**A COST COMPARATIVE ANALYSIS OF INTERLOCKING BRICKS AND NON-INTERLOCKING BRICKS IN LAGOS STATE**

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**ABSTRACT**

*Building materials constitute the largest single input in housing construction. In spite of this, Adedeji (2010) observed that about sixty (60) per cent of the total housing expenditure goes for the purchase of building materials, Arayela (2005) averred that the cost of building materials constitute about 65 percent of the construction cost. Ogunsemi (2010) supported the claim that building materials form the main factors that restricts the supply of housing and ascertained that they account for between 50-60 percent of the cost of buildings. There are varieties of interlocking and non-interlocking bricks which differ by the method of production, construction, shapes, sizes and material constituents, function and strength. The interlocking bricks of Bolyn, NBRRI and Hydra form models (which are ones currently used in Nigeria) will be examined. This study is aimed to assess the rates of usage of interlocking bricks and non-interlocking bricks and also evaluates the factors affecting the costs of interlocking bricks and non-interlocking bricks.*

**INTRODUCTION**

Construction activities and its output is an integral part of a country’s national economy and industrial development. The construction industry is often seen as a driver of economic growth especially in developing countries. Construction sector and construction activities are considered to be one of the major sources of economic growth, development and economic activities. Construction and engineering services industry play an important role in the economic uplift and development of the country. It can be regarded as a mechanism of generating the employment and offering job opportunities to millions of unskilled, semi-skilled and skilled work force. It also plays key role in generating income in both formal and informal sector. It supplements the foreign exchange earnings derived from trade in construction material and engineering services. The construction industry plays an essential role in the socio economic development of a country. The activities of the industry have great significance to the achievement of national socio-economic development goals of providing infrastructure, sanctuary and employment. It includes hospitals, schools, townships, offices, houses and other buildings; urban infrastructure (including water supply, sewerage, drainage); highways, roads, ports, railways, airports; power systems; irrigation and agriculture systems; telecommunications etc. It deals with all economic activities directed to the creation, renovation, repair or extension of fixed assets in the form of buildings, land improvements of an engineering nature. Besides, the construction industry generates substantial employment and provides a growth impetus to other sectors through backward and forward linkages. It is, essential therefore, that, this vital activity is nurtured for the healthy growth of the economy. The industry can mobilize and effectively utilize local human and material resources in the development and maintenance of housing and infrastructure to promote local employment and improve economic efficiency.(Raza Ali Khan,2009).

Housing despite its importance, has become a serious problem to mankind in recent times. One aspect that constitutes a grim problem is its delivery and affordability in developing countries like Nigeria. Housing being one of the basic human needs is usually ranked third after food and clothing (Simion, 2009). Building materials constitute the largest single input in housing construction. In spite of this, Adedeji (2010) observed that about sixty (60) per cent of the total housing expenditure goes for the purchase of building materials, Arayela (2005) averred that the cost of building materials constitute about 65 percent of the construction cost. Ogunsemi (2010) supported the claim that building materials form the main factors that restricts the supply of housing and ascertained that they account for between 50-60 percent of the cost of buildings.

Thus, Adedeji (2002) rightly observed that one main barrier to the realization of effective housing in Nigeria as revealed in successive government efforts has been the cost of housing materials in the country. He argued that in the early periods, shelter in Nigeria was easily affordable as building materials were sourced from man’s immediate environment at affordable costs. Technology also was readily available with commensurate simple techniques. But contact with the outside world through interregional and international training of professionals in foreign countries as occasioned by colonization, brought changes to tastes and hence outlook to house forms. These changes rendered the undeveloped local building materials inadequate while there was an increased demand for exotic ones.

Accordingly, correct selection of building materials can be performed by taking into account their complete life time (i.e. from cradle to grave) and by choosing products with the minimal environmental impacts. For instance, Gonzalezand Navarro (2006) estimated that the selection of building materials with low environmental impacts can reduce carbon dioxide (CO2) emissions by up to 30%.

The other factors that greatly affect the selection of building materials are their costs and social requirements such as thermal comfort, good mechanical properties (strength and durability), aesthetic characteristics and an ability to construct quickly. Ideally, the combination of all environmental, economic and social factors can give a clear description of a material, and thus helps in a decision making process regarding the selection of the materials suitable for buildings. It is along this line that the building industry in Nigeria is evolving varied kinds of building system adapted to the local materials, environmental conditions, city developments and levels of techniques of building construction that are in use. One of such system is the adaptation/ introduction of interlocking masonry into the building industry which forms the focus of this research.

