A TAXONOMY OF BUILDING COLLAPSE CAUSES IN LAGOS STATE NIGERIA

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ABSTRACT
This Lagos-based study provides an unsupervised grouping of the causes of building collapse in Lagos State Nigeria using purposively obtained data from construction professionals (n=34) in the state. Hierarchical cluster analysis technique and mean scores were used for the analyses. Findings show that the causes of building collapse in Lagos State can be statistically grouped into design and construction-related, policy-related and quality-related causes. The most important causes of building collapse under each of these groups are respectively: poor maintenance culture, change of use of building and use of substandard materials in construction. Government needs to strengthen efforts at monitoring both the design and construction of buildings, starting with fine-tuning building related policies. A holistic approach should be adopted in addressing building material counterfeiting and circulation of substandard construction materials in the study area.

Keywords: Building Approval, Building Collapse, Building Failure, Cluster Analysis, Lagos State.

1. INTRODUCTION
Buildings are among the most important artifacts in the landscapes of the world. They provide homes for people to live in, and carry out other social activities. At the present state of civilization, life without buildings is unimaginable. Consequently, most nations of the world have clear policies for building provision to meet different needs, like accommodation, office spaces, educational and health facilities amongst others. At individual levels, ownership of buildings attracts social respect, and a decent accommodation confers dignity and social acceptance. Nationally, countries display the ingenuity of their architects and engineers by the elegance and complexity of their built environment. Building collapse therefore hurts users of the building, physically, socially, economically and psychologically [1, 2] and reduces national pride. When a building collapses the impact of the shock is society-wide, and sometimes even international [3], and brings embarrassment to the entire chain of stakeholders in the particular building.

Building collapse is a global problem. Instances include the collapse of a six-storey apartment building in Italy on 11th November 1999 [4] collapse of an eight storey garment factory in Dhaka, Bangladesh on 24th April 2013 [5] collapse of a five storey building in Mumbai, India on 27th September, 2013 [6] and collapse of a balcony in Berkeley California on June 16, 2015 [7]. In any case, building collapse appears to be more prevalent in developing countries owing to institutional deficiencies and loose implementation of building control laws. Nigeria especially Lagos State, has been reported to be the "world's junk-yard" of collapsed buildings running into billions of Naira [8]. The losses caused by this problem in financial terms may be far above N500 billion (N 360 =$1) since independence in 1960 [9]. Building collapse, therefore, attracts much research attention in countries like Nigeria [1, 10, 11], most of which are dedicated to identifying the causes of building collapse. Existing studies have, however, not pointed out the most critical causes of building collapse in Nigeria to guide policy formation.

Secondly, despite the preponderance of studies on the collapse of buildings in Nigeria, there are insufficient attempts in literature to statistically group these causes to ease implementation of preventive measures. Apart from identifying the causes of building collapse, some studies have also pointed out

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the buildings that collapsed and their dates of collapse [1, 12, 13]. To enhance the coordination of measures for preventing building collapse in Nigeria, it will be necessary to obtain an unsupervised grouping of the causes of building collapse. Such a grouping is required for assigning responsibilities to undertake appropriate preventive measures to the different stakeholders in building production. Two prominent causes of collapse of buildings are disasters and human negligence. In the developed world, buildings collapse are mostly triggered by natural disasters and fire incidences. Consequently, most studies on building collapse from developed countries focus on building collapse as a result of force majeure [14 - 16]. On the contrary, the causes of building collapse in developing countries are predominantly related to human negligence. Blame trading usually follows every incident of building collapse as stakeholders try to assign responsibility for the collapse and press criminal charges against defaulters. A careful categorisation of building collapse causes will, therefore, direct the attention of stakeholders to the likely domain of responsibility for future collapse incidents. Ultimately, stakeholders will attempt to ensure that they are free of blame for building collapses in Nigeria. The aim of this study is to group the causes of building collapse, and determine the important causes of building collapse under each category in a bid to curb the incidences of building collapse in Nigeria

