ANALYZING THE FACTORS THAT AFFECT THE QUALITY OF STAIRCASES: A CASE STUDY OF UNIVERSITIES IN THE CENTRAL REGION, UGANDA

BY

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A DISSERTATION SUBMITTED TO KYAMBOGO UNIVERSITY DIRECTORATE OF RESEARCH AND GRADUATE TRAINING IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE IN CONSTRUCTION TECHNOLOGY AND MANAGEMENT DEGREE OF KYAMBOGO UNIVERSITY

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CERTIFICATION

The undersigned approve that they have read and hereby recommend for submission to the Directorate of research and graduate training of Kyambogo University a dissertation titled **"Analyzing the factors that affect the quality of staircases of storeyed buildings: A case study of Universities in the central region, Uganda"** in fulfilment of the requirements for the award of Master of Science Degree in Construction Technology and Management of Kyambogo University.

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DECLARATION

I, **Mukhwana Benjamin Khabusi**, hereby declare that this submission is my own work and that to the best of my knowledge and belief, it contains no material previously published or written by another person nor material which has been accepted for the award of any other degree of the university or other institutions of higher learning, except where due acknowledgement has been made in the text and reference list.

SIGNATURE:…………………………………. DATE: ………………………………

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Finally, I would like to thank Dr. Muhwezi Lawrence for all the support during the research process despite not being my research Supervisor.

DEDICATION

This research is dedicated to the engineering fraternity as it is intended to remind us of our duty of ensuring safety as we engage in the design and construction of buildings both private and public towards the infrastructural development of Uganda as a whole and beyond.

This research is intended to contribute to the body of knowledge with regard to the quality of staircases in public buildings of Uganda which is key to reducing/preventing the occurrence of negative impacts and/ or accidents on the users/occupants of the buildings.

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LIST OF ABBREVIATIONS

BLDG	Building
BS	British Standard
CVI	Content Validity Index
IBC	International Building Code
MoGLSD	Ministry of Gender, Labour and Social Development
NCHE	National Council for Higher Education
NDP	National Development Plan
O & M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
PSNs	Persons with Special Needs
PWD	Persons with Disability
RU	Research University
SDGs	Sustainable Development Goals
SPSS	Statistical Package for Social Scientists
TGSIs	Tactile Ground Surface Indicators
UK	United Kingdom
UNAPD	Uganda National Action on Physical Disability
UN	United Nations
WHO	World Health Organization

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ABSTRACT

Staircases are the most common means of vertical access in low and medium rise storeyed buildings in Uganda. Their purpose is to provide safe means of movement from floor to floor. Reduction of accidents would be one of the functional requirements of stairs which is part and parcel of safety. However, the high accident rates are an indication of poorly designed and constructed stairs. With such problems on staircases, this study sought to investigate the factors that affect their quality in storeyed buildings in Ugandan universities specifically in the central region in a bid to minimize the occurrence accidents. Four kinds of surveys including observational, design and construction, technical and staircase user surveys were conducted in the study. The observational survey done using a check list revealed that the key features for quality vertitical access were; tactile ground indicators, balustrades, handrails, risers, treads, stair flights, newel posts, nosings, landings and presence of ramps in buildings. The design and construction survey which was done using self-admistered questionnaires involving 22 respondents revealed that the major factors that affect the quality of staircases were: design proficiency, construction competences, design review and other project factors. The technical survey conducted using a technical tool revealed that 66% of the stairs did not conform to the design and construction requirements due to riser heights, tread depths, slope relationship (2Rise + Going), stair slopes, handrail heights, handrail extensions and depth of nosing contrasts not conforming to the standards. The staircase user survey carried out using self-admistered questionnaires involving 212 respondents revealed that 26.3% of the users were injured while using the staircases due to missed steps, slippery surfaces, inadequate lighting in the stairwell, unevenness in the risers and treads and broken edges of steps. It was therefore concluded that to minimize the occurrence of accidents on staircases, proper design, construction and supervision need to be done in accordance with the standards short of which will lead to accidents.

Key words: Staircase, quality, accidents, design, construction, supervision, user

CHAPTER ONE : INTRODUCTION

1.0 Background

This chapter gives the background information on the evolution of staircases globally and specifically in Uganda where the research study was carried out by highlighting the importance of staircases in buildings and what happens if this means of vertical access is not constructed to the design and construction requirements. It also describes other related research studies that have been carried out on staircases by other researchers. The problem statement, objectives of the research study which include the general and specific objectives have also been stated. The research questions, justification, significance of the study, the scope which includes geographical scope, content scope and the time scope have been fully described. The conceptual framework for the study has been given to show the variables that were considered.

The construction of storeyed buildings globally dates back to the 19th century where such buildings have evolved and become key in defining infrastructural development of all countries across the globe. In Uganda, storeyed buildings begun to be constructed in the 20th century. The first high rise building (having 10 or more storeys) currently named Sheraton Hotel was constructed in 1965 while others were mainly low-rise buildings (having up to 4 storeys) such as Makerere University Main Building (circa 1941). The construction of storeyed buildings in Uganda has continued to grow partly as a result of urbanization, modernization and limited land especially in urban and peri-urban areas due to the growing population and rural-urban migration. Storeyed developments dictate provision of the means of vertical access within buildings as a link between the lower and upper floors. This can be achieved through inclusion of staircases, escalators, lifts, ladders, and/ or ramps. Staircases and ramps are the most common means of accessing upper floors in storeyed buildings in Uganda.

The quality of staircases and ramps plays an important role in the provision of safe, effective, easy and comfortable vertical access in these buildings. For this to be achieved, the design of these means of access must therefore conform to or comply with the regulations laid down in the Building Codes, Regulations and/ or Building Acts of a particular region or country. Adherence to the quality requirements in these regulations is important as non-adherence will cause impacts such as user discomfort, sliding, tripping, fatigue and sometimes leading to accidents hence causing injury or fatalities. According to a research review (WHO, 2016), about 7% to 36% of the unintentional falls occur on stairs. Also, according to Crist (2017), over one million injuries occur each year as a result of stairway falls in the United States. Staircase accidents constitute the second leading cause of unintentional injury, second only to motor vehicle accidents (Crist, 2017).

Other researchers carried out related studies on the staircases though the studies were based on different variables from those that are being analyzed in this study. For example, Nagata (1991) carried out a study on the occupational accidents while walking on stairways which focused on collection of data on occupational injury and causes associated with the accidents in Tokyo, Japan based on labour casualty reports. This study on the quality of the staircases, however, had a wider scope in that it investigated the factors that influence the quality of the staircases including design, construction, supervision, maintenance, environmental, materials and individual user factors based on as-built measurements, observations as well as user experiences.

Mcgann *et al.* (2015) carried out a study on stairs though it concentrated on comparing the physical activity behaviours in different buildings in relation to circulation patterns which is totally different from the outcome of the current research.

It was therefore against this background that there was need to carry out a comprehensive analysis of the quality of staircases in the Ugandan higher institutions of learning to identify the factors that lead to quality problems on staircases in line with the design and construction requirements for conformance. This study also investigated the occurrence of accidents on the stairs in the selected universities which indicates their performance during use. The study has identified the factors that lead to poor quality staircases including design, construction and supervision factors which lead to accidents/injuries to the users. It has also contributed a practical framework for construction stakeholders including Engineers, Consultants, Contractors and other line-stakeholders like the clients on the performance of staircases in universities which can be inferred to other public buildings.

1.1 Statement of the Problem

As the construction of storeyed buildings continues to grow locally, regionally and globally, provision of effective, safe, easy and comfortable vertical access in these buildings from one floor to another becomes inevitable. Aware that universities as educational institutions with a broad range of users, they represent public places where students, employees and others move within buildings. Moreover, lately, these institutions have seen an upsurge in storeyed building construction due to deliberate efforts for densification of urban areas arising out of conservation needs for scarce land resources and therefore good quality staircases help to provide safe vertical access.

Whereas there are various codes of practice like building codes and regulations including Eurocodes, British standards, building control regulations and public health (building) rules that stipulate quality requirements during design and construction of staircases, the effectiveness and safety of the stairs are still far from being achieved. This is because accidents continue to occur on staircases which are the leading cause of unintentional falls, second to motor vehicle accidents since 7% to 36% of these falls occur on stairs (WHO, 2016). In Uganda, according to the data obtained from Mulago National Referral Hospital (2022), from a sample of 1000 patients that visited the hospital between 2017 and 2019, 24 (2.4%) of the total sample of patients were due to falls from staircases. From these statistics, it is evident that even in Uganda, accidents on staircases continue to occur. These accidents are as a result of discomfort, sliding, tripping and fatigue while walking on the stairs. The accidents lead to trauma, sprains, strains, fractures, dislocations, lameness and/ or even death. This ultimately has far-reaching effects to the victims, their families and the country at large in terms of productivity and eventually impacting the economy in terms of the time taken to treat the casualties, cost of treatment and compensation. Some of these effects are sometimes not recorded or published as with the case in Uganda.

As a result, there was therefore need to analyse the quality of the staircases in the Ugandan context in order to find a solution to improve the situation. Through the research, a framework has been developed that will be used by construction stakeholders during design and construction. Better quality stairs will improve the safety and consequently protect the health of users thereby reducing on the downtime of the users while undergoing treatment or reduce the effects due to such accidents.

1.2 Objectives

1.2.1 General Objective

The main objective of this research study was to investigate the factors that affect the quality of staircases of storeyed buildings in Ugandan universities.

1.2.2 Specific Objectives

The specific objectives of the study were:

(i) To identify key features for the design and construction of quality staircases;

(ii) To identify the factors that influence the design and construction of quality staircases in public buildings, specifically universities;

(iii) To establish the extent to which the staircases meet the design and construction requirements;

(iv) To determine the extent to which staircase quality affects the users of the selected buildings; and

(v) To develop a framework for improving the performance of staircases in public buildings, specifically universities.

1.3 Research Questions

The research was guided by the following questions.

(a) Are the features that are considered for a quality staircase in existence on the staircases of the selected buildings?

(b) What are the major factors that influence the design and construction of quality staircases in public buildings, specifically universities?

(c) To what extent do the staircases in the selected buildings meet the design and construction requirements?

(d) What are the impacts of the staircases of the selected buildings on the users?

1.4 Justification

According to a research review by WHO (2016), globally, accidents on staircases rank the second highest of the unintentional falls second to motor vehicle accidents. These accidents to a large extent are caused by quality problems resulting from uneven treads and risers, missing or damaged handrails/or kerb rails, lack of facilities for persons with special needs (PSNs), too long flights, slippery staircase surfaces, too steep staircases, narrow treads, insufficient lighting in the stairwell, faulty or damaged/broken steps, objects left on the staircase, poor ventilation, poorly visible nosings, poor workmanship and use of materials that do not comply with the minimum requirements. The occurrence of these quality problems leads to various consequences to the users of the buildings including sliding, tripping off the steps, poor vision, fatigue and discomfort which may also lead to injury, lameness and/ or death.

Without sufficient research which gives evidence of the existence of quality problems on staircases in public buildings, there are bound to be impacts/accidents which sometimes may not even be documented or published leading to increased number of PSNs and/or mortality rates. This affects the lives of the users including the already existing PSNs, the families of the victims, the universities as well as the government due to reduced productivity hence the need for this research. There was not enough literature on staircase quality in Uganda which would give a clear picture on the existence of quality problems which this research study sought to explore hence increasing on the body of knowledge in regard to staircase quality and accidents.

The United Nations (UN) supports the need for healthy lives, equitable quality education, full and productive employment as well as building resilient infrastructure through achievement of Sustainable Development Goals (SDGs) 3, 4, 8 and 9. SDG 3 aims at ensuring healthy lives and promoting the well-being of all ages through strengthening the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks. UN through SDG 4 aims at providing quality education by building and upgrading education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all. SDG 8 also aims at promoting sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all. SDG 9 also supports the need for this research by developing quality, reliable, sustainable and resilient infrastructure to support economic development and human well-being, with a focus on affordable and equitable access for all.

The National Development Plan (NDP III, 2020), is also supportive of the need for improving quality and relevant education which can be achieved through a healthy population and provision of resilient infrastructure in the educational institutions.

Aware of the support of the SDGs and NDP III in health, education and infrastructural development, the quality of staircases in buildings of educational institutions like those selected need to be designed and constructed basing on the stipulated quality requirements to provide effective, safe, easy and comfortable access in and around the buildings thereby achieving the UN and the country's objectives hence the need for this research.

1.5 Significance of the Study

The quality of staircases in public buildings depends upon a number of factors including the design and construction requirements laid down in the Building Codes, Regulations and Building Acts, construction methods and workmanship. Therefore, adherence to these requirements and proper construction is important if safe, effective, easy and comfortable access to storeyed buildings is to be provided.

This research sought to contribute to the body of knowledge in regard to the quality of staircases in selected buildings in public universities of Uganda which is key to reducing/preventing the occurrence of negative impacts and/ or accidents on the users/occupants of the buildings.

The research contributed a practical framework for construction stakeholders including engineers, consultants, contractors and other line-stakeholders like the clients on the performance of staircases in public universities which can be inferred to other public buildings. This will be used as a reference for constant supervision during all the project phases of future public storeyed buildings.

The study sought to identify the impact of poor quality staircases on users which will help in seeking engineering solutions to prevent further faults during design and construction.

1.6 Scope of the study

1.6.1 Content Scope

The scope of this research was limited to selected storeyed buildings in universities within the central region in Uganda irrespective of the age of the buildings. The study considered only the architectural design of the staircases and not their structural design. The study did not cover storeyed buildings completed but not yet occupied. It took into account the factors that influence the quality of the staircases, features and parameters used in staircase design and construction as well as the impact of poor quality staircases on users.

1.6.2 Geographical Scope

Five (5) universities from central region were purposively selected. The purposive selection of the universities was done based on the number of storeyed buildings in the universities with at least 5 buildings and if they were less than 5, then the buildings must have had at least 4 floors. The universities selected included: Makerere University, Kyambogo University, Kampala International University, St. Lawrence University and Ndejje University. A total of 24 buildings were purposively selected in which 50 staircases were studied.

1.6.3 Time Scope

This study took a total duration of one year between February 2022 and February 2023 in which various activities were carried out including review of the literature, development and validation of data collection tools, fieldwork and data collection, data capture and analysis as well as dissertation writing and approval by the Supervisors.

1.7 Conceptual Framework

The diagrammatic representation of the variables used in the research to achieve the objectives is as shown in Figure 1.1. The variables considered included independent, control, moderator and dependent variables.

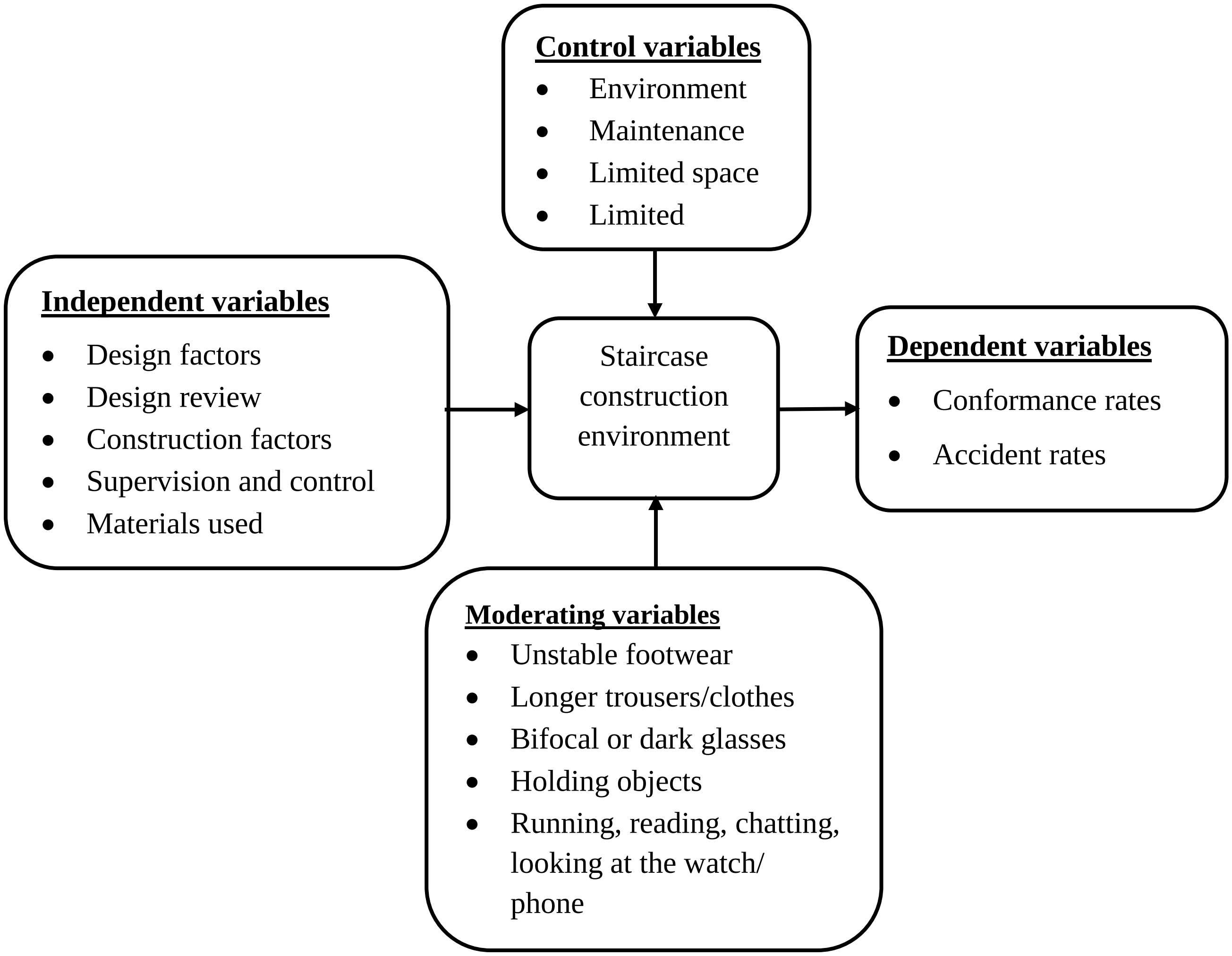

Figure 1.1 Conceptual framework

The independent variables were identified as the major factors that affected the quality of staircases which included: design factors, construction factors, design review, supervision and control as well as materials used on the staircases. These variables directly affect the quality of staircases. Control variables were included as factors that were not major in the study but could lead to poor quality staircases hence causing accidents. The control variables investigated included: environment factors, maintenance factors, limited space and finances. The investigation of these variables helped in enhancing the internal validity of the study by limiting the influence of other factors on the quality of staircases which would lead to a wrong conclusion. Moderating variables which included individual and behavioural factors such as unstable footwear, longer trousers/clothes than they are supposed to be, bifocal or dark glasses, holding objects, running, reading, chatting, looking at the watch/ phone. These factors if not investigated would lead to the conclusion of having poor quality staircases yet they are due to individual user factors thereby influencing the relationship between the independent and dependent variables. Dependent variables were identified as those factors that would change as a result of the impact of the independent variables. In this study, good quality staircases would be as the result of adherence to design and construction requirements which would reduce on the rate of staircase accidents while non-adherence would increase on the accident rates.

