THE INTERSECTION OF BUILDING MAINTENANCE AND QUALITY OF URBAN BUILT ENVIRONMENT

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Abstract

Urbanization manifests by way of concentration of human populations into distinct areas and mainly due to rural urban migration. This concentration leads to the change of land use from previous land uses such as agriculture to new land uses for residential, commercial, industrial, recreational and transportation purposes. This creates the need for high-quality built environments which have long been promoted in urban planning and design on the grounds that they are, among other things, socially beneficial places where positive social activity and behaviour abound. In the process of planning, feasibility, design, construction, commissioning and maintenance of buildings, there is need to pay attention to the impact of the development on the environment. To a great extent compliance and adherence to the building regulations (codes) and developing as per the approved building plans is critical in achieving quality built-environment. Furthermore, it is prudent to involve building surveyors from conception of the project so that they can advise on how to achieve satisfactory levels of the following aspects: ventilation (air quality); solid waste management options; natural lighting; energy efficiency; health effects; functionality; and water recycling options. When these aspects are carefully considered and addressed appropriately the end result will be quality & conducive urban human settlements. Building maintenance management is the coordination of maintenance activities designed to maintain, repair, and improve buildings and their related systems and provide a safe, habitable, comfortable, and functional environment in a cost-effective manner. It is important to adhere to building maintenance plans in order to achieve: energy and resource efficiency, waste reduction, health and wellbeing. The aim of this study is to determine the relationship between building maintenance and the quality of the urban built environment. The first specific objective is to establish the factors that affect the quality of the urban built environment. The second specific objective is to determine the effect of building maintenance on the quality of the urban built environment. The last specific objective is to recommend a model to encourage and facilitate adherence to building maintenance plans. The significance of this study would be to inform key stakeholders involved in the management of the urban built environment on the importance and benefits of formulating, implementing and adhering to maintenance plans in order to achieve quality urban built environment.

Key Words: *Building Maintenance; Built Environment; Quality; Sustainability*.

1.0 INTRODUCTION

The building envelope is determinant for the comfort level of a building (Madureira et al, 2017). Madureira et al. (2017) are of the view that in this context, facades define the building's appearance, simultaneously working as a barrier to external aggressions and a communication element between inside and outside (through light, visibility and ventilation). Facades are composed of walls, openings and different types of claddings (continuous or discontinuous, directly or indirectly fastened) (Madureira et al., 2017). It is important to ensure that the buildings including the façade is well maintained at all times in order to guarantee a conducive indoor and outdoor environment that was envisaged in the designs and during subsequent improvements to the building. Barrelas et al. (2021) indicate that during their service life, the action of climate agents, along with other causes of different origins, continuously contributes to the degradation process and natural ageing of the buildings' envelope materials and components.

The built environment is often defined as the human environment, such as communities, workplaces, and road environments (Ye et al., 2023). Furthermore, studies have shown that the built environment has a strong correlation with the health of the population but the mechanisms by which it affects health are complex. This is due to the combined effects of specific social and economic conditions and individual usage patterns, along with environmental influences, including physical activity and environmental pollution. According to Dempsey (2008) high-quality built environments have long been promoted in urban planning and design on the grounds that they are, among other things, socially beneficial places where positive social activity and behaviour abound.

Urban Land Institute (ULI) (2013) believe that healthy places are designed, built, and programmed to support the physical, mental, and social well-being of the people who live, work, learn, and visit there. According to ULI (2013) a healthy community begins with housing, which is the platform for physical, cognitive, and social health. But we also need to recognize that a community is more than a building—it includes its context. The internal environment of our buildings must also be healthy, with clean fresh air, daylight, healthy building materials, and reduced energy consumption (ULI, 2013). ULI (2013) further points out that healthier communities have lower turnover and higher occupancy.
Healthy buildings provide a foundation for healthy lives through design and construction that support well-being with safe, well-lit, attractive, comfortable, and pollution-free spaces (ULI, 2013). According to ULI (2023), there is a great opportunity for the architecture and building communities to ensure that new and renovated buildings are designed to conserve energy, improve health, and encourage healthy behaviours.

Indoor air pollution can cause health problems ranging from coughs, eye irritation, headaches, and allergic reactions to potentially life-threatening conditions, such as carbon monoxide poisoning. Health threats from "sick buildings" contaminated by mold or bacteria can make occupants ill, reduce employee productivity through absenteeism, and reduce real estate values (ULI, 2023). Building greener, with design and materials that reduce indoor air pollution, use less energy, and use recycled or renewable materials, is inherently healthier for people.

The United Nations (2019), point out that today, more than half of the global population lives in urban areas, up from around one-third in 1950 and projected to increase to around two-thirds in 2050 and in this regard ssustainable development would depend critically on the successful management of urban growth to create sustainable cities in both developed and developing countries. This is shown in the table below.

