Factors Affecting the Physical and Functional Performance of Buildings in Kenya

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Abstract

Building performance is a broad subject whose meaning covers the ability of structures to serve the intended function based on a well-defined criterion such as the assessment of functional, physical, environmental, or even social attributes considered jointly or separately. Building failures and general collapses are some of the most severe consequences of failed performance of buildings which have a great impact on livelihoods yet have remained persistent in Kenya over decades despite various interventions. This paper analyses building performance based on observable attributes and sentiments of respondents collected from construction project sites across Kenya. The study aimed to characterize buildings that are likely to fail physically and functionally at different stages based on five factors drawn from the literature as institutional, ethical, financial, legal, and technical factors, with the intention of proposing the necessary stop-gap measures. The study employed a cross-sectional (survey) design in which quantitative research methods were applied to collect and analyze data from a random sample of 400 building construction projects selected through proportionate cluster sampling across the 47 counties of Kenya. A semi-structured questionnaire was used to gather data on the perception of industry professionals, building users, and generally the stakeholders on the identified area of the research. Data was analyzed using descriptive statistics, factor analysis, and regression analysis. The physical performance of buildings appeared to cause an alarming concern with elements such as wall and slab stability recording poor scores. Based on functional performance the aspects of disability mainstreaming and compliance to green building standards were noted to be under-performing. Multiple Regression analysis results revealed that institutional, ethical, financial, legal, and technical factors explained 17.1% of the variability in building performance. Notably, only ethical, legal, and technical factors were the statistically significant predictors of building performance. The study thus recommends a detailed review, restructuring, and optimization of the ethical, legal, and technical environment of building construction management to enhance buildings performance.

Keywords: Collapse, Construction, Failure, Kenya, Performance, Regulation

Introduction

According to Designing Buildings Ltd (2022), a building's performance is defined by its functionality to an established criterion which can be physical, social, or environmental. Assessment of building performance is an old practice that has been used in evaluating the quality of housing since the Neolithic times when civilizations started permanent settlements occasioning the need for certain assurances. Hussein (2011) notes that the concept grew significantly during the Industrial Revolution when buildings were designed to reflect people’s everyday lives, changing society, changing environment, and increasing technology; and where owners wanted to ensure their buildings remained competitive in the market while optimizing life-cycle costs. Performance can therefore be measured at different stages of a project based on the criteria in use. In this study, a criterion grounded on five factors identified in the literature was used to define both the physical and functional performance aspects of buildings. This is because failures can be physical - meaning they can result in deficiency of certain features like strength or performance-centered - meaning it faces a reduction of functionality below certain required limits (NCA, 2020). Greater emphasis has been placed on the physical failure of structures, often associated with collapses which is the ultimate and most serious result of the failure of a built structure.

Some of the most recent cases of physical failure of buildings include the 13th January 2018 incident in Indonesia during which an exchange walkway collapsed causing injury to over 70 people (Reuters, 2018), and the 27th May 2017 partial collapse of a parking garage at Eindhoven Airport (Dutch Safety Board, 2018). In Kenya, some of the major documented cases of failure and collapse of Buildings include the 13th May 1996 incident at Nairobi’s Sunbeam Supermarket where 16 people perished while taking cover from the rain, and the 29th April 2016 Nairobi’s Huruma incident where a 7-storey building structure collapsed leading to the death of 51 people, and during which 140 persons were rescued, and 2 others remained unaccounted for (NCA, 2020). Others include the Kawangware’s Precious Talent School classrooms collapse which occurred on 23rd September 2019 killing at least 7 pupils and leading to injury to more than 50 others (The Standard, 2019), and the Kiharu Sub-county, Muran’ga County Collapse where a three-storey building under construction collapsed leading several injuries and loss of lives (The Standard, 2023). Despite these, in the ’80s and early ’90s Kenya had a relatively good safety record with nearly no incidences of structural failure and collapses of buildings. This lull can be attributed to the then Local Authorities and City Council who carried out most of the design and supervision of the key housing and commercial constructions then. The number of building failures and collapses however shot up from 1 in 1990 to over 12 per year by 2020, with a cumulative 119 cases recorded over the period.

From the record, incidences of failure and collapse of structures are no longer new, but rather issues that emerged and have become stubborn to deal with in Kenya. While some buildings fail physically to the degree of collapse, others fail in their functionality to the space users. The government of Kenya has continued to institute measures including legal and structural reforms, to try and exterminate these incidences. These include the establishment of the National Construction Authority (NCA) through the NCA Act No. 41 of 2011, the National Building Inspectorate (NBI) established through Executive Order No. 1 of 2018, and the ongoing drafting of a Construction Industry Policy (CIP) among others. The challenge however persists prompting the need for deeper inquiry.

Building Performance

Overview to the Determinants of Building Performance

Well-designed and constructed buildings can be marvellous, safe, and healthy spaces for human habitation, however, when the right processes are not followed, negligence opens avenues for several dangers. Human error, failure to apply appropriate codes and safety standards, coupled with poor enforcement mechanisms among others have been observed to lead to shocking disasters. While many causes of building failure are attributed to work on a construction site, there remains a considerable set of causes that are quite distant – in time and space – from the happenings on a site. Some of these are related to institutional, ethical, financial, legal, and technological factors that emanate from how players in the construction industry value chain relate within the construction ecosystem, and the consequences can extend to loss of environmental integrity, crises among the parties concerned, loss or damage of property and investments, loss of jobs/ incomes, loss of trust and dignity, and damage to the general image of the Industry over and above injuries and loss of lives (Ede, 2010; NCA, 2020).

Institutional Factors

Several countries have established measures for development and building control, to ensure order and erection of well-performing buildings through observance of regulations, policies, codes, and procedures. Fernandez (2014) however observes that approvals are sometimes granted on the basis of falsified documentation of plans and materials punctuated by processes marred by incidences of dishonesty and fraud. This weakens the quality control protocols and practices, with effects often noted a bit late into the projects (Ede, 2010). As such, inadequately constructed buildings not only become risky in the short term but also spread risk across generations, especially in the unfortunate occurrence of triggers such as earthquakes. At the turn of the millennium, for example, the Netherlands was faced with the challenge of failure and collapse of buildings. Upon inquiry, weighty challenges in the implementation of public building regulations were noted, with the lack of the requisite capacity to implement regulations by the municipal Building Control Department (BCD) topping the list (Heijden, 2009). This occasioned a review of the BCDs procedures to entrench the engagement of certified private sector inspectorates as an alternative to BCDs. Overall, Oseghale *et al.,* (2015) and NCA (2020) have among other stated aspects of carrying out of geological tests, enforcement of standards and codes, insistence on occupation certificate, and regular building maintenance, as the bare minimum requirements for buildings. Figueroa-Fernandez (2014) on his part proposes the promotion of open-access reporting systems, stringent concrete testing measures, and promotion of obligatory self-regulation among professionals as some of the best approaches. Generally, proposals for proactive action to enforce compliance with safe construction principles have been at the forefront (NCA, 2020).