1.8 Chapter Summary

This chapter provided the background information on storeyed buildings which necessitate the provision of staircases for access. It also highlighted the problem that was tackled in the research, objectives including general and specific objectives. The justification, significance and scope of the research study were also described. The chapter concluded with the conceptual framework which indicates the different variables that were investigated for completion of the study including independent, control, moderator and dependent variables.

CHAPTER TWO : LITERATURE REVIEW

2.1 Introduction

This chapter highlights the information that was reviewed in this study to give a deeper insight into the quality of staircases in public storeyed buildings in reference to the available literature. This review considered both the empirical and conceptual literature of previous studies done by other researchers.

2.2 Safety of Stairs

The purpose of stairs is to provide safe means of movement from floor to floor in buildings. Reduction of accidents is one of the functional requirements of stairs which is part and parcel of safety. According to Occupational Safety and Health Administration (2012), safety refers to the prevention of accidents including avoiding unwanted events from occurring. Safety is also seen as the basic value in the workplace. Staircase safety therefore, is the prevention of untintentional accidents while using stairs by putting in place measures which protect users against tripping hazards which would otherwise cause injury. Staircase safety depends on: staircase dimensions and geometry; handrails and railings; lighting, ground surface indicators/warning signs, slip resistance; and presence of escape stairways for emergencies.

2.3 Quality of Staircases

Quality can be defined as the meeting of legal, aesthetic and functional requirements of a construction project (Arditi and Gunaydin, 1997). Quality of the staircases can therefore be defined as meeting the requirements of the designer, constructor, regulatory agencies and the client to minimize the accurrence of accidents to the users. The staircases of the storeyed buildings were considered to be of quality where they conformed to the requirements laid down in the building regulations. The quality of staircases was analysed based on the different factors as follows.

2.4 Architectural Design

2.4.1 Introduction

Architectural design of staircases involves taking care of the needs and demands of storeyed buildings by creating and including spaces that accommodate the staircases.

In architectural design, the form and function of a building component are very important in defining the building purpose. According to John Hendrix (2015), the real relation between form and function in architecture involves contradiction as well as conformance. For these purposes, form is the visual appearance of a building which includes line, outline, shape and composition while function is the structural and functional requirements of a building which includes construction, shelter, program, organization, use, occupancy and materials.

The architecture of the staircases includes the incorporation of features that bring about the beauty of the staircases and also ensuring conformance to the minimum requirements.

2.4.2 Staircase Terminologies

Various features are used on staircases which bring about safety, aesthetics and quality in the buildings. *Figure 2.1* shows the different features and terminologies that are applicable in the design of staircases.

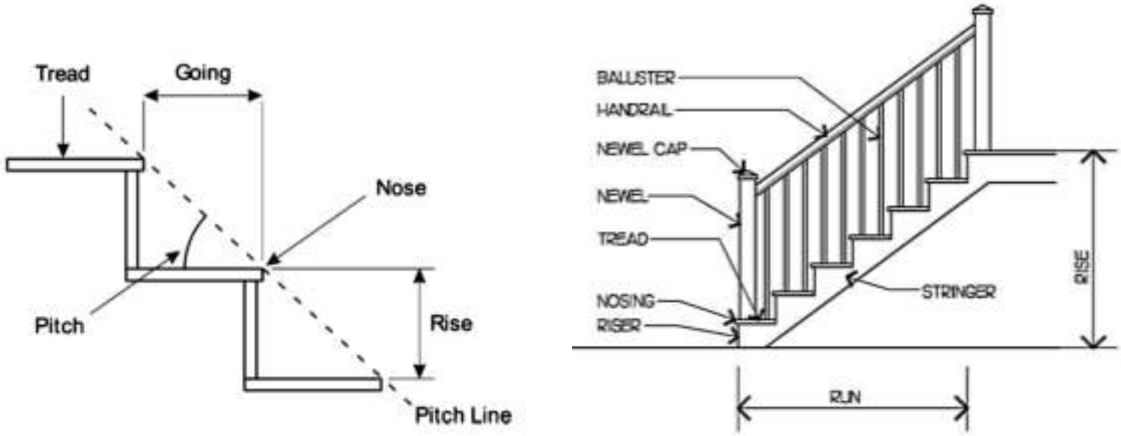

Figure 2.1: Staircase terminologies

The most common terminologies used in staircase design are described as follows:

Step. It is that portion of the stair which permits ascent and descent.

Tread. It is the upper horizontal portion of a step upon which the feet are placed.

Riser. It is the vertical portion between each tread on the stair.

Handrail. This is a rail which is designed to be grasped by the hand so as to provide stability or support.

Baluster. This is a vertical member of wood or metal supporting the handrails.

Newel post. This is the vertical member which is placed at the ends of flights to connect handrails.

Run. It is the total length of the stair in a horizontal plane.

Nosing. It is the projecting part of the tread beyond the face of the riser.

Stringers. These are the sloping wooden members which support the steps in a stair running along the slope of the stair.

Pitch line. This is a notional line which connects the nosings of all treads in a flight with the nosing of the landing at the top of the flight down to the ramp or landing at the bottom of the flight.

Going. This is the horizontal distance between the nosing of a tread and the nosing of the tread, ramp or landing next above it.

Landing. This is the floor area at either end of stairs and possibly in between.

Stairwell. It is the space in which the stairs and landing are housed.

Margin. It is the space left between the edge of the nosing and edge of the string.

Rise. This is a vertical distance from the top of one tread to the top of the next tread.

Flight. This refers to a series of continuous steps between floors or landings in the staircase.

Waist: This is the thickness of the waist-slab on which steps are made.

2.4.3 Classification of Stairs

Stairs are classified based on the use and purpose they satisfy. According to the UK Staircase Building Regulations (2010), the stairs are classified as follows;

(a) *Private stair*. This stair is one which is used by occupants in dwellings.

(b) *Institutional or assembly stair*. This is a stair which serves places or buildings where many people gather.

(c) *Utility stair*. This is a stair which is used for escape, access for maintenance or purposes other than as usual route for movement between levels on a day - to - day basis.

(d) *Easy access stair*. This is a stair used by a broad range of users and on a day - to - day basis as a usual route between levels.

2.4.4 Types of staircases

The aesthetics, safety and quality of a staircase in a building also depend upon the type of the staircase adopted during the design. Staircases are categorized into two types as follows.

(a) Transversely supported stairs. These are stairs that are supported in the direction of movement and include:

- Simply supported steps supported by two walls or beams or a combination of both;
- Steps cantilevering from a wall or a beam; and
- Stairs cantilevering from a central spine beam.

Figure 2.2 shows a transverse stair supported between reinforced concrete walls.

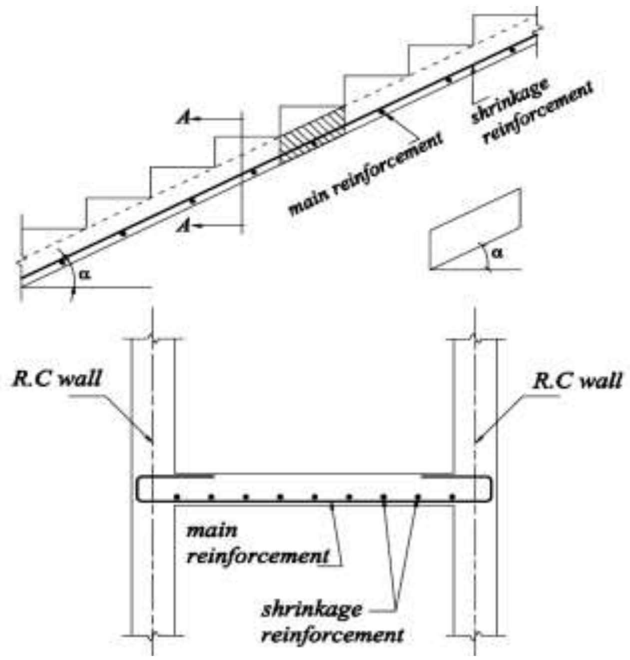

Figure 2.2: A transverse stair supported between reinforced concrete walls

Source: Adopted from https://www.slideshare.net/FeritFazliu1/stairs-32879218 (2014)

(b) Longitudinally supported stairs. These stairs span between supports at the top and bottom of a flight and unsupported at the sides. Longitudinally supported stairs may be supported in any of the following ways:

- Beams or walls at the outside edges of the landings;
- Internal beams at the ends of the flight in addition to beams or walls at the outside edges of the landings;
- Landings which are supported by beams or walls running in the longitudinal direction; and

- Stairs with quarter landings associated with open-well stairs.

Figure 2.3 shows longitudinal stair supported between two walls.

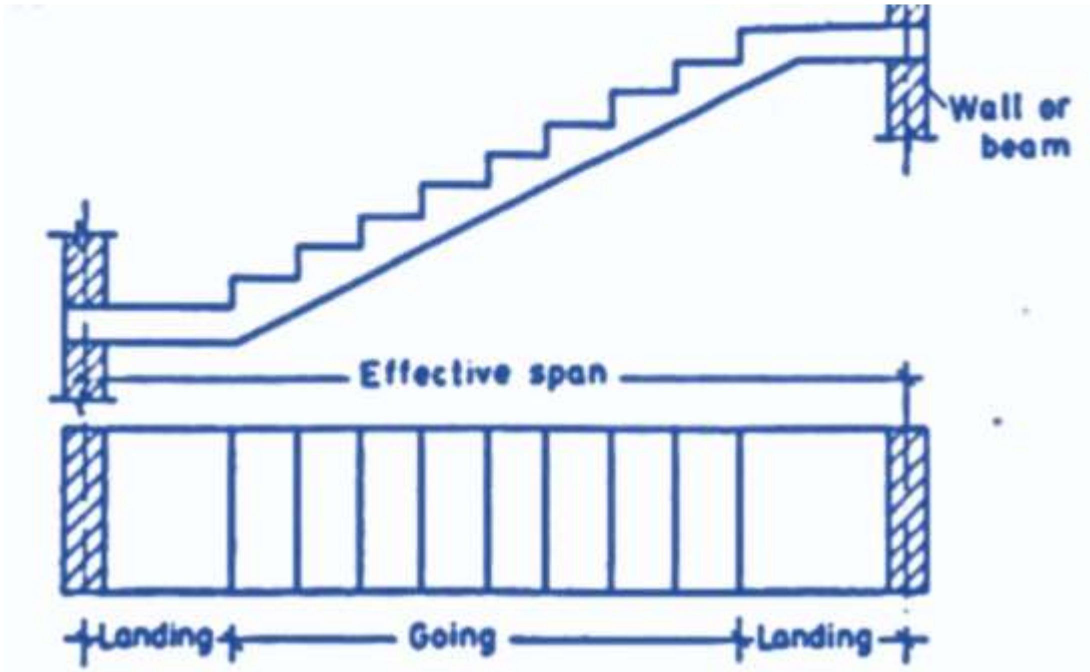

Figure 2.3: Longitudinal stair supported between two walls

Source: Adopted from https://theconstructor.org/building/design-longitudinally-spanning-r-c-c-stair/224003/ (2020)

The choice of the type of staircase for use in a building depends upon factors such as the budget, available space, materials available for use, safety considerations of the staircase, target group of the occupants and building regulations. Also, the architectural design of quality staircases takes into consideration factors involving aesthetics, structural feasibility and functional requirements.

Other influencing factors for the selection are lighting, ventilation, comfort and accessibility.

With these factors in mind, any of the types of staircases illustrated in *Figure 2.4* can be selected for use in public storeyed buildings and the construction method adopted will bring about the quality required. The types of stairs are as follows;

Straight run. This has no turns i.e. no change in direction on any flight.

L-shaped or quarter-turn stair. It has one landing at some point along the flight of steps with one 90^{o} turn.

Double-L stairs. These have two 90^{o} turns along the flight.

U-shaped or half-turn stairs. These have two flights of steps parallel to each other and have a level landing placed across the two flights at the change of direction.

Winder stairs. These have pie-shaped or triangular steps at the corner transition instead of having a flat landing.

Spiral stairs. These are stairs in which the steps or treads are connected to a centre column and they are used where little space is available. Most are made from steel and welded together.

Circular stairs. These are custom made. The steps are trapezoidal in shape and have no centre column as in the case of spiral staircase.

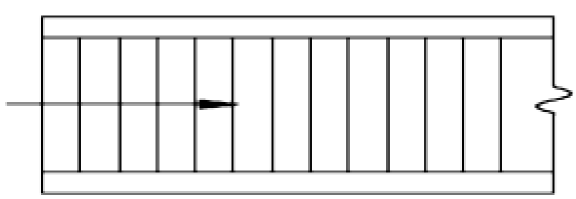

Figure 2.4(a): Straight run stair without a landing

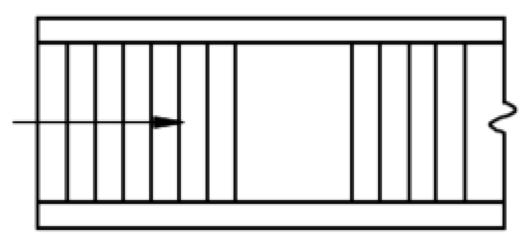

Figure 2.4(b): Straight run stair with a landing

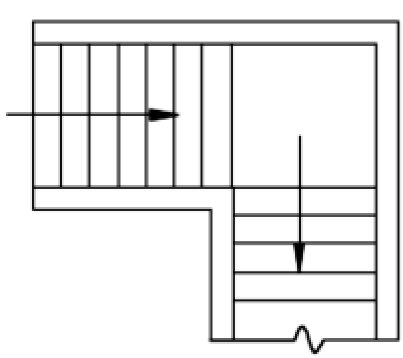

Figure 2.4(c): L - stair (Quarter turn)

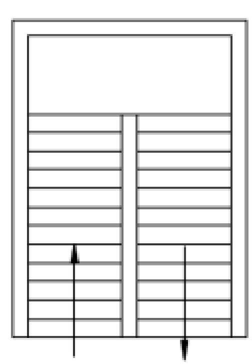

Figure 2.4(d): Dogleg stair (U-shaped/half turn stair)

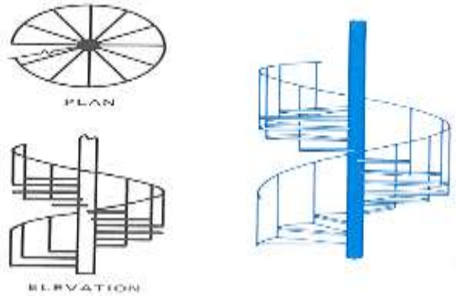

Figure 2.4(e): Spiral stair

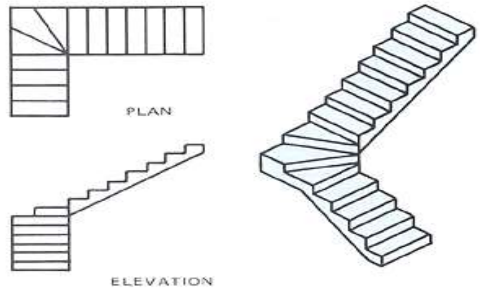

Figure 2.4(f): Winder stair

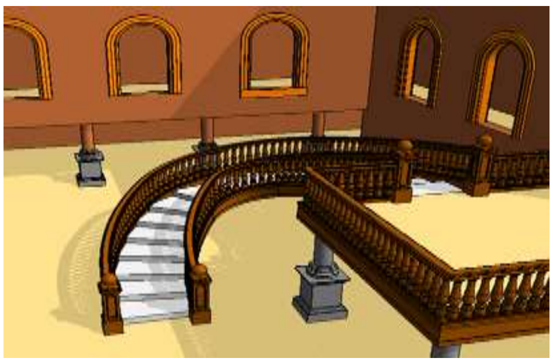

Figure 2.4(g): Circular stair

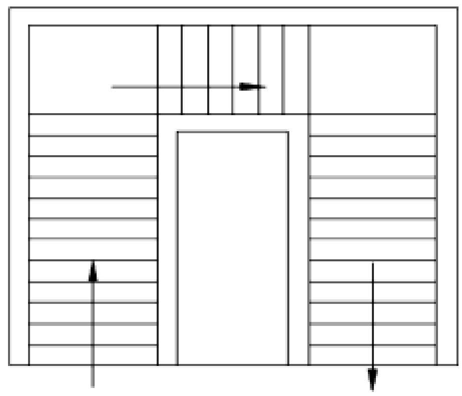

Figure 2.4(h): Double L

Figure 2.4: Types of Staircases

Source: Adopted from Http://i-learn.yolasite.com/resources/stairs (2015)

2.4.5 Design Requirements

According to Nagata (1991) in his study of occupational accidents while walking on stairways, accidents on staircases are as a result of a combination of factors including design, environmental and maintenance factors. The design factors that affect the quality of stairs include; uneven risers and treads, too steep staircase flights, slippery nosings or treads, narrow treads, lack of key features like handrails, treads and risers with irregular dimensions, longer straight flights and lack of TGSIs. The environmental factors include; ventilation and poor lighting in the stairwell. Maintenance factors include: broken steps, lubricating materials on the steps, torn or loose coverings and presence of objects or

obstacles on the staircases. This means that proper design and maintenance of the stairway environment will help improve the quality of the staircases in public buildings.
Poor design and maintenance of the staircases will lead to poor quality staircases which will cause injuries such as bruises, fractures, sprains, strains, cuts, dislocations, trauma or even death to the users of the staircases.

However, in the same research study, Nagata (1991) states that accidents are also caused by other factors. These include human and behavioural factors such as unstable footwear, longer trousers/clothes than they are supposed to be (tripping hazards), bifocal or dark glasses, holding objects, running, reading, chatting, looking at the watch/ phone or lack of concentration in general. There is no specific or published literature and/ or research on the staircase quality and accidents in Uganda despite such problems existing. However, according to the statistics obtained from Mulago National Referral Hospital (2022) from a sample of 1000 patients that visited the hospital between 2017 and 2019 as recorded on the patient index cards, 24 (2.4%) of the patients in this sample were due to accidents on staircases.

Design of quality staircases takes into consideration the requirements and specifications stipulated in Building Standards, Codes, Regulations and Acts. The following requirements are necessary in the analysis of staircases for conformance with the standards (Bright, 2017).

- The width of a staircase should be as wide as possible but not less than 1000mm between handrails or supports.
- The minimum rise of a public staircase should be 150mm while the maximum should be 170mm.