It is observed that the development and understanding of building materials has generally received much less attention in the last few decades compared to sophisticated analysis and design procedures. The latter is much more exciting, and often considered intellectual, whereas, the former is labelled as mundane and experimental. The provision of alternative economical materials for wall construction has a significant impact on cost of construction. The study of the economical effectiveness of materials could not be concluded, if the lifecycle of the materials are not considered. Natural clay and silt have a very important and unique role in the contribution they can make to alleviate the housing problem. They are not only occurring in luxurious abundance in many parts of the world, but they also can directly lead to energy savings, conservation of the world’s more scarce resources and protects the environment. The fact that one of the most easily and readily repressible earth’s resources can be used to solve, at least, one of the most acute forms of human misery, it’s just as challenging, not only to the basic human instinct of fellow, but also to the science and skills developed technologies. For example, clay is one of the easily renewable natural resources, and yet the ability to use them in durable construction is far from reality.

There are varieties of interlocking and non-interlocking bricks which differ by the method of production, construction, shapes, sizes and material constituents, function and strength. The interlocking bricks of Bolyn, NBRRI and Hydra form models (which are ones currently used in Nigeria) will be examined.

**STATEMENT OF RESEARCH PROBLEMS**

A major contributing factor to the housing problems is the inadequate application of technologies and use of natural resources. The use of readily available natural resources such as clay in the construction industry is fading out timely. The urge to find alternative materials to existing conventional ones and the need to bring down the cost and time of construction, also, reversibly improving its stability and aesthetic purpose has compelled the researchers to intensify work on clay with a view to investigating its usefulness wholly as a construction material or partly as a substitute for fine aggregate component of sandcrete. It is believed that the use of clay bricks in lieu of sandcrete blocks as walling element in buildings would go a long way in reducing the cost; maintenance and time of construction, and this will not jeopardizing aestheticism and structural stability.

This study therefore will critically examine the effectiveness of interlocking stabilized soil bricks and the non-interlocking type for construction of low-cost housing, yet more durable buildings to that of sandcrete blocks, thereby improving the country’s level of urbanization, and mitigate rampant situation of building collapse and global warming.

There is high rural-urban drift in Nigeria because of the inequalities, in terms of infrastructural facilities, services, social amenities and heterogeneity economic activities in favor of urban centers. (Oyeleye, 2013). The building materials and construction industry constitutes one of the most important sectors in Nigeria’s economy. Some of the materials, which are produced in some large-scale industries, end up being costly due to high costs of production arising from high electricity cost. It is also costly to transport the materials to the construction site.

**RESEARCH QUESTIONS**

1. What are the factors influencing the cost of interlocking bricks and non-interlocking bricks?
2. What are the rates of usage of interlocking bricks and non-interlocking bricks?

**AIM AND OBJECTIVES**

The aim of this research is to make a comparative analysis of cost of interlocking bricks and non-interlocking bricks in Nigeria. The objective of this study includes:

1. To identify the factors influencing the cost of interlocking bricks and non-interlocking bricks in Lagos State.
2. To assess the rates of usage of interlocking bricks and non-interlocking bricks Lagos State.

**Overview of History of Interlocking Blocks**

Earth has been used as a building material for years. From ancient times to the present day, it's been used to build everything from modest shelters to elaborate temples using a wide variety of techniques. Earthen construction has witnessed a renaissance in recent years due to largely economic & environmental concerns, availability, low cost & ecofriendly nature of soil as a building material makes it an attractive alternative to conventional building methods. (Makiga, 2008).The first attempts for compressed earth blocks were tried in the early days of the 19th century in Europe. The architect François Cointeraux precast small blocks of rammed earth and he used hand rammers to compress the humid soil into a small wooden mould held with the feet. (The first steel manual press which has been produced in the world in the 1950’s was the Cinvaram. It was the result of a research programme for a social housing in Colombia to improve the hand molded & sun dried brick (adobe). This press could get regular blocks in shape and size, denser, stronger and more water resistant than the common adobe. Since then many more types of machines were designed and many laboratories got specialized and skilled to identify the soils for buildings. Many countries in Africa as well as South America, India and South Asia have been using this technique a lot.

Bankole (2008), noted that research activities that ultimately led to the development of the interlocking block technique, which is gaining popularity in Thailand, as well as Malaysia and the Philippines, to have dated back to the 1960s. In these countries, houses in the rural areas were traditionally built of timber, which was readily available in the extensive forest areas. However, the alarming rate of deforestation in Thailand - from 70% forest cover in 1936 to about 55% in 1961 (now it is less than 30%) - led the government to initiate research into alternative materials for building construction in the rural areas. The idea of making blocks by compacting earth or mixing it with stabilizing supplements is an old concept dating back thousands of years. Previously, and still customary in certain parts of the world, wooden molds are used for making sun-dried or burned earth blocks. A key step in the evolution of this technology was the creation of the CINVA-RAM press in the 1950s by the Chilean engineer Raul Ramirez for the Inter-American Housing Center in Bogota, Colombia Since then, the methods of producing earth blocks has progressed resulting in diverse types of motor-driven and manual presses, and mobile and industrial scale production units Even though the CINVA-Ram and other machines of this sort provided a more cost effective and environmentally-friendly solution for block-making, some disadvantages remained. There was still a need for masonry skills to lay the blocks, as well as significant amounts of cement for mortar. The Human Settlements Division of the Asian Institute of Technology (HSD-AIT) along with the Thailand Institute of Scientific and Technological Research (TISTR) combined efforts for the creation of the first interlocking soil blocks by modifying the CINVARAM machine in the early 1980s (Nils,2009). This new wall construction technique reduced the use of cement drastically; hence reducing final building cost considerably, and enhanced the structural stability of the wall.