Ethical Factors

The construction ecosystem is complex and often a breeding ground for intricate political, social, and economic linkages. Construction activity itself being a business makes ethics a critical component. Oseghale *et al.,* (2015) links performance issues of buildings to systemic ethical issues where for instance authorities approve technically deficient plans on receiving bribes, or even where developers sometimes alter existing buildings illegally, using guesses without consulting qualified professionals or seeking approval from the regulatory agencies. Other ethical issues such as the compromise of compliance and enforcement officers at the construction sites have been cited variously (Ahzahar *et al.*, 2011; Asante and Sasu, 2018; Figueroa-Fernandez, 2014; NCA, 2020). In such circumstances, buildings end up being constructed or modified without the authorities' knowledge or involvement, and it is until an incident occurs that the malpractices get exposed. The involvement of unqualified persons who masquerade as professionals have also been noted as a challenge in fighting performance issues of buildings. Ahzahar *et al.*, (2011) observes that quacks have infiltrated most construction sectors thus negatively affecting the quality of works, especially among the unsuspecting members of the public. Instances of use of unlicensed plans, fraud, and and hidden use of substandard materials among others have also been variously reported by Madu (2005); Ahzahar *et al.* (2011); Figueroa-Fernandez (2014); and NCA (2020). To alleviate these, Oseghale *et al.*, (2015) and NCA (2020) propose that developers should be obligated to vet and only engage competent persons, and where signs of building performance failures are noted, the same should be voiced, works suspended and evacuated at the earliest.

Financial Factors

Financial issues have also been noted to play critical role in determining the performance of buildings. Madu (2005) for instance observes that finances being finite, developers sometimes change specifications against technical advice especially when they want to cut the project cost. Ahzahar *et al.*, (2011) further extends this to instances where Contractors sometimes overstep their mandates by usurping the Consultants' roles, thereby misleading the Clients for instance to change the size of rebars and building elements, often to cushion themselves from the effects of high price fluctuations, project variations and ultimately to maximize profits in materials and labour. These savings are often detrimental to the performance of metrics of buildings. In this case, a failure and/or collapses in a project is blamed on the technical teams, whereas the real cause relates to the financial characteristics of the Client. Ahzahar *et al.*, (2011) further extend this practice to quacks who infiltrate the construction sector with the promise of cheap services especially among unsuspecting members of the public, but eventually leading to detrimental results. NCA (2020) recommends engagement on the basis of binding to tame errant behaviours and ensure prudence.

Legal Factors

Regulatory framework for construction industry has been noted to be one of the longest and most complex hence creates avenue for exploration of regulatory gaps by dissidents. Legal factors are interconnected with all the other factors including institutional, ethical, financial, and technical, and their latent effect only gets exposed when a building fails. The legal and technical incapacities among most regulators have been observed to create a fertile ground for compromise (Ahzahar *et al.* 2011; Asante & Sasu, 2018; Figueroa-Fernandez, 2014). Madu (2005) further observes that sometimes Clients disregard Consultants' technical advice but still coerce them to design and supervise projects with limited legal recourse. Clear legal frameworks can help tame errant behaviour among players and establish protocols for handling construction works (NCA, 2020).

Technical Factors

Technical factors form the broadest category of contributors to performance issues of buildings. Oyewande (1992) attributes 40% of the collapse of structures to general technical faults, while Ogusemi (2002) relates 18.4% to substandard materials and poor workmanship, and 19% to poor workmanship. Characteristics of manpower involved at various stages of a building such as ineptitude therefore form the biggest contributor to its performance metrics (Madu, 2005; Ahzahar *et al.*, 2011; Figueroa-Fernandez, 2014; NCA, 2020). Standard of materials and applicable technologies have also been raised as major contributor to the poor performance of buildings by Ahzahar *et al.* (2011), Figueroa-Fernandez (2014), Hall (1984), and Ogunsemi (2002). Hall (1984) and Ogusemi (2002) record that structural failures mostly occur when substandard materials are used against a backdrop of inadequate workmanship. Ahzahar *et al.* (2011) on his part relates causes of building failures to the covert use of dirty water for concrete mixes thus reducing the strength of the concrete; utilization of sand with acidic content and/or salts that negatively affects the strength of concrete mixes among other. Mohammed (2017) delves into the broad subject of natural disasters such as earthquakes, floods, fire hazards, and bomb blasts which can be a cause or a trigger for failure and collapse, especially where adequate safety factors considerations were not considered. In a case of India, building collapses were noted to be prevalent in the rapidly growing urban centres, mostly involving the low-income, semi-formal, and informal housing segments, as a result of poor construction practices promoted by gaps in the system. The India Disaster Report observed inadequate structural designs, improper selection of materials, instabilities due to building geometry, use of defective materials, vandalism, sabotage, and natural disasters among others as causes (NIDM, 2014). To alleviate collapse of buildings as a result of technical factors, Oseghale *et al.,* (2015) and NCA (2020) propose a thorough design process, efficient supervision of works, elimination of professional malpractices, use of certified building materials, and the approval of building works at all stages.

Building Performance in Kenya

Building Failure and Collapses in Kenya

The occurrence of building failure and/or collapses in Kenya today remains an intractable problem associated with many factors. According to an audit undertaken by the National Building Inspectorate (2015), Kenya had almost zero incidences of failure and collapse of buildings in the early ’80s to mid ’90s. The first recorded case of building collapse in Kenya was a high-rise building in Dagoretti area of Nairobi which occurred in 1990 leading to the death of one person and injuries to several others (NCA, 2020). This was the beginning of array of collapses with at least 119 structures recorded as having collapsed between 1990 and 2020, with a peak number of 22 collapses recorded in 2015. Out of these, 226 No. documented deaths have been recorded with 2016 being highest with 78 No. deaths as shown in **Figure 1.** These statistics show an industry that has been heavily losing not only the lives of its citizens, but also its investments to the scourge of building failure and collapses. Despite these realities, building performance measures are still not being critically evaluated in Kenya. These socio-economic loses then prompt following questions: (i) why are these developments not stopped in time to avoid the grave risks associated with their failure? and (ii) What are the suitable corrective interventions that can be put in place to alleviate and forestall future similar occurrences?