- The respective dimensions of the treads and risers for all the parallel steps should be the same in consecutive floors of a building.
- The minimum length of a going should be 250mm while the maximum should be 320mm.
- The minimum gait or slope relationship (2R+G) should be equal to 550mm while the maximum should be 700mm.
- The minimum headroom above any step should be 2000mm.
- Handrails:
  - Where the staircase has more than 3 risers, there should be provision of handrails.
  - The handrail height above the pitch line should be greater or equal to 900mm and less or equal to 1000mm.
  - Handrails should be terminated downwards or into the wall or by returning back.
  - Handrails should be continuous along the full length of each stair flight or ramp run and should extend at the bottom by at least a full stair tread while at the top by at least 300mm from the last/first riser nosing respectively.
  - Handrails should have a minimum diameter of 32mm and a maximum of 50mm.

The handrails serve multiple functions including visual cues to the stairway's presence, directional guidance, postural stability, fall mitigation, and reducing conflicts in ascent or descent by cueing stair users to stay to the side, usually to the right on stairways. When they are not included, loose or broken, accidents are likely to happen.

- The staircase should be guarded at the sides where the total rise is greater than 600mm.
- To permit for safe passage, the steepest slope of a ramp to cater for persons with disabilities should be 1:12.

- An intermediate landing shall be provided in between floor levels at intervals of not more than 16 rises.
- No flight of stairs shall exceed 12 steps in any flight; any intervening landings shall have a minimum length of 690mm except when the landing extends for a length of not less than 1200mm. No stairway shall exceed two flights without a turning.
- The location of the staircase should be such that it is centrally accessible from every corner of the building. Light and proper ventilation should be available.
- The pitch of the staircase should not exceed 42^o and not less than 30^o.
- The staircase surface (risers and treads) should be opaque to avoid reflections.
- There should not be overhangs in treads which are 280mm or deeper.
- The minimum depth of the contrast of the nosing area should be 50mm and the maximum should be 75mm.
- Fire escape staircases shall be provided in occupancies other than residential exceeding two storeys above ground level. These shall be positioned on the outside of the building or occasionally inside but separate from the main areas of the building.
- Tiles must not be loose, worn-out, or improperly installed as these would also make the stairway unsafe. Placing rugs at the top or bottom of the stairs can also increase the risk of a fall because they may trip users.

Conformance of the staircases to these requirements is a must if the quality is to be attained.

In this research study however, structural design that deals with the analysis of the staircases to obtain the loadings, flexural design, checking for deflections, shear and reinforcement details were not investigated.

2.4.6 Architectural Design of Stairs

Before the consitruction of staircases, a design has to be done to determine the number of risers, risers heights and tread width of stairs and it is done as follows:

(a) **Risers**. The number of risers is calculated by considering the total floor to floor height called the staircase height. Therefore;

Number of risers = $\frac{Staircase\ height}{Height\ of\ one\ riser}$

(b) Treads. The number of treads = $Number\ of\ risers\ -\ 1$

Tread width = $\frac{Horizontal\ clear\ span\ between\ landings}{Number\ of\ treads}$

The ideal ratio of the riser height to tread width should be 2:1.

(c) **Slope of the stair.** This is determined by considering the total stair rise and the total tread width.

Therefore;

Slope = $tan^{-1}\left(\frac{\text{Total stair rise}}{\text{Total tread width}}\right)$

2.4.7 Other Design Factors that Affect the Quality of Staircases

Other factors that affect the quality of staircases include tactile ground surface indicators/warning signs (TGSIs). These are used by persons who are vision impaired to detect the existence/presence of staircases in the buildings.According to the approved document M of the UK Building Regulations (2010) and accessibility standards (2010) as produced by the Uganda National Action on Physical Disability (UNADP) in collaboration with the Ministry of Gender, Labour and Social Development (MoGLSD), provision should be made in the building for these facilities which should be placed at the beginning and end of the stairs and the ramps.

TGSIs are in three types and include; warning TGSIs, directional TGSIs and Integrated TGSIs. TGSIs are installed on pedestrian surfaces to assist in the orientation of the vision impaired and give tactile warning so that they may safely navigate the buildings. Classic Architectural Group (2018) describes the three types of TGSIs as follows;

Warning tactile indicators, also known as hazard tactile indicators are textured surface features applied to the walking surfaces that are intended to function much like a stop sign. They alert pedestrians who are blind or vision-impaired to hazards in their line of travel; indicating that they should stop to determine the nature of the hazard before proceeding further.

Directional tactile indicators, also known as leading tactile indicators are textured surface features consisting of directional bars applied to walking surfaces to give directional orientation to people who are blind or who have low-vision. Directional tactile indicators help vision-impaired people to navigate in open spaces and designate the continuous accessible route to be taken. These indicators also guide people who must deviate from the continuous accessible path of travel, allowing them to safely access a crossing point, public transport access point or the entrance to a significant public facility.

Integrated tactile indicators, are those in which the raised buttons or directional markers are integrated into a paver or tile. The raised sections of the TGSIs are of the same colour as the background tile.

According to Classic Architectural Group (2018), the following are the types of materials used for TGSIs; Polyurethane tactile indicators, stainless steel tactile indicators, brass tactile indicators and aluminium tactile indicators.

It is noted that tactiles alone will not make an unsafe environment safe. Therefore, there is need for good design and planning for public spaces with tactiles playing an important secondary role in providing vital warnings and directional information to the vision impaired.

2.5 Design Review

Design review in general is an important aspect towards obtaining quality in construction projects. According to the Community and Government Services (2013), the purpose of design review in construction projects is to finalize design related issues, technical criteria, technical performance objectives, and budget forecasts so that the contract documents can be prepared.

According to (Prieto, 2020) design reviews of final drawings and specifications help to:

- confirm that client and regulatory requirements are met;
- confirm that quality requirements to be met by suppliers and construction are clearly and completely specified; and
- confirm that enough detail is provided to ensure the quality of the final output meets the client's requirements and the business basis of design.

Design reviews in project management therefore help to improve on the quality of the final output for the client's satisfaction.

2.6 Construction of Staircases

The quality of staircases in public buildings can be affected by the method of construction and workmanship. It is possible that the designer or architect designs a very good staircase yet poor workmanship during implementation causes it to lose the desired quality. Proper setting out of the staircases with appropriate formwork cut to the required dimensions will enable the construction of good quality staircases. During construction, it is essential to keep the dimensions of the treads and risers constant throughout any flight of steps to reduce the possibility of compromising the quality of the entire staircase (Chudley, 2006). Care must be taken when setting out the staircases.

Good quality staircases must be constructed using non-combustible materials though combustible materials are allowed to be used as finishes to the upper surface of the staircase or landing. Reinforced concrete staircases are non-combustible, strong and hard wearing. The concrete used in the construction of reinforced concrete staircases should be of a very strong mix ratio such as 1 : 1½ : 3/10mm aggregates. The water/cement ratio being greater than 0.5, otherwise concrete will flow over the formwork. Mild steel or high yield steel bars are used to reinforce concrete stairs, the bars being lapped to starter bars at the ground floor and taken into the landing or floor support slab. The materials for use in the flooring of staircase surfaces which influence quality were investigated as well in this study that included terrazzo, glossy tiles, non-slip tiles, cement/sand screed, timber, mild steel plates, granite, slates, carpets and laminated flooring.

Other factors that were investigated under implementation of construction activities of staircases included client demands. According to Kakitahi et al. (2012), the client determines and expresses the requirements to all participants under the project and provides leadership to all participants in transforming the requirements into a completed facility. Therefore, if the client is unable to communicate these requirements effectively, there are bound to be unncesarry demands and/ or changes during the implementation stage of the project which in most cases affects the quality of the entire building when inplemented. The extent to which these demands contribute to the quality of staircases was of paramount importance in drawing conclusions on the factors that influence the quality of staircases in public buildings.

2.7 Supervision and Control during Construction

The quality of both the building product and the construction process is the satisfaction of a whole range of performance criteria owned by a range of internal stakeholders and mediated by a range of mechanisms from regulations to market forces (Barrett, 2000; Winch, 2010; cited in Kakitahi *et al.* (2012). Poor quality work during implementation stages of any building contract can be as a result of inadequate supervision of the different phases of the project. This is therefore an important factor which was also investigated. The factors that were investigated in this research study under supervision and control included; Inadequate supervision for the operatives by the contractor, corruption, inadequate supervision of the contractor's work by the consultants/site supervisors, inconsistent instructions issued on site by the supervisors, inexperienced site supervisors and changes made on the drawings by the architect during the construction process.

According to Hampson and Sherif (2001) in their study on the effect of quality supervision on rework in the Indonesian context, all project managers agreed that the effectiveness of supervisors' efforts is judged by how well they manage each phase during the construction process and by the value of the end products or services produced. This team also states that from their findings, it was strongly agreed that inexperienced supervisors and lack of labour skill are major causes of rework. In this case, rework is as a result of quality problems in which work is deemed complete but not to the satisfaction of the client (Hampson and Sherif, 2001).

Ogundipe *et al.* (2018)in his research study on assessing the impact of quality supervision on construction operatives' project delivery in Nigeria state that though skilled operatives are knowledgeable in their area of specialization but adequate supervision on application of materials and other components of buildings would help them to correct quite a number of errors before they escalate into exorbitant damages on sites. Different aspects of supervision on construction sites therefore need to be further investigated to give a clear picture and determine the extent to which these factors influence the quality of construction work in particular during the construction of staircases in public buildings in the Ugandan context.

2.8 Operation and Maintenance (O & M)

During their use, the staircases must maintain their quality to prevent the occurrence of accidents. Nagata (1991) includes maintenance factors as part of the major causes of staircase accidents which includes the presence of broken edges on steps, damaged handrails/balustrades and torn or loose coverings on staircase surfaces. Environmental factors including the presence of obstacles and lubricating materials on the steps would cause accidents though these were control factors as investigated in the study. The existence of such factors affects the quality of staircases during their use. For the quality of staircases to be maintained during their use, there is need for preparation of maintenance plans which help in making schedules aimed at ensuring that the staircases are clean, free from obstacles and broken parts or features are repaired/replaced as soon as they occur.

2.9 Individual User Factors

According to Nagata (1991), human and behavioural factors are also classified as major causes of accidents on staircases. In his research study, some of the human factors that caused accidents on staircases included unstable footwear, dark glasses and long trousers while behavioural factors included holding objects, running, reading, chatting and looking at a watch.

In this study on the quality of staircases, these individual user factors have been investigated as moderator variables rather than independent variables since the study is looking as mainly compliance to design and construction requirements short of which accidents are bound to occur on the stairs.

2.10 Knowledge Gaps in the Literature

There was no evidence of published literature or research studies carried out on the staircase accidents in Uganda. This left a gap for investigation which this research study sought to address. There was also no evidence of detailed literature on the transversely and longitudinally supported stairs but since this was not the main area of study, this has just been illustrated partially.

Nagata (1991) made an analysis of occupational injuries while walking on stairways and the causes associated with the accidents. This study was based on labour casualty reports in which 1486 stair accidents from greater Tokyo were analysed. In this research, design factors as causes of accidents included; type of stair flights, tread and riser dimensions as well as tread flooring materials. The design factors in this research were only mentioned as causes of staircase accidents with no further discussion on how these factors led to accidents.

Mcgann *et al.* (2015)carried out a research study on workplace stair design and use where there was a comparison between staircase quality and physical activity in three buildings. The researcher used the architectural method as one of the methods in the study. Three buildings were comparatively considered as follows:

Building 1 had attractive, well-lit and comfortable staircases. Buildings 2 and 3 in contrast had stairs which were more problematic to use. All the three staircases in Building 1 had an excellent spatial quality and attractiveness. These were brightly lit by large windows and had views to the outside. The staircases were spacious and had open feeling. Attractive fixtures and finishes had been used. The staircases were clean and well maintained.

Building 2 had one main staircase external to the building and two secondary internal staircases. One of these joined level two to level three. The second stair joined levels three and four to the outside of level two. The last staircase was somewhat hidden down one of many corridors rather than located on a major thoroughfare: as a result, it was not much used. The main, external staircase had some aesthetic quality, being open to views, fresh air (although also rain, cold or heat depending on the season). The stair treads were of a comfortable size. The two internal stairs were narrow and dark with no natural light or attractive quality. All the three stairs were in reasonable condition and cleanliness.

Building 3 staircases were accessed from narrow corridors which branch from the main corridors of the building. The door to the staircase was painted the same emergency red as the door to the fire equipment cabinet. Inside staircase was lit artificially as there were no windows. The aesthetic was in keeping with the 'brutalist' architectural style – which with its simple and raw materials and form (in combination in this case with a lack of windows) was unlikely to appeal to a lay audience. The inside of staircase doors had signs which explained what to do if you got locked in, suggesting that this had happened with some frequency. From the analysis, it was found out that since the staircases in building 1 were of much better quality than those of buildings 2 and 3, the participants in building

1 recorded the highest mean level of physical activity which is consistent with the exertion of walking quickly or going up and down stairs.

Whereas the research tried to relate the architectural design of stairs in the buildings in terms of their quality to physical activity, the factors only contributed to the use of the staircases rather than a solution to the effects of poor quality staircases on the users due to design problems. The tread size was mentioned as "comfortable size" without giving specific sizes which made the stairs comfortable. The internal stairs for Building 2 were described as narrow without stating the dimensions that made them to be categorized as narrow. The researcher also concluded that further exploration into movement behaviours of workers viewed through a lens combining both health and design perspectives is needed.

It was noted that different literature and design standards across the globe gave different design requirements for the staircases including those in the UK Building Regulations, International Building Code (IBC), BS 5395, Occupational Safety and Health Administration (OSHA), Building Control Regulations (Uganda) and Public Health Act (Uganda). For example, the UK Building regulations specify the minimum riser to be 150mm and maximum of 170mm while BS 5395 specifies the minimum riser to be 150mm and maximum to be 180mm for normal use stairs. On the same requirement, the Building Control Regulations (Uganda) only specifies the maximum of 170mm but not the minimum. Also, the International Building Code (IBC) specifies the minimum tread depth as 279mm (11") and with no specified maximum value while the Occupational Safety and Health Administration (OSHA) specifies the minimum tread depth as 240mm

(9.5”). Even within the Ugandan regulations and standards, there were some variations on the riser and tread depth requirements.

In respect to the handrail height requirement, UK Building Code specifies 900mm as minimum, 1000mm as the maximum which match with the BS 5395. OSHA specifies 762mm (30”) and 965mm (38”) for the minimum and maximum handrail requirement while IBC specifies 863mm (34”) and 965mm (38”) respectively. Other parameters that varied in dimensions for the different codes included; the staircase slope, headroom, handrail diameter, handrail encroachment, spacing of the balusters and handrail extension beyond the last tread at the bottom and top of the staircase flights.

It was noted that the variations are due to the strictness in the standards depending on the country, the type of stairs and location in which some are found typically in areas that are open to the public and have much higher traffic as with the case of IBC design requirements.

These knowledge gaps in the existing literature therefore informed the field study in which the study addressed the health and design perspectives, minimum and maximum requirements for categorization as well as providing more literature.

2.11 Chapter Summary

This chapter highlighted the details and the literature necessary in the study. It included the introductory part of the chapter after which the design of staircases as a key factor in the study was discussed. The factors that are considered during the selection and design of staircases were also explicitly discussed. The features, terminologies and the types of stairs that are considered to bring about beauty, safety and quality of the staircases were also included.

The construction and maintenance aspects in relation to quality of the staircases have also been highlighted. Comparison with other related studies like that of Nagata (1991) have been made in relation to this research study. Other literature from Ogundipe *et al.* (2018) and Kakitahi (2012) has been brought in to strengthen the literature review.

The chapter concluded with knowledge gaps in the literature in which it was noted that different literature across the globe gave different design requirements for the staircases including those in the UK Building Regulations, International Building Code (IBC), BS 5395, Occupational Safety and Health Administration (OSHA), Building Control Regulations (Uganda) and Public Health Act (Uganda).

CHAPTER THREE : RESEARCH METHODOLOGY

3.1 Introduction

This chapter highlights the techniques which were used in obtaining the necessary data for analysis.

3.2 Research Design

In this study, both experimental and descriptive research designs were adopted. Experimental research design involved on-site measurements to collect as-built data which were analysed to determine how they impact the quality of the staircases. The experimental design was adopted because it offers the highsets level of control over the variables and it enables the isolation of specific variables. The descriptive research design included the use of questionnaires to investigate the factors that influence the quality of staircases and the impact of poor quality staircases on the users. Descriptive design was selected because it helps in comparing variables and validating the exsting conditions.

3.3 Research Approaches

The quantitative research approach was adopted in data collection. It took into account the various parameters and features used in the construction of quality staircases. As-built data on the staircases were also collected which were used to make comparisons between the measured values and the standard requirements as laid down in Building Codes, Regulations, Acts and Standards.

3.4 Data Sources

Both primary and secondary data were collected. The primary data were collected using direct self-administered questionnaires, onsite measurements and observations on the staircases. The secondary data were collected from the selected universities, National

Council for Higher Education (NCHE) and Mulago National Refferal Hospital using request and introductory letters. Standard requirements for staircase design and construction were obtained from Building Codes, Regulations, Acts and Standards.

3.5 Development of Data Collection Tools

The literature obtained from published reports, journal articles, text books, Building Codes, Regulations, Acts and Standards, published research studies and other dissertations from the previous Masters students guided in the development of data collection tools. The specific survey tools used included:

(a) **Technical survey tool:** Physical measurements were conducted using a tape measure and a technical survey tool to obtain the relevant data which were compared with the recommended requirements in the Building Codes, Regulations, Acts and Standards for conformance.

(b) **Observational survey tool:** Observations were made to record the state of the staircases in the respective storeyed buildings including all the existing features on the staircases.

(c) **Questionnaires:** These involved the use of questionnaires which were self-administered to the users of the selected buildings in the respective universities and technocrats who had participated in the construction of such buildings to collect the necessary data for analysis. This involved the use of self-administered staircase design and construction survey questionnaires as well as the staircase user survey questionnaires.

3.6 Study Population

Central region has 28 accredited universities (both private and government) as per the list obtained from National Council for Higher Education (NCHE). Five (5) universities representing 18% were selected for the study based on the number of storeyed buildings in the universities with at least 5 buildings and if they were less than 5, then the buildings must have had at least 4 floors. This percentage of the number of buildings was appropriate as it would give more depth to the study. The universities through the Estates and Works Departments/Directorates provided the information on the number of buildings including those with the highest and lowest number of floors. They also provided information on the details of the designers, contractors and supervisors who participated in the construction of some of their storeyed buildings.

3.7 Sampling Techniques

The respondents were sampled using the purposive technique based on the respondents that were using or have ever used the staircases in the selected buildings and those that have been involved in the design and construction of such public buildings.