Table 1: Average annual increment of the Urban Population and distribution of that increment by Geographic Region, Selected Periods, 1950-2050

	Annual increment of the urban population (millions)					*Percentage of annual increment*				
Geographic region	*1950-1970*	*1970-1990*	*1990-2018*	*2018-2030*	*2030-2050*	*1950-1970*	*1970-1990*	*1990-2018*	*2018-2030*	*2030-2050*
World	30.2	46.8	71.0	79.0	75.6	100.0	100.0	100.0	100.0	100.0
Africa	2.5	5.9	12.7	23.0	33.2	8.3	12.6	17.9	29.2	44.0
Asia	13.0	26.6	45.1	44.7	33.8	43.2	56.9	63.5	56.6	44.7
Europe	6.5	4.5	1.8	1.7	1.3	21.7	9.6	2.6	2.1	1.7
Latin America and the Caribbean	4.8	7.5	7.8	6.2	4.2	15.8	16.1	11.0	7.9	5.6
Northern America	3.0	2.0	3.2	3.0	2.6	10.0	4.4	4.5	3.8	3.4
Oceania	0.3	0.3	0.3	0.4	0.4	1.0	0.6	0.5	0.5	0.6

Source: (UN, 2019)

1.1 Problem Statement

The trend of urbanization has been sustained owing to the pull factors in the urban areas of developing nations. The main reason for this trend is the availability of diverse and superior employment/entrepreneurial/business opportunities in urban areas. This has spurred the need and demand for housing development to cater for the residential and business/office premises activities.

Housing development to cater for the various land uses in urban areas is provided for by the planning authorities. Actual construction has to adhere to the current building regulations/codes. These building regulations/codes in many countries have been reviewed to performance building regulations/codes as opposed to the earlier ones that were prescriptive. The new building regulations/codes have taken into consideration and encourage housing developments that are environmentally friendly in such a way that they are energy efficient and aid in reduction of greenhouse gases (GHG).

The aspects of energy efficiency and reduction of GHG have to be duly taken care during new developments and when there is an opportunity for carrying out building maintenance. This can be achieved during planned, corrective or emergency maintenance programs. Ultimately, once the issues of energy efficiency and reduction of reduction of GHG are satisfactorily addressed the resultant housing development whether old or new will be sustainable and able to accord the dwellers the following: functional dwellings/premises; temperature comfort; acoustic comfort; indoor light comfort; indoor/outdoor air quality/humidity comfort; and aesthetically appealing built environment.

1.2 Main Objective

The main objective of the study is to determine the relationship between building maintenance and the quality of the urban built environment.

1.2.1 Specific Objective

The following are specific objectives:

1. To establish the factors that affect the quality of the urban built environment with special focus on the indoor and outdoor areas of buildings.
2. To determine the effect of building maintenance on the quality of the urban built environment.
3. To recommend a model to encourage and facilitate adherence to building maintenance plans.

1.3 Significance of the Study

There is need to adequately and comprehensively establish how the quality of the indoor and outdoor environment of buildings can be attributed to the designs and subsequent maintenance works. This study will clearly depict and ascertain core aspects that have to be considered during designs and maintenance and how they impact on the quality of the environment.

This study is very important as it brings to the fore the need to adequately plan and provide resources for building maintenance in planned, corrective or emergency maintenance works. During the planning and execution of the works there is to be conscious and deliberate in addressing issues of energy efficiency and reduction of greenhouse gases (GHG). The people involved in building maintenance it is prudent for them to be adequately involved in the planning and design stage of housing developments so that they can advise on the best ways of achieving development that are sustainable and bearing into mind the life cycle costs of the developments.

1.4 Scope of the Study

The scope of the study is divided into three focal aspects, each focusing on a particular aspect of the study that facilitated the execution of the necessary tasks to achieve the study objectives.
Geographical Scope: Regarding the geographical coverage of the study, it was imperative that the target population was comprehensive to guarantee a representative sample for analysis. This was ensured by collecting data from members of the institution of Surveyors of Kenya who are involved in Building Maintenance or Property Management.
Conceptual Scope: The study was confined to assessment of activities of building maintenance and their effect on the built environment.
Methodological Scope: The study adopted a mixed research design, with descriptive research approach to analyze primary data.

2.0 LITERATURE REVIEW

2.1 Building Maintenance

Woods (2009) concurs that building maintenance is the work carried out in order to keep, restore or improve every facility i.e every part of the building, its services and surrounds to a currently acceptable standard and to sustain the utility and value of the facility. Horner et al. (1997) advocates for a novel, systematic approach to the management of building maintenance as this method will lead to reduction in the cost of maintenance while preserving the safety, health and satisfaction of the users.