Reuters (2022) relates the incidences poorly performing buildings in Kenya to pervasive corruption in planning processes and poor, outdated building standards while others like Commissions of Inquiry (1996) presents a cocktail of issues that span uncontrolled physical planning, inadequate and out-dated laws that lack effective control and enforcement mechanisms, corruption on the part of the enforcement authorities, and ineptitude and inefficiency on the part of some professionals and other players in the industry. NCA (2020) just like the Commissions of Inquiry (1996) emphasizes that the critical parties that contribute to a great extend to the success or failure of a building in Kenya as the Client (owner of the structure), design team, the contractor and the linkages between them.

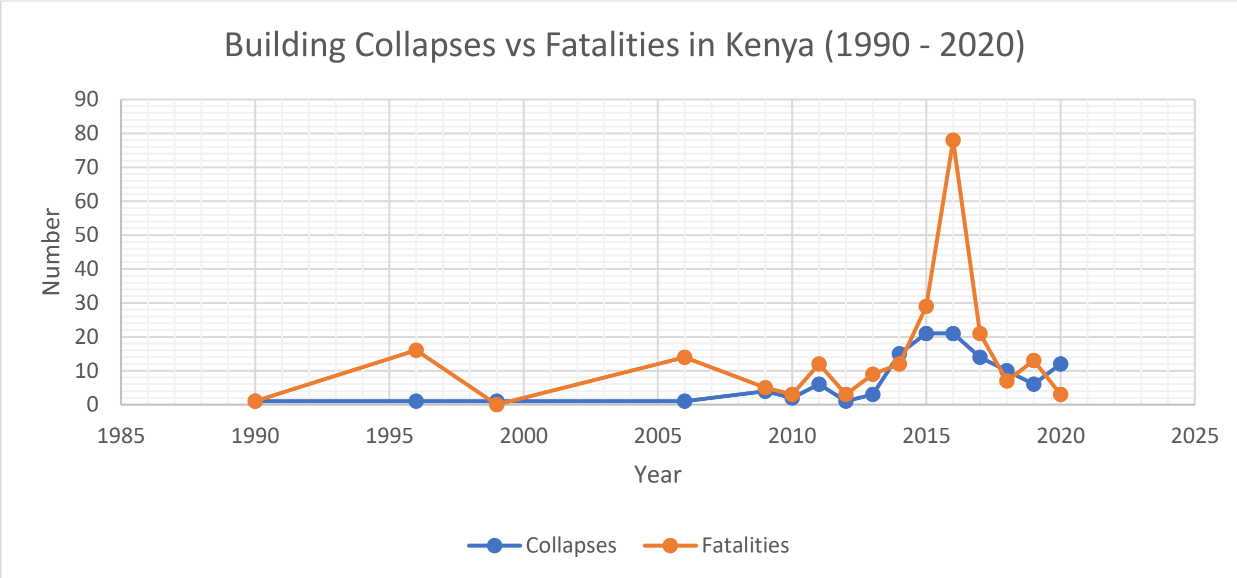

Figure 1: Trend Line of Failure and Collapse of Buildings in Kenya (1990-2020), and Related Fatalities

Source: Compiled by Authors

Regulation of Buildings Performance in Kenya

Regulation of buildings performance is a process involving strategies before, during and after construction. Pre-construction measures are geared towards ensuring competence and diligence in planning and design through the engagement of the qualified professionals to design and supervise the works from commissioning to decommissioning, and the selection of competent contractor(s). Measures undertaken during the construction phase on the other hand are aimed at ensuring delivery of good quality work by all those involved through prior vetting of building technologies, and progressive testing of building materials. Post-construction regulatory measures, on the other hand, are geared towards maintaining or enhancing the performance of the constructed facilities to guarantee continued functionality throughout their life spans by limiting deterioration. Regulatory controls can be in the form of rules, specifications, policies, or standards in compliance with the requirements of regulatory agencies in areas such as the environment, construction methods, construction machines and equipment, construction materials, and construction manpower. UN Habitat (2009) cites six major aspects that contribute to non-compliance of buildings to development control as inadequate institutional capacity and deficient legal framework, political interference and patronage, poverty and inadequate financial resources, low and incompetent regulations enforcement, laxity and corruption, high and unregulated professional fees, and imbalanced dissemination of information.

The construction industry in Kenya is being regulated through a set of building by-laws introduced by the colonial administration in 1926, and applied to the then Nairobi Town Council, before being replaced by the Nairobi City Council By-laws (Building) in 1948, and later the Local Government (Adoptive By-Laws) (Building) 1968 also called the Building Code, a duplication of the then British Building guidelines. Since the 1996 collapse of the Sunbeam Building in Nairobi, a long and arduous journey to entrench a shift from the highly prescriptive 1968 Building Codes to more progressive performance-based codes was started, but has not been realized to date. Although more multifarious legal and institutional frameworks have been put in place since then to regulate the construction industry, compliance remains low. The promulgation of a new Constitution of Kenya 2010 made this situation worse as it repealed the Local Government Act (CAP 265) that anchored the 1968 Building Code, making it redundant as it lacked the required enforcing authority, further aggravating challenge. Cognizant of the challenges and the severe human and socio-economic losses consequent to regulatory control failures in the construction industry, there has been a concerted effort from the government and industry stakeholders to enhance the existing institutional frameworks. The National Construction Authority Act No. 41 of 2011 was amended in 2020 through the Business Laws (Amendment) Act (2020) to entrench the Building Code, now referred to as the Draft National Building Code 2023 as its formulation is yet to be finalized. This presents an outright lacuna in the regulation of buildings in Kenya.