India’s large and growing brick industry, its rapidly expanding economy, and the variety of development levels across the country make it a good case study for this research. As of 2012, “no study exists in India or elsewhere that has tried to estimate the impact of soil loss and productivity due to brick-making” (Kathuria & Balasubramanian, 2012). Nearly all research in the environmental impact of bricks has focused on the firing process, primarily because firing is responsible for nearly all polluting emissions of fired bricks and greater than 90% of the energy consumption (Energy for Building, 1991).Additionally, research into the brick industry in developing countries includes unfired bricks, but typically focuses on cost and labor instead of environmental impact (Hodge, 2007)

**Brick Manufacturing Process**

People have made bricks for millennia in many different parts of the world, developing different recipes and processes for the bricks they use. Despite some of the differences, every brick begins with the extraction of raw materials, which must be sifted and mixed together, and must be formed into the desired shape.

Making different types of bricks requires different components and processing steps. In addition to the steps mentioned above, components are often sifted or somehow purified before being mixed. Sometimes, stacking bricks is considered its own step because it may affect the drying time, required labour, and cost. Although the unfired bricks in this analysis are by definition not fired, the firing step is included in the process flow chart because it is the final process for so many bricks and it is therefore important to understand how it fits in.

**Bricks Additives**

The simplest bricks are simple mixtures of clayey soil and water, pressed into the desired shape and dried in the sun. Some bricks include fillers such as straw, rocks, or extra sand to reduce the cost, though often also reducing the structural integrity. Others include small amounts of stabilizers such as cement or lime, which strengthen bricks and are discussed in more detail below.

**Stabilizers**

Stabilizer is a general term used to refer to compounds which are added to enhance the strength and durability of the brick. They typically react chemically with rest of the brick material either in the presence of heat or water, forming a strong matrix around soil particles, locking them in place and making the brick more stable (Harper, 2011). Portland cement and lime are the two most common stabilizers in unfired bricks, but people have experimented with using fly ash, rice husk ash, and other common materials to improve the quality of their bricks (Maini, 2010).

Portland cement is particularly good for stabilizing bricks made from sandy soils. The calcium silicates react with water to form a matrix with the silica in the grains of sand (Harper, 2011). At least 5% cement should be used to form a cohesive matrix; smaller amounts will reduce cohesion because smaller pieces of matrix separate the clay without joining together to form a full matrix (Maini, 2010). Lime (CaO) is particularly good for clayey soils as it has a pozzolanic reaction with clay. When exposed to water or a humid environment, the calcium ions in the lime react with the clay to reduce its plasticity (Maini, 2010).

**Fly Ash**

Fly ash is a by-product of many industrial processes, which is often both expensive and environmentally harmful to dispose of, but has been incorporated into a variety of masonry units in the construction industry. Although fly ash is not a traditional component of bricks, it is increasingly used into bricks to reduce the cost of raw materials and to deal with the industrial waste.

Fly ash is used both as a stabilizer and as a main component in bricks. Class C, coal-derived, fly ash contains around 20% lime and can be used as a stabilizer on its own, but other types of fly ash are successful stabilizers when mixed with cement (Maini, 2010). Others have used fly ash as a substitute for some percentage of the soil in an effort to reduce the cost of the bricks and to deal with the industrial waste. Making fly ash bricks with over 50% fly ash and using fly ash in conjunction with other raw materials are areas of current research (Chindaprasirt & Pimraksa, 2008). Because fly ash is a by-product and typically considered waste, the energy used and carbon dioxide emitted in its production are generally attributed to the intended product, such as paper or coal-derived energy, and not to the fly ash. For this reason, using fly ash is considered environmentally beneficial; even though the industrial process which produce fly ash are energy intensive and polluting.