2. LITERATURE REVIEW
2.1. Building collapse
Building collapse is the total or partial breakdown of the superstructure of a building, which renders it unfit to meet the purpose for which it was built. It is a situation where a part or the whole structure suddenly or gradually gives way [17]. When the structure fails and most members have caved-in, deteriorated or distorted and the building can no longer stand as originally built, then the building is said to be in the state of complete collapse. It can be seen, therefore, that collapse is the very extreme state of failure [18] which makes a building incapable of fulfilling the original functions for which it was constructed [11, 19]. In this study, building collapse has been defined as structural failure. A collapsed building in this study is one that shows evidence of structural failure either in the form of being visibly out of vertical alignment or in the form of the presence of a structural crack. This measure of collapse was

chosen because many authors have related structural failure to building collapse [20-23 23]. Also, defining building collapse in this way enables relevant stakeholders to activate necessary preventive/ corrective measures prior to the complete crumbling of the building structure. Akinyemi *et al* [13] reported some cases of building collapse in Lagos state and its environs as stated in the Table 1 showed below. Majority of the collapsed buildings were privately owned storey buildings. Table 1 demonstrates the danger of allowing buildings to collapse. Buildings normally show early warning signs of instability before they finally crumble. In most cases, these signs are ignored and the building collapses killing human beings. Defining building collapse as the structural failure of a building will help the authorities to commence preventive measures once it is clear that a structure has failed, even though it has not crumbled.

2.2. Collapse of old buildings and buildings under construction
Extant reports on collapsed buildings refer to storey buildings (old storey buildings and storey buildings under construction) as the most collapse-prone (see Table 1). Old buildings are those that have outlived their life spans. Such buildings often have cracks at various joints or in their structural members due to structural failures. It has been noted that many old or weak buildings collapse due to inadequate design standard and improper construction practice at the initial time [24, 25], which results in structural failure later on [20 - 23]. Suggestively, poor construction practices at the time of building construction may delay their manifestations to a later day in the life of the building. In other cases, due to change of use or imposition of excessive live load, a building may experience structural failure which will lead to a total or partial collapse [21, 26]. Some old buildings collapse as a result of excessive exposure of their structural elements to weather. In this category are some colonial era buildings that have deteriorated to become unfit for human habitation as a result of poor maintenance. Low income earners, however, refuse to be evicted from such buildings for want of alternative accommodation.

Collapse of buildings under construction is also relatively common. For instance, a twelve storey building under construction in Chennai, India collapsed in 2014 as a result of use of substandard materials, leaving some persons dead and several

others injured [27]. Studies in Nigeria identify both faulty designs and faulty construction methodology as causes of failure of buildings under construction [11, 21]. This not only questions the exercise of professional diligence in the conceptualisation and design of buildings in Nigeria, it also points to the incapacity of contractors' site personnel to adapt designs to site conditions. In the bid to achieve home ownership as cheaply as possible, some low-income developers employ quacks at the design and construction phases of their development which leads to the erection of collapse-vulnerable buildings [28, 20]. Fakere, Fadairo, and Fakere, [29] and Adewole, Oladejo, and Ajagbe, [30] for instance, showed that buildings under construction can collapse as a result of poor concrete mix ratio due to inadequate supervision by the consultants [11, 13, 22, 23]. Clearly, building projects for which there are no consultants, and those being supervised by quacks will be worse of. Currently, insufficient literature efforts to organize the causes of building collapse in Nigeria into statistically obtained genres mitigates the assignment of roles for the prevention of future collapse of buildings in Nigeria. Causes of building collapse in Nigeria have been systematically discussed under design-related and construction-related factors in this section of the study.

2.3. Design-related causes of building collapse

Most authors attribute building collapse to faulty designs [11, 20, 21, 31- 33]. Design-related causes of building collapse refer to those causes of building collapse that occur prior to the engagement of a contractor. Broadly, design-related issues do not only refer to the inputs of the structural engineer, whose duty it is to analyse the structure for the optimum distribution of its dead and live loads [31]. Design-related issues encompass decisions such as choice of site, financial provision for the project and other duties of the design team and the client. While it is generally expected that the structural engineer would have considered all relevant issues before arriving at a design, it is sometimes not the case. Despite this, structural engineers are hardly indicted for culpability for building collapse in Nigeria. Infirm implementation of building design and construction policies may be blamed for this. According to [11, 29] policy control issues such as poor town planning approval/ development monitoring process contribute to building collapse in Nigeria. According to [28, 34], the government rarely make the sanctions against

planning control defaulters public to serve as a deterrent to others who may wish to act the same way. The lengthy litigation processes that usually follow building collapses in Nigeria often result in the public losing interest in the cases, without following through to the final outcome. In some cases, buildings collapse as a result of clients' choice of difficult sites [31, 33] such as water-logged, made-up and marshy sites. Problematic sites necessitate the use of expensive foundation types for which the client may not be financially prepared.