Gap in Literature

Several authors have canvassed the subject of building performance as it relates to failure and collapse of building in various jurisdictions. While several causes of failure and collapse of structures, as well as measures to mitigate against it have been proposed and/or implemented the challenge persists at varying levels world-over. In Kenya for instance, different authorities including Ministry of Housing (2015), the Building Law & Regulation Review and Harmonization Committee (2009), Commissions of Inquiry (1996) and Mshiri (2016) have advanced extensive arguments as to why the buildings are failing physically in Kenya, but were never conclusive owing to the largely cursory approaches taken. As such, findings from these studies have not been any different from those discussed in international literature. Most studies also seem to have a bias towards financial performance of buildings rather than operational performance. This study therefore sought an in-depth review of the problem and tested five main variables and their surrogates established through local and international literature, and subjected them to a countrywide survey as discussed in the succeeding section. Given the consequences associated with failure and collapses, the extermination of this challenge remains of utmost priority for the government of Kenya. This study, therefore, contributes to the ongoing discourse by attempting to identify and amplify factors that significantly contribute to the scourge of failure and collapse of buildings for necessary intervention.

Methodology

Research Design and Strategy

The study employed a cross-sectional research design which is a type of observational research that analyses data of variables collected at one given point in time across a sample population (Bryman, 2012). This enabled the researchers to examine the data to detect possible patterns of association (Mugenda & Mugenda, 2003). A quantitative research strategy was employed in this study, where quantifiable data was gathered across several project sites and analysed by performing statistical, mathematical, and /or computational techniques on the data (Bryman, 2012).

Population and Sampling

The unit of analysis was the building whose performance and processes during construction and use was under scrutiny. The inquiry was on the extent to which a structure had failed physically and functionally. As such, the study was conducted on buildings under construction across the country, and covered low-rise and high-rise buildings in all sub-categories like residential and commercials buildings, both private and public. For the survey design, the target population was all ongoing building projects in all the 47 counties of Kenya estimated at 12,000 projects, and from which a random sample was calculated using Yamane's formula, which provided a minimum sample size as below.

$$n = \frac{N}{1+N(e)2},\ n = \frac{12000}{1+12000(0.05)2},\ n = 387$$

Where,
n = is the sample size being sought
N = the population of the study
e = the margin error in the calculation (with confidence level set at 0.05)

The minimum sample size that could be used in this study was found to be 387 building projects. According to Mugenda and Mugenda (2003), a sufficient sample size for a population of more than 10,000 at 95% confidence level is about 384 projects. Therefore, a sample size of 387 was deemed viable and representative of the entire population. However, in order to allow for the likelihood of attrition in the respondents, a sample size of 400 projects was targeted. Additionally, a proportionate cluster sampling method was used in order to include every county in the country.

Variables in the Study

The outcome variable (Y) was described as building performance which was based on physical and functional assessment. The study contained five (5) explanatory variables (X) which included the technical factors, financial factors, institutional factors, legal factors and ethical factors. The conceptual definitions of the variables together with their operationalization and measurement are **captured in Table 1.**

Table 1: Variables in the Study

	Variable	Conceptual Definition	Operational Definition
Dependent Variable (Y)			
	Building performance	The physical and functional aspects of the building	Measured in terms of 29 surrogates, each on a scale of 0 - 5; aggregated to an overall scale of 0-174
Explanatory Variables (X)			
	Technical factors	The adversity of technical factors	Measured in terms of 6 surrogates, each on a scale of 0 - 3; aggregated to an overall scale of 0 - 24
	Financial factors	The adversity of financial factors	Measured in terms of 5 surrogates, each on a scale of 0 - 3; aggregated to an overall scale of 0 - 20
	Institutional factors	Slothfulness of institutional processes of development control - approvals, certifications, etc.	Measured in terms of 5 surrogates, each on a scale of 0 - 3; aggregated to an overall scale of 0 - 20

	Legal factors	Deficiency in the construction/ development laws and regulations in the country	Measured in terms of 5 surrogates, each on a scale of 0 - 3; aggregated to an overall scale of 0 - 20
	Ethical factors	Degree of unethical behaviour of the project participants in the regulatory, design, and construction system(s);	Measured in terms of 5 surrogates, each on a scale of 0 - 3; aggregated to an overall scale of 0 - 20

Source: Authors

Research Hypothesis

It was hypothesized that building performance is influenced by technical, financial, institutional, legal and ethical factors. The research hypothesis was formulated as follows.

$$Null\ hypothesis\ (H_0): \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0;$$

$$Alternative\ hypothesis\ (H_1): Atleast\ one\ \beta_i \neq 0\ ;$$

β_i represents the estimate values for technical, financial, institutional, legal and ethical factors.

Data Collection and Analysis

Data collection was conducted from project lead consultants using a questionnaire. It included an observation checklist, which was filled in by research assistants (data collectors) to assess the functional non-performance i.e. failure level of the building. Questions on other parts were answered by the project's lead consultants. Data analysis was conducted using both descriptive and inferential statistics. Descriptive statistics entailed computing the mean, standard deviation and generating the ranks among the surrogates associated with building performance. Confirmatory factors analysis (CFA) was also conducted to generate the factor loadings of the indicators associated with each of the independent variables. Under inferential statistics, the study employed multiple regression analysis to examine the impact of technical, financial, institutional, legal and ethical factors on building performance. The data analysis programs used were Microsoft Excel and the Statistical Package for Social Sciences (IBM SPSS Statistics, V. 25).

Reliability and Validity

Reliability and validity ensure stability, repeatability and integrity of a study's results (Bryman, 2012). With regard to reliability, a test was conducted to assess the internal consistency of the scale employed in the data collection tool, and it generated a Cronbach's alpha (α) of 0.803 which indicated good internal consistency as it is above the recommended minimum of 0.7. To determine validity, the study employed construct validity to assess the degree to which the operational definitions and measurements used in the study accurately represented the theoretical constructs or concepts being studied. This was important because it ensured that the variables and measures used aligned with the study's objectives.