**Factors that influences costs of interlocking bricks and non-interlocking bricks**

The issue of the cost of construction work is one that is rarely far from the minds of construction clients, design teams, constructors and, of course, quantity surveyors. The cost of constructing a building project is a primary concern for the vast majority of construction clients. Indeed one of the most common initial questions a client has is „*what is it going to cost me*? ‟ often followed closely by „*can we do it any cheaper*?‟ Providing answers to such questions is a key objective of quantity surveyors, whose task it is to predict the likely cost of building work and to manage the evolving project design to ensure that the clients approved budget is not exceeded. This is a challenging task, which frequently involves one-off, unique, purpose made buildings, and the QS typically operates within a design team brought together specifically for that particular project. Clients are often somewhat aware of what their building should cost. Indicative cost ranges for various types of development are regularly published by the larger quantity surveying practices and are also found in construction price-books. It is only natural for a client to question why their development cannot be budgeted at the lower end of the indicative cost range. In these situations the quantity surveyor will need to explain that the cost of construction work is influenced by a wide range of factors. These include the identity and priorities of the client, the nature of the project and who is responsible for developing its design, the choice of procurement options, the prevailing market conditions and legislative constraints.

**Value for Money**

It is not the cheaper things in life that we want to possess, but the expensive things that cost less– John Ruskin*.* Achieving value for money may be seen as being a balance between satisfying client needs and expectations and the resources required to achieve them. The Code of Practice for Project Management summarizes typical expectations thus, the client expects that effective project management will enable the project’s completion, by the time when it is wanted, of a standard and quality that is required and a price that is competitive (Chartered Institute of Building, 2002). Standards and quality expectations are, however, constrained by cost and time and therefore objectives must be prioritized.

**The Client’s Priorities**

All construction work is ultimately undertaken for the benefit of a client. Clients fund the construction process, whether they are individuals extending their homes, or a multi-national corporation developing a cutting-edge production facility, or a government department providing much needed social infrastructure. The importance of clients cannot be over-emphasized. Very often clients do not get the building they want, because they do not know how to ask for it and the architect or other consultants think the building should look a different way. Clients expect that the project will be a success and that the providers will deliver a competent service. They will be dissatisfied, if these expectations are not met.

**Quality Considerations**

“Quality is remembered long after the price is forgotten” Sir Henry Royce. A project may be completed on time and within budget, but unless it achieves the specified quality or performance criteria it will be considered to be a disappointment or even an outright failure. High profile building failures such as Priory Hall only serve to strengthen the public concern expressed in the Egan Report’s findings that 30% of buildings fail to meet the expectations of their owners. Such failures may be prohibitively expensive to rectify, dangerous and can ruin reputations overnight. The notion of quality is multidimensional and includes aspects which may be appraised subjectively.

**Cost Considerations**

“It is unwise to pay too much, but it is worse to pay too little”. - John Ruskin. The relationship of quality to cost is often expressed in the saying that „you get what you pay for.‟ Regardless of Ruskin’s advice, cost is a critical factor in most building projects and some clients will seek a low price. Low price and maximum price competition, however, often have negative impacts on quality standards and achieving best value for money overall. In the current economic climate below cost tendering has heightened the risk of contractor insolvency and it may be difficult and expensive to obtain protection from this risk. Unrealistic and inadequate budgets often lead to projects becoming finance driven where cheaper options are preferred to better or more sustainable alternatives. Certain clients may have fixed budgets which may not be exceeded in any circumstances. In such circumstances the client will expect the quantity surveyor to maintain rigorous cost control during the project in order to deliver the project within budget. Designing to achieve such cost limits might curtail the introduction of beneficial features and/or variations which may result in excessive running and maintenance costs later on.

**Environmental Impact Assessment of Bricks**

Unfired bricks have been generally assumed to be more environmentally beneficial than fired bricks because they do not include the energy intensive, often polluting step of firing, and have therefore been left out of most environmental impact assessments. Because the firing of bricks is responsible for most of their energy consumption and pollutants, much research has been done on fired bricks and specifically on kiln technologies. One study estimated the embodied energy of a “common [fired] brick” to be 218.2 Btu/in3 while the embodied energy of an Adobe compressed earth brick made with mechanized production is just 4.46 Btu/in3 (McHenry, 1984); the difference can be almost entirely attributed to firing. Although those numbers are from a United States context and this analysis focuses on India, a difference of similar order of magnitude between the fired and unfired bricks is expected. Although there are many compressed earth structures which have lasted for centuries, fired bricks can generally bear greater loads and are more suited to the multi-story construction seen in the United States (Nelson, 2002).

Due to the increased prevalence of unfired bricks in areas where fuel is expensive or kiln technology is not accessible, many people are now using and researching different types of unfired bricks, from sun baked mud bricks to mechanically compressed, chemically stabilized earthen blocks (Energy for Building, 1991). A rising world population means a growing construction industry, especially in developing countries where unfired bricks are popular for their high durability to cost ratio.