In the traditional procurement method (predominantly practiced in Nigeria), the expertise of the design team bears heavily on the outcome of building projects. The contractor is merely employed to construct an already designed facility. As a result, extant flaws within the design, such as wrong assumption of the bearing capacity of the soil could lead to the building's structural failure, especially, if the contractor goes ahead to build exactly as designed. Conceptually, therefore, design-related factors affect the construction of a building and may lead to its eventual collapse. Construction-related factors are usually viewed as the immediate causes of building collapse, whereas the remote causes are sometimes design-related.

2.4. Construction-related causes of building collapse

Normally, it is the responsibility of contractors to physically erect a building on site. The contractor works within certain constraints. He has an already made design to which he did not contribute. He has a site chosen by the client, which may be challenging construction-wise. It is expected of the contractor that he already possesses the capacity within his organisation to surmount the construction challenge of the project. Nevertheless, in some cases, contractors lack the requisite manpower capacity to undertake a project. Ifedolapo [35] pointed out that to minimise incidences of building collapse in Nigeria, it is needful to be sure of the competences of those who design, approve, supervise and erect buildings. Unfortunately, indigenous contractors in Nigeria are notorious for engaging quacks as supervisors of construction projects. Oloyede *et al.* [11] and Hassan *et al.* [21] attributed the causes of building failure to faulty construction methodology, which results from the engagement of unqualified personnel. The use of quacks has been top of the list on the factors causing building collapse [20- 23, 27]. Some authors believe

that poor workmanship is a key factor contributing to building collapse in Nigeria [20, 22, 32, 33]. This could be related to the failure of the previously vibrant apprenticeship system in the Nigerian construction industry. It used to be common for upcoming artisans and tradesmen to stay under the tutelage of established artisans, and become independent only after mastering the trade. Craftsmen of nowadays mostly accommodate only a brief stint with experienced artisans, and thereafter venture out on their own with inadequate knowledge and training.

In some cases, collapse of buildings result from the use of poor quality materials during construction [11, 13. 22, 29, 31, 32]. In the bid to reduce construction cost, the contractor or the client may reduce the quality of the material specified by the designer of a building. Compromises and other unethical practices by consultants and contractors encourage or directly lead to the use of poor-quality materials. Currently, a strong regulatory framework to ensure the use of only quality materials in building construction is absent. Although consultants are expected to ensure that the contractor utilised quality materials during construction, sometimes they abdicate this role due to unethical compromises with the contractor.

As shown in Table 2, numerous authors have stated different factors that lead to building collapse. Inadvertently, hardly has any study attempted to statistically group the causes of building collapse in Nigeria in order to determine their taxonomy. Such a grouping can best be realized using an unsupervised statistical grouping technique that will circumvent researchers' biases and provide stakeholders with where to look for answers when a building collapses.

Table 1: Instances of collapsed buildings in Lagos State

S/N	Locations in Lagos State	Date	Types of building	Numbers of casualty
1	Oshodi	2006	Two-storey market plaza	4
2	Obute Meta	2006	Four storey block of flat	25
3	Sururele	2006	Three-storey building caved in	28
4	Ogudu, Ojota,	2008	Three storey building under construction	unknown
5	Oshodi	2010	Building under construction (for Lagos state govt.	4
6	Victoria Island,	2011	Four-Storey Building	3
7	Maryland	2011	Five-storey structure with a Pent-house	unknown
8	Ikotun Egbe, Synagogue Church	2014	Six-storey building under construction	115
9	Magodo phase I,	2015	Three-Bedroom bungalow	4
10	Lekki District	2016	Five-storey building under construction	34
11	Ita-ifaji	2019	Three-storey building housing school Pupils	20
12	Jakande Estate	2019	Three storey building	NIL
13	Agarawu,	2019	Three storey building	1
14	Oshodi	2019	One Storey Building	NIL