Results and Findings

Respondents' Profile

The demographics revealed that 88% of the respondents were male while 12% were female. The difference in percentages is a clear illustration that the construction industry in Kenya is dominated by male workers. The findings also showed that most of the lead consultants involved in the construction projects were engineers (80%), followed by architects (14%) with only few projects (6%) engaging quantity surveyors as lead consultants. Based on the respondent's years of experience, most of them (55%) had between 1 to 3 years of experience while another significant proportion (43%) had more than three years of experience in construction. Only 2% of the respondents had below one year of experience in construction as illustrated in **Figure 2.**

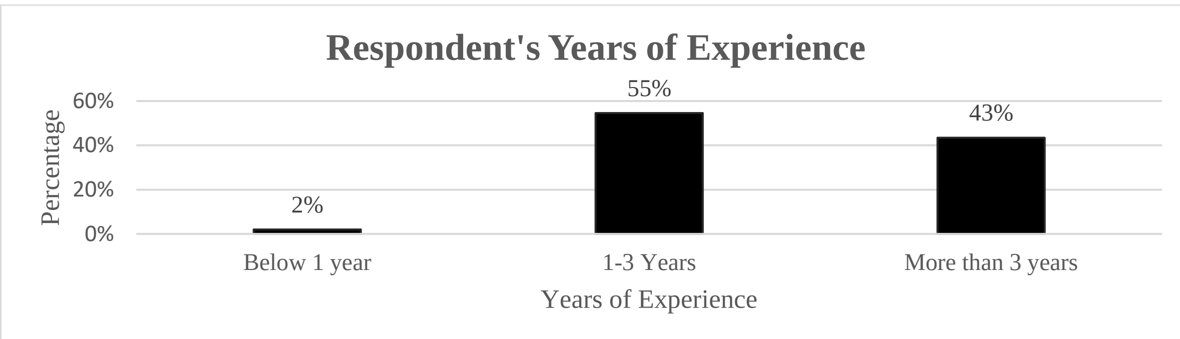

Figure 2: Graph Showing the Distribution of Respondents Based on Years of Experience.

Source: Authors

Buildings Profiles

Building sites at different stages of construction were visited where 2% of the projects were at site preparation stage and eight percent (8%) of the projects were at footing stage. Thirty-two percent (32%) of the projects were at slabbing stage while 30% were at framing stage. Further, 9% were at roofing stage and 19% were at finishes and fit-out-stage as shown in Figure 3.

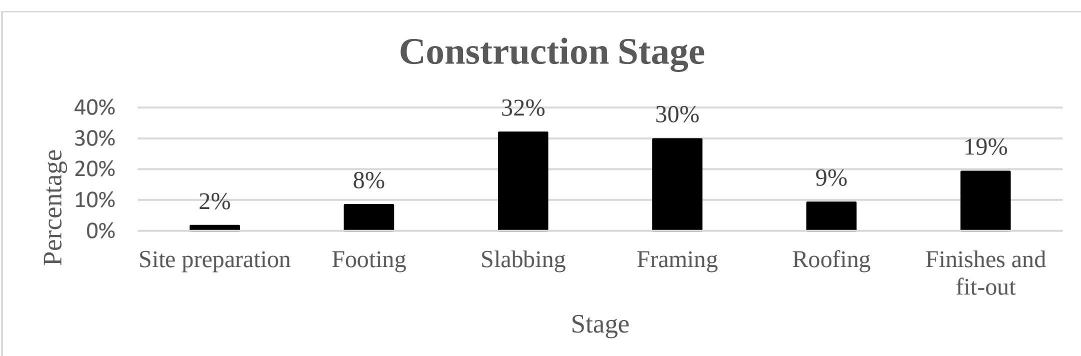

Figure 3: Graph Showing the Distribution of Construction Projects Based on Stages of Construction

Source: Authors

Building Performance

The study entailed a performance evaluation of buildings based on the physical and functional attributes. The evaluation of the physical performance was grounded on 13 elements while the measurement of functional performance was built on 16 elements.

Physical Performance

Based on the physical performance, structural alignment with elements such as slabs (M=4.69, SD= 1.07), columns (M=4.51, SD=1.32), and beams (M=4.48, SD=1.35), exhibited good performance demonstrating solid construction practices within the sites. On the other hand, the stability of the building appeared to cause an alarming concern with elements such as wall stability (M=1.62, SD=1.45) and slab stability (M=1.36, SD=1.15) recording poor scores hence gesturing potential structural concerns. Moreover, visible cracks and poor waterproofing were prevalent in most of the buildings with elements such as walls waterproofing (M=1.27, SD=1.00) and slabs waterproofing (M=1.18, SD=0.83) recording very poor scores, Table 2.

Table 2: Performance of The Building Based on Physical Aspects

No	Physical Performance	Range	Min	Max	Mean	SD	Rank
1	Slab alignment	4	1	5	4.69	1.074	1
2	Column alignment	4	1	5	4.51	1.318	2
3	Beam alignment	4	1	5	4.48	1.352	3
4	Wall alignment	4	1	5	4.24	1.575	4
5	Walls stability	4	1	5	1.62	1.446	5
6	Slab stability	4	1	5	1.36	1.149	6
7	Wall condition	4	1	5	1.3	1.047	7
8	Walls waterproofing	4	1	5	1.27	1.001	8
9	Slabs condition	4	1	5	1.2	0.863	9
10	Slab waterproofing	4	1	5	1.18	0.833	10
11	Beams condition	4	1	5	1.17	0.807	11
12	Columns conditions	4	1	5	1.16	0.795	12
13	Roof waterproofing	4	1	5	1.11	0.663	13

Source: Authors

Functional Performance

On the functional aspects of the building, elements such as the size of the building (M=4.36, SD= 0.65), street accessibility (M= 4.26, SD= 0.74), plasterwork (M=4.23, SD= 0.74), size of the circulation space (M=4.22, SD= 0.745), paintwork (M=4.21, SD=0.77) and clean water supply recorded satisfactory performance. Aspects such as natural lighting and overall aesthetics reflected good performance. However, poor performance was notable in the aspects such as disability mainstreaming (M=3.58, SD= 1.14) and compliance to green building standards (M=3.58, SD=1.06), Table 3.

Table 3: Performance of The Building Based pn Functional Aspects

Functional Performance		Range	Min	Max	Mean	SD	Rank
1	Size of the building	3	2	5	4.36	0.65	1
2	Street accessibility	4	1	5	4.26	0.735	2
3	Plasterwork	4	1	5	4.23	0.74	3
4	Size of the circulation space	4	1	5	4.22	0.745	4
5	Clean water supply	4	1	5	4.21	0.735	5
6	Paintwork	4	1	5	4.21	0.77	6
7	Natural lighting	4	1	5	4.2	0.769	7
8	General condition of the building	4	1	5	4.2	0.757	8
9	Quality water circulation	4	1	5	4.16	0.753	9
10	Accessibility to staircase	4	1	5	4.14	0.698	10
11	Circulation space	4	1	5	4.14	0.79	11
12	Foul water disposal	4	1	5	4.11	0.785	12
13	Harmony of the building	4	1	5	4.07	0.861	13
14	Modernity of the building	4	1	5	3.87	0.948	14
15	Disability mainstreaming	4	1	5	3.58	1.137	15
16	Compliance to green building standards	4	1	5	3.58	1.061	16

Source: Authors

Factor Analysis

The study applied confirmatory factor analysis (CFA) to generate factors which were then used to model building performance. The analysis resulted in five factors which aligned with the variables observed in literature. The five factors were generated based on the component loadings affiliated to the underlying factor. The factor loading values in **the Table 4 represent** the correlation between the observed variable and the latent factor. The placement of the variables was based on how strongly the observed variable correlated with the latent factor.