Talib et al. (2014) established 5 major factors affecting building maintenance of public buildings as: lack of preventive maintenance, insufficient funds to maintain the building, lack of building maintenance standard, non-availability to replacement parts and components and non-response to maintenance request. Furthermore, other 5 significant factors of building defect also were: lack of building maintenance, overlooked site conditions, defective material, environment conditions and moisture from wet areas.

Talib et al (2014) identified and analyzed the following 10 factors affecting defects of public buildings: lacking in maintaining the buildings; moisture problem from wet areas leading to leakage; environmental conditions; aging of building; poor quality control: preventive method; lack of training and skills of maintenance crew; lack of motivation in taking care of buildings; poor communication in maintenance process; defective materials used for maintenance works; and overlooked site conditions. The variables are structural components condition, roof components, toilet facilities, discharge of waste water component, exterior wall condition, condition of walkway within the building premises, electrical wire and switches conditions, interior walls surface condition.

According to Waziri and Vanduhe (2013) the most significant factors affecting building maintenance are: lack of preventive maintenance (maintenance culture); faulty workmanship during construction/maintenance; Design deficiency affecting building resolution; and use of substandard of materials and building components. The significant factors are: insufficient fund to maintain the building; ignorance about the basic properties of building materials and components; and unavailability of skilled maintenance personnel. The less significant factors are: lack of building maintenance standard and policy; client attitude to maintenance; poor management of maintenance group; use of new material and components in buildings; low concern to future maintenance; delay in occupancy after completion; incorrect selection of building material component and system; wrong behavior of occupants; lack of communication between maintenance contractors, clients and users; technological change and fashion; non availability of replacement parts and components; and lack of understanding the importance of maintenance work.

Ogunbayo et al, (2022) points out the need for Maintenance Budget that encapsulates the prioritization of maintenance financing, valuation of maintenance operation budget, maintenance operation financing and other activities undertaken by the maintenance department of the public organizations that deals with financial planning for maintenance operations and execution. This is key consideration in that there is need for adequate planning and provision of resources for building maintenance. A building is an asset whose value changes in accordance with the quality (and quantity) of maintenance invested in them (Lateef et al, 2010).

The building and housing sector accounts for 40 % of Europe's energy consumption and 36% of its GHG emissions (EU, 2023). In the EU there is a directive for the public sector to procure energy efficient buildings without compromising the indoor climate quality and to do so with the efficient use of public money. Vinokurov et al. (2019) are of the opinion that selecting a design solution has to be based on solution's ability to provide indoor climate quality and GHG emission reductions from the perspective of the life cycle economy.

2.2 Purpose of Building Maintenance

According to Woods, 2009 buildings exist (and are created) largely for the benefit of their occupants and for what goes on in the building. In this connection the building elements (floors, walls, roofs, walls, ceiling, doors, windows etc.) exist largely to divide the building's uses one from another and to keep at bay the external elements of wind, rain, snow, unacceptable high or low temperatures. Barrie and Swallow (2007) are of the view that the growth in the significance of building maintenance as a proportion of the output of the construction industry has taken place against a backdrop of mounting pressure on new-build activity, and growing awareness of the need to manage the condition of the nation's building stock more effectively.

According to Madureira et al. (2017), humidity is the main cause of anomalies in facades, but loads, stress, deformation, radiation, extreme temperatures, dirt, pollution, salts, bacteria, plants, mould, insects, birds, to name a few factors, combined with poor constructive details, may also significantly affect the facade's performance. Building maintenance is carried out in order to allow those functions to continue to be carried out preferably in the way and to the standard of that originally envisaged, designed and built and at least satisfactorily (Woods, 2009). The most sensible approach to take at the onset is to see maintenance work as that which enables the building to continue to efficiently perform the functions for which it was designed (Barrie & Swallow, 2007). This may include some upgrading to raise the original standards, where appropriate to contemporary norms and the rectification of design faults. The problem of maintaining residential buildings in adequate technical condition also imposes providing for optimal planning of maintenance works, while the proper determination of the scope and program of refurbishment requires a diagnosis of the technical condition to be carried out (Nowogonska, 2019). Madureira et al. (2017), points out that if maintenance plans were implemented at the design stage with predefined performance levels, they would allow optimizing global costs and fulfilling user's satisfaction through the knowledge of the buildings' in-service behaviour, and its degradation mechanisms and agents, as well as the type and main causes of anomalies.

