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USING THE PARETO PRINCIPLE TO CONTROL BUILDING COST IN NIGERIA

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Abstract

The reduction of slum dwellers through enhanced provision of adequate, safe and affordable housing is one of the critical targets of the sustainable development agenda of the United Nations. By implication, the construction cost of residential buildings needs to be reduced to make them more affordable. Reduction in the cost of cost-significant building elements will lead to substantial reduction in the construction cost of any residential building executed. This paper reports the findings on the cost-significant elements of residential building projects executed in Nigeria with a view to using them to reduce building cost. Cost data on 34 residential building projects executed in various locations of Nigeria between 2008 and 2016 were collected from Quantity Surveying consulting firms in Lagos State, Nigeria using random sampling technique. The cost data were converted to the same base year values using cost indices and then analysed using the Pareto Analysis procedure to obtain cost-significant elements. Findings from the study indicated that the cost-significant elements of residential building projects executed in the study area were electrical services installations which account for 16% of total construction cost, mechanical services installations (15%) and windows and upper floors (10%), respectively. The paper concluded that these cost-significant elements, representing 33% of total number of elements account for 50% of total construction cost. Reduction in the cost of these few elements will lead to significant reduction in the cost of residential building projects executed in the study area.

Key Words: *Building, Cost-significant, Elements, Pareto Principle, Projects*

Introduction

Owing to unbalanced development approach, population explosion in developing countries of the world is skewed against the urban centres. Consequently, inadequate housing supply is evident and prevalent in most cities of developing and third world countries, including Nigeria (Alagbe, 2013). The housing deficit in Nigeria was put at 16 million in 2013 and about 17 million in 2014 (Ayorinde and Ekemode, 2015). This acute housing shortage in Nigeria has led to deteriorating living conditions of most Nigerians. For example, it was claimed that between 68% and 70% of Lagos population lived in slums in 2013 (Lagos Bureau of Statistics, 2013; Jimoh *et al.*, 2013). Aribisala (2015) observed that the housing problem of Nigeria was in two parts – housing deficit and affordability. The author posited that the United Nations recommended that Nigeria's housing problem could be addressed using Public Private Partnership. However, Aribigbola (2012) observed that the houses built through this initiative were unaffordable to low-income earners who are the original targets. There is hence the need to reduce the construction cost of residential buildings to make them more affordable to low-income earners. This study is hence considered necessary as it will increase the understanding that the construction cost of building projects could be reduced by focusing on the few cost-significant elements of buildings. Identification of cost-significant elements is necessary in providing efficient cost reduction to the construction of building projects. The Pareto Principle otherwise called the principle of vital few and trivial many can be used to achieve much with less. Thus, reduction in the cost of few significant building elements will lead to substantial reduction in the construction cost of residential building projects executed thereby making them more affordable to low-income earners.

Literature Review

The Pareto Principle is named after Vilfredo Pareto a 19th century French-born economist who discovered that the pattern of wealth distribution in England was unbalanced. This unbalanced distribution was further tested empirically and it was found that a consistent mathematical relationship existed between the proportion of the population and the amount of income and wealth they controlled. Several names have since been given to this mathematical relationship including the Pareto Principle, the Pareto Law, the 80/20 Rule, the Principle of Least Effort, the Principle of cost significance, the Principle of Imbalance, the Principle of unequal distribution and the Principle of Vital Few and Trivial Many (Koch, 1998). Pandey *et al.* (2013) however alluded that Joseph M. Juran (a renowned management consultant) proposed the Principle as one in which 80% of the required work is done in 20% of the time allotted.

The Principle is essentially one that establishes the relationships between the values of the various parts of a population and the total value of the population. For a building project, for example, the operation of the Principle entails breaking down the building into constituent parts like building elements, trades or activities with their corresponding costs. This is followed by establishing the percentage relationship between the cost of each part and the total cost of the building. The next procedure is to find the average cost of the building by dividing the total cost by the total number of the elements, trades or activities which make up the building. Any part which cost is greater than the average cost is regarded to be cost-significant. Subsequently, a mathematical model (percentage ratio) is derived for the relationship between the cost of the significant items and total cost of building.

The Pareto Principle remained dormant for almost a generation after its discovery until after the Second World War. However, Blackman and Chan (2013) affirmed that the Principle can be applied to several fields. Among the earliest users of the Principle were George K. Zipf, Joseph M. Juran and International Business Machines (IBM) (Koch, 1998). The author posited that in 1949, Zipf (a

Harvard Professor of Philosophy) used the Principle to establish that 20-30% of any resource accounted for 70-80% of the activity related to that resource. Similarly, Alecu (2010) claimed that Joseph M. Juran used the Principle in 1951 in the information technology (IT) field to revolutionize product quality in Japan by identifying the 20% of causes which accounted for 80% of errors. Moreover, in 1963, IBM used the Principle to identify the 20% of the most used operating codes to enhance the efficiency of computers. This has led to the production of cheaper and more user-friendly computers that we have today.