In addition, unfired bricks are seen by some as an environmentally beneficial alternative to fired bricks or concrete blocks. Several organizations in India are researching and promoting the use of unfired, stabilized, and interlocking bricks as a way to improve environmental impact and reduce costs while maintaining performance (Indian Brick Sector, 2012). The tradeoff between environmental impact and performance is particularly interesting, because these are often inversely related but sometimes unrelated or even positively correlated (Reddy & Jagadish, 2003).

# RESEARCH METHODOLOGY

## RESEARCH APPROACH/METHODS

The methodology adopted in this research is a quantitative method. The main aim of quantitative research method was to provide an accurate and valid representation of the factors or variables that are relevant to the research questions. There are categories of quantitative research: true experiment research, quasi-experimental research and non-experimental research. The research category adopted is the non-experimental research under quantitative research because is based on the content of this study and in order to achieve the aims and objectives proposed at the beginning of the study. This research was done by surveys and observational studies through administering structured questionnaires distributed among respondents.

**RESEARCH DESIGN**

Kothari (2004), defined research design as the conceptual structure within which research is conducted. It consists of the blueprint for the collection, measurement and analysis of data. As such the design includes an outline of the framework of study, availability of various data, and observations in order to achieve the aims and objectives proposed at the beginning of the study. This research was done by survey through administering structured questionnaires distributed among respondents.

## RESEARCH POPULATION

Population is the total unit of element about which a conclusion is to be drawn from, therefore the category of population for this research will include the professionals ( quantity surveyors, architects, contractors/builders and engineers) in Lagos state, Nigeria, because they all contribute towards the differences in cost of construction and maintenance of these two walling materials(interlocking bricks and non-interlocking bricks) and they have in one way or the other been responsible for the execution of building projects and also cost data of various executed building project in Lagos state. The population of this study is made up of the building professionals which include: architect, quantity surveyors, contractors/builders, civil or structural engineers in Lagos state of which their total number (population) is 100 from the list of registered professionals in different professionals in different offices and ministry of works and infrastructure, Lagos state.

## SAMPLING TECHNIQUES AND SAMPLE SIZE

Sample is a portion of the population that is taken to represent the whole population. However, there is need for a sample size to be large in comparison to the population to minimize the sampling error. Downie and Heath (1974) were cited in Chukwuneke (2008) that as sample grows larger beyond 30, the critical t or F-value decreases and then begins to approximate the values associated with normal distribution curves.

N= total number of population

n= sample size

e= level of significant (0.05)

n=$ 80$

 1+80(0.05)

n=$ 80$

 1+80(0.0025)

n=$ 80$

 1+80(0.25)

n=$ 80$

 1.25

 = 64

Therefore, for a population of 100, sample size will be 64.

## DATA COLLECTION AND MEASUREMENT QUESTIONNAIRES

The questionnaire is in four sections, each section in the questionnaire was designed to measure a specific aspect of the set objectives. Section one will be designed to collect demographic information about the respondents, such as official designation, gender, age, types of organization, academic qualification, years of working experience, membership of professional bodies and number of projects executed.

**DATA ANAYSIS AND TOOLS**

Data was collected from primary sources. The primary data was collected through questionnaire that was administered to the professionals (quantity surveyors, architects, contractors/builders and engineers) in Lagos state. The statistical tool that will be used for analysing the data is the Statistical Package for Social Sciences 17.0 (SPSS17.0).

# DATA ANALYSIS AND PRESENTATION

**Table 1: Assessment of the rates of usage of interlocking bricks in Lagos State.**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Categories of Buildings** | **Total Number** | **Mean** | **Minimum** | **Maximum** | **Rank** |
|  |  |  |  |  |  |
| Prisons | 49 | 4.12 | 2 | 5 | 1 |
| Motels | 49 | 3.70 | 2 | 5 | 2 |
| Factories | 49 | 3.46 | 1 | 2 | 3 |
| Hotels | 49 | 3.44 | 2 | 4 | 4 |
| Grocery Stores |  49 | 3.28 | 3 | 3 | 5 |
| Warehouses | 49 | 3.12 | 2 | 3 | 6 |
| Arenas | 49 | 3.00 | 1 | 4 | 7 |
| Gas Stations | 49 | 3.00 | 2 | 3 | 7 |
| Churches | 49 | 2.91 | 1 | 2 | 9 |
| Hospitals | 49 | 2.91 | 2 | 3 | 9 |
| Nursing Homes | 49 | 2.91 | 3 | 5 | 9 |
| Houses | 49 | 2.91 | 1 | 3 | 9 |
| Apartment Buildings | 49 | 2.91 | 1 | 5 | 9 |
| Parking Garages | 49 | 2.91 | 2 | 5 | 9 |
| Theatres  | 49 | 2.68 | 2 | 4 | 15 |
| Restaurants | 49 | 2.54 | 2 | 4 | 16 |
| Schools | 49 | 2.54 | 3 | 3 | 16 |
| Stadia | 49 | 2.46 | 2 | 5 | 18 |
| Insurance Agencies | 49 | 2.46 | 2 | 3 | 18 |
| Department Stores | 49 | 2.46 | 1 | 5 | 18 |
| Buildings where explosives are kept | 49 | 2.42 | 3 | 5 | 21 |
| Banks | 49 | 2.25 | 2 | 4 | 22 |
| Buildings for keeping high toxic materials | 49 | 2.16 | 2 | 5 | 23 |
| Mosques | 49 | 1.46 | 2 | 5 | 24 |
| Government Buildings | 49 | 1.46 | 2 | 4 | 24 |