Source: [13]

Table 2: Causes of building collapse

S/N	Causes of Collapse Building	Oloyede et al [11] (2010)	Obot and Archibong [28] (2016).	Omenihu et al [20] (2016)	Fakere, et al [29] (2012)	Ifedolapo [34] (2015)	Ayodeji [32] (2011)	Akinyemi et al [13] (2016)	Hassan et al [21] (2016)	Hamma-adama, and Kouider [26] (2017)	Yunusa, and Sada, [33] (2017)	Tanko et al [22] (2012),	Olusola, et al. [31] (2011).	Essien and Ajayi [23] (2017)	Adewole, et al [30] (2014)
X1	Faulty structural design	√		√			√		√		√		√		
X2	Incompetent contractor	√													
X3	Faulty construction methodology	√							√						
X4	poor Town Planning approval /development monitoring process	√			√										
X5	Non-compliance with specifications/ standards by developers/contractors	√													
X6	The use of substandard materials and equipment	√		√	√		√	√	√	√	√	√	√		
X7	Inadequate supervision or inspection/ monitoring	√							√			√		√	
X8	Economic pressures	√													
X9	Incompetent communication	√													
X10	Change of use of buildings	√									√				
X11	Aged buildings	√													
X12	Poor maintenance culture	√					√								
X13	The use of quacks		√	√				√	√			√		√	
X14	Government not making sanctions public		√			√									

S/N	Causes of Collapse Building	Oloyede et al [11] (2010)	Obot and Archibong [28] (2016)	Omenihu et al [20] (2016)	Fakere, et al [29] (2012)	Ifedolapo [34] (2015)	Ayodeji [32] (2011)	Akinyemi et al [13] (2016)	Hassan et al [21] (2016)	Hamma-adama, and Kouider [26] (2017)	Yunusa, and Sada, [33] (2017)	Tanko et al [22] (2012)	Olusola, et al. [31] (2011)	Essien and Ajayi [23] (2017)	Adewole, et al [30] (2014)
X15	Structural failure/faulty foundations			√					√			√		√	
X16	poor workmanship			√			√				√	√			
X17	Inadequate preliminary works				√										
X18	Adoption of wrong foundation,				√								√		
X19	Poor concrete mix ratio				√										√
X20	Improper walling				√										
X21	Natural phenomenon						√								
X22	Excessive loading						√		√						
X23	Approach to procurement							√							
X24	Selection of site										√		√		
X25	Site –trade training												√		
X26	Corruption												√		
X27	Inefficient stringent quality control													√	
X28	Absence of proper site investigation													√	

Source: Various authors

3. METHODOLOGY

The main purpose of this study is to determine how the numerous causes of building collapse in Lagos State may be scientifically grouped for easier implementation of measures to curb the menace of building collapse in the state. As shown in Table 2, the causes of building collapse were obtained from previous studies. However, the original set of variables was carefully edited to prevent duplication of variables. A questionnaire containing the variables as well as request for demographic data of the respondents was sent to construction professionals in Lagos State. They were asked to indicate their opinions on the importance of each of the causes of building collapse in the state on a Likert scale of 1=unimportant, 2=low importance 3=important, 4=moderately important and 5=highly important. The questionnaire was purposively targeted at builders, civil/structural engineers, quantity surveyors and architects. By training and law, these professionals should be knowledgeable of building construction and maintenance, and be directly involved in the

construction of buildings. The analysis was based on 34 suitably filled copies of the questionnaire. Hierarchical cluster analysis was used to group the causes of building collapse in Lagos State, Nigeria. Previous uses of the technique in construction related studies include [36] where it was used for contractor prequalification, [37] used it to identify possible strategic groups within the Turkish construction industry, while [38] used it for the classification of clients' payment practices. The analysis was done using the Statistical Package for Social Sciences version 20 (SPSS 20). Additionally, the variables were ranked under each category based on their means.