The selection of buildings to be studied in each University was determined using the purposive sampling technique depending on the buildings visited or used by students, clients and employees most such as the senate buildings and lecture blocks. In universities where the senate is not hosted on storeyed buildings, other storeyed buildings which host various categories of people were considered.

3.8 Sample size

The size of the sample was determined using the Cochran's formula;

$$n_o = \frac{z^2 \times p \times q}{e^2} \qquad \text{Equation (3.1)}$$

Where;

n_o = Sample size

e = Desired level of precision or margin of error

p = Estimated proportion of the population

$q = 1 - p$

z = a value got from the Z table

In this study and from the Cochran's formula, it was assumed that at least 50% of the occupants of the selected storeyed buildings had used the staircases for access to the buildings with a 95% confidence interval and 6.5% margin of error.

Therefore;

$p = 0.5$,

$q = 1 - 0.5 = 0.5$ and therefore, Z-value = 1.96

$e = 6.5\% = 0.065$

$$n_o = \frac{1.96^2 \times 0.5 \times 0.5}{0.065^2}$$

The sample size, $\boldsymbol{n_o = 227.3 \cong 227}$ respondents

Total number of buildings analysed = **24**

Number of staircase user respondents expected per building = $\frac{Sample\ size}{Number\ of\ buildings}$

$= \frac{227}{24} = 9.4$

$\cong$ 9 respondents.

Total number of staircase user respondents = $9 \times 24 = 216$

Number of respondents for the staircase design and construction questionnaire = 22

The total number of respondents expected from the survey = 22+216 = 238

Table 3.1: Sample size determination

S/N	Region	University	Number of buildings	Number of respondents
A.	**Staircase users/occupants**			
1.	Central region	1. Makerere University	6	45
		2. Kyambogo University	6	74
		3. Kampala International University	5	50
		4. St. Lawrence University	2	13
		5. Ndejje University	5	30
	Subtotal		**24**	**212**
S/N	**Construction team**		**Number of respondents**	
B.	**Staircase Design and Construction team**			
1.	Clients		4	
2.	Designers		5	
3.	Contractors		6	
4.	Supervision consultants/Site supervisors		7	
5.	**Subtotal**		**22**	
6.	**Total number of respondents expected from the survey**		**234**	

However, a total of 234 respondents participated in the surveys which gave a response rate of 98.3% as it was difficult to get the exact number as expected because some were not willing to participate in the survey citing busy schedules while others were given questionnaires but did not return them.

3.9 Reliability of Data

The data were tested using the Cronbach's Alpha, α. The value of this coefficient ranges from 0 to 1 and the higher the value, the more acceptable the results were. Table 3.2 shows the expected internal consistency of the Cronbach's alpha values.

Table 3.2: Internal consistency of Cronbach's Alpha

Cronbach's Alpha value	**Internal Consistency**
$\alpha \geq 0.9$	Excellent
$0.8 \leq \alpha < 0.9$	Good
$0.7 \leq \alpha < 0.8$	Acceptable
$0.6 \leq \alpha < 0.7$	Questionable
$0.5 \leq \alpha < 0.6$	Poor
$\alpha < 0.5$	Unacceptable

Source: George and Mallery (2003)

The Cronbach's Alpha for the data was computed using and gave the results in *table 3.3*.

Table 3.3: Cronbach's alpha of the data

	Factors	**No. of Items**	**Cronbach's Alpha**
A	Participation in staircase design, construction and supervision of public buildings	6	0.740
B	Factors that influence the quality of staircases in public buildings during the design and construction	16	0.800
C	Major indicators of staircases that do not meet quality standards	20	0.817
D	Recommended materials for floor finishing of staircase surfaces in public buildings	11	0.744
E	Staircase user survey	12	0.842

The data was considered reliable as the Cronbach's alpha for the measured factors was above 0.7 which showed acceptability as indicated in Tables 3.2 and 3.3.

3.10 Validity of the questionnaires

The validity was tested by computing the Content Validity Index (CVI) as shown in Table 3.4. The data that had a CVI greater than 0.6 was considered valid.

Table 3.4: Content validity index for the data

	Factors	No. of Items	Content Validity Index
A	Participation in staircase design, construction and supervision of public buildings	6	0.833
B	Factors that influence the quality of staircases in public buildings during the design and construction	16	0.875
C	Major Indicators of staircases that do not meet quality standards	20	0.850
D	Recommended materials for floor finishing of staircase surfaces in public buildings	11	0.818
E	Staircase user survey	12	0.917

All the data from both questionnaires was considered valid as the CVIs of the factors measured were greater than 0.6 which showed acceptability.

3.11 Analysis of Results

The results were analysed as follows:

The data obtained in the observational survey were analysed using spread sheets from which charts were drawn to show the representation of the data. The data from the design and construction survey were analysed using the Statistical Package for Social Scientists (SPSS) in which means, standard deviations, loading factors, variances and eigen values were obtained which were used to draw conclusions. The factors which had loadings factors of 0.5 were eliminated. The specific factors that affected the quality of the staircases investigated under the design and construction survey were grouped into four categories including design proficiency, construction competences design reviews and other projects factors. The data obtained from the technical survey was analysed using spread sheets to determine the conformance rates of staircase parameters and features to the established standards.

After developing the performance framework, the universities were then ranked according to the quality of staircases based on all the buildings in a particular university. This was done by computing the compliance rates from the performance framework in Table 4.34. Each tick (✓) from the framework represented compliance while a cross (x) represented noncompliance of parameters to the design and contruction requirements. The percentages were calculated as follows:

$$\text{Compliance (\%)} = \frac{Number\ of\ ticks\ repersenting\ compliance}{Total\ number\ of\ staircase\ parameters\ for\ that\ univesity} \times 100$$

The total number of parameters included all the ticks and crosses for each of the universities. The quality was then ranked based on the highest compliance rate. The higher the compliance rate, the better the quality.

The data collected from the user survey was analysed using spread sheets and the variables involved were compared on a cause-effect relationship to test the extent to which staircase quality was affected by various factors.

3.12 Ethical Considerations

The following ethical considerations were made in the research study;

Introductory letters which were written by the Head of Department, Civil and Environmental Engineering were sent to the respective study universities.

Confidentiality agreements were also signed and acceptance letters given before the student was allowed to conduct research in the sampled universities.

The universities and buildings studied were assigned codes e.g. RU001 (Research university number 001) and RU001-BLDG101 (Research university number 100, building number 01, university 1) which were indicated on the survey tools whose identities were only known to the student for confidentiality purposes.

To ensure confidentiality, the questionnaires had a statement which indicated that the information obtained was for study purposes only.

3.13 Chapter Summary

In this chapter, the research design and approaches that were used in the study have been fully discussed. It highlighted how the sample size of the study population was determined. The reliability and validity of the data were also discussed. The methods used in data analysis have been fully been described in this chapter showing how the study was conducted and data obtained for analysis from which conclusions and recommendations on the study were drawn.

CHAPTER FOUR : PRESENTATION, ANALYSIS AND DISCUSSION OF FINDINGS

4.1 Introduction

The research findings from the survey tools and questionnaires which included technical survey tool, observational survey tool, staircase user survey questionnaires and, staircase design and construction survey questionnaires in line with the research objectives and questions are presented and discussed in this chapter. The discussion is based on the analysis made on the findings using Statistical Package for Social Scientists (SPSS) and Ms Excel.

4.2 Nature of the Respondents

4.2.1 Staircase User Respondents

The respondents for staircase user survey were mainly those who were found or were thought to have used the staircases in the respective buildings including students and employees of the universities. Others were university clients and visitors. Table 4.1 shows the respondents for the staircase user questionnaire.

Table 4.1: Staircase user respondents

Category		Yes	No	Total
Employees	Number	78	3	**81**
	%age	38.0	42.9	**38.2**
Students	Number	119	1	**120**
	%age	58.0	14.3	**56.6**
Clients	Number	6	2	**8**
	%age	2.9	28.6	**3.8**
Others	Number	2	1	**3**
	%age	1.0	14.3	**1.4**
Total	**Number**	**205**	**7**	**212**
	Sample %age	**96.7**	**3.3**	**100.0**

From Table 4.1, out of the 212 staircase user respondents, 56.6% of the users were students who were the majority, 38.2% were employees of the universities while only 3.8% were clients and 1.4% represented other categories like visitors and interns. The respondents that had used staircases of the selected buildings were 96.7% while 3.3% had not used them. Of those who had used the staircases in the buildings, 58% were students, 38% were employees, 2.9% were clients while 1.0% were other categories. The higher percentage of students was attributed to the category of buildings selected which were mostly lecture rooms in which several students responded positively to the study. The lower percentage of employees as respondents in this category were mainly found in buildings which had administrative offices like the senate, receptions of lecture blocks and other offices in lecture blocks/colleges/faculties/departments of the universities.

Clients of the universities who were found to be only 3.8% do not stay at the universities and therefore only came when there was business to transact. The lowest percentage of responses (1.0%) was from other categories like visitors and interns who did not consider themselves under the other three categories. These interns and other visitors were also staircase user respondents as they were found within the confines of some buildings within the universities selected for investigation.

4.2.2 Staircase Design and Construction Respondents

The respondents for staircase design and construction survey questionnaire were architects/designers, contractors, supervision consultants/site supervisors and clients who were mainly represented by the Estates Engineers. Figure 4.2 shows a pie chart for the staircase design and construction respondents.

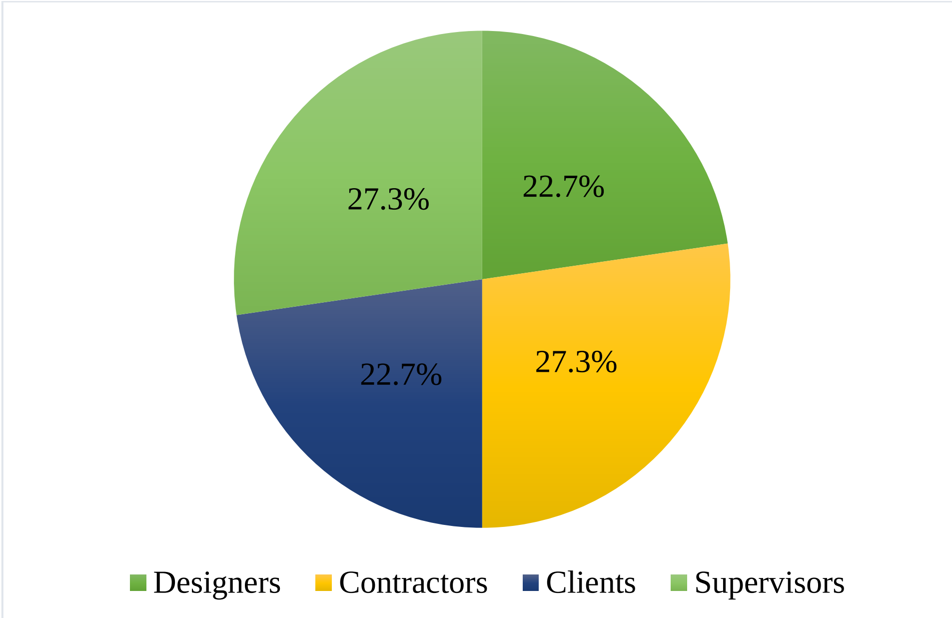

Figure 4.1: Design and construction respondents

The respondents of the design and construction survey revealed that 22.7% were designers who were mainly architects. 27.3% were contractors, and 27.3% supervision consultants respectively while 22.7% were clients in which the Estates Engineers took part in the survey on behalf of the universities as clients. The results represent an equal percentage of contractors and supervision consultants who participated in the survey represented by a slightly higher percentage compared to the clients and designers whose percentages were also the same. The higher percentage of the contractors and supervision consultants was aimed at making a fair analysis from the responses given compared to when one category is involved in the survey. It was expected that each university proposes two contractors, two supervision consultants and two designers/architects together with one client represented by the Estates Engineer of the university. However, this was not achieved as some universities did not propose any of the categories from the building team including none response from some of the universities themselves. In some universities, it was found that the supervision of the construction works had been done by the Estates Engineers thereby reducing the number of respondents expected.

4.3 Age of the Respondents

4.3.1 Staircase User Respondents

The age distribution by gender of the staircase users was as represented in Table 4.2.

Table 4.2: Age distribution by gender of the staircase users

Age group distribution		*Gender*		Total
		Male	**Female**	
18-30 years	Number	68	52	120
	%age	54.0	60.5	56.6
31-45 years	Number	34	21	55
	%age	27.0	24.4	25.9
46-60 years	Number	24	13	37
	%age	19.0	15.1	17.5
Total	**Number**	**126**	**86**	**212**
	Sample %age	**59.4**	**40.6**	**100.0**

From the survey, 126 users representing 59.4% of the total number of the user respondents were male while 86 (40.6%) were female. The majority of the staircase users were between 18 and 31 years of age with 120 (56.6%). The majority of the staircase users were between 18 and 31 years of age with 120 (56.6%). The females in this age group were 60.5% while 54.0% of the males were in this age group. These represented the largest number of male and female respondents in the study. Age group 31 – 45 years were lower represented by 55 (25.9%) as these were mainly employees with 27.0% of the males being in this age group and 24.4% of the females being in the same group. 37 users representing 17.5% of the user respondents were between 46 and 60 years of age who were also employees of the Universities with 19.0% of the males and 15.1% of the females lying in this age group.

The age group of 18 – 30 years was the majority because many buildings were used as lecture rooms and the students who fall in this age group were easily available for the study. Age group 31 – 45 years were lower represented by 55 (25.9%) as these were mainly employees in which some of them were not willing to participate in the survey. Some of them did not give back the questionnaires as expected citing busy work schedules. The user respondents between 49 and 60 years of age who were also employees of the universities were 37 representing 17.5%. The respondents in this age group were least as most of them are in higher positions of administrataion and could not be reached. Their subordinates were the ones available for the study who fall in the other age groups.

4.3.2 Staircase Design and Construction Respondents

The ages of the design and construction respondents were as distributed in Table 4.3. These were mainly employees of the companies that participated in the survey.

Table 4.3: Age distribution by gender of the staircase design and construction respondents

Age group distribution		*Gender*		**Total**
		Male	**Female**	
18-30 years	Number	3	3	6
	%age	17.7	60.0	27.3
31-45 years	Number	11	1	12
	%age	64.7	20.0	54.6
46-60 years	Number	3	1	4
	%age	17.7	20.0	18.2
Total	**Number**	**17**	**5**	**22**
	Sample %age	**77.3**	**22.7**	**100.0**

The results in Table 4.3 showing the age distribution of the design and construction respondents indicated that 77.3% were male while only 22.7% were female respondents. Within the age groups, respondents with the ages between 31 and 45 years were the majority with 54.6% with 20.0% of females being in the group while males were 64.7%. Respondents with the ages between 18 and 30 years were second representing 27.3% with

60.0% of the females being in this age group and males being 17.7%. Those with ages between 46 and 60 years followed at 18.2% having 20.0% of females in the group and males being 17.7%. There was no respondent with the age of over 60 years. The predominance of age group 31 – 45 years was due to the fact that in the workplaces, this is the prime age group with much higher productivity and experience which is so important in the workplace hence giving the majority.

For age group 18 – 30 years, the number of these respondents in workplaces is slightly lower as some of them are still studying (18 – 22 years) while others are just beginning to access gainful employment (23 – 30 years). The absence of the respondents of over 60 years of age is due the fact that most employees retire at the age of 60 years and only given contracts especially in public universities. Also in private companies, most employees at this age are the Managers/Chief Executives in the companies and therefore coul not be accessed for response. The female respondents were fewer (22.73%) as some of them would not want to waste time on the questionnaires. Some of them also did not know what to expect from the questionnaires and therefore did not want to participate leave alone even looking at the questionnaire.

4.4 The existence of Key Features Recommended for Quality Staircases

This was analysed basing on the various features that were used on or are recommended for use on the stairs as discussed in the following subsections (4.4.1 – 4.4.12).

4.4.1 Types of Stairs Used in the Selected Buildings

According to the classifications by the approved document K of the UK building regulations (2010), the stairs in the buildings were categorized as utility stairs and easy access stairs. Utility stairs were represented by 14% of the total number of stairs while easy access stairs which were the majority were represented by 86%. The easy access stairs were used as general access stairs for the day-to-day movement of users from floor to floor in the buildings while the utility stairs were mainly used as escape or emergency stairs for the occupants of the buildings. Staircases BLDG 101-2 (No. 2), BLDG 101-3 (No. 3), BLDG 101-4 (No. 4), BLDG 101-5 (No. 5), BLDG 103-2 (No. 10), BLDG 201-2 (No. 20) and BLDG 504-2 (No. 49) as seen in Appendix 2 were the utility stairs while the rest were easy access stairs. In addition, the buildings had various types of stairs depending on what the designer wanted and the site conditions as shown in Table 4.4.

Table 4.4: Types of stairs that were in the buildings under study

Type of stair	**Number**	**Percent**	**Cumulative Percent**
Half turn stairs	27	54.0	54
Double L stairs	13	26.0	80
Straight run stairs	3	6.0	86
Spiral stairs	2	4.0	90
Bifurcated stairs	2	4.0	94
Double L stair and half turn stairs	1	2.0	96
Half turn and winder stairs	1	2.0	98
Quarter turn and half turn stair	1	2.0	100
Total	**50**	**100.0**	

The most common type of stairs used in the buildings under study were the half turn stairs which represented 54% of the total number of stairs. The second most common type of stairs were the double L stairs with 26% of the total number of stairs studied. Other types of stairs used in the buildings under study included straight run stairs with 6% and spiral stairs at 4%. Bifurcated stairs were represented by 4%, double L used along with half turn stairs were represented by 2%, half turn used along with winder stairs at 2% and quarter turn used along with half turn at 2%. The predominance of the use of half turn stairs in buildings has an advantage of having a wider resting point from one flight to the next.

The use of double L stairs in buildings is due to their two 90^o turns which make it safe for the users in case of a fall on the stairs. These were the second predominantly used stairs in the buildings under study. They consist of three flights between floors where the use of two flights would have been uneconomical or unsafe for the users as there would be many more steps than recommended in the flights.

The use of spiral staircases in the buildings under study was limited as these were only used in few isolated buildings which was represented by 4.0%. In one of the buildings, the spiral staircase was used as an emergency stair from the ground floor direct to the second floor externally while another was used to link the ground floor to the first floor internally on one side of the building. Bifurcated (split) stair which was not common was used where there was enough space to cater for the splitting of the stair at the landing on each of the floors.