Table 1 showed the rates at which interlocking bricks are used in different categories of buildings, these categories represent different facet of building types according to the International Building Codes. Prisons happened to be the building where interlocking bricks are being used the most with mean score of 4.12, followed by motels with mean score 3.70, then, factories with mean score 3.46, hotels with mean score 3.44, grocery with mean score 3.28, warehouses with mean score 3.12, arenas and gas stations with mean score 3.00, - churches, hospitals, nursing homes, houses, apartment building parking garages, all with mean score 2.91. Also, followed by theatres with mean score 2.68, restaurants and schools with mean score 2.54 - stadia, insurance agencies and department stores with mean score 2.46, buildings where explosives are kept with mean score 3.42, banks with mean score 2.25, buildings for keeping high toxic materials with mean score 2.16, mosques with mean score 1.46, and finally, mosque and government buildings being the least where interlocking bricks are used with mean score 1.46.

**Table 2: Assessment of the rates of usage of interlocking bricks in Lagos State.**

|  |  |  |
| --- | --- | --- |
| **Categories of buildings** | **Mean Ranking** | **Ranking** |
| Prisons | 22.12 | 1 |
| Motels | 20.39 | 2 |
| Hotels | 18.90 | 3 |
| Factories | 18.78 | 4 |
| Grocery Stores | 17.28 | 5 |
| Warehouses | 16.68 | 6 |
| Arenas | 15.94 | 7 |
| Gas Stations | 15.94 | 7 |
| Churches | 13.70 | 9 |
| Nursing Homes | 13.70 | 9 |
| Houses | 13.70 | 9 |
| Apartment Buildings | 13.70 | 9 |
| Parking Garages | 13.70 | 9 |
| Hospitals | 13.09 | 9 |
| Schools | 12.54 | 15 |
| Theatres Interlocking | 11.31 | 16 |
| Restaurants | 11.04 | 17 |
| Stadia | 10.15 | 18 |
| Insurance Agencies | 10.15 | 18 |
| Department Stores | 10.15 | 18 |
| Buildings where explosives are kept | 9.87 | 21 |
| Banks | 8.82 | 22 |
| Buildings for keeping high toxic materials | 8.21 | 23 |
| Mosques | 2.57 | 24 |
| Government Buildings | 2.57 | 24 |

Table 2 compared the mean ranks between the categories of buildings and thereafter indicated how the buildings differ in their respective rate of usages. Therefore, prisons happened to be the building which is most the related to other groups with respect to their rates of usages of interlocking bricks and this happened to other building in the descending order. That is, mosques and government building being the least building in terms of its’ with other building categories.

**Table 3 Assessment of the rates of usage of non-interlocking bricks in Lagos State.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Categories of buildings** | **Total number** | **Mean** | **Minimum** | **Maximum** |
|  |  |  |  |  |
| Mosques | 49 | 4.70 | 4 | 5 |
| Hospitals | 49 | 4.70 | 2 | 5 |
| Banks | 49 | 4.54 | 4 | 5 |
| Churches | 49 | 4.46 | 4 | 5 |
| Government Buildings | 49 | 4.46 | 3 | 4 |
| Schools | 49 | 4.44 | 3 | 4 |
| Theatres | 49 | 4.25 | 4 | 5 |
| Insurance Agencies | 49 | 4.09 | 3 | 5 |
| Buildings where explosives are kept | 49 | 4.09 | 4 | 5 |
| Houses | 49 | 4.09 | 2 | 5 |
| Apartment Buildings | 49 | 4.09 | 3 | 5 |
| Parking Garages | 49 | 3.77 | 3 | 5 |
| Restaurants | 49 | 3.72 | 1 | 4 |
| Factories | 49 | 3.68 | 4 | 5 |
| Nursing Homes | 49 | 3.56 | 1 | 5 |
| Stadia | 49 | 3.54 | 1 | 5 |
| Gas Stations | 49 | 3.54 | 3 | 4 |
| Department Stores | 49 | 3.54 | 1 | 5 |
| Motels | 49 | 3.54 | 3 | 4 |
| Arenas | 49 | 3.46 | 3 | 4 |
| Buildings for keeping high toxic materials | 49 | 3.21 | 3 | 5 |
| Hotels | 49 | 3.04 | 3 | 5 |
| Grocery Stores | 49 | 2.98 | 3 | 4 |
| Grocery Stores | 49 | 2.93 | 1 | 3 |
| Warehouses | 49 | 2.09 | 3 | 4 |
|  |  |  |  |  |