According to Nowogonska (2019), periods of durability of individual building components from selected building materials varies as follows for the different components as shown in the table below : Brick foundations;; Masonry partition walls; Wooden beam ceilings; Wooden stairs; Roof rafter; Tail caver; Gutters and drain pipes; Internal plasters; External plasters; Windows; Doors; Glazing; Wooden floor; Wall coatings; Woodwork oil; coatings; Cores of ceramic cookers; Tiled stove; Central heating pipes; Boilers and heaters; Water supply and sewage pipes; Water supply and sanitation fittings; Gas pipes; and Electrical installations.

2.3 Buildings Maintenance and the Environment

Sustainable building practices are rooted in the need for reliable information on the long-term performance of building materials; specifically, the expected service-life of building materials, components, and assemblies (Lacasse et al, 2020). They further point out that this need is ever more evident given the anticipated effects of climate change on the built environment and the many governmental initiatives world-wide focused on ensuring that structures are not only resilient at their inception but also, can maintain their resilience over the long-term.

Jorge and Silva (2020) are of the position that the sustainability of the built environment can only be achieved through the maintenance planning of built facilities during their life cycle, considering social, economic, functional, technical, and ecological aspects. They expound further by indicating that stakeholders should be conscious of the existing tools and knowledge for the optimization of maintenance and rehabilitation actions, considering the degradation mechanisms and the risk of failure over time.

According to Woods (2009,) buildings are substantial users of energy. For instance, across Europe they are the main users, consuming some 40% of the total energy production, twice that of transport or Industry. Woods (2009) further elaborates that every time a maintenance intervention is made there is scope for attending to matters of energy efficiency and gives the following examples: a single glazed window should be replaced with a double or a triple glazed unit; a door could have draught-proofing added; a roof-space could have insulation installed, or more added; and an old heating system could be replaced with a condensing boiler.

Buildings cause pollution given that their consumption of energy may result in direct pollution from the burning of fossil fuels or their use of electricity may be requiring the use of coal or gas to be burnt at a power station (Woods, 2009). Timber treatment, paints and vanishes and cleaning materials may contain dangerous and volatile chemicals.

Climate change is forcing society to address factors affecting building maintenance needs from a life cycle perspective that entails the use of proactive maintenance to extend the operational life of buildings and equipment (Grynning et al., 2020).

The heating energy and the cooling demands of the building are determined by the various heat losses, loads and gains. Ventilation is a major heat loss component causing 30–60% of the energy demand in buildings in industrialized countries. Up to 90% of the ventilation heat losses can be recovered with modern ventilation heat recovery systems, which reduce the heat demand.

The demand-based operation strategy and automation can further reduce the heat losses of ventilation, which would reduce the building’s heating demand. In addition, heating and cooling demand can be reduced with the building envelope materials that have improved thermal insulation and air tightness. Building envelope solutions, such as window sizing and orientation, as well as potential shadings and blinds, have to be optimized to reduce the purchase energy demand for heating and cooling.

According to Vinokurov et al. (2019), indoor climate quality has to be considered during the feasibility assessment of design solution alternatives when converting energy use into energy efficiency. The initiatives are geared towards achieving the following aspects: Indoor temperature comfort; indoor air quality/humidity comfort; acoustic comfort; and indoor lighting comfort. Vinokurov et al. (2019) points out that indoor temperature comfort is affected by: heating and cooling demands; the building envelope design; level of occupation; use of lighting and various electrical appliances; and use of ventilation system. Indoor air quality/humidity comfort is affected by the materials, occupants, air filtration, ventilations and the building envelope (Vinokurov et al., 2019). Acoustic comfort is influenced by the following: Selection, sizing & positioning HVAC equipment and silencers; and sound insulation. Indoor lighting comfort is affected by: lighting equipment & control; daylighting; and surface**.**

According to ULI (2023) other building programs, such as Passive House and zero-net-energy buildings, go further by reducing or eliminating energy costs through insulation, tight construction, and new heating and cooling technologies. Passive solar exposure and large operable windows promote healthy orientation to daylight, keep fresh air flowing, and can reduce energy costs. Green roofs produce multiple climate, health, and economic benefits: They provide insulation that lowers energy demand and utility costs, and they reduce noise and the urban heat-island effect. Green roofs cleanse and reduce stormwater runoff, create open space for community gatherings and recreation, and provide natural areas and community gardens.

The intersection of health, sustainability, and livability in urban environments are at the center of these issues. High-quality design can contribute to the creation of highly livable, compact, connected, and healthy buildings and neighborhoods—the creation of great places that make us feel better, and that enrich the soul.

Water quality and sanitation in the built environment—including clean water infrastructure, sanitary disposal of human waste, effective stormwater management, and water pollution mitigation—have a significant impact on health, sustainable growth, and development of communities. Establishing and maintaining clean drinking water and adequate sanitation systems require careful attention to water supply, rainwater drainage, solid-waste disposal, and human-waste disposal.