Other types of staircases indicated in Table 4.4 with 2.0% each were used to blend the different types of stairs within the same staircases. For example, on staircase No. 46 (BLDG 503-1), double L stair was used between the basement floor and the ground floor while the rest of the floors had half turn stairs. This led to the categorization of the staircase as double L and half turn stair. Also, on staircase No. 50 (BLDG 505-1), half turn stair was used but due to limited space/height as the steps went up the balcony, the last flight was changed to winder stair thereby categorizing the stair as half turn and winder stair.

The last type of stair case was categorized as quarter turn and half turn stair. This was used on staircase No. 9 (BLDG 103-1), the staircase started with the quarter turn in the basement and changes into half turn on the ground floor up to the top floors hence the categorization.

4.4.2 Tactile Ground Surface Indicators/Warning Signs (TGSIs)

From the observational survey, all the staircases and ramps did not have tactile ground surface indicators thereby limiting access for persons who are vision impaired which rendered the access facilities to be of lower quality. This means that such persons would require guidance and support from other people to access the upper floors of these buildings.

According to Bright (2017) and Uganda National Action on Physical Disability (2007), provision should be made in the buildings for these facilities which should be placed at the beginning and end of the stairs and the ramps.

However, from the study, it was found out that no building had TGSIs. This meant that persons who are vision impaired cannot access such buildings or they have to be supported in order to access them. Exclusion of these features on all staircases makes them to be hazardous and a potential risk in causing accidents.

4.4.3 Balustrades

The balustrades are important as they support the handrails and prevent users from falling off the stairs from the open ends. Figure 4.4 below shows a pie chart showing the existence of balustrades on the staircases.

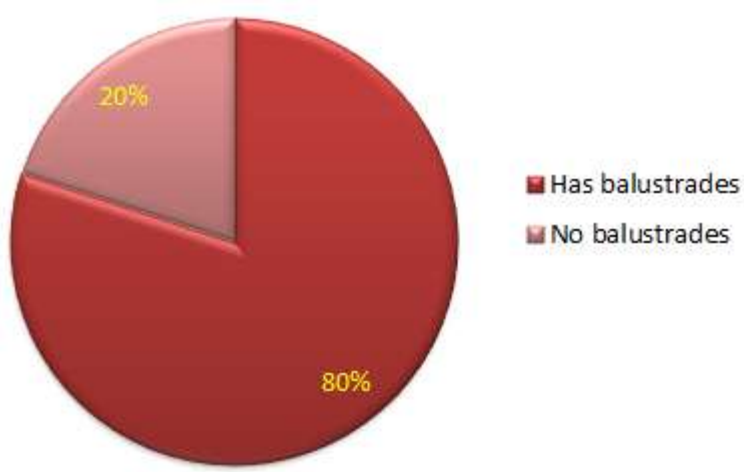

Figure 4.2: Existence of balustrades on stairs

Twenty precent of the staircases did not have balustrades. Despite 20% not having the balustrades, 30% of the stairs that did not have balustrades were supported between walls along the flights. The balustrades used on staircases were mainly made of mild steel hollow sections of sizes 25mm × 25mm with a spacing of 100mm centre to centre. Some stairs had balusters of 12mm diameter bars spaced at 100mm centre to centre. Balusters on some other stairs were spaced at different spacings like 130mm, 200mm, 120mm and 150mm centre/centre. Stairs that had balusters that did not meet the minimum spacing were represented by 8%. According to the Building Regulations, the spacing between the balusters should not permit a sphere of 100mm to pass through. It was noted that 72% of the staircases had balustrades that met the minimum requirements.

4.4.4 Handrails

The inclusion of handrails on the staircases helps the users to support themselves while going up and down the stair. Table 4.5 shows the existence of handrails on the staircases.

Table 4.5: Handrails on the staircases

Description	**Number**	**Percent**	**Cumulative Percent**
Handrails on one side	34	68.0	68.0
Handrails on both sides	14	28.0	96.0
No handrails	2	4.0	100.0
Total	**50**	**100.0**	

It was noted that 96% of the staircases had handrails. From table 4.5, 34 stairs representing 68% had handrails on one side while 28% of the staircases had them on both sides. Only 4% did not have handrails at all. Forty staircases (80%) had widths greater than 1000mm. From the design requirements, all staircases which are more than 1000mm wide should have handrails on both sides. This means that 80% of the staircases were supposed to have handrails on both sides yet only 28% met this requirement thereby making them of lower quality. The clear minimum gap of between 50mm and 75mm should be provided between the handrail and adjacent wall. The 96% of the stairs that had handrails met this requirement as they had a gap of at least 50mm.

4.4.5 Number of Steps in Flights

The maximum number of steps in each flight should be 12 while the minimum number should be 3. From the findings, only 18 flights representing 5% of the total number of flights in all stairs had the number of steps greater than 12 in the respective flights while 95% of the flights had the number of steps ranging between 3 and 12 steps. It was therefore concluded that only a small number of flights did not meet the design requirements. The stairs therefore were of quality in respect to the number of steps in each of the stair flights.

4.4.6 Open Risers

Open risers in public buildings can increase the possibility of accidents to the users in which their feet can easily get stuck in between the steps causing falls. In this study, only 6% of the staircases were found to be open riser staircases. These were mainly found on the spiral staircases and another external stair No. 12 (BLDG 104-2). Since these were not the main staircases on the buildings in which they were used, they would have little impact on the safety of the users and hence did not affect the quality of the staircases as there were alternative staircases in these particular buildings.

4.4.7 Stairwell Lighting

Lighting in the stairwell is very important for proper vision while walking on the stair. The lighting in the stairwell was as shown in Table 4.6.

Table 4.6: Lighting in the stairwells

Staircase lighting	Number of stairs	Percent	Cumulative Percent
Has sufficient lighting	38	76.0	76.0
No sufficient lighting	12	24.0	100.0
Total	**50**	**100.0**	

The findings in respect to lighting indicated that 24.0% of the staircases had insufficient lighting in the stairwell. This was due to either vandalized/blown electric lamps that provide artificial lighting or little natural light due to limited ventilation in the staircase area. Insufficient lighting therefore would cause accidents as the users may not have clear vision of the nosings leading to sliding or tripping hence causing falls. However, a much higher percentage (76%) of the staircases had sufficient lighting from both natural and artificial lighting. The lighting by natural means was mainly from the use of large windows and ventilators in the landing areas. According to the International Building Code (2015), the means of egress walking paths through a building must be illuminated at all times, the building space served by that means of egress is occupied. Also according to the UK building regulations (2010), interior stairways are supposed to be provided with an artificial light source to illuminate the landings and treads. The light source should be capable of illuminating treads and landings to levels of not less than 1 footcandle (11 lux) as measured at the centre of treads and landings. There should be a wall switch at each floor level to control the light source where the stairway has six or more risers. Some staircases had artificial lighting with switches mainly at the bottom of each floor though some of them had the lighting fittings either blown or vandalized and not replaced.

4.4.8 Newel Posts

This is an important feature that is normally incorporated in the staircases to support the handrails onto which the users support themselves and also for aesthetic purposes.

During the study, only one staircase (2%) was found to have a newel post. This was mainly because most handrails had been terminated in various ways which did not require the newel posts. According to the building regulations, in the absence of a newel post, the handrail should terminate by either returning or into safety terminals.

4.4.9 Termination of Handrails

Termination of handrails should be in such a way that they are easy and comfortable to use and not causing injury during their use. The ways in which handrails were terminated are as shown in Table 4.7.

Table 4.7: Termination of handrails

S/N	Ways of termination	No. of Staircases	%age
1.	Into the walls	2	4
2.	Returning back	1	2
3.	Into the wall and downwards	12	24
4.	Stopped end at the newel and into the wall	23	46
5.	Stopped end	6	12
6.	Stopped end and rotating round	1	2
7.	No termination	3	6
8.	No handrail	2	4
	Total	**50**	**100**

The predominant way of termination was where the handrails had a stopped end at the newel post and all other ends terminated into the wall both at the top and at the bottom. This way of termination represented 46% of the handrails on the staircases while 24% was by termination into the wall and downwards. Termination downwards was mainly at the bottom of the staircases while into the wall was either at the end of the staircase on the top most floor or into the wall at the bottom where the staircases were being supported. Other ways of termination included; both ends terminated into the walls (4%), returning back (2%), stopped ends only (12%) and, stopped end and rotating (4%). Six percent represented handrails that were not terminated in any way while 2% did not have a handrail at all. It was therefore concluded that 6% of the handrails did not meet design and construction requirements in respect to the handrail termination. Since these were not terminated, there should have beennewel posts at the end especially at the bottom of the stairs to prevent catching or snagging of clothing of users.

The approved document M of the UK building regulations (2010) recommends handrails to return to wall ends to prevent clothing or objects carried being caught and causing potential injury.

4.4.10 Materials for Handrails

Materials for handrails are selected basing on the ease with which they can be moulded without causing injuries to the users and the beauty they give on the staircases. Table 4.8 shows how the materials were used on the staircases under study.

Table 4.8: Materials used for handrails on staircases

S/N	Material	No. of Staircases	%age
1.	Mild steel	25	50
2.	Timber	19	38
3.	Plastic strip over mild steel flat bar	3	6
4.	Masonry wall	1	2
5.	No handrail	2	4
	Total	**50**	**100**

From Table 4.8, mild steel was used as a handrail material most on 50% of the staircases. The use of mild steel is due to its strength and durability which explains why it was predominantly used for handrails on the staircases. Timber was the second predominantly used handrail material used on 38% of the staircases under study. This is because it gives a beautiful appearance on the staircases and can be moulded into any shape.

It was also found that a plastic strip mounted over a mild steel flat bar had been used as a handrail. This was done on 6% of the staircases. Masonry was the least used on the staircases. This consisted of a short wall of about 1000mm from the floor and users can support themselves as they walk along the stairs. This is not a common handrail material but it can be classified under other materials which include stone and marble.According to the building regulations, other materials that can be used for making handrails include aluminium, stainless steel, concrete, fibre glass, PVC, brass, chrome and copper.

4.4.11 Ramps

According to the approved document M (2010) and accessibility standards (2010), ramps play an important role in providing access to buildings especially for persons with mobility challenges. In this study, 70.8% of the buildings did not have ramps yet with no lifts making them inaccessible for persons with mobility problems. It was observed that the buildings that had ramps were newer buildings compared to those that did not have or if they were older, then the ramp was constructed later to meet the requirements and cater for the special interest groups that require such access. It was also noted that whereas some buildings had lifts, these were not in use as they were non-functional. For example, buildings BLDG 101 and BLDG 106 had lifts but they were not in use yet with no ramps.

The absence of ramps in buildings for access renders them not to meet the design and construction requirements as laid down in the approved document M and accessibility standards catering for persons with mobility problems especially for those that use wheelchairs.

4.4.12 Flooring Materials

The study found out that 50% of the staircases had floors finished with terrazzo while mild steel plates and non-slip ceramic tiles accounted for only 2% each as shown in Table 4.9.

Table 4.9: Materials used in flooring of staircases

Flooring material	Number	Percent	Cumulative Percent
Terrazzo	25	50	98
Cement sand screed	17	34	34
Ceramic tiles and cement sand screed	4	8	42
Mild steel plates	1	2	44
Non slip ceramic tiles	1	2	46
Rough cast surface	1	2	48
Unfinished concrete surface	1	2	100
Total	**50**	**100**	

Terrazzo has become increasingly a major material in the flooring of surfaces due to its various benefits including aesthetic properties in the environment giving various colours. It creates lasting first impressions. Terrazzo is also one of the most durable flooring materials for high traffic in public access buildings explaining why it was used more on the staircases. Another benefit is low maintenance cost which lowers the overall maintenance cost for the buildings.

Cement-sand screed which accounted for 34% of the flooring materials found on the staircase surfaces was the second predominantly used floor finish. The use of this finish was due to economic reasons as it is cheaper than other floor finishes despite the lower aesthetic properties. Some staircases had some flights with cement-sand screed while others had ceramic floor tiles. The mild steel plates were mainly used on spiral staircases due to its malleability properties which help it to be fabricated into various shapes. Other flooring materials included unfinished concrete surfaces and roughly finished terrazzo surfaces which accounted for 2%. Unfinished floor surfaces were mainly due to incomplete construction process yet the stairs were being used in that state. The staircase design and construction respondents gave their views on what they thought were the recommended flooring materials on the staircases as shown in Table 4.10.

Table 4.10: Extent to which the respondents agreed on the use of flooring materials

S/N	Material	Mean	Standard Deviation
1	Non-slip tiles	3.95	0.21
2	Terrazzo	3.73	0.70
3	Cement/sand screed	3.73	0.63
4	Slates	3.41	0.73
5	Mild steel plates	3.36	0.85
6	Granite	3.36	0.90
7	Timber	3.23	0.92
8	Carpets	3.14	0.94
9	Laminated flooring	3.00	0.76
10	Glossy tiles	2.45	0.74

According to the results from the staircase design and construction survey which was also investigating the recommended flooring materials on staircases, non-slip tiles were ranked highest with a mean of 3.95, terrazzo and cement sand screed followed each with a mean of 3.73 as shown in Table 4.10. The least recommended flooring material from the survey was glossy tiles with a mean of 2.45 which correlated with what was used on the staircases under study as there were no staircases with glossy tiles.

All materials with a mean of between 1 and 2.4 would be interpreted that the respondents disagree that the materials are recommended for flooring on staircases. A mean value of between 2.5 to 3.4 would be interpreted as the respondents having not been sure that such materials are recommended for use on staircases while a mean of 3.5 to 5 would indicate that the respondents agreed that the materials are recommended for flooring the staircase surfaces. The results also showed that the respondents were not sure that mild steel with a mean of 3.36, slates (3.41), granite (3.36), timber (3.23), carpets (3.14) and laminated flooring (3.00) were recommended for use as floor materials.

To improve on the quality of staircases in buildings, certain factors have to be put in mind when selecting flooring materials. The factors include level of maintenance, noise produced by the material during its use, slip resistance and level of traffic. The materials that were mostly used on the staircases are slip resistant and can easily be maintained.

4.5 Factors that influence the Design and Construction of Quality Staircases

4.5.1 Responsibility Centre for the Quality of Staircases

This was carried out to establish who was responsible for the quality of staircases using the design and construction survey questionnaire. Table 4.11 shows the ranking of the personnel responsible for staircase quality.

Table 4.11: Responsibility for quality staircase

Personnel	Loading factor	Rank
1. Contractors	0.915	1
2. Supervision consultants/ supervisors	0.894	2
3. Designers/Architects	0.819	3
4. Clients	0.792	4

When the construction team was asked who was responsible for the quality of the staircases in buildings, the respondents indicated that all members of the building team played a part in staircase quality.

It was revealed that the contractors were more responsible for staircase quality with a loading factor of 0.915 followed by the supervision consultants with 0.894 loading factor while the designers had a loading factor of 0.819. Clients played a minimal role in the quality of the staircases which was shown by the loading factor of 0.792. The contractors have greater responsibility as they are in charge of all the technical aspects of the projects. Poor workmanship and construction methods will lead to poor quality work.

Site supervisors being responsible for ensuring that the contractors do the right work follow the contractors in responsibility on the quality of staircases. Without proper or adequate supervision, contractors always want do work their own way which may lead to poor quality projects. Inadequate supervision will lead to rework hence cost overruns.

Designers as they are responsible for making the clients' dreams come to reality through giving designs; they are also responsible for the quality of staircases in buildings. Poor designs will make the contractors to construct using poor designs which leads to poor quality work.

The clients, to a smaller extent are responsible for the quality of staircases in the buildings since they give client requirements of what needs to be done and resources in order for their dreams to come to a reality. The client requirements have to be well communicated for good quality work. Other factors like unprofessional demands by the client would affect the quality of the projects.

4.5.2 Factors that Influence the Quality of Staircases During Design and Construction

In order to pinpoint the factors that influence the design and construction of quality staircases in public buildings, the factor analysis tool was employed to the data from the construction personnel. Factor analysis helps to identify the most relevant components of a variable and as well suggests the individual items that make up each of the components.

The items with loadings less than 0.500 were eliminated. Table 4.12 shows the analysis of the factors that influence the quality of staircases as given by the respondents.

Table 4.12: Influence of loading factors on the quality of staircases

Factor	**Design Proficiency**	**Construction Competences**	**Other project factors**	**Design reviews**
1. Use of incompetent designers	0.702			
2. Non-adherence to design codes and regulations during the design process	0.916			
3. Negligence by the designers	0.807			
4. Mistakes made in the drawings during design	0.830			
5. Poor workmanship during the construction process by the contractors		0.855		
6. Use of nonstandard materials from those specified in the contract documents		0.652		
7. Inadequate supervision for the operatives by the contractor		0.879		
8. Inexperienced site supervisors		0.703		
9. Inconsistences in instructions issued on site by the supervisors.		0.593		

10. Corruption			0.855	
11. Unprofessional client demands			0.784	
12. Limited project finances/funds			0.824	
13. Changes made on the drawings by the architect during the construction process				0.666
14. Inadequate design reviews of the construction projects				0.578
Eigen Value	**4.370**	**3.363**	**2.253**	**1.368**
Variance %	**27.313**	**21.016**	**14.080**	**8.547**
Cumulative %	**27.313**	**48.329**	**62.409**	**70.956**

From Table 4.12, the factors that influence the design and construction of staircases generally comprised of four main factors and these included design proficiency, construction competences, other project factors and design reviews which all together accounted for 70.9% of the variance in staircase quality.

Design Proficiency: This was the most dominant factor which accounted for 27.3% of the variance of staircase quality with an eigen value of 4.4. The most critical factors of the design proficiency pertain to the failure of the design teams to abide by the requirements in regulations during design of the buildings giving rise to a loading factor of 0.916. Another very serious factor on the design proficiency had to do with mistakes made in the drawings during design with a loading factor of 0.830 while negligence by the designers had a loading factor of 0.807. Use of incompetent designers had a lower loading factor (0.702) which is the lowest in the design proficiency.

The results therefore show that the poor-quality staircases in public buildings specifically universities caused by the design teams are due to non-adherence to design codes and regulations during the design process. Mistakes made by the designers is another main factor from the design process that affects the quality of staircases.

Construction Competences: The construction competences relate to the factors that affect the quality of the staircases during the construction phase. Construction competences accounted for 21.0% of the variance for staircase quality with an eigen value of 3.4. The most significant factor that influences the quality of the staircases pertains to the failure of the contractor to supervise his operatives adequately with a loading factor of 0.879 which leads to poor setting out of the staircases hence uneven risers and treads which affect staircase quality. The second predominant factor under construction competences was poor workmanship with a loading factor of 0.855. Poor workmanship reduces the overall quality of the staircases in terms of aesthetics which can lead to rework hence increasing the overall cost of the project.