Table 3 showed the rates at which non-interlocking bricks are used in different categories of buildings, these categories represent different facet of building types according to the International Building Codes. mosque and hospitals happened to be the building where interlocking bricks are being used the most with mean score of 4.70, followed by banks with mean score 4.54, then, churches and government buildings with mean score 4.46, schools with mean score 4.44, theatres with mean score 4.25, insurance agencies, buildings where explosives are kept, houses and apartment buildings with mean score 4.09, parking garages with mean score 3.77, restaurants with mean score 3.72, factories with mean score 3.68, nursing homes with mean score 3.56, stadia, gas stations, department stores and motels with mean score 3.54, arenas with mean score 3.46, buildings for keeping high toxic materials houses with mean score 3.21, hotels with mean score 3.04, grocery stores with mean score 2.98, and finally, warehouses with mean score 2.09.

**Table 4 RATES OF USAGE OF NON-INTERLOCKING BRICKS IN LAGOS STATE.**

|  |  |  |
| --- | --- | --- |
| **Categories of buildings** | **Mean Ranking** | **Ranking** |
| Mosques | 19.51 | 1 |
| Hospitals | 19.51 | 1 |
| Banks | 19.48 | 3 |
| Schools | 17.92 | 4 |
| Churches | 17.32 | 5 |
| Government Buildings | 17.32 | 5 |
| Theatres | 16.82 | 7 |
| Insurance Agencies | 15.54 | 8 |
| Buildings where explosives are kept | 15.54 | 9 |
| Houses | 15.54 | 9 |
| Apartment Buildings | 15.54 | 9 |
| Nursing Homes | 12.72 | 12 |
| Parking Garages | 12.57 | 13 |
| Restaurants | 12.54 | 14 |
| Factories | 11.52 | 15 |
| Stadia | 10.69 | 16 |
| Gas Stations | 10.69 | 16 |
| Department Stores | 10.69 | 16 |
| Motels | 10.69 | 16 |
| Arenas | 10.13 | 20 |
| Buildings for keeping high toxic materials | 10.04 | 21 |
| Grocery Stores | 6.72 | 22 |
| Hotels | 6.49 | 23 |
| Grocery Stores | 6.43 | 24 |
| Warehouses | 3.01 | 25 |

Table 4 compared the mean ranks between the categories of buildings and thereafter indicated how the buildings differ in their respective rate of usages. Therefore, mosque happened to be the building which is most the related to other groups with respect to their rates of usages of non-interlocking bricks and this happened to other building in the descending order. That is, warehouses being the least building in terms of its’ with other building categories.

**Table 5:** **FACTORS AFFECTING COSTS OF INTERLOCKING BRICKS IN LAGOS STATE.**

|  |  |  |
| --- | --- | --- |
| **Categories of buildings** | **Mean Ranking** |  **Ranking**  |
| High level of skill required for construction and installation |  11.69  |  1  |
| High level of technicality needed while operating its plants |  9.61  |  2  |
| Higher quality consideration |  9.49  |  3  |
| Increase in time needed for installation |  8.87  |  4  |
| Quality Consideration |  8.50  |  5  |
| Coldness of the internal building during hot weather |  7.82  |  6  |
| Environmental Friendly |  7.70  |  7  |
| Aesthetics Purposes |  6.98  |  8  |
| Health Friendly |  4.93  |  9  |
| Coldness of the internal building during cold weather |  4.39  |  10  |
| Warmness of the internal building during cold weather |  4.39  |  10  |
| Higher cost of designing |  4.39  |  10  |
| Level of supervision |  2.25  |  13  |

Table 5 compared the mean ranks between the factors that affect cost and thereafter indicated how they relate to one another. Therefore, high level of skill required for construction and installation happened to be the factor which is mostly related to other groups. That is, level of supervision being the least factors in terms how they relate with other factors.

**DISCUSSION OF FINDINGS**

This study is aimed to assess the rates of usage of interlocking bricks and non-interlocking bricks and also identify the factors affecting the costs of interlocking bricks and non-interlocking bricks. Therefore, it is very important to ascertain the costs of alternative building materials so as to secure the concept of value for money to the clients in the construction industry.