4. RESULT AND DISCUSSION
4.1. Demographic Data of the Respondents
Table 3 shows information on the respondents of the study majority of whom were engineers (38%). Most of the respondents have had at least six years work

experience in the construction industry. It is expected that such professionals must have been directly involved in a building project at least once in their professional lives. While most of the respondents are members of their respective professional bodies, it is also shown in Table 3 that all the respondents are graduates. The data in Table 3 implies that the respondents are quite suitable to respond to the causes of building collapse in Lagos State.

4.2. Cluster analysis of causes of building collapse in Lagos State
From the findings in Table 4, it was observed that the dominant variables in cluster 1 such as poor maintenance culture, wrong foundation, faulty structural design, and incompetent contractors are either design or construction related.

Table 3: Demographic data of the respondents

s/n	Characteristics of the Respondents	Frequency	Percentage
	Profession		
1	Architecture	6	18%
2	Civil/Structural Engineering	13	38%
3	Building	11	32%
4	Quantity Surveying	4	12%
	Construction Industry Work Experience (years)		
1	1-5	2	6%
2	6-10	12	35%
3	11-15	8	24%
4	16-20	4	12%
5	Above 20	8	24%
	Academic Qualification		
1	HND/B.Sc	34	100%
2	M.Sc	17	50%
3	PhD	5	15%
	Professional Qualification		
1	Member, Nigeria Society of Engineers (NSE)	13	38%
2	Council for the Regulation of Engineering in Nigeria (COREN)	8	24%
3	Member, Nigerian Institute of Quantity Surveyors (NIQS)	4	12%
4	Quantity Surveyors Registration Board of Nigeria (QSRBN)	4	12%
5	Council of Registered Builders of Nigeria (CORBON)	9	26%
6	Nigerian Institute of Building (NIOB)	10	29%
7	Architects Registration Council of Nigeria (ARCON)	4	12%
8	Member, Nigerian Institute of Architects (NIA)	5	15%

Hence, cluster 1 was named the design and construction cluster. The variables in cluster 2 such as change of use of building, economic pressure, and site-trade training of artisans are predominantly policy related, while the variables in cluster 3 such as the use of substandard materials and equipment, and poor supervision or inspection/ monitoring, and aged building are dominantly quality related. Clusters 2 and 3 were named policy-related and quality-related causes respectively.