The other factors in construction competences were the use of inexperienced site supervisors and inconsistences in instructions issued by site supervisors with loading factors of 0.703 and 0.593 respectively. Many times, clients find professional and experienced supervisors more expensive to contract and therefore resort to those who have little knowledge on the construction process but practising the trade and may end up making mistakes hence poor-quality work. Use of nonstandard materials in the construction of the staircases accounted for the lowest rank in the construction competences with 0.652 loading factor. Materials used in the construction of buildings in particular staircases must be as recommended by the standards or codes of practice otherwise this would lead to poor quality staircases hence causing accidents.

It was therefore noted that the major factors under the construction competences included poor workmanship during the construction process by the contractor, use of nonstandard materials from those specified in the contract documents, inadequate supervision for the operatives by the contractors and inexperienced site supervisors. Inconsistent instructions issued during the construction process have little impact on the quality of staircases as its loading factor was just 0.593.

Design Review: Before the commencement of any constriction project, there ought to be reviews on the designs to ensure that there are no omissions which would lead to poor quality projects. This accounted for 8.5% of the variance of the staircase quality with an eigen value of 1.4. According to the study, lack of or inadequate design reviews will affect the quality of staircases in buildings. The factors under this included changes made on the drawings by the architect during the construction process and inadequate design reviews of the construction projects which had loading factors of 0.666 and 0.578 respectively. It was noted that some factors had loading factors of less than 0.5 which signified that they did not influence the quality of staircases. The factors whose loading factors were below 0.5 included inadequate supervision of the the contractor’s work by the consultants/site supervisors and limited space for the construction.

Other project factors. Other project factors included corruption, unprofessional client demands and limited project finances with loading factors of 0.855, 0.824, 0.784 respectively. These factors accounted for 14.1% of the variance for staircase quality with an eigen value of 2.3. Corruption is a major factor in the construction of quality staircases under other project factors. Contractors who bribe their way to get public projects tend to produce lower quality work as they cover up what they have spent through such tendencies. Without clear understanding of the construction projects by the clients, they tend to bring in other demands during the project process which affect the outcomes hence affecting the quality of such projects. Sometimes clients start projects with little finance with the hope that they will get more finances. However, in case this does not come to reality, the client will always find the cheapest way of completing the project which affects its quality.

From Table 4.12, all the eigen values for the factors are greater than zero. This implies that the factors are greatly associated with staircase quality. The values are also positive implying that the model relating to staircase quality is well-conditioned. Since the eigen values are far from zero, it indicates that the confidence intervals are smaller which means the results on staircase quality from the design and construction survey are more reliable. On the other hand, 27.3% of the variance is explained by the first factor (design proficiency), 21% explained by the second factor (construction competence), 14.1% by the third factor (other project factors) and 8.5% explained by the fourth factor (design review) while 39% of the variance is explained by factors other than the ones mentioned.

4.5.3 Major Indicators of Poorly Constructed Staircases

In this study, absence of certain features on the staircases and deviation from the design requirements were all indicators of poor quality staircases. Table 4.13 shows the analysis of results ranked according to the mean to give the indicators of poor quality staircases.

Table 4.13: Analysis of results on major indicators of poor quality staircases

S/N	Indicator	Mean	Standard deviation
1	Narrow treads	4.00	0.00
2	Uneven risers	3.95	0.21
3	Uneven treads	3.86	0.47
4	Poor lighting in the stairwell	3.86	0.47
5	Poorly constructed/installed handrails that do not meet the construction requirements.	3.82	0.59
6	Too steep staircase flights	3.82	0.50
7	More steps in staircase flights than recommended	3.73	0.55
8	Poorly maintained staircases including broken steps	3.68	0.72
9	Slippery nosings or treads	3.68	0.72
10	Missing or damaged handrails and balusters	3.64	0.73
11	Obstacles/objects on the stairs	3.64	0.73
12	Open risers	3.59	0.73
13	Missing or damaged ramps	3.55	0.80
14	Overhanging treads	3.50	0.86
15	Lack of tactile ground surface indicators (TGSIs) or warning signs on the existence of staircases or ramps	3.50	0.80
16	Lack of emergency or escape routes	3.50	0.80
17	Poorly ventilated staircases and ramps	3.45	0.86
18	Poorly visible nosings due to indistinct colour designs	3.45	0.80
19	Glossy or shiny/reflective floor surfaces	3.36	0.85
20	Missing or damaged kerb rails along the ramps	3.32	0.89

From the findings in Table 4.13, all indicators that had a mean of between 3.5 and 4 were ranked to have a significant effect on the quality of staircases while those with a mean of between 3.0 to 3.45 were ranked to have a non significant effect and therefore do not contribute to the quality of staircases.

Indicators like poorly ventilated staircases and ramps, poorly visible nosings due to indistinct colour designs, glossy or shiny/reflective floor surfaces, missing or damaged kerb rails along the ramps which had means of 3.45, 3.45, 3.36 and 3.32 respectively were considered not to be major indicators of poor quality staircases as their standard deviations were way too below the mean of 4. Therefore, Table 4.14 gives the summary of the major indicators which had means between 3.5 and 4.

Table 4.14: Summary of major indicators of poor quality staircases

S/N	Indicator	Mean	Standard deviation
1	Narrow treads	4.00	0.00
2	Uneven risers	3.95	0.21
3	Uneven treads	3.86	0.47
4	Poor lighting in the stairwell	3.86	0.47
5	Poorly constructed/installed handrails that do not meet the construction requirements.	3.82	0.59
6	Too steep staircase flights	3.82	0.50
7	More steps in staircase flights than recommended	3.73	0.55
8	Poorly maintained staircases including broken steps	3.68	0.72
9	Slippery nosings or treads	3.68	0.72
10	Missing or damaged handrails and balusters	3.64	0.73
11	Obstacles/objects on the stairs	3.64	0.73
12	Open risers	3.59	0.73
13	Missing or damaged ramps	3.55	0.80
14	Overhanging treads	3.50	0.86
15	Lack of tactile ground surface indicators (TGSIs) or warning signs on the existence of staircases or ramps	3.50	0.80
16	Lack of emergency or escape routes	3.50	0.80

There was a correlation between these indicators and the findings in the study as some staircases were found to have narrow treads, uneven risers, uneven treads, poorly lit stairwell and poorly constructed/installed handrails that do not meet the construction requirements. Other indicators that were noted on the staircases included: more steps in staircase flights than recommended though this was to smaller extent; poorly maintained staircases including the existence of steps with broken edges; slippery nosings or treads; missing or damaged handrails and balusters; open risers but this occurred mainly in spiral stairs; missing or damaged ramps; and overhanging treads. The existence of such issues on the staircases affected their quality as these are major causes of accidents on the staircases.

4.6 The extent to Which the Staircases Meet the Design and Construction Requirements

From specific objective (iv), the extent to which the staircases met the design and construction requirements was investigated by direct measurement using as-built dimensions as compared with the standard requirements. The measurements included those of risers, goings, handrail heights, extension of the handrails and depth of contrast of the nosings.

4.6.1 Riser Measurements

Direct measurement of the risers in all the flights was done using the technical survey tool and a tape measure. Table 4.15 shows the number of risers analysed.

Table 4.15: Riser measurements in comparison with the standard requirements

Riser requirements	**Number of risers**	**%age**
Less than 150mm	1662	47.4
Equal to 150mm	734	21.0
Between 150mm and 170mm	814	23.3
Greater than 170mm	290	8.3
Total	**3500**	**100.0**

A total of 3500 risers in 364 flights were measured and compared with the minimum and maximum requirements according to the approved document K of the UK building regulations in which the minimum riser requirement is 150mm and the maximum is 170mm.

The risers whose heights were less than 150mm were 1662 representing 47.4%, 734 risers representing 21% had heights equal to 150mm, 814 risers (23.3%) had heights between 150mm and 170mm while 290 (8.3%) had heights greater than 170mm. In regard to these results, it was deduced that all risers which had heights less than 150mm or greater 170mm were considered not to meet the design requirements hence making the staircases to be of poor quality. Therefore, 1952 risers representing 55.8% did not meet the design requirements and 1548 (44.2%) met the design requirements.

The results therefore show a much higher percentage of risers not meeting the design requirements as laid down in the building regulations compared to those that met the requirements. The fact that over 50% of risers in the staircases did not meet the requirements indicates that such stairs were of poor quality. There is a likelihood of these stairs causing accidents to the users. The extent to which risers did not meet the design and construction requirements was also checked by comparing their heights for unevenness. The unevenness in the risers in stair flights was checked by computing the statistical range in each of the flights and the results are as shown in Table 4.16.

Table 4.16: Statistical ranges in the flights to show unevenness of risers

Statistical range (mm)	Number of flights	%age
Equal to 0	6	1.6
$0 > x \leq 5$	24	6.6
$5 > x \leq 20$	142	39.0
$20 > x \leq 50$	135	37.1
$50 > x \leq 160$	57	15.7
Total	**364**	**100**

From the results, it was noted that only 6 flights representing 1.6% of the total number of flights analysed had risers which were even/uniform in height with no statistical ranges. The staircase flights under study that had uneven/non uniform risers were 6.6% with statistical ranges between 0mm and 5mm. This range was considered small and due to the tolerance allowed in construction of approximately 5mm (Australian standard AS1657), the risers in these flights were considered to be even and with no effect on the staircase users. Whereas these flights were considered to have even risers, it was observed that these were much fewer and isolated for the stairs to be considered of good quality. An overwhelming 91.8% of the flights in staircases had uneven risers with ranges greater than 5mm and up to 160mm.

The unevenness of the risers was attributed to poor setting out of stairs and poor designing of staircases as the floor height was not properly matched. On others, there seemed to have been change in the flooring materials from tiles to terrazzo and vice versa without maintaining the levels and due to the different thicknesses of the materials.

Uneven heights of risers have a tendency of causing tripping and falling of the users hence causing injury. It is noted that the users normally interest themselves with the first, second and third step after which the foot will always move without a glance. Unevenness in the risers will cause confusion in the movement in which abrupt steps will be met by the feet while going up and missed step while going down. This is because the feet will come across a step when it is not expected or miss a step when it is expected thereby causing tripping or sliding. These results correlate with the results obtained from the staircase user survey where 24.5% of the users had said they came across an abrupt step in which 17.3% of these said this was due to the step being higher than expected. Also in the same user survey, 8.7% of those users who had missed a step while walking on the stair was due to some steps being lower than expected. This mainly happens when walking down the stair. Unevenness in the risers was one of the major indicators of poorly constructed staircases with a mean of 3.95 as shown in Table 4.3. Unevenness is therefore a serious factor in affecting the quality of the staircases. It was concluded that unevenness in the risers significantly affects the quality of the staircases which results into serious tripping hazards hence causing injuries to the users.

4.6.2 Tread depths

Direct measurement of tread widths was done using the technical survey tool and a tape measure. Where the risers were vertical, the going was taken to be equal to the width of the tread while where the treads were overhanging, the going was computed as the difference between the tread width and the overhang. The overhangs were ranging from 10mm to 25mm. Table 4.17 shows the comparison of the goings with the standard requirements.

Table 4.17: Comparison of the goings with the standard requirements

Going requirements	Number of treads	%age
Less than 250mm	117	3.7
Equal to 250mm	123	3.9
Between 250mm and 320mm	2709	86.4
Greater than 320mm	188	6.0
Total	**3137**	**100.0**

From Table 4.17, 2709 treads (86.4%) had goings between 250mm and 320mm, 123 treads (3.9%) had goings equal to 250mm while 117 (3.7%) treads had goings which were less than 250mm while 188 treads (6.0%) had goings greater than 320mm. Treads which had a depth of less that 250mm were considered narrow and this accounted for 3.7% of the total number of the treads analysed. These results indicated that treads were designed and constructed to meet the requirements despite 9.7% not meeting the design requirements and were considered narrower/wider.

From the design and construction survey carried out under the major indicators of staircases that did not meet the design and construction requirements, it was noted that narrow treads were one of the major indicators of poorly constructed stairs with a mean of 4.0 as shown in Table 4.3. The unevenness of the stair treads was checked by computing the statistical ranges of the different flights on the staircases. Table 4.18 shows the results obtained from the analysis.

Table 4.18: Statistical ranges in the flights to show unevenness of treads

Statistical range	Number of flights	%age
Equal to 0	13	3.6
$0 > x \leq 5$	56	15.4
$5 > x \leq 20$	188	51.6
$20 > x \leq 50$	87	23.9
$50 > x \leq 130$	20	5.5
Total	**364**	**100**

From the results in Table 4.18, 3.6% of the stair flights had treads with no range indicating evenness/uniformity while 15.4% of the flights had treads with ranges between 0 and 5mm indicating unevenness/non uniformity.

With the majority of widths of stair treads having ranges between 5mm and 130mm as shown in Table 4.18 representing 81% which indicates unevenness in the treads, it was concluded that 81% of the staircases had uneven treads indicating that they were poorly constructed.

Like the evenness in the risers, uneven treads are as a result of poor design and setting out which are a potential risk to the users which are likely to cause accidents through missing of the steps. From the design and construction survey, uneven treads were one of the major indicators of poor quality staircases with a mean of 3.86 as shown in Table 4.13. According to the Standards Association of Australia (2018), all risers and goings in the same flight of stairs shall be of uniform dimensions within a tolerance of ±5mm. The results in Table 4.18 can therefore be interpreted in a way that all flights that had treads with a statistical range of 0mm to 5mm were considered as even which were represented by 19% and therefore safe to the users. Those flights that had treads with a statistical range above 5mm were considered uneven and therefore unsafe to the users. This was represented by 81% of all the stair flights under study.

4.6.3 Slope Relationship Between the Risers and the Goings

The slope relationship between risers and goings is called gait and was computed by using the expression 2 Rise + Going. These values were then compared with the minimum and maximum requirement for the relationship. The results are as shown in Table 4.19.

Table 4.19: Slope relationship between the goings and the risers

Gait requirements (2 Rise+Going)	Number of steps	%age
Less than 550mm	515	16.4
Equal to 550mm	110	3.5
Between 550mm and 700mm	2436	77.7
Greater than 700mm	76	2.4
Total	**3137**	**100**

From the results, 2436 treads representing 77.7% fell between 550mm and 700mm. One hundred ten steps (3.5%) had a gait equal to 550mm which was the minimum requirement while 515 steps (16.4%) had a gait which was below the minimum requirement of 550mm and 76 steps (2.4%) had a gait greater than 700mm. This showed that majority of the steps (2546) representing 81.2% met the minimum and maximum requirement for the gait while 591 treads representing 18.8% did not meet the minimum and maximum design requirements.

Whereas the treads which were not meeting the design requirements in terms of the gait were 18.8%, this percentage was significant enough to cause accidents to users since this affects the movement of the lower extremities which must balance and carry along the head, arms and trunk. According to the Australian standard AS1657 (2018), the tread depth should not be more than 30mm shorter than the going (G). Deviation from this standard would cause steepness hence causing side effects.

4.6.4 Staircase Slopes

The slope of a staircase determines its steepness. The steeper the slope, the lower the quality and vice versa. The slope is important as it affects the tread depth and riser height. Table 4.20 *s*hows the analysis results of the staircase slopes in comparison with the minimum and maximum requirements.

Table 4.20: Staircase slope

Slope requirements	**Number of stairs**	**%age**
Less than 30^o	27	54.0
Equal to 30^o	3	6.0
Between 30^o and 42^o	15	30.0
Greater than 42^o	5	10.0
Total	**50**	**100**

The analysis of the staircase slopes in comparison with the minimum and maximum requirements shows that 54% of the stair slopes were below 30^o which were predominant. It was also noted that the second predominant stair slopes were between 30^o and 42^o represented by 30% of the stairs while 6% were equal to 30^o. The slopes which were greater than 42^o had a percentage of 10%. The stairs which had slopes less than 30^o and greater than 42^o indicate poorly designed stairs which do not meet the minimum and maximum design requirements.

It can therefore be deduced that 64% of the stairs did not meet the design requirements. Stairs which had slopes below 30^o were considered to be tending to flat ground while those greater than 42^o were considered very steep. Both of these conditions are not good for staircase users as lower slopes require more floor area and can lead to accidents due to tripping while very steep stairs affect the tread depth and riser height which lead to narrower treads. The narrow treads are major indicators of poor quality stairs which results in a smaller walking surface which is likely to cause fatigue, discomfort and missing of steps. The steepness of the staircase affects the movement of the users by affecting the movement of the lower extremities which must balance and carry along the head, arms and the trunk short of which will lead to accidents. Only 36% of the stairs met the design slope requirements with the slopes ranging between 30^o and 42^o. These were considered to be of good quality due to the gentle slope and hence cannot cause accidents to the users.

4.6.5 Staircase Widths

The width of a staircase determines how narrow the staircase is which needs to meet the minimum requirements as laid down in the building codes. Table 4.21 shows the findings on the widths of the staircases in comparison with the minimum requirements.

Table 4.21: Staircase widths

Stair width requirements	**Number of treads**	**%age**
Between 0 and 1000mm	8	16
Between 1000 and 2000	40	80
Greater than 2000	2	4
Total	**50**	**100**

From this analysis, it was noted that 16% of the staircases had their widths less than the minimum of 1000mm while 80% of the staircases had the widths between 1000mm and 2000mm. It was also seen that 4% of the staircases had their widths greater than 2000mm.

According to the Approved Document K of Building Regulations (2010), the minimum width of the staircase of a public building should be 1000mm while the maximum width should be 2000mm. Therefore, the results indicate that 16% of the staircases did not meet the minimum requirement for the staircase width hence considered narrow.

Narrow staircases normally interfere with the free and comfortable movement of users while using the staircase at the same time as there will not be enough space to allow passage by two users at a particular point at the same time. This will cause delay of movement for the users who want to move faster.

The staircases with widths between 1000mm and 2000mm were considered to meet the design and construction requirements. The compliance to this requirement makes the users comfortable and avoids delays and accidents while using the stairs. Whereas these staircases were not considered to be of poor quality, they had to meet another requirement of providing handrails on both sides to meet the requirements.

According to the Building Regulations (2010), any staircase that has a width greater than the minimum requirement (1000mm) should be provided with handrails on both sides. It was noted that 80% of the stairs which had their widths greater than 1000mm but less than 2000mm did not have handrails on both sides whereas 20% of these stairs had handrails on both sides. Lack of handrails on both sides would cause fatigue and discomfort to users while using the staircases especially those who would want to support themselves or with other health conditions hence the likelihood of causing accidents. It was also noted that 4% of the stairs under the study had widths greater than 2000mm which is the upper limit of the requirement.

All stairs with widths greater 2000mm which is the upper limit should be divided into two with balustrades and handrails in the middle. This was not the case with the stairs whose widths were greater than 2000mm. Lack of separation of these staircases would make the stairs uncomfortable for use. Also, according to Maynard and Brogmus (2007), if the stairway is two or more lanes wide, there is need to install intermediate railings in the middle to make the stairway more noticeable and to help people avoid or correct missteps.

