condition into consideration when selecting materials.The reaction of materials to climatic behavior should be made a priority for the specification of building materials due to the performance required from such materials as a building’s last line of defense against climatic elements. The solution can help decision makers with the selection of an appropriate combination of materials aimed to decrease climate change.

Table 1. Test of Significance of Individual Regressions

		Unstandardized coefficients		Standardized coefficients	*t*	Significance
	Model	*B*	*SE*	β	*B*	*SE*
1	(Constant)	.922	.119		7.720	.000
	Reasons for specification: Client’s demand	.288	.060	.340	4.779	.000
	Reasons for specification: Cost consideration	.250	.080	.270	3.099	.004
	Reasons for specification: Climate compliant	.309	.069	.351	4.696	.000

The percentage of the respondents who agree on cost of materials as a major factor in deciding which material to specify as shown in Table 2 is 58%. Buildings represent a large and long-lasting investment in financial terms as well as in other resources [13]. Improvements of cost effectiveness of buildings is consequently of common interest to all stakeholders especially the client [5]. With increasing pressure to provide environmentally responsible buildings, stakeholders are putting significant foci on the early identification of financial viability of building projects. This could explain the reason cost was rated more important than climatic consideration. However, to base selection of building materials on cost and maintenance demand with little consideration of climatic condition remains an irreconcilable issue because of the influence of climate on the overall performance and maintenance of buildings.

As much as projects are expected to be kept within a cost limit, selection of high quality materials is not being jeopardized by architects practicing in Nigeria. However, only 33.3% of respondents subscribe to the fact that clients' choice plays a significant role in the course of their job as shown in Table 2 below. The middle of the scale decision of 58.3% shows that despite the agreement of only a third part of respondents on the issue of clients' choice, the specifications of architects in the area does not jettison the choice of the clients who are probably the end users.

This is supported by the fact that the client's choice has significant impact on maintenance at $p < .05$ as shown in Table 1. In fact, clients' choice as well as cost consideration and climate compliance of building materials are all good predictors of maintenance demand of materials, which is the most critical issue that respondents consider before selecting any building material. This is further explained with a mode of 3.0, 3.0, 4.0, and 4.0, respectively, for the variables as shown in Table 3.

These variables equally, summarily, constitute 82.9% of the reasons for selecting building materials by architects as shown in the coefficient of multiple regressions (R^2) in Table 4 below. It shows 82.9% of maintenance demand of materials as the highest factor for selection of materials and is explained by F1, F2, and F3. The *F*-calculated of 234.964 as shown in Table 5 below, which is higher than the *F*-tabulated of 2.694, further explains this phenomenon in the testing of the overall significance.

Table 2. Importance Distribution

	Importance				
Factors (Variable)	Least important	Fairly important	Important	Very Important	Extremely important
C1—Client demand	3	5.4	58.3	14.1	19.2
C2—Cost	—	6.6	35.4	34.0	24.0
C3—Climate	—	15.4	35.5	38.1	13.0
C4—Maintenance	—	9.1	18.9	54.5	17.5

Table 3. Mean and Mode of F1, F2, F3, and F4

	Reasons for selection: Client's demand	Reasons for selection: Cost consideration	Reasons for selection: Climate compliant	Reasons for selection: Maintenance demand
N				
Valid	165	165	165	165
Missing	0	0	0	0
M	3.342	3.720	3.720	3.790
Mode	3.0	3.0	4.0	4.0

Table 4. Coefficient of Multiple Regressions

	R	R^2	Adjusted R^2	*SE* of the estimate	Change statistics				
Model	R^2 change	*F* change	*df*1	*df*2	Significance, *F* change	R^2 change	*F* change	*df*1	*df*2
1	.905[a]	.829	.823	.3629	.829	234.964	3	156	.000

[a]Coefficients—predictors: (constant); reasons for selection: climate compliant; reasons for selection: client's demand; reasons for selection; cost consideration.

Table 5. Overall Significance

Model		Sum of squares	*df*	$_M$2	*F*	Significance
1	Regression	88.352	3	29.228	234.964	.000[a]
	Residual	20.428	157	.135		
	Total	107.676	158			

[a]Coefficients—predictors: (constant); reasons for selection: climate compliant; reasons for selection: client's demand; reasons for selection: cost consideration.

4. Conclusion and Recommendation

This paper provided empirical data to test three factors (variables) with regards to the decision-making process in the selection of building materials by architects practicing in Nigeria building industry. They include climate compliant, cost consideration and maintenance demand. Through a questionnaire survey, the empirical survey findings indicated that all the three factors studied have a positive and statistically considerable influence in building materials selection. Moreover, maintenance demand of building materials was identified as the most principal factor driving the selection of building materials. A critical issue noticed however is the little consideration given to climate compliant compared to the other two factors studied. Architects and specifiers therefore need proper information about the behaviour of building materials in relation to climatic condition to avoid inaccurate decision making, thereby leading to increase maintainace of selected materials.

This work, of course, is not exempt from limitations, the overcoming of which constitute possible directions for future research. In general, the fact that this study focused only on three factors without considering additional contingencies might offer only a partial and limited picture of the problem. The inclusion of a wide range of variables would give a more complete view of the complex mechanism driving building materials selection practices in Nigeria. The research will also benefit from views of other professional specifiers apart from the architects. Further, qualitative research would allow for the issues raised here to be explored in more depth. Interviews with respondents could verify the findings here and provide more detailed explanations of their responses. Although the results only reported on some local findings, they are also vital to other countries for international comparisons.

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