Temperature Comfort: The following factors will influence the temperature comfort: Availability of Heating appliances; Appropriate Building Envelope (Including doors, windows, walls and their influence on heating and cooling requirements; Adequate Ventilation Systems Safe Construction materials; and Cooling appliances.

Indoor air quality/humidity comfort: The following factors will influence the Indoor air quality/humidity comfort: Appropriate window sizes; Proper orientation of windows; Adequate Size of doors and accessways; Proper Orientation of doorways (External doors) and accessways to the building; and general orientation of the building.

Indoor lighting comfort: The following factors will influence the Indoor lighting comfort: Availability of Lighting equipment (Illuminance uniformity, luminous distribution and light colour characteristics); Availability of Daylighting; and Appropriate Surface reflectance.

Outdoor air/humidity comfort: The following factors will influence the Outdoor air/humidity comfort: Adequate Landscaping (Tree cover, greenery, etc); Adequate Storm water drainage systems; Adequate Sewerage system (From individual building to main sewer connection); and Appropriate Solid waste management system (Collection facility).

Acoustic Comfort: The following factors will influence the Acoustic Comfort: Proper selection, sizing and positioning of Heating, Ventilation & Cooling (HVAC) equipment and services and their effect on acoustic comfort; and adequate Sound insulation.

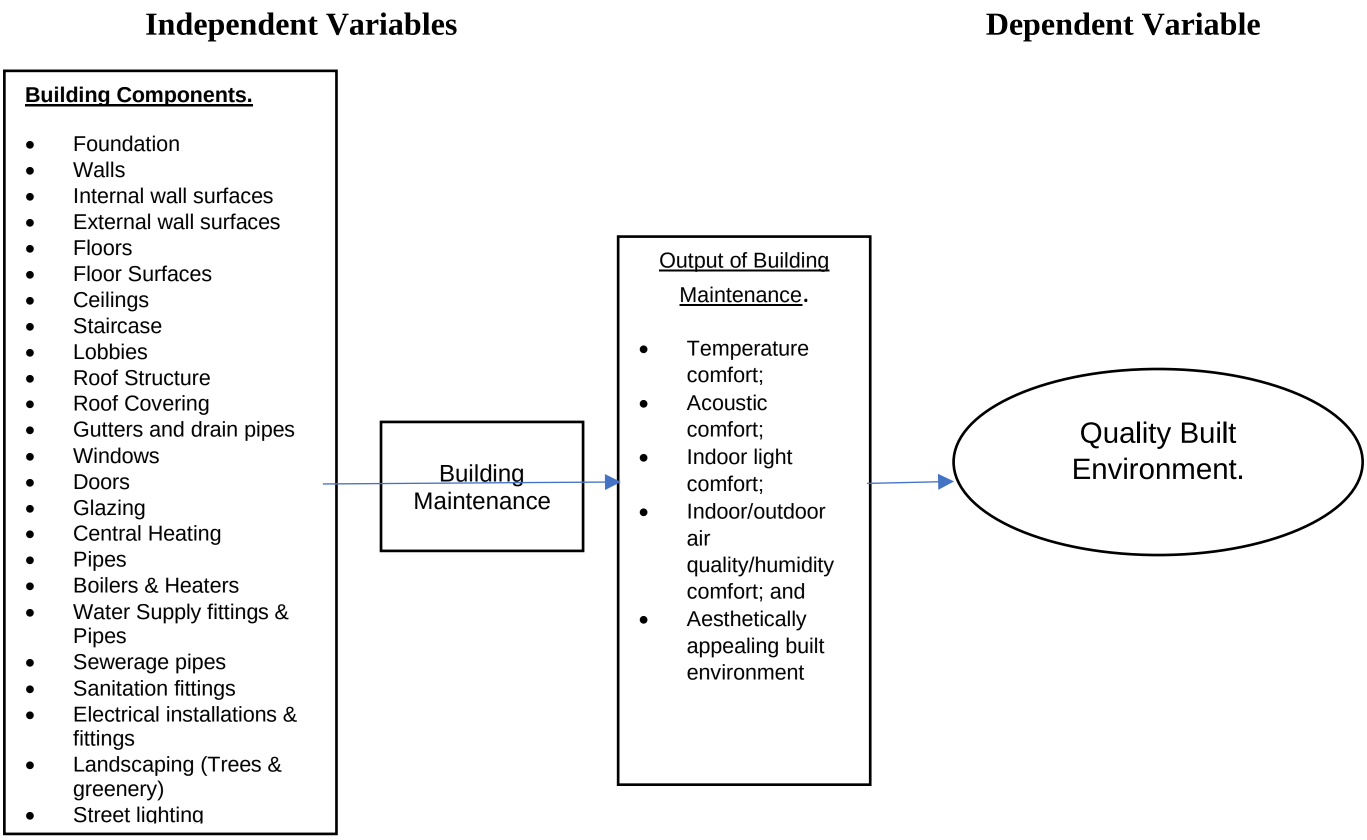

Figure 1: Conceptual Framework for the study

3.0 RESEARCH METHODOLOGY

The study adopted the Delphi survey technique. According to (Isu & Sandford, 2007) the Delphi technique is a widely used and accepted method for gathering data from respondents within their domain of expertise. The technique is designed as a group communication process which aims to achieve a convergence of opinion on a specific real-world issue. In this study the respondents comprised of members from the Institution of Surveyors of Kenya (Building Surveyors Chapter; Valuation Chapter; and Property Management Chapter) who are involved in the management and maintenance of buildings.

For the measurement of the quality aspects of the urban built environment, respondents were requested to provide a rating for the above variables in a column measured on a ten-point Likert scale, ranging from ‘1 = No Importance’ to ‘10 = Very High Importance’. The results from this column were used to determine the importance of each surrogate. On the other hand, the measurement of the building maintenance and the quality of the urban built environment sought to ascertain the respondent’s perception of the role of maintenance to the quality of the urban built environment. The scale of these columns ranged from ‘1 = No Contribution’ to ‘10 = Very High Contribution’.

Raw quantitative data collected from the questionnaires were coded and entered into SPSS (version 28) software for analysis. The coding process involved identifying and assigning values to the different variables used in the questionnaire for easier entry into SPSS. From there, descriptive statistics including measures of central tendency, dispersion, and distribution were analyzed and after which the data was presented in the form of tables and charts. Further, the Relative Importance Index (RII) analysis of the relevant variables was calculated to provide the appropriate rankings for the surrogates.