Similarly, the Principle has been applied to the construction industry at large. Durdyev and Ismail (2012) have used the Pareto Principle to establish the 20% of factors causing 80% of on-site productivity problems in the New Zealand construction industry. Stojcetovic *et al*. (2015) used the Principle to identify the critical activities that have the most impact on construction projects in Russia with a view to drawing project managers' attention to them. Similarly, Obolewicz and Dabrowski (2017) used the Principle to diagnose managers' and workers' perceptions of occupational health and safety on selected sites in Poland. In India, Sarkav (2018) used the Principle to study the engineering related quality issues of electrification projects.

In the field of quantity surveying, the Pareto Principle has been used by several researchers including Short (1970), Horner *et al*. (1976), Harmer (1983), Saket (1986), Allman (1988), Betts and Gunner (1993), McGowan (1994) and Bababola and Jagboro (2003). Short (1970) applied the concept of cost-significant items and concluded that 90% of total project cost were inspired by 10% of the items of bill of quantities (BQ). Barnes (1971) used the Pareto Law to conclude that 75 to 90% of the total cost in a BQ were accounted for by 20% of bill items. Harmer (1983) also used the Pareto Law to establish that 20% of BQ items accounted for 69 to 89% of the total value. Saket (1986) used the concept of cost-significant items to develop iterative estimating for construction works. According to the author, cost-significant items are those whose value are greater than the average value of the BQ.

Allman (1988) used the concept of cost-significance to develop a simplified estimating system called significant items estimating. Betts and Gunner (1993) and McGowan (1994) also developed a cost estimating model based on cost-significant items. The foregoing empirical studies show that the application of the Pareto Principle in the construction industry have not only been far between, it has also been largely limited to the developed countries. Moreover, there seem to be scanty empirical studies on the application of the Principle to the control of the cost of building projects. There is hence the need to explore the potential advantage of the Pareto Principle to control the cost of building projects in Nigeria so as to make them more affordable to low-income earners. Identification of the few significant elements of residential buildings and directing efforts at controlling their cost will lead to substantial reduction of the cost of residential building projects executed. According to the Department of Transportation and Main Roads (2013), one way of reducing cost of infrastructure projects is through the use of innovation, research and technology. Koch (1998) also advised that to achieve enhanced efficiency, time and energy should be concentrated on the 20% of activities that contribute the most to success.

Owing to locational variability in the cost of construction projects, it is necessary to note that apart from the application of the Principle in diverse fields around the world, similar studies exist in the field of quantity surveying in the same locational context with this present study. These include those by Kadiri (2015a), Kadiri (2015b) and Adegoke *et al*. (2017). Kadiri (2015a) used the Principle to develop cost models for highrise office buildings in Nigeria. Similarly, Kadiri (2015b) used the Principle to identify the cost-significant items of hospital building projects in Nigeria. Adegoke *et al*. (2017) developed Pareto-based models for residential building projects executed in Abuja, Nigeria. In spite of the above studies, however, those based on the use of the Pareto Principle to control building cost seem scanty, hence this study. Emanating from the above, this study aimed at identifying the cost-significant elements of residential building projects executed in Nigeria with a view to focusing on them in reducing the construction cost of buildings. This could make them become more affordable and hence reduce the number of slum dwellers in Nigeria.

Research Methods

Archival cost data in the form of bills of quantities on residential building projects executed in Nigeria between 2008 and 2016 were collected from Quantity Surveying (QS) consulting firms operating in Lagos State using random sampling technique. Lagos State was chosen because more than 50% of the vibrant QS firms operate from the State. Thus, using the State afforded the opportunity to access large pool of cost data for past projects. In all, 34 bills of quantities of residential building projects executed in different parts of the country were collected and used for the analysis. The cost data were reduced to cost per square metre and then converted to the same base year values using cost indices to reduce the project costs at various years to a common denominator.

The data were analysed using Pareto Analysis procedure explained above to obtain cost-significant elements and their percentage contributions to the total construction cost of residential building projects.

Results and Discussion

Table 1 shows the percentage contribution of each element to total construction cost arranged in descending order of magnitude. It can be seen from the Table that four elements are cost-significant (those with cost higher than the mean value), after Saket (1986).