Table 4: Cluster analysis results

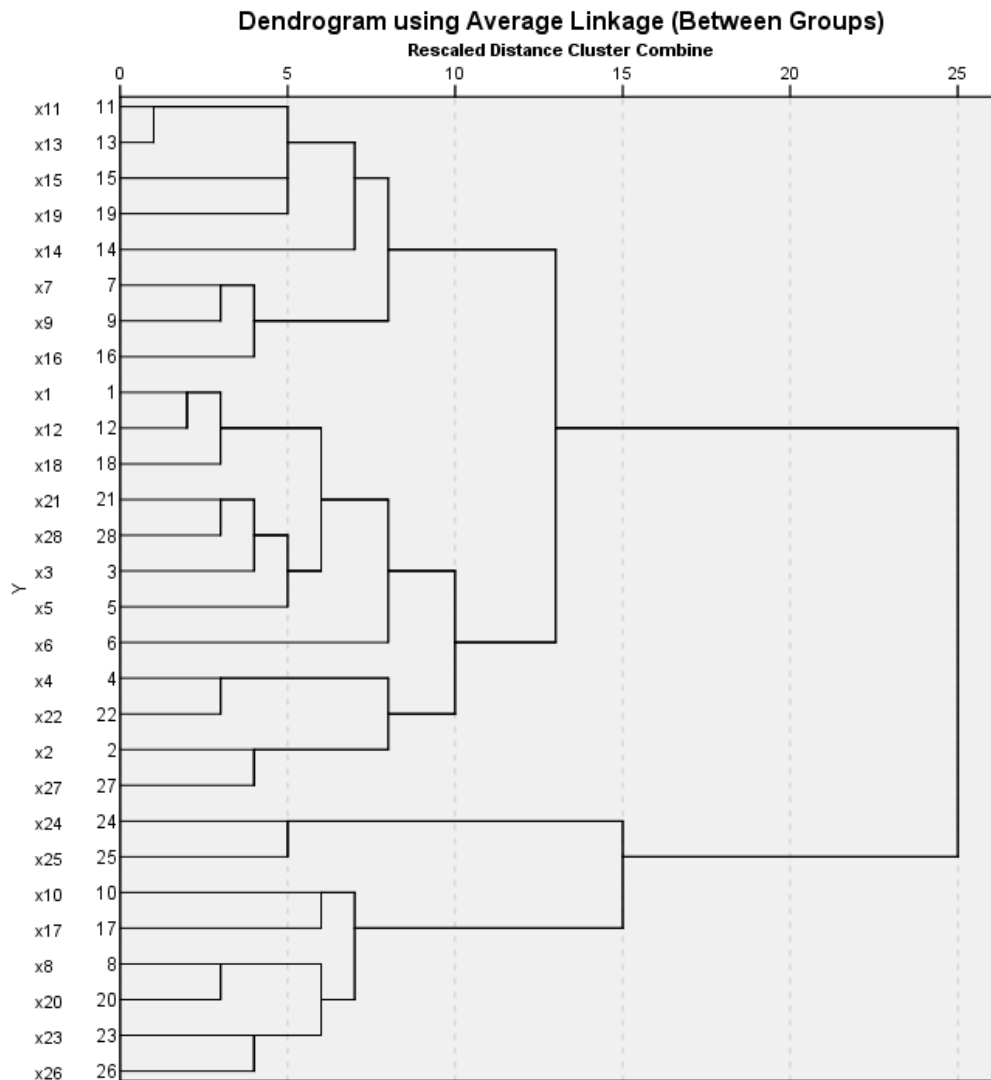|	Cluster 1: Design and Construction	mean	Standard deviation	Rank	Overall mean
x12	Poor maintenance culture	3.9412	1.20457	1	
x18	Adoption of wrong foundation,	3.9412	1.15316	2	
x1	faulty structural design	3.8529	1.23417	3	
x2	incompetent contractor	3.7647	1.47830	4	
x21	Natural phenomenon	3.6471	1.20309	5	
x3	faulty construction methodology	3.6176	1.30302	6	
x5	Non-compliance with specifications/ standards by developers/contractors	3.5882	1.15778	7	
x27	Inefficient stringent quality control	3.5882	1.53973	8	
x14	Government not making sanction public	3.4118	1.30541	9	
x22	Excessive loading	3.3529	1.27641	10	
x17	Inadequate preliminary works	3.3235	1.49181	11	
x4	poor Town Planning approval /development monitoring process	3.2647	1.26272	12	3.61
	Cluster 2: Policy-related				
x10	Change of use of buildings	3.1765	1.74895	1	
x26	corruption	3.0000	1.57634	2	
x20	Improper walling	2.9412	1.45521	3	
x8	Economic pressures	2.9118	1.56414	4	
x23	wrong method of site operation/construction methodology	2.9118	1.58339	5	
x25	Site –trade training of artisans	2.5882	1.37329	6	
x24	Selection of site	2.3529	1.47468	7	2.84
	Cluster 3: Quality Management-related				
x6	The use of substandard materials	3.9706	.96876	1	
x28	Absence of proper site investigation	3.7941	1.03805	2	
x19	Poor concrete mix ratio	3.7059	.93839	3	
x15	Structural failure/faulty foundations	3.6471	1.12499	4	
x11	Aged buildings	3.5882	1.01854	5	
x13	The use of quacks	3.5882	1.01854	6	
x16	poor workmanship	3.4118	.85697	7	
x7	Inadequate supervision or inspection/ monitoring	3.3824	.69695	8	
x9	Inadequate communication	3.2941	.75996	9	3.60