4.0 RESULTS AND FINDINGS

4.1 Demographics

Gender: The results show that the gender was approximately even, with females taking the edge (51.43%) compared to males (48.75%).
Age bracket: The results also indicated that the age brackets of above 50 years (25.71%) and 47 – 50 years (25.71%) had the majority of the respondents. Others were as follows; 27 – 30 years (8.57%); 31 – 34 years (5.71%); 35 – 38 years (8.57%); 39 – 42 years (5.71%); and 43 – 46 years (20%)
Highest Level of Education: Respondents with a Master's degree (57.14%) were the majority followed by those with a bachelor's degree (40%) and finally those with a doctorate (2.86%).
Years of Experience: A majority of the respondents had more than 20 years of experience in the built environment followed by those with 16 – 19 years (14.29%) and 8 – 11 years (14.29%).
Chapter of ISK: A significant number of the respondents were in the building surveying chapter (51.43%) of the ISK followed by those in the Valuation chapter (25.71%) of ISK.

4.2 Descriptive Statistics

In this study, descriptive statistics including measures of central tendency, dispersion, and distribution were analysed and after which the data was presented in the form of tables.

4.2.1 Quality of the Urban Built Environment

In this case, the means of the variables were fairly high with most ranging between 4.71 and 8.3. As such, this was an indication of the respondents rating the surrogates above average for each of the aspects under investigation.

4.2.2 Building Maintenance and the Quality of the Urban Built Environment

With regard to the aspects of building maintenance, the means of the responses were fairly high ranging between 6.9 and 8.2. This indicated the high rating of the surrogates in the elements under consideration in the study. The scores were as follows: Availability of Heating appliances-4.71; Appropriate Building Envelope (Including doors, windows, walls and their influence on heating and cooling requirements)-7.49; Adequate Ventilation Systems-8.23; Safe Construction materials-7.97; Appropriate Cooling appliances-6.43; Appropriate window sizes-8; Proper orientation of windows-7.66; Adequate Size of doors and access ways-7.69; Proper Orientation of doorways (External doors) and access ways to the building-7.66; Adequate Landscaping (Tree cover, greenery, etc)-7.11; Availability of Lighting equipment (Illuminance uniformity, luminous distribution and light colour characteristics)-7.23; Availability of Daylighting-7.97; Appropriate Surface reflectance-6.8; Adequate Storm water drainage systems-7.94; Adequate Sewerage system (From individual building to main sewer connection)-8; Appropriate Solid waste management system (Collection facility)-7.97; Appropriate General orientation of the building-7.49; Proper selection, sizing and positioning of Heating, Ventilation & Cooling (HVAC) equipment and services and their effect on acoustic comfort-6.94; Adequate Sound insulation-6.97; and Availability of Domestic Hot Water (DHW) system-6.74

Table 2: Descriptive Statistics of Building Maintenance and Quality of the Urban Built Environment