Table 1: Cost-significant Elements of Residential Buildings

Elements	Mean Elemental Cost (₦)	% of Total	Rank
Electrical Services*	2,698	15.5	1
Mechanical Services*	2,575	14.8	2
Windows*	1,750	10.1	3
Upper Floors*	1,725	10.0	4
Fittings and Fixtures	1,265	7.3	5
Doors	1,258	7.2	6
Finishings	1,218	7.0	7
Roof	1,081	6.2	8
Staircases	1,051	6.1	9
Frame	926	5.3	10
Substructure	909	5.2	11
Walls	909	5.2	12
Total	17,365	100	

Mean= ₦1,447; * Cost-significant Elements

These cost-significant elements are electrical services which account for 16% of total construction cost, mechanical services (15%), windows and upper floors (10%), respectively. It is instructive to note that the two services elements contribute 31% to total construction cost of residential buildings executed in the study area. Similarly, the four cost-significant elements together contribute 51% of total construction cost. These findings align in part with Harmer (1983), Saket (1986) and Allman (1988) who reported that plumbing installations were cost-significant.

On the other hand, the results are not aligned in part with the above studies the fact that the authors also all reported that concrete works, brickwork, wood work and finishings were cost-significant. The differences in the results could be because of the different methodology adopted for this study when compared with the others. This study was based on building elements while the other studies were based on building trades. It is expected that the constituents of cost will differ for building elements as against trades. Moreover, the difference in the findings could be because of locational variability between tropical and temperate climates. Building construction in tropical Nigeria is expected to present marked differences from that of temperate regions on which the other studies were based. The cost profiles of buildings in the different locational contexts are bound to differ.

With regards to mathematical relationship between cost-significant elements and the value of BQ, Table 2 shows that the Pareto-based relationship (mathematical model) derived from this study is 51/33. This implies that 51% of BQ value is accounted for by 33% of bill elements. In other words, by executing four elements (33%) out of the 12 elements in the building, 51% of total construction cost would have been spent. Conversely, this also means that 67% of elements account for 49% cost only. The implication is that it will be more expedient to concentrate on four elements and execute them well than wasting much time and resources on eight elements which cost less than half the BQ value. Applying this concept to cost reduction, it implies that efforts directed at reducing the cost of the four cost-significant elements will be more rewarding than the eight elements that are not cost-significant. This argument is the main trust of this study that residential building projects could be constructed at more affordable cost if efforts are directed toward reducing the cost of the more expensive aspects. Hence, to know the elements to direct efforts on, they must first be identified using the Pareto Principle. The methodology of cost reduction for these four elements could involve the various phases of construction works including design, planning, procurement method used and, of course, the construction phase. However, the above results do not align with several previous studies. For example, Horner *et al*. (1976) affirmed that 80% of BQ value was accounted for by 20% of work items. Similarly, Short (1970) reported a 90/10 relationship while Barnes (1971) concluded that 75 to 90% of BQ value was inspired by 20% items. It should however be noted that the level of alignment of these type of studies depends on projects' locations, similarity and pricing strategies adopted.

Table 2: Relationship between CSEs and Construction Cost

Elements	Rank	% of Total No of Elements	Elemental Cost (₦)	Cumulative Cost (₦)	% of Total
Electrical Services	1	8.3	2,698	2,698	15.5
Mechanical Services	2	16.7	2,575	5,273	30.4
Windows	3	25	1,750	7,023	40.4
Upper Floors	4	33.3*	1,725	8,748	50.4*
Fittings and Fixtures	5	41.7	1,265	10,013	57.7
Doors	6	50	1,258	11,271	64.9
Finishings	7	58.3	1,218	12,489	71.9
Roof	8	66.7	1,081	13,570	78.1
Staircases	9	75	1,051	14,621	84.2
Frame	10	83.5	926	15,547	89.5
Substructure	11	91.7	909	16,456	94.8
Walls	12	100	909	17,365	100

*33/51: 33% of Elements account for 51% of Cost

Moreover, Babalola and Jagboro (2003) found that 80% of total cost of items of preliminaries of building projects was accounted for by 20 to 23% of them. Again, the above differences are expected to be so. Differences in location and time could have been responsible for the disparity between this study outcome and those of Stone (1970), Barnes (1971) and Horner *et al.* (1976). Price levels are expected to differ with location and time. Similarly, the study of Babalola and Jagboro (2003) was on preliminaries which are different from the cost of building elements on which this study was based.

Conclusion

Emanating from the findings from this study, it is concluded that leveraging on the principle of achieving much with few, which is the major contribution of the Pareto Principle, the cost of residential building projects executed in Nigeria can be substantially reduced by focusing efforts on reducing the cost of few elements. These are electrical and mechanical services, windows and upper floors. Hence, it is recommended that construction stakeholders should direct efforts at reducing the cost of these elements so as to make residential buildings more affordable to low-income earners. This could reduce the number of people living in slums in the study area.

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