4.6.6 Handrail heights

The height of the handrails on a staircase must meet the design requirements for comfort and ease of the users supporting themselves while walking on the stairs. Table 4.22 shows the results on the handrail heights in comparison with the minimum requirements.

Table 4.22: Handrail heights

Handrail requirements	Number of stairs	%age
Less than 900mm	31	62
Between 900 and 1000	12	24
Greater than 1000mm	5	10
No handrail	2	4
Total	**50**	**100**

It was noted that 62% of the handrails had heights less than 900mm which makes them not to meet the minimum design requirement while 24% had heights between the 900mm and 1000mm. 10% had heights greater 1000mm while 4% of the staircases had no handrails.

All the staircases that had handrails at heights less than 900mm and at heights greater than 1000mm were considered not to meet the design and construction requirement while those that were at heights between 900mm and 1000mm were considered to meet the design and construction requirements.

According to the approved document K of the UK building regulations (2010), handrails on staircases should be installed at a minimum height of 900mm and should not exceed a height of 1000mm. From this requirement therefore, it was concluded that 76% of the staircases had handrails that do not meet the design and construction requirements while only 24% met the requirement. The higher percentage of the staircases with handrails that do not meet the design and construction requirements are an indication of poorly installed handrails which make it uncomfortable for the users as the majority of the staircases had handrails at lower heights with some others being greater than the maximum requirement.

4.6.7 Extension of the handrails

It is recommended that the handrails extend beyond the first or last step of the flight on the staircase by at least 300mm or the depth of a tread at the bottom and top respectively which provides safer entry into or exit from the staircase. *Table 4.23* shows the extension of handrails in comparison with the minimum requirements.

Table 4.23: Extension of the handrails

Extension requirements	**Number of stairs**	**%age**
No extension	39	78
Extension between 0 and 300mm	8	16
Greater than 300mm	1	2
No handrail	2	4
Total	**50**	**100%**

From this study, 78% of the staircases had handrails with no extensions beyond the first and last tread at the bottom and top of the flights. The staircases that had handrails with extensions between 0 and 300mm were represented by 16%. Only 2% of the handrails had the extension greater than 300mm which is the minimum while 4% of the staircases had no handrails. The handrails are expected to extend beyond the first and last treads at the bottom and top of the stair flights. Only 9 staircases representing 18% had handrails that extended beyond the first and last step of the stair while the rest had no extension. Building regulations stipulate that the handrails must extend beyond the first and last riser by either a full tread or by 300mm. Whereas 18% of the stairs had handrail extensions, only 2% of all the staircases met the minimum handrail extension requirement of 300mm.

As a result, 98% of the staircases were considered to be of poor quality in respect to handrail extension requirement. The handrail extension helps to provide additional support for the users when moving from the last tread to the landing. Therefore, absence of such extensions on the handrails renders the staircase of low quality. Lack of handrail extensions on the staircases is an indication of hazardous staircases. This indicates that only one staircase had handrails which met the design and construction requirement. According to Maynard and Brogmus (2007), the handrail should continue horizontally beyond the bottom step for a distance at least equal to the depth of one tread.

4.6.8 Nosing contrast

The nosing contrast is recommended to be used on the steps of the staircases to provide a reflective surface by use of distinct colours on the surface for proper visibility of the steps. The depth of the nosing contrast should be between 50mm and 75mm. *Table 4.24* shows the depths of nosing contrasts in comparison with the minimum requirements from the staircases under study.

Table 4.24: Nosing contrast

Depth of contrast	**Number of stairs**	**%age**
Less than 50mm	3	6
Between 50mm and 75mm	10	20
Greater than 75mm	17	34
No nosing contrast	20	40
Total	**50**	**100**

From Table 4.24, 40% of the staircases had no nosing contrasts, 6% had a nosing contrast though its depth was less than the minimum requirement of 50mm. Also, 34% of the staircases had the nosing contrasts more than the maximum design requirement of 75mm whereas only 20% had nosing contrasts falling within the recommended standards. This may mean that the design and construction teams did not follow the standards in the design and construct of the treads to include the nosing contrast at recommended depths hence making them not to serve the purpose for which they are required which can result into accidents because of poorly visible nosings especially where there is insufficient lighting.

A visual contrast on tread nosings or at the leading edges of treads without nosings should be provided so that stair treads are more visible for people with low vision. According to the US Access Board Research as cited by Maynard and Brogmus (2007), the surfaces that are coloured safety yellow are the “most visually detectable”. It is therefore noted that the greatest percentage represented by 80% of the staircases did not meet the requirements for the provision of nosing contrasts hence rendering them to be of low quality.

4.7 The Extent to Which the Quality of Staircases Affects the Users of the Buildings

The extent to which the quality of staircases affected the users of the buildings was determined using the accidents rates and the causal factors that were associated with the accidents.

4.7.1 Broken Edges of Steps

Broken edges of steps are indicators of poorly maintained staircases which lead to accidents in which the users may knock their feet and fall off the stairs. Table 4.25 shows the staircases that had broken edges.

Table 4.25: Broken edges on the staircases

Damage on steps	**Number**	**Percent**	**Cumulative Percent**
Stairs with broken edges on steps	17	34.0	34.0
Stairs without broken edges on steps	33	66.0	100.0
Total	**50**	**100.0**	

From Table 4.25, 17 staircases representing 34% had some steps with broken edges while the remaining percentage (66%) were good. This percentage of 34% is significant enough to cause fatal accidents on the staircases. This may mean that accidents are likely to occur on more than a third of the stairs studied. Many accidents occur due to poor maintenance, inattention and use. The stair treads should be kept clean and in good condition. In addition, there should not be excessive wear, missing treads or loose treads as these would lead to poor maintenance conditions on the staircases thereby causing accidents. According to the staircase user survey carried out in this study, it was noted that out of the 67 users who had slid while walking on the stairs, 7.5% slid due to broken edges of the steps. The sliding due to broken edges of steps on the stairs can therefore prove hazardous to the users. Immediate attention should always be paid to such maintenance factors to avoid accidents on stairs.

According to Nagata (1991), maintenance of stairs is one of the factors that affects the quality of staircases leading to accidents. The factors include the presence of broken edges on steps, broken handrails/balustrades and torn or loose coverings on staircase surfaces which should be replaced or worked on immediately they happen on stairs.

4.7.2 Slippery Floor Surfaces

Staircase floor surfaces can be a major cause of accidents if the materials used are slippery just as it was seen in the staircase design and construction survey that glossy tiles as a flooring material were ranked last indicating that they are not recommended as they can increase the rate of accidents on the staircases. Table 4.26 shows the number staircases that had slippery surfaces.

Table 4.26: Slippery floor surfaces on the staircases

Slippery floor surfaces	Number	Percent	Cumulative Percent
Stairs with slippery surfaces	1	2.0	2.0
Stairs without slippery surfaces	49	98.0	100.0
Total	**50**	**100.0**	

In this study, only one staircase (2%) was found to have slippery surfaces. This was not because of the materials used but due the long-term use of the steps in which the nosings became worn-out and hence slippery. These results show that stairs were not slippery and therefore the likelihood of the staircases causing accidents due to slippery floors was minimal. Despite this finding, 20.9% of the users who slid on the staircases in the survey thought that they slid due to the slippery edges of the steps while 7.5% thought that they slid due to the slippery nature of flooring material as shown in Table 4.27.

4.7.3 Tendency of the feet to slide

This was investigated using the staircase user survey questionnaire. Table 4.27 shows the factors that caused sliding of the users' feet while walking on the staircases under study.

Table 4.27: Causes of sliding on the stairs

Cause of sliding	Number	Percent	Cumulative Percent
Was hurrying/ running	28	41.8	41.8
Slippery edges of the steps	14	20.9	62.7
The surface was wet	13	19.4	82.1
Floor finishing material was slippery	5	7.5	89.6
Broken edges of the steps	5	7.5	97.0
Others	2	3.0	100.0
Total	**67**	**100.0**	

From Table 4.27, 41.8% of the users said they slid on the staircases due to hurrying/running along the staircase while 20.9% slid due to slippery surfaces on the staircases. The respondents wh slid due to the wet surface of the stairs were 19.4% of the totl number of respondents. While those who thought the floor finish was responsible for their sliding was 7.5% which was the same as those who said they slid due to broken edges.

Hurrying/running on the stair is an individual user factor as supported by Nagata (1991) in his study of the occupational accidents while walking on stairways. Slippery edges of the steps and floor finishing material are design factors which lead to accidents on staircases while broken edges of the steps are maintenance factors as highlighted in the conceptual framework. The surface being wet is an environmental factor which leads to sliding of users.

4.7.4 Abrupt Steps on the Staircase Flight

Abrupt steps on staircase flights will cause accidents as this will cause missing of the steps. Table 4.28 shows the users that came across abrupt steps on the stairs.

Table 4.28: Abrupt steps on stairs

Abrupt step	Number	Percent	Cumulative Percent
Hurrying/ running	23	44.2	44.2
The step was higher than expected	9	17.3	61.5
Thought had finished all the steps	8	15.4	76.9
Was on phone	6	11.5	88.5
Was not aware of its existence	5	9.6	98.1
Others	1	1.9	100.0
Total	**52**	**100.0**	

As in the case of the feet sliding while walking on stairs, hurrying/running with 44.2% of the users whose feet came across an abrupt step came out as the predominant factor while 17.3% represented causes where users found that the abrupt step was higher than expected. This correlates with the riser measurements in which 3% of the risers were beyond the maximum recommended height.

The users that thought they had completed the flight yet they had not were represented by 15.4%. This could have been due to longer flights than expected by the users especially those with more than 12 steps. 11.5% were on phone which was an individual user factor. Hurrying and being on phone are individual user factors while higher steps and longer flights are design factors which can cause accidents on staircases.

4.7.5 Missing of steps

Missing of the steps is an indication of the steps being lower than they are supposed to be or lower than expected. Table 4.29 shows the users that missed steps while walking on the stairs under study.

Table 4.29: Causes of missing steps while walking on the stairs

Missed step	Number	Percent	Cumulative Percent
Hurrying/ running	53	51.0	6.7
Was on phone	19	18.3	20.2
The width of the step was smaller than expected	14	13.5	71.2
The height of the step was lower than expected	9	8.7	79.8
The steps were not properly seen	7	6.7	98.1
Others	2	1.9	100.0
Total	**104**	**100.0**	

From Table 4.29, 51% of the total number of users who missed steps was due to hurrying/running which was the predominant factor. Other causes were represented by 18.3% having been on phone, 13.5% due to narrow width and 8.7% due lower height of the riser than expected. These statistics are in agreement with the survey to determine the compliance of the staircases to design and construction requirements in which 3.73% of the treads were narrow while 47% of the risers were lower than the minimum requirements.

4.7.6 Users Who Ever Got Injured

Table 4.30 shows the number of users who ever got injured while using the stairs in the buildings under study.

Table 4.30: Users who ever got injured

Users injured	Number	Percent	Cumulative Percent
Yes	54	26.3	26.3
No	128	62.5	88.8
Not Sure	23	11.2	100.0
Total	**205**	**100.0**	

When users were asked whether they had ever got injured while using the different stairs in the buildings, 26.3% said they had ever got injured while 11.2% were not sure. The rest (62.5%) had never been injured. The injuries on the staircases are as a result of a combination of factors including design and construction factors, maintenance factors as well as individual user factors.

Table 4.31 also shows the users who said they have ever seen/heard of someone who got injured while using the selected staircases.

Table 4.31: Users who ever got injured but were not respondents

Users injured	Number	Percent	Cumulative Percent
Yes	56	27.3	27.3
No	129	62.9	90.2
Not Sure	20	9.8	100.0
Total	**205**	**100.0**	

From Table 4.31, 27.3% of the users had ever seen/heard of someone who got injured when using the stairs while 62.9% had never seen/heard of anyone who got injured while using the stairs.

It has been established that these injuries were due to various factors as shown in Table 4.14 of summary of major indicators of poor quality staircases that do not meet the minimum standards including uneven risers, narrow treads, broken edges of the steps due to non-maintenance, individual users factors and many others.

4.7.7 Extent to which the Users were Affected by the Quality of Staircases

The users highlighted different types of health effects/injuries that were sustained while using the staircases as shown in Table 4.32.

Table 4.32: Extent to which the Users were Affected by the Quality of Staircases

Type of health effect/injury	Frequency	Percent	Cumulative Percent
Discomfort	8	25.0	25.0
Fatigue	9	28.1	53.1
Dislocated limbs	11	34.4	87.5
Spinal cord damage	1	3.1	90.6
Body cuts and bruises	3	9.4	100.0
Total	**32**	**100.0**	

Out of the 26.3% of the users who ever got injured while using the stairs as shown in Table 4.30, 34.4% had injuries of dislocated limbs, 28% had an effect of fatigue while walking on the stairs, 25% had an effect of discomfort during their use. 9.4% had body cuts and bruises. These injuries are a major cause of increased number of persons with disabilities which affects victim's family and productivity at workplace/dropping out of the studies. Dislocated limbs, spinal cord damage, body cuts and bruises are user effects resulting from falls on stairs while discomfort and fatigue are due to long flights, very steep stairs and lack of supports.

4.7.8 Causes of Staircase Effects/Injuries

Table 4.33 shows the causes of the effects/ injuries while walking on stairs.

Table 4.33: Causes of staircase effects/injuries

Cause	Number	Percent	Cumulative Percent
Hurrying/ running	2	6.3	6.3
Missed a step	4	12.5	18.8
Steps are not easily seen	19	59.4	78.1
Slippery floor surface	1	3.1	81.3
Inadequate lighting along stairs	1	3.1	84.4
Was on phone	2	6.25	90.6
Very steep steps	3	9.4	100.0
Total	**32**	**100.0**	

From Table 4.33, out of the 26.3% of the users who got injured/ had an effect as shown in Table 4.30, 59.4% were due to steps not being easily seen, 12.5% were due to a missed step while 6.3% were due to individual user factors which included hurrying. These causes correlated with the major indicators of staircases which do not meet quality standards.

According to the staircase design and construction survey, one of the major indicators of poorly constructed stairs included inadequate lighting in the stairwell with a mean of 3.86 as shown in Table 4.3. Also, according to the observational survey on the staircases, 24% of the stairs had insufficient lighting including both natural and artificial lighting. Inadequate lighting would lead to steps not to be easily seen which would cause missing of the steps and hence sliding by the users. This poor visibility of the steps is the main cause of injuries as shown in Table 4.33 with a percentage of 59.4% hence poor quality stairs observed.

4.8 Performance Framework for the Staircases

The performance of the staircases was measured based on the extent to which staircase parameters and existing features conformed to the standards in relation to the minimum design requirements. This performance framework is envisaged to help the construction stakeholders including designers, contractors, supervision engineers, project managers and clients to realize that poor quality staircases do exist in public buildings in Uganda due to various factors which lead to staircase accidents. Table 4.34 shows the framework that will be used by the industry practitioners in identifying poor quality staircases thereby acting as a checklist in the design and construction of staircases in public buildings. The framework shows major parameters and features on the staircases and the extent to which they conform to the design requirements thereby giving a bigger picture of the existing problem in public buildings which needs to be dealt with in the design and construction of future buildings.

The key features of the performance framework include parameters/features that were used to determine the quality of the staircases under study. It gives a checklist of the existence/nonexistence of features and conformance/nonconformance to design standards. It consists of the following:

***Building code*:** Each building was assigned a unique code with respect to the university, the number of buildings in that university and the number of staircases in the particular building which identified staircases. For example, RU001-BLDG101-1 means research university number 001, building 01 in university 1, staircase 1. The purpose of the coding was to help in identifying the staircases within the buildings in the universities.

Type of stair: The performance framework was aimed at also identifying the type of staircases that were used in each of the buildings in respect to the space available. Buildings which had more space available and with respect to safety considerations had half turn and double L stairs. Half turn stairs had an advantage of having a wider resting point from one flight to the next while the use of double L stairs was due to their two 90^{o} turns which make it safe for the users in case of a fall on the stairs. Double L stairs have three flights between floors where the use of two flights would have been uneconomical or unsafe for the users as there would be many more steps than recommended in the flights.

***Anchorage*:** The means of support of each of the stairs in the buildings was considered in terms of whether it was simply supported or cantilevered. Cantilevered staircases were used mainly on the spiral staircases round a central column while simply supported were used on the remaining stairs either between two walls or supported between landings along walls of the buildings. The stair support/anchorage determines the strength and quality of the staircases.

Location**:** The location of a stair in a building is very important as it determines the function and flow throughout the building. It is required for the stairs to be located near the entrance. Before the design of the floor plans, it is important for the architects to determine the location of the stairs. The locations of the staircases were internal or external. The principle of stair orientation is that the stairs should turn from the North to the South or from the East to West in the clockwise direction.

Features**:** The framework indicates a checklist of the existence of staircase features in respect to standards. The following features have been indicated in the framework: tactile ground surface indicators (TGSIs); existence of balustrades; existence of handrails on both sides of stairs; existence of overhanging treads; existence of open risers; presence of sufficient lighting; existence of newel posts; presence of broken edges/steps; presence of slippery surfaces on the staircases; existence of even risers; existence of even treads; standard handrail sizes; termination of handrails; standard staircase widths; non varying widths of fights; standard staircase slope; standard handrail height; standard headroom; handrail extension; handrail materials and flooring materials

The construction stakeholders need to discover that most public buildings with up to six floors, except those which have lifts yet some of the lifts are non-functional, do not cater for movement of persons with special needs like the blind, lame and the elderly.

During the lifecycle of these facilities, the performance framework will support the users and other stakeholders in the proper use and maintenance of the stairs of the buildings to prevent health related effects and accidents/hazards. The framework will be used as a checklist during all the project phases of future public storeyed buildings to ensure that standards are adrered to .

The limitation of this framework is that it is a checklist showing whether the parameters/features on the staircases are compliant or non compliant and therefore does not show to what extent the features are compliant.