According to Mwangi (2013), the cost of construction materials has been seen to affect the adoption of the program, in that, the conventional materials are seen to attract high transport cost a factor that may work in favor of ISSBs. On the other hand, access to ISSBs equipment in the county may hinder the effective implementation of ISSBs technology. The prohibitive cost of this equipment was found to hinder adoption of ISSBs. The study likewise found that, perception on the quality of ISSBs has effect on the adoption of the technology. This is much so due to the fact that, the people view ISSBs as of high quality, cost effective and beautiful with all the respondents indicating they would build their houses using ISSBs. With regards to this research, respondent’s responses to the questionnaire showed that interlocking bricks prisons happened to be the building where interlocking bricks are being used the most with mean score of 4.12, this could be due to the fact that, the comprehensive strength of bricks makes it harder to break and has reduced level of maintenance when compared to the conventional sandcrete blocks, and followed by motels with mean score 3.70, then, factories with mean score 3,46, hotels with mean score 3.44, grocery with mean score 3.28, warehouses with mean score 3.12, arenas and gas stations with mean score 3.00, - churches, hospitals, nursing homes, houses, apartment building parking garages, all with mean score 2.91. Also, followed by theatres with mean score 2.68, restaurants and schools with mean score 2.54 - stadia, insurance agencies and department stores with mean score 2.46, buildings where explosives are kept with mean score 3.42, banks with mean score 2.25, buildings for keeping high toxic materials with mean score 2.16, mosques with mean score 1.46, and finally, mosque and government buildings being the least where interlocking bricks are used with mean score 1.46. Non-interlocking bricks assessment showed that the rates at which non-interlocking bricks are used in different categories of buildings, these categories represent different facet of building types according to the International Building Codes. mosque and hospitals happened to be the building where interlocking bricks are being used the most with mean score of 4.70, followed by banks with mean score 4.54, then, churches and government buildings with mean score 4.46, schools with mean score 4.44.

Theatres with mean score 4.25, insurance agencies, buildings where explosives are kept, houses and apartment buildings with mean score 4.09, parking garages with mean score 3.77, restaurants with mean score 3.72, factories with mean score 3.68, nursing homes with mean score 3.56, stadia, gas stations, department stores and motels with mean score 3.54, arenas with mean score 3.46, buildings for keeping high toxic materials houses with mean score 3.21, hotels with mean score 3.04, grocery stores with mean score 2.98, and finally, warehouses with mean score 2.09. The first objective which was to determine the factors affecting costs of interlocking bricks and non-interlocking bricks in Lagos state, the findings showed the ranking of mean scores for factors that do hinder the costs of interlocking bricks. It concluded that high level of skill required for construction and installation of interlocking bricks is the most significant factors that affects bricks’ costs with mean score 4.77 while level of supervision being the least factors that could hinder the costs. Level of supervision, being the most possible factors that hinder cost of interlocking bricks could be because, the technicians that install interlocking bricks are mostly being trained in expensive ways and moreover, these technicians are limited in numbers presently in Lagos state.

**CONCLUSION AND RECOMMENDATIONS**

The main aim of the clientis to get their project completed without any delay or additional cost, in other words, getting value for his money which should also be the focus of consultant who is representing the client in achieving the objective of project in term of cost, time and quality.

Based on outcome of this research, it was concluded that;

1. Rate at which interlocking and non-interlocking bricks are used in Lagos State is very low considering outcome of this research, based on the result that prison is the most building type where interlocking bricks are being used as against the conventional residential building. The reason for this is being envisaged that interlocking brick is very high in compressive strengths, lower maintenance and construction cost.
2. Non-interlocking bricks usage is common in mosque construction, hospitals, banks, churches, government buildings, schools, theatres, insurance agencies, buildings, houses, apartment buildings, parking garages, restaurants, factories, nursing homes, stadia, gas stations, department stores, motels, arenas, buildings for keeping high toxic materials, houses, hotels, grocery stores, and finally, warehouses. Most ware-houses are constructed with hollow sandcrete blocks with embedded stanchions.
3. High level of skill required for construction and installation of interlocking bricks is the most significant factors that affect bricks’ costs, while level of supervision being the least factors that could hinder the costs of interlocking.
4. Quality consideration and high level of technicality needed while operating its plants is the most significant factors that affect non-interlocking bricks’ cost, while level of supervision being the least factors that could hinder the cost of non-interlocking bricks.

**RECOMMENDATIONS**

After the extensive research on this topic from introduction to conclusion, these are my following recommendations:

1. There is need to create more awareness about the costs, aesthetics, quality, and sustainability of interlocking and non-interlocking bricks. That is, disclosing its’ information to the clients.
2. Training labourers on how to operate the hydraform machines for brick making and the installation techniques. This will increase availability of more skilled labourers, thereby, reducing the cost of installations.

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