Table 4: Factors Affecting Building Functionality Generated from Factor Analysis.

Factor	Name	Components	Factor Loading
Factor 1	Institutional Issues	Tolerance to cartels	0.869
		Non-availability of performance standards for the building type	0.849
		High cost of disputes and conflicts on site	0.823
		Non-approval of building works at all stages	0.821
		Collusion between development control officers and project teams	0.798
		Use of unapproved building plans	0.882
		Consultant not accessible for quality checks	0.847
		Lack of individual accountability in the consultancy team	0.826

Factor 2	Ethical Issues	Client disregarding consultants' advice	0.670
		Approval of technically deficient drawings by the approving authorities	0.697
Factor 3	Financial Issues	High cost of tender process	0.847
		High price fluctuations	0.843
		Advance payment not provided	0.793
		Excessive contractual claims	0.787
		Excessive project variations	0.778
Factor 4	Legal Issues	Government policy on condemnation of faulty buildings	0.641
		Zero tolerance to cartels	0.612
		Outdated building laws and regulations	0.584
		Respect of public utility land	0.591
		Regular inspections by relevant government bodies	0.466
Factor 5	Technical Issues	Poor workmanship	0.864
		Poor material handling and storage	0.856
		Erroneous building design	0.852
		Use of unapproved building plans	0.836
		Inadequate tools for specific jobs	0.821
		Shortage of skilled workers	0.811

Source: Authors

The first component generated from the analysis represented **institutional** issues such as adherence to standards, regulatory institutions, tolerance to cartels, non-approval of buildings at all stages and collusion between developmental control officers. The second component comprised **ethical** issues such as lack of individual accountability, honouring agreements, non-conformity to planning standards, use of unproved building plans and substandard materials among others. The third component comprised of **financial** factors such as high price fluctuations, advance payment, excessive contractual claims, excessive project variations, unplanned expenditure in the course of construction, high cost of financing, and delays in receiving interim payments among others. The fourth component comprised of **legal issues** such as the government policy on condemnation of faulty buildings, government policy on quality assurance and outdated building laws and regulations. The final component entailed **technical factors** that contained issues such as erroneous building design, inadequate tools for specific jobs, use of unapproved building plans, and poor material handling and storage. The generated factors were extracted and subjected to regression analysis to assess their impact on building performance.

Multiple Regression Analysis

Factor analysis aided the generation of the independent variables which were regressed against building performance. The model summary under regression analysis generated a coefficient of determination of 0.171. The value suggests that 17.1% of variability in building performance is attributed to institutional, ethical, financial, legal and technical factors. The unexplained variance of 82.9% is due to other factors not in the model. The context of building failure and collapse is an inherently complex phenomenon influenced by a variety of factors that might not be all captured by the selected variables. Therefore, the lower R squared of 0.171 signifies a realistic representation of the complex nature of building failure and collapse in Kenya. Additionally, Ozili (2003) affirms that an R-squared between 0.10 and 0.50 is acceptable in the context of social research, thus the R-squared of 0.171 was considered adequate for this study, **Table 5.**

Table 5: Model Summary of Regression Analysis

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.413a	.171	.127	.45230
a. Predictors: (Constant), Technical Factors, Legal Factors, Financial Factors, Ethical Factors, Institutional Factors				

Source: Authors

The ANOVA generated from regression analysis revealed that the model was significant, F (5, 101) =3.949, p=0.003. Thus, institutional, ethical, financial, legal and technical factors were identified as significant predictors of building performance as **illustrated in Table 6.**

Table 6: Significance of The Regression Model

ANOVAa						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.039	5	.808	3.949	.003b
	Residual	19.639	96	.205		
	Total	23.678	101			
a. Dependent Variable: Building Performance						
b. Predictors: (Constant), Technical Factors, Legal Factors, Financial Factors, Ethical Factors, Institutional Factors						

Source: Authors

The coefficient table displaying the independent variables revealed that Institutional factors had p-value greater than 0.05 (p=.175). Therefore, the variable did not have a significant impact on building failure. However, the factor possessed a positive coefficient (β=.062) which imply a positive association between institutional factors and building performance. Therefore, strengthening regulatory institution is likely to improve the performance of the building hence reducing likelihood of building failures. The ethical factors produced a p-value less than 0.05, (p=.034) indicating that a significant relationship exist between ethical factors and building failure. Notably, a positive beta coefficient (β=.097) was produced suggesting a positive association between the building performance and ethical factors. Thus, practicing and prioritizing ethical considerations in construction would improve building functionality and hence reduce building failure. Although the financial factors did not a have statistically significant impact on building performance (p=.662), the beta coefficient generated was positive (β=.020), indicating that financial factor and building performance are connected. This implies that access to adequate finances could improve the functionality and performance of the building and ultimately decrease the risk of building failure. The findings further revealed that legal factors were highly statistically significant ($p < 0.04$) with a positive beta coefficient of 0.133. This infers that strong adherence to legal regulations, building codes, and compliance with legal standards may lead to improved building quality and lower failure rates, Table 7.

Additionally, the technical factors had a statistically significant impact on building performance ($p = 0.041$). The beta coefficient under the technical factors was 0.093 which suggests a potential positive relationship between building performance and technical factors.