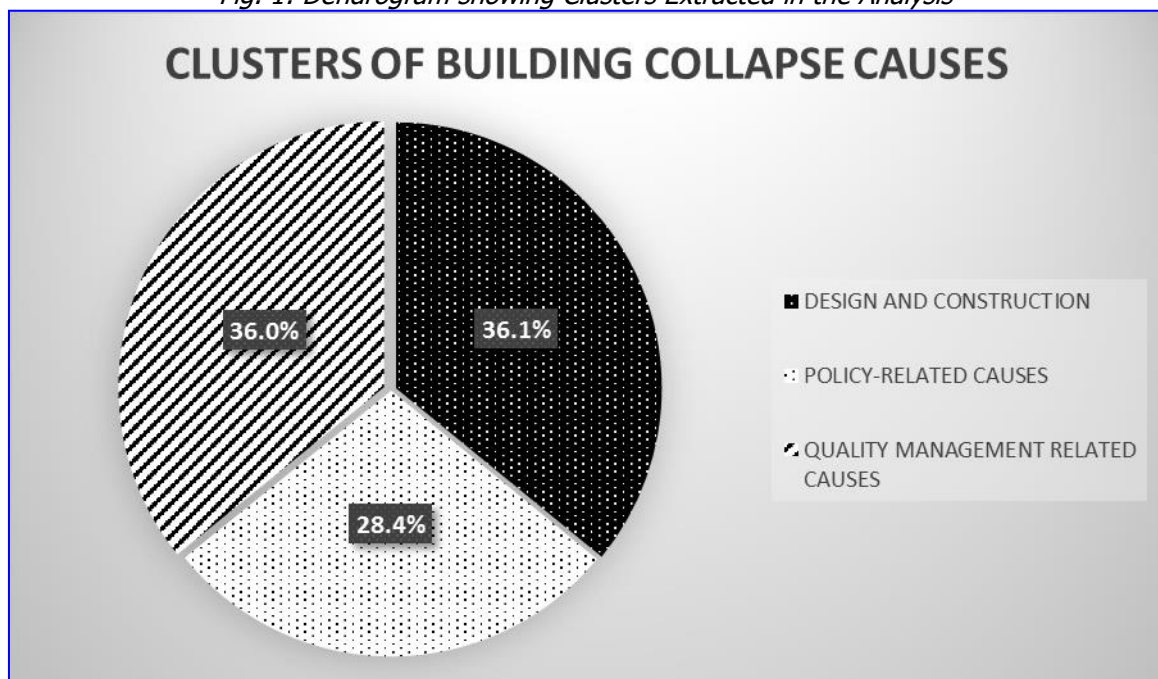Fig. 1: Dendrogram showing Clusters Extracted in the Analysis

Fig. 2: Clusters of Building Collapse Causes

4.3. Cluster 1: Design and Construction

There is need to imbibe maintenance culture after the construction of a building in order to keep the building functional for a long period of time. Poor maintenance culture is ranked highest ($\tilde{x} =$ 3.9412) among the variables in cluster 1. Oloyede, Omoogun and Akinjare [11] and Ayodeji [32] equally attributed the causes of building collapse to poor maintenance culture, although their studies did not statistically group them under design and construction variables. The high rank of poor maintenance in this study is because most collapsed buildings in Lagos were old buildings. Besides this however, contractors are supposed to maintain their built products at least for a post-construction period of 6 months during the defects liability period. The defects liability period which usually covers at least one rainy season enables the contractor to observe the onset of any structural problems. In practice, contractors hardly come around to observe the performance of their products during the defects liability period. As a result, simple structural faults get complex over time and result in substantial failure of the building. Adoption of a wrong foundation type ranked second ($\tilde{x} = 3.9412$). This is already a noted cause of building collapse [29, 31]. Some parts of Lagos State are reclaimed lands, while others have very high-water tables. A. higher engineering expertise is required for making foundations for most buildings in Lagos State than those normally used for other parts of mainland Nigeria. In spite of this, low income earners consider it expensive to hire the services of qualified persons to design and supervise their building projects. Resultantly, the risks of wrong choice of foundation type, and wrong construction of foundations are both very high in the state. Thus, the third-place rank of faulty structural design ($\tilde{x} = $ 3.8529) is a reflection of low level of expertise of the engineering personnel that often design the buildings which agrees with findings in previous studies [20, 31, 32, 33]. Table 3 shows that the group mean of the design and construction cluster (cluster 1) is the highest ($\tilde{x} = 3.61$) amongst the three clusters. Impliedly, the most important group of causes of building collapse are design and construction-related factors.