No.	Aspect	N	Mean	Median	Mode	Std. Deviation	Variance	Skewness	Kurtosis	Range
1.	Foundation	35	7.49	9	10	2.884	8.316	-0.699	-1.185	8
2.	Walls	35	8.11	9	10	2.349	5.516	-1.157	-0.063	7
3.	Internal wall surfaces	35	7.66	9	9	2.425	5.879	-0.821	-0.831	7
4.	External wall surfaces	35	8.23	9	10	2.315	5.358	-1.276	0.298	7
5.	Floors	35	7.83	9	10	2.358	5.558	-0.982	-0.319	7
6.	Floor Surfaces	35	7.74	8	10	2.305	5.314	-0.98	-0.268	7
7.	Ceilings	35	7.74	9	9	2.393	5.726	-0.948	-0.57	7
8.	Staircase	35	7.69	8	8	2.272	5.163	-0.863	-0.532	7
9.	Lobbies	35	7.54	8	10	2.292	5.255	-0.657	-0.828	7
10.	Roof Structure	35	8.29	9	10	2.308	5.328	-1.36	0.484	7
11.	Roof Covering	35	8.29	10	10	2.396	5.739	-1.216	0.021	7
12.	Gutters and drain pipes	35	7.86	9	10	2.341	5.479	-1.073	0.092	8
13.	Windows	35	8.14	9	9a	2.238	5.008	-1.342	0.518	7
14.	Doors	35	7.8	9	9	2.22	4.929	-1.066	-0.168	7
15.	Glazing	35	7.6	8	10	2.452	6.012	-0.89	-0.418	8
16.	Central Heating Pipes	35	6.97	8	9	2.431	5.911	-0.59	-0.921	8
17.	Boilers & Heaters	35	6.91	7	9	2.306	5.316	-0.607	-0.772	8
18.	Water Supply fittings &Pipes	35	7.86	9	10	2.366	5.597	-0.936	-0.487	7
19.	Sewerage pipes	35	7.91	9	10	2.639	6.963	-0.981	-0.693	7
20.	Sanitation fittings	35	8.23	9	10	2.438	5.946	-1.302	0.156	7
21.	Electrical installations & fittings	35	8	9	10	2.509	6.294	-1.138	-0.182	7
22.	Landscaping (Trees & greenery)	35	7.4	8	8	2.379	5.659	-0.869	-0.246	8
23.	Street lighting	35	7.51	8	9	2.215	4.904	-0.925	-0.017	8
24.	Solid waste management System (Collection facility)	35	8.29	9	10	2.432	5.916	-1.381	0.596	8

4.3 Relative Importance Index

The Relative Importance Index (RII) approach is used to describe the relative importance of the specific causes and effects based on the likelihood of occurrence and effect on the project using the Likert scale of five scales.

4.3.1 Quality of the Urban Built Environment

From the calculated RRI, it was noted that adequate ventilation systems (0.822), appropriate window sizes (0.800), and adequate sewerage system - from individual building to main sewer connection (0.800) were the top three elements as ranked by the respondents to be of very high importance in the built environment. On the other hand, availability of Domestic Hot Water (DHW) system (0.6743), appropriate cooling appliances (0.642) and availability of heating appliances (0.471) were the bottom three as ranked by the respondents to be of little importance in the built environment.

Table 3: Relative Importance Index of Quality of the Urban Built Environment

No.	Aspect	Rating of Importance					RII	Rank
		No Importance	Low Importance	Moderate Importance	High Importance	Very High Importance		
1.	Adequate Ventilation Systems	0	7	0	4	24	0.8229	1
2.	Appropriate window sizes	0	7	0	7	21	0.8000	2
3.	Adequate Sewerage system (From individual building to main sewer connection)	1	6	3	2	23	0.8000	2
4.	Safe Construction materials	0	9	0	2	24	0.7971	4
5.	Availability of Daylighting	1	7	1	3	23	0.7971	4
6.	Appropriate Solid waste management system (Collection facility)	1	6	3	2	23	0.7971	4
7.	Adequate Storm water drainage systems	1	6	3	1	24	0.7943	7
8.	Adequate Size of doors and accessways	1	6	2	7	19	0.7686	8
9.	Proper orientation of windows	1	7	1	7	19	0.7657	9
10.	Proper Orientation of doorways (External doors) and accessways to the building	2	5	3	4	21	0.7657	9
11.	Appropriate Building Envelope (Including doors, windows, walls and their influence on heating and cooling requirements	1	7	2	9	16	0.7486	11
12.	Appropriate General orientation of the building	1	8	1	7	18	0.7486	11
13.	Availability of Lighting equipment (Illuminance uniformity, luminous distribution and light colour characteristics)	2	7	1	8	17	0.7229	13
14.	Adequate Landscaping (Tree cover, greenery, etc)	2	5	4	12	12	0.7114	14
15.	Proper selection, sizing and positioning of Heating, Ventilation & Cooling (HVAC) equipment and services and their effect on acoustic comfort.	1	9	3	7	15	0.6943	15
16.	Adequate Sound insulation	3	7	2	9	14	0.6971	16
17.	Appropriate Surface reflectance	2	8	2	10	13	0.6800	17
18.	Availability of Domestic Hot Water (DHW) system	3	8	3	6	15	0.6743	18
19.	Appropriate Cooling appliances	4	8	2	11	10	0.6429	19
20.	Availability of Heating appliances	13	3	8	7	4	0.4714	20