Table 7: Significance of the Independent Variables

Coefficientsa						
Model		Unstandardized Coefficients		Standardized Coefficients	t	**Sig.**
		B	Std. Error	Beta		
1	(Constant)	3.308	.045		73.857	.000
	Institutional Factors	.062	.045	.127	1.367	.175
	Ethical Factors	.097	.045	.200	2.153	.034
	Financial Factors	.020	.045	.041	.438	.662
	Legal Factors	.133	.045	.275	2.957	.004
	Technical Factors	.093	.045	.193	2.075	.041
a. Dependent Variable: Building Performance						

Source: Authors

Discussions of Findings

The assessment of building performance was based on the physical and functional performance. Under the physical performance the stability of the building appeared to cause an alarming concern with elements such as wall stability and slab stability recording poor scores gesturing potential structural concerns. On the other hand, functional performance revealed poor performance on the aspects of disability mainstreaming and compliance to green building standards. This observation builds upon the ideas presented by Reuters (2022) who connect incidences of failure and collapse to pervasive corruption in planning processes and poor building standards. Additionally, Madu (2005) cites the issue of rebars and quality of building materials as essential in the performance of a building, noting that compromising standards here could result in a drop in building performance. Madu (2005) further indicates that some contractors deceive their clients in the alteration of design specifications to maximize profits to the detriment of the project.

Institutional Factors

The effect of institutional factors on building performance was also analysed. As confirmed through factors analysis, these elements include aspects of standards and codes, characteristics of regulatory institutions, approval protocols for buildings and character of developmental control and enforcement officers among other. Regression analysis revealed a positive effect (β=.062) of institutional factors on building performance. This implies that strengthening regulatory institutions through ways such as ensuring zero tolerance to cartels, transparency, approval of buildings at all stages of construction, updating codes and standards, and ensuring harmony among the developmental control and enforcement officers could improve the quality of construction. These are consistent with the findings Figueroa-Fernandez (2014), Oseghale *et al.*, (2015), and NCA (2020) which revealed institutional factors as crucial in assuring the performance of the buildings. From the aforementioned studies, proposals for institutional proactive action to ensure good construction principles have been placed at the forefront.

Ethical Factors

The ethical factors which constituted elements such as the use of unapproved buildings plans, unavailability of consultants for quality checks, lack of individual accountability and client disregard of consultants' advice had a statistically significant impact on building performance (p=.034). The variable was noted to positively impact building performance suggesting that maintaining adherence to construction ethics during all the stages of construction minimizes failure and collapse of the buildings. Therefore, embracing accountability, using approved building plans, and obeying technical advice can positively enhance a building's performance. These findings build upon observations of Oseghale *et al.,* (2015) which affirm that alleviating failure and collapse of buildings requires developers to vet and ensure hiring of qualified and competent persons.

Financial Factors

The study through factor analysis confirmed, high cost of tender processes, high price fluctuations, lack of provision of advance payments, and excessive contractual claims as indicators of the financial factor. Although, this did not a have a statistically significant impact on building performance (p=.662), the beta coefficient generated was positive (β=.020), indicating the presence of a weak positive association. Therefore, access to adequate finances could improve the performance of the building and ultimately decrease the risk of building failure. The findings align with those of Ahzahar et al., (2011) who associate building failure to financial reasons, and thus propose among other detailed design and specification, and control of high price fluctuation and project variation. Generally, shortcuts employed in an attempt to cut down the cost of the construction projects can result in poor building performance and should be avoided (NCA, 2020; Madu, 2005).

Legal Factors

The legal findings contained aspects such as government policy on condemnation of faulty buildings, outdated building laws and regulations, respect of public utility land and regular inspections by relevant government bodies. The regression analysis revealed that legal factors were highly statistically significant ($p < 0.04$) with a positive coefficient of 0.133. This infers that strong adherence to legal regulations, building codes, and compliance with legal standards may lead to improved building quality and lower failure rates. These findings are well aligned with the arguments of Asante and Sasu (2018), Ahzahar *et al.* (2011), and Figueroa-Fernandez (2014) which confirm that the legal and technical incapacities among most regulators contribute to faulty buildings.

Technical Factors

From the factor analysis, the technical factors comprised of components such as poor workmanship, poor material choices, handling and storage, erroneous building designs, use of unapproved building plans, and use of inappropriate tools for specific jobs. The technical factors had a statistically significant impact on building performance (p = 0.041). The beta coefficient under the technical factors was 0.093 which suggests a potential positive relationship between building performance and technical factors. These outcomes build upon the findings by Hall (1984) where he notes that structural failures mostly occur as a result of the application of substandard materials as well as poor workmanship. Additionally, the findings are consistent with observations of Ahzahar *et al.* (2011) which relates causes of building failures to the covert use of dirty water for concrete mixes thus reducing the strength of the concrete, utilization of sand with acidic content and/or salts that negatively affect the strength of concrete for the mix among other factors.

Conclusions

The study aimed to establish the factors affecting the physical and functional performance of buildings in Kenya. It was established that the stability of most buildings cause alarm with elements such as wall and slab stability recording poor scores hence gesturing potential structural concerns. Moreover, visible cracks and poor waterproofing practices were rampant in most of the buildings with elements such as walls and slabs recording very poor scores. These observations were also supported by the results of regression analysis which revealed that technical factors such as poor material handling and storage, erroneous building design and use of unapproved building plans and inadequate tools for specific jobs as significant predictors of building performance. The functional performance of the building further revealed that natural lighting and overall aesthetics reflected good performance. However, poor performance was notable in the aspects such as disability mainstreaming and compliance to green building standards. Overall, the multiple regression analysis results revealed that institutional, ethical, financial, legal, and technical factors explained 17.1% of the variability in building performance. Notably, only ethical, legal and technical factors were the statistically significant predictors of building performance. The study thus recommends ethical, legal and technical solutions for achieving optimal construction practices. Clients should therefore embrace accountability, use only the approved building plans, engage and heed advice of qualified experts in order to improve the physical and functional performance of buildings. The contractors should also ensure they employ skilled construction worker and engage qualified professionals for advice at all stages of construction. There is also a need for a review of the building codes and the refinement of government policy on the condemnation of faulty buildings. Finally, there should be binding agreements, streamlined tender processes, and regular risk assessment strategies to protect clients from unqualified persons and extremities such as high price fluctuation of construction materials. As an area of interest, this study recommends further studies into the quantification of economic losses associated with the collapse and failure of buildings.

Authors Declaration of Conflict of Interest

The Authors wish to declare no potential conflicts of interest concerning this article.