4.4. Cluster 2: Policy-related factor:

Cluster 2 has the least number of causes of building collapse in Lagos State, and has the lowest group mean of 2.84. It can also be seen that the means of most of the variables under this cluster are lower than 3.0 showing that the respondents consider the causes of building collapse under this category to be of a lower degree of importance. Most causes of building failure under this cluster are policy-related. What this shows is that most buildings do not fail for want of good policies in Lagos State. For instance, while Section 41 of the law for the Administration of Physical Planning, Urban Development, Urban Regeneration and Building Control in Lagos State and for Connected Purposes [39] prohibits change of use of buildings without authorisation, this study finds that change of use of buildings is an important factor under cluster 2. Other researchers had also identified change of use of building as a cause of building collapse in the state [11, 33].

Sometimes, developers present a commercial building development as a residential development to town planning authorities only for the use of the building to change to commercial upon completion of the building without further reference to the planning authorities. The second-place rank of corruption ($\tilde{x} =$ 3.00) under this cluster is instructive. It implies that developers may get away with such malpractices irrespective of the law as a result of corrupt connivance with town planning authority personnel.

Oloyede, Omoogun and Akinjare [11] noted that the enforcement of planning laws is made difficult by the fact that most developers are prominent persons or are connected to prominent persons in the society who are able to frustrate attempts at prosecuting offenders of building control laws.

4.5. Cluster 3: Quality management-related causes of building collapse

Use of substandard materials ranks highest under cluster 3 ($\tilde{x} = 3.9412$). Many previous studies believe that the use of substandard materials in building construction in the country is a major reason for most collapse of buildings [13, 32, 33]. The control of quality of building materials goes beyond the construction site. There are agencies such as the Standards Organisation of Nigeria (SON) that should certify the quality of construction materials in the

market. However, building materials like molded blocks usually do not come with the seal of approval of SON, unlike materials like cement. For instance, low quality blocks can be made from high quality cement. Already, as shown in Table 3, the respondents believe that use of low-quality concrete mix ($\tilde{x} =$ 3.7059) is one of the reasons why buildings collapse in the study area. In practice, it is the responsibility of the consultants to prevent contractors from indulging in shoddy jobs. Notwithstanding, it appears that the intensity of project supervision in the study area is quite low since the respondents identified inadequate supervision or inspection/ monitoring ($\tilde{x} =$ 3.3824) as one of the reasons why buildings collapse in the area. By the findings of this study, quality management issues are the second most important causes of building collapse in the study area ($\tilde{x} = 3.60$). Figure 1 presents a summary of the clusters of building collapse causes identified in this study.

5. CONCLUSION AND RECOMMENDATION

There used to exist unorganised causes of building collapse in Nigeria identified by various authors. No serious attempts were made to statistically categorise the causes of building collapse in Nigeria to aid decision making for policy formulation. This study grouped the causes of building collapse in Lagos State, Nigeria, using the hierarchical cluster analysis technique. It was shown in this study that the causes of building collapse in Lagos State can be grouped into three, namely: design and construction causes, policy-related causes and quality management causes of building collapse. Furthermore, design and construction causes of building collapse are the most important of the three groups followed by quality management causes of building collapse. It can be drawn from this study that policy formulation is the least serious of the groups of factors leading to building collapse in the area. Rather, the implementation of the policies should be strengthened at the levels of building design and construction and in the enforcement of standards of materials and workmanship. The highest-ranking causes of building collapse under clusters 1, 2 and 3 are respectively poor maintenance culture, change of use of buildings, and use of substandard materials. Both government and researchers should reinvigorate campaigns for the maintenance of buildings as a way of securing their long-time utility.

Laws proscribing change of use of buildings should be enforced more strictly to prevent developers from putting buildings to uses for which the buildings are not well-suited. From markets to the sites, governments should strengthen measures to prevent use of substandard materials in the construction of buildings, especially, materials that are critical to the strength of buildings such as cement and reinforcement bars. Buildings under construction that are not being supervised by competent persons should be halted and the developer prosecuted.

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