4.3.2 Building Maintenance and the Quality of the Urban Built Environment

The results indicated that solid waste management system (collection facility) (0.828), roof structure (0.828) and roof covering (0.828) were the top three ranked aspects by the respondents with regard to their very high contribution to the quality of the urban built environment. On the other hand, landscaping (trees & greenery) (0.74), central heating pipes (0.69) and boilers & heaters (0.69) were the bottom ranked aspects by the respondents due to their contribution to the urban built environment.

Table 4: Relative Importance Index of Building Maintenance and the Quality of the Urban Built Environment

No.	Aspect	Rating of Contribution					RII	Rank
		No Contribution	Low Contribution	Moderate Contribution	High Contribution	Very High Contribution		
1.	Roof Structure	0	6	0	6	23	0.8286	1
2.	Roof Covering	0	6	1	5	23	0.8286	1
3.	Solid waste management System (Collection facility)	1	5	1	5	23	0.8286	1
4.	External wall surfaces	0	6	0	7	22	0.8229	4
5.	Sanitation fittings	0	6	1	3	25	0.8229	4
6.	Windows	0	6	0	7	22	0.8143	6
7.	Walls	0	6	1	7	21	0.8114	7
8.	Electrical installations & fittings	0	7	0	7	21	0.8000	8
9.	Sewerage pipes	0	8	1	4	22	0.7914	9
10.	Gutters and drain pipes	1	5	2	9	18	0.7857	10
11.	Water Supply fittings & Pipes	0	7	1	9	18	0.7857	10
12.	Floors	0	6	2	9	18	0.7829	12
13.	Doors	0	6	1	8	19	0.7800	13
14.	Floor Surfaces	0	6	2	10	17	0.7743	14
15.	Ceilings	0	6	3	7	19	0.7743	14
16.	Staircase	0	6	3	11	15	0.7686	16
17.	Internal wall surfaces	0	6	5	5	19	0.7657	17
18.	Glazing	1	6	1	11	16	0.7600	18
19.	Lobbies	0	6	4	10	15	0.7543	19
20.	Street lighting	1	5	3	11	15	0.7514	20
21.	Foundation	2	8	1	4	20	0.7486	21
22.	Landscaping (Trees & greenery)	1	6	1	15	12	0.7400	22
23.	Central Heating Pipes	1	7	5	5	13	0.6971	23
24.	Boilers & Heaters	1	7	4	12	11	0.6914	24

5.0 CONCLUSION

A review of the relevant literature was able to establish the integral parameters to consider during new housing development and when carrying out building maintenance works. This will go a long way in cushioning against adverse effects on the quality of indoor and outdoor environments. In regard to Quality of the Urban Built Environment, from the calculated RRI, it was noted that adequate ventilation systems (0.822), appropriate window sizes (0.800), and adequate sewerage system - from individual building to main sewer connection (0.800) were the top three elements as ranked by the respondents to be of very high importance in the built environment. In regard to Building Maintenance and the Quality of the Urban Built Environment the results indicated that solid waste management system (collection facility) (0.828), roof structure (0.828) and roof covering (0.828) were the top three ranked aspects by the respondents with regard to their very high contribution to the quality of the urban built environment.

6.0 RECOMMENDATIONS

First, it is important to create awareness on the understanding of the core contribution of building maintenance activities in ensuring a sustainable and conducive built environment. Secondly, there is need for prioritization of resources to be utilized in building maintenance based on the projected deterioration of the building components. Thirdly, stakeholders can utilize advanced technologies in identification and measurement of factors that will inhibit and interfere with the quality of the indoor and outdoor building environments. Fourthly, it is imperative to encourage collaborations between urban planners, architects, engineers, building surveyors and other stakeholders whose purpose will be to check on both new and old housing developments. Lastly, it is very vital in developing building maintenance and adhering to the attendant provisions. These maintenance plans will be implemented through appropriate strategies. Furthermore, there is need to adopt emerging/innovative technologies and reliance on robust modalities of engaging the community that are provided for in progressive policy frameworks.

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