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References

Ahzahar, N., Karim, N., Hassan, S., & Eman, J. (2011). A Study of Contribution Factors to Building Failures and Defects in Construction Industry. *Elsevier Ltd*, 249-255. doi: 10.1016/j.proeng.2011.11.162

Asante, L. A., & Sasu, A. (2018). The Challenge of Reducing the Incidence of Building Collapse in Ghana: Analyzing the Perspectives of Building Inspectors in Kumasi. *SAGE Open*, 1-12. doi:10.1177/2158244018778109

BLRRHC. (2009). *Building Law & Regulation Review and Harmonization Committee (2009).* Nairobi.

Bryman, A. (2012). *Social Research Methods.* Oxford: Oxford University Press.

Commissions of Inquiry. (1996, December 19). *Report of the Commission of Inquiry to Examine the Existing Building Laws, Bylaws and Regulations.* Retrieved October 10, 2023, from Kenya Law: http://kenyalaw.org/kl/fileadmin/CommissionReports/Report-of-the-Commission-of-Inquiry-to-Examine-the-Existing-Building-Laws-By-Laws-and-Regulations.pdf.

Designing Buildings Ltd. (2022, February 7). *Building Performance*. Retrieved October 9, 2023, from Designing Buildings: The Construction WIKI: https://www.designingbuildings.co.uk/wiki/Building_performance.

Dutch Safety Board. (2018). *Constructing Structural Safety - Lessons from the Eindhoven Airport Parking Building Collapse.* The Hague: Dutch Safety Board. Retrieved August 16, 2023, from https://www.onderzoeksraad.nl/en/page/4758/constructing-structural-safety---lessons-from-the-eindhoven-airport.

Ede, A. N. (2010). Building Collapse in Nigeria: The Trend of Casualties in the Last Decade (2000-2010). Vol. 10 No.6. *International Journal of Civil & Environmental Engineering, 10*(6), 32-42.

Figueroa-Fernandez, R. H. (2014). *Strategies to Reduce the Risk of Building Collapse in Developing Countries.* Carnegie Mellon University, Engineering and Public Policy. Pittsburgh, PA: Carnegie Mellon University. Retrieved from http://repository.cmu.edu/dissertations.

Hall, G. (1984). *Revision Notes on Building Maintenance and Adaptation.* England: Butterwrths and Co.

Heijden, J. v. (2009). *Building regulatory enforcement regimes: Comparative analysis of private sector involvement in the enforcement of public building regulations.* Amsterdam: IOS Press BV.

Hussein, J. (2011). *Assessment of Building Performance Measurement in Tanzania.* KTH Royal Institute of Technology, Real Estate and Construction Management. Stockholm: KTH Royal Institute of Technology. Retrieved July 1, 2023, from https://www.diva-portal.org/smash/get/diva2:440561/FULLTEXT01.pdf

Madu, L. (2005, November 3). Architecture: Research & Practice. *Journal of Nigeria Institute of Architects (N.I.A), 1*(3), 1597-2947.

Ministry of Housing. (2015). *National Building Regulations 2015.* Nairobi.

Mohammed, A. (2017). Structural Failure of Buildings: Issues and Challenges. *Scientific World Journal,* 97-108.

Mshiri, M. (2016, May 15). Jailing Junior Officers Will Not Address the Rot in Kenya's Construction Industry. 18. Nairobi, Kenya: The Standard.

Mugenda, O. M., & Mugenda, A. G. (2003). *Research Methods: Quantitative and Qualitative Approaches (Revised Ed).* Nairobi: African Centre for Technology Studies (ACTS).

NBI. (2015). *Building Audit Report.* Nairobi.

NCA. (2020). *Research on Failure and Collapse of Buildings in Kenya.* National Construction Authority (NCA). Nairobi: NCA. Retrieved January 20, 2023, from https://www.icorce.go.ke/sites/default/files/publication/Research-on-Failure-and-Collapse-of-Buildings-Final-Report-31-10-2019.pdf.

NIDM. (2014). *India Disaster Report 2013.* National Institute of Disaster Management. Ministry of Home Affairs, Government of India. Retrieved March 24, 2023, from https://nidm.gov.in/pdf/pubs/india%20disaster%20report%202013.pdf.

Ogunsemi, D. R. (2002). Building Collapse: Causes, Prevention and Remedies. In D. R. Ogunsemi, *Cost Control and Quality Standard of Building Projects.* Nigerian Institute of Building.

Oseghale, G., Ikpo, I. J., & Ajayi, O. D. (2015). Causes and Effects of Building Collapse in Lagos State, Nigeria Civil and Environmental Research. 7(4), 34. *Civil and Environmental Engineering, 7*(4), 34-43. Retrieved from https://core.ac.uk/download/pdf/234677998.pdf.

Oyewande, B. (1992, June/July). A search for quality in construction industry. *Builders Magazine*, 163-168. Lagos, Nigeria.

Ozili, P. K. (2003). The Acceptable R-Square in Empirical Modelling for Social Science Research. In C. A. Saliya, *Social Research Methodology and Publishing Results: A Guide to Non-Native English Speakers* (pp. 134-143). IGI Global.

Reuters. (2018, January 16). *Indonesia Exchange Walkway Collapse Due to 'building failure': Initial Report*. Retrieved from Reuters: https://www.reuters.com/article/us-indonesia-stock-exchange-report-idUSKBN1F51NL.

Reuters. (2022, November 23). *Kenyan Building Collapses Spark Alarm as Cities Swell.* Retrieved from Reuters: https://www.reuters.com/world/africa/kenyan-building-collapses-spark-alarm-cities-swell-2022-11-23/.

The Standard. (2019, September 23). *Developing story: Seven pupils killed, several injured as classroom wall collapses in Dagoretti*. Retrieved from The Standard Group: https://www.standardmedia.co.ke/article/2001342979/precious-talent-school-tragedy-six-killed-as-classroom-wall-collapses.

The Standard. (2023, June 19). *Three Storey Building Collapses in Murang'a Town*. Retrieved from The Standard Group: https://www.standardmedia.co.ke/central/article/2001475531/three-storey-building-collapses-in-muranga-town.

UN Habitat. (2009). *Planning Sustainable Cities: Policy Directions. Global Report on Human Settlements 2009 (Abridged Edition).* London: Earthscan. Retrieved October 14, 2023, from https://unhabitat.org/sites/default/files/download-manager-files/Global%20Report%20on%20Human%20Settlements%202009%2C%20Planning%20Sustainable%20Cities%20Policy%20Direction%20-%20Abridged%20Edition.pdf.