Table 34: Staircase performance framework

S/N	Staircase code	Number of floors	Type of stair	Anchorage	Location of stair	TGSIs/warning signs	Balustrades	Handrails on both sides	No overhanging treads	No open risers	Sufficient lighting	Newel posts	No broken edges/ steps	No slippery surfaces	Even risers	Even treads	Standard treads	Standard handrail size	Termination of handrails	Minimum width	Flights not varying in width	Stair not steep	Height of handrail	Headroom	Depth of contrast	Handrail extension	Handrail material	Flooring material
1	RU001-BLDG101-1	4	Double L stair	Fixed	Internal	X	X	X	✓	✓	✓	X	✓	X	✓	✓	X	✓	✓	✓	X	✓	X	✓	✓	X	✓	✓
2	RU001-BLDG101-2	4	Double L stair	Fixed	Internal	X	X	X	✓	✓	✓	X	✓	X	✓	✓	X	✓	✓	X	X	✓	X	✓	✓	X	✓	✓
3	RU001-BLDG101-3	4	Double L stair	Fixed	Internal	X	X	X	✓	✓	✓	X	✓	X	✓	✓	X	✓	✓	X	X	✓	X	✓	✓	X	✓	✓
4	RU001-BLDG101-4	4	Double L stair	Fixed	Internal	X	X	X	✓	✓	✓	X	✓	✓	✓	✓	X	✓	✓	X	X	✓	X	✓	✓	X	✓	✓
5	RU001-BLDG101-5	4	Double L stair	Fixed	Internal	X	X	X	✓	✓	✓	X	✓	✓	X	X	X	✓	✓	X	X	✓	X	✓	✓	X	✓	✓
6	RU001-BLDG102-1	2	Half turn	Fixed	Internal	X	✓	X	X	✓	X	X	X	X	✓	✓	X	✓	✓	✓	X	✓	X	✓	✓	✓	✓	✓
7	RU001-BLDG102-2	1	Spiral stair	Cantilever	Internal	X	✓	X	✓	X	✓	X	✓	✓	X	X	X	✓	✓	✓	-	-	X	✓	X	X	✓	✓
8	RU001-BLDG102-3	1	Straight run stair	Fixed	Internal	X	✓	✓	✓	✓	✓	X	X	✓	X	X	X	✓	✓	X	X	✓	X	✓	✓	X	✓	✓

9	RU001-BLDG103-1	3	Quarter turn stair and Half turn	Fixed	Internal	X	X	✓	✓	✓	✓	X	✓	✓	X	✓	X	✓	✓	✓	X	X	X	✓	X	X	✓	✓
10	RU001-BLDG103-2	2	Half turn	Fixed	External	X	✓	✓	X	✓	✓	X	X	✓	X	X	X	✓	✓	✓	X	✓	X	✓	X	X	✓	✓
11	RU001-BLDG104-1	4	Double L stair	Fixed	Internal	X	✓	✓	✓	✓	X	X	X	✓	X	✓	X	✓	✓	✓	✓	✓	✓	✓	X	X	✓	✓
12	RU001-BLDG104-2	4	Bifurcated stair	Fixed	External	X	✓	✓	✓	✓	✓	X	X	✓	X	X	X	✓	✓	✓	X	✓	X	✓	X	X	✓	✓
13	RU001-BLDG104-3	4	Double L stair	Fixed	Internal	X	✓	✓	X	✓	✓	X	X	✓	X	X	X	✓	✓	✓	X	✓	✓	✓	X	X	✓	✓
14	RU001-BLDG104-4	4	Double L stair	Fixed	Internal	X	✓	X	X	✓	X	X	X	✓	X	✓	X	✓	✓	✓	X	✓	✓	✓	X	X	✓	✓
15	RU001-BLDG104-5	4	Double L stair	Fixed	Internal	X	✓	✓	✓	✓	X	X	X	✓	X	✓	X	✓	✓	✓	X	✓	✓	✓	X	X	✓	✓
16	RU001-BLDG105-1	3	Half turn	Fixed	Internal	X	✓	✓	✓	✓	✓	X	✓	✓	X	✓	X	X	✓	✓	X	✓	X	✓	X	X	✓	✓
17	RU001-BLDG106-1	6	Bifurcated stair	Fixed	Internal	X	✓	✓	✓	✓	✓	X	✓	✓	X	X	X	✓	✓	✓	X	X	X	✓	X	X	✓	✓
18	RU001-BLDG106-2	3	Double L stair	Fixed	Internal	X	✓	X	✓	✓	✓	X	X	✓	X	X	X	✓	✓	✓	X	✓	X	✓	X	X	✓	✓
19	RU002-BLDG201-1	3	Half turn	Fixed	Internal	X	✓	X	X	✓	✓	X	X	✓	X	X	✓	X	✓	✓	X	✓	X	✓	X	X	✓	✓
20	RU002-BLDG201-2	3	Half turn	Fixed	Internal	X	✓	X	X	✓	✓	X	✓	✓	X	X	X	X	✓	X	X	✓	X	✓	✓	X	✓	✓

21	RU002-BLDG202-1	2	Half turn	Fixed	Internal	X	✓	X	✓	✓	X	X	✓	✓	X	X	X	✓	✓	✓	X	✓	X	✓	X	X	✓	✓
22	RU002-BLDG203-1	3	Half turn	Fixed	Internal	X	✓	X	X	✓	✓	X	✓	✓	✓	✓	X	✓	✓	✓	X	✓	X	✓	X	X	✓	✓
23	RU002-BLDG203-2	3	Half turn	Fixed	Internal	X	✓	X	X	✓	✓	X	✓	✓	✓	✓	X	✓	✓	✓	X	✓	X	✓	X	X	✓	✓
24	RU002-BLDG204-1	3	Double L stair	Fixed	Internal	X	✓	X	✓	✓	✓	X	✓	✓	✓	✓	X	✓	✓	✓	X	X	✓	✓	✓	X	✓	✓
25	RU002-BLDG205-1	2	Half turn	Fixed	External	X	✓	X	✓	✓	✓	X	✓	✓	X	X	X	✓	✓	✓	X	✓	X	✓	X	X	✓	✓
26	RU002-BLDG206-1	2	Half turn	Fixed	External	X	✓	X	✓	✓	✓	X	✓	✓	✓	✓	X	✓	✓	✓	X	✓	X	✓	X	X	✓	✓
27	RU002-BLDG206-2	2	Half turn	Fixed	External	X	✓	X	✓	✓	✓	X	✓	✓	✓	✓	X	✓	✓	✓	X	✓	X	✓	X	X	✓	✓
28	R003-BLDG301-1	3	Half turn	Fixed	Internal	X	✓	X	✓	✓	X	X	✓	✓	X	X	X	✓	✓	✓	X	X	X	✓	X	X	✓	✓
29	R003-BLDG301-2	1	Straight run stair	Fixed	External	X	X	X	✓	✓	X	X	✓	✓	X	X	X	X	✓	✓	✓	✓	X	✓	X	X	✓	✓
30	R003-BLDG302-1	8	Half turn	Fixed	Internal	X	X	X	✓	✓	✓	X	✓	✓	X	X	X	✓	✓	✓	X	✓	✓	✓	X	X	✓	✓
31	R003-BLDG302-2	7	Half turn	Fixed	Internal	X	✓	✓	✓	✓	✓	X	✓	✓	X	X	X	X	✓	✓	X	✓	✓	✓	X	X	✓	✓
32	R003-BLDG303-1	4	Half turn	Fixed	External	X	✓	X	✓	✓	✓	X	✓	✓	X	X	X	X	✓	✓	X	✓	✓	✓	X	X	✓	✓

33	R003-BLDG303-2	5	Half turn	Fixed	Internal	X	✓	X	✓	✓	✓	X	X	✓	X	X	X	X	✓	✓	✓	✓	✓	✓	X	X	✓	✓
34	R003-BLDG304-1	6	Half turn	Fixed	Internal	X	✓	X	✓	✓	X	X	X	✓	X	X	X	X	✓	✓	X	✓	✓	✓	X	X	✓	✓
35	R003-BLDG304-2	6	Half turn	Fixed	External	X	✓	✓	✓	✓	✓	X	X	✓	X	X	X	X	✓	✓	X	✓	✓	✓	X	X	✓	✓
36	R003-BLDG304-3	6	Half turn	Fixed	External	X	✓	✓	✓	✓	✓	X	X	✓	X	X	X	X	✓	✓	X	✓	✓	✓	X	X	✓	✓
37	R003-BLDG305-1	3	Half turn	Fixed	External	X	✓	X	✓	✓	✓	X	✓	✓	X	X	X	X	✓	X	X	✓	X	✓	X	X	✓	✓
38	RU004-BLDG401-1	4	Double L stair	Fixed	Internal	X	✓	X	✓	✓	✓	✓	✓	✓	X	✓	X	X	✓	✓	X	✓	X	✓	X	X	✓	✓
39	RU004-BLDG401-2	4	Half turn	Fixed	External	X	✓	X	✓	✓	✓	X	✓	✓	X	✓	X	X	✓	✓	X	✓	X	✓	X	X	✓	✓
40	RU004-BLDG401-3	4	Half turn	Fixed	External	X	✓	X	✓	✓	✓	X	✓	✓	X	X	X	X	✓	✓	X	✓	X	✓	X	X	✓	✓
41	RU004-BLDG402-1	4	Half turn	Fixed	External	X	✓	X	✓	✓	✓	X	✓	✓	X	X	X	X	✓	✓	X	✓	X	✓	X	X	✓	✓
42	RU004-BLDG402-2	3	Half turn	Fixed	Internal	X	✓	✓	✓	✓	X	X	X	✓	X	X	X	X	✓	✓	X	✓	✓	✓	X	X	✓	X
43	RU005-BLDG501-1	3	Half turn	Simply Supported	Internal	X	✓	X	✓	✓	✓	X	X	✓	X	X	X	X	X	✓	X	✓	X	✓	X	X	✓	✓
44	RU005-BLDG501-2	3	Half turn	Fixed	Internal	X	✓	X	✓	✓	X	X	X	✓	X	X	X	X	✓	✓	X	X	✓	✓	X	X	✓	✓

45	RU005-BLDG502-1	2	Double L stair	Fixed	Internal	X	X	X	✓	✓	✓	X	✓	✓	X	X	X	X	X	✓	X	X	✓	✓	✓	X	✓	✓
46	RU005-BLDG503-1	5	Double L stair and Half turn	Fixed	Internal	X	✓	X	✓	✓	✓	X	✓	✓	X	X	X	X	✓	✓	X	✓	✓	✓	X	X	✓	✓
47	RU005-BLDG503-2	1	Straight run stair	Fixed	External	X	X	X	✓	✓	✓	X	✓	✓	X	X	X	X	✓	✓	✓	-	X	✓	X	X	✓	✓
48	RU005-BLDG504-1	3	Half turn	Fixed	Internal	X	✓	X	✓	✓	X	X	✓	✓	X	X	X	X	✓	X	X	✓	X	✓	X	X	✓	✓
49	RU005-BLDG504-2	3	Spiral stairs	Canti lever	External	X	✓	X	✓	X	✓	X	✓	✓	X	X	X	X	✓	✓	X	-	X	✓	X	X	✓	✓
50	RU005-BLDG505-1	3	Half turn, Winder stair	Fixed	External	X	✓	✓	✓	✓	X	X	✓	✓	X	X	X	✓	✓	✓	X	✓	X	✓	X	X	✓	✓

4.9 Ranking of the Universities According to the Quality of Stairs

The ranking of the universities according to the quality of stairs in the buildings was done by computing compliance rates from the performance framework in Table 4.34. Each tick (✓) from the framework represented compliance while a cross (x) represented noncompliance of parameters to the design and contruction requirements. Table 4.35 shows the rankings of the universities.

Table 35: Rankings of the Univesities

Code	Number of staircase parameters (ticks)	Total number of parameters (all)	Compliance (%)	Rank
R001	259	414	62.6	1
R004	62	115	53.9	2
R002	111	207	53.6	3
R003	116	230	50.5	4
R005	89	184	48.4	5
Total	**637**	**1150**		

From Table 4.35, university RU001 was ranked as No. 1 in having good quality staircases with 62.6% compliance rate. This was attributed to most staircases that had balustrades, handrails on both sides as required, staircase widths meeting the requirements, very few overhanging treads, fewer open risers, well terminated handrails, sufficient lighting in most of the stairwells, few broken edges of steps, much fewer slippery surfaces, most stairs meeting the slope requirements, handrail materials being standard, handrails being of standard size, headroom meeting a minimum height of 2000mm and the flooring materials on the staircases being appropriate. Despite this, 37.4% of the parameters were non compliant due to lack of tactile ground surface indicators, lack of newel posts on staircases, uneven risers and treads, flights varying in width, risers and treads being out of range of the standards, handrail heights not meeting the requirements, absence of nosings, handrail extensions not meeting the standards.

The second ranked university with better quality staircases was RU004 with a compliance rate of 53.9%. This was attributed to the presence of balustrades on all the staircases, no overhanging treads, no open risers, no slippery surfaces, well terminated of handrails, staircase width meeting the standards, slope requirements met, headroom meeting a minimum height of 2000mm and the flooring materials on the staircases being appropriate. However, this university had parameters which were not meeting the requirements contributing 46.5% noncompliance due to lack of tactile ground surface indicators, no handrails on most stairs that required them, lack of newel posts on staircases, uneven risers and treads, risers and treads being out of range of the standards, handrail heights not meeting the requirements, flights varying in width, absence of nosings, handrail extensions not meeting the standards and handrails not be being of standard size.

University RU002 followed with a compliance rate of 53.6% which is almost similar quality as RU004. Universities RU003 and RU005 followed in fouth and fifth rankings with 50.5% and 48.4% compliance respectively as most of their stairs had uneven risers and treads. The riser heights and tread widths were either below the minimum or too high above the requirements. Absence of TGSIs, no handrails on both sides of stairs, no newel posts, non standard sizes of handrails, no handrail extensions, stair slopes not meeting the requirements, height of handrails not meeting the standard and stairs not have nosing contrasts all affected the quality of stairs in these two universities.

4.10 Summary of the Findings

Tables 4.36 and 4.37 show the summary of the findings in the study in respect to conformance and staircase accidents.

Table 36: Summary for the findings on conformity to the design requirements

S/N	Parameter	Conformance (%)	Non-conformance (%)
A.	**The existence of key features recommended for quality staircases**		
1.	Tactile ground surface indicators	0	100
2.	Presence of balustrades	72	28
3.	Existence of handrails on both sides of stairs	28	72
4.	Number of steps in stair flights (maximum 12No.)	95	5
5.	Open risers	94	6
6.	Stairwell lighting	76	24
7.	Existence of newel posts	2	98
8.	Termination of handrails	92	8
9.	Materials used for handrails	98	2
10.	Ramps in buildings	29.2	70.8
11.	Flooring materials	96	4
B.	**The extent to which the staircases meet the design and construction**		
1.	Riser heights	44.2	55.8
2.	Evenness of the risers	8.2	91.8
3.	Tread depths	90.3	9.7
4.	Evenness of the treads	19	81
5.	Slope relationship (2R+G)	81.2	18.8
6.	Staircase slopes	36	64
7.	Staircase widths	84	16
8.	Handrail heights	24	76
9.	Handrail extension beyond the first and last tread in stairs	2	98
10.	Nosing contrast	20	80
C.	**The extent to which the quality of staircases affects the users of the buildings**		
1.	Steps without broken edges	66	34
2.	Floors with no slippery surfaces	98	2

Table 37: Summary of findings on staircase accidents their causes and effects on the users

S/N	Description	Yes	No	Not sure
A.	**Existence of accidents on the stairs**			
1.	Those who ever got injured on the stairs	26.3	62.5	11.2
2.	Those who had ever seen/heard ever heard of someone getting injured on the	27.3	62.9	9.8
B.	**Impacts/Accidents/injuries sustained on the stairs**			
1.	Discomfort	25		
2.	Fatigue	28.1		
3.	Dislocated limbs	34.4		
4.	Spinal cord damage	3.1		
5.	Body cuts and bruises	9.4		
C.	**Causes of impacts/accidents/injuries**			
1.	Hurrying	6.3		
2.	Missed step	12.5		
3.	Steps not easily seen	59.4		
4.	Slippery floor surface	3.1		
5.	Inadequate lighting	3.1		
6.	Was on phone	6.25		
7.	Very steep steps	9.4		

4.11 Chapter Summary

This chapter discussed the research findings in detail including the features that affect the quality of the staircases. It also gave the details and results of the factors that influence the quality of staircases as well as the performance of the staircases in relation to compliance with the requirements stipulated in building codes and regulations.

The chapter also gave the analysis of the causes of accidents on the stairs using user data which looked into the types of injuries or health effects sustained on the staircases which revealed the existence of poor-quality staircases. The performance framework in which key features of the framework and its limitations were discussed. The chapter concluded with the summary of the key findings in the study.

CHAPTER FIVE : CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter gives conclusions and recommendations on the research findings in respect to the quality of staircases in storeyed buildings in universities. The conclusions have been made based on each of the specific objectives of the research.

5.2 Conclusions

5.2.1 To identify key features for the design and construction of quality staircases

According to the study, the key features recommended for use on the staircases for their quality included handrails, balustrades, nosing contrasts, risers, treads, tactile ground surface indicators/warning signs and newel posts and existence of ramps in the buildings.

The non-existence of the key identified features on the staircases rendered them of poor quality. Therefore, this study concluded that non- existence of nosing contrasts on the treads, lack of newel posts, lack of handrails on both sides of staircases with widths greater than 1000mm, lack of tactile ground surface indicators/warning signs in all the stairs and the absence of ramps in 70.8% of the buildings studied rendered the access provisions to be of poor quality which will have various impacts on the users including injuries, fatigue and discomfort when they want to use them.

5.2.2 To identify the factors that influence the quality of staircases

The study revealed that four major factors influenced the quality of staircases which included design proficiency, construction competence, design reviews and other project factors. The construction competence factors included; poor workmanship during the construction process by the contractor, use of nonstandard materials from those specified in the contract documents, inadequate supervision for the operatives by the contractor, inexperienced site supervisors and inconsistent instructions issued on site by the supervisors. From the design and construction survey, it was revealed that the contractors and site supervisors are majorly responsible for the quality of staircases.

Therefore, it was concluded that the quality of staircases was as a result of a combination of factors which included; design, construction, supervision, materials used, maintenance and individual user factors as stated in the conceptual framework.

5.2.3 To establish the extent to which the staircases meet the design and construction requirements

Different parameters were checked to see the extent to which they meet the requirements as stipulated in the building codes and regulations including the minimum and maximum requirements. It was concluded that staircases that fell short of the minimum requirements and above the maximum requirements were of poor quality. All universities including Makerere University, Kyambogo University, Kampala International University, St. Lawrence University and Ndejje University had at least a building with staircases that fell short of the design and construction requrements. The requirements that were not met by the staircases included riser heights, goings, slope relationship (2R + G), stair slopes, handrail heights, handrail extensions and depth of nosing contrasts.

5.2.4 To determine the extent to which the staircase quality affects the users of the buildings

Staircases which had broken steps, slippery floor surfaces, uneven risers, uneven treads and those whose measurements did not meet the design requirements were considered of poor quality.

The users were injured while using the staircases due to missed steps, slippery surfaces, inadequate lighting in the stairwell, broken edges of steps, unevenness in the risers and treads which were categorized as design, environmental and maintenance factors which led to impacts such as discomfort and fatigue while using stairs, dislocated limbs, spinal cord damage as well as body cuts and bruises.

5.2.5 To develop a framework of performance for staircases

The performance of staircases was determined after analysing all the stairs and a checklist developed to show how the staircases performed. The framework considered the following parameters; the number of floors in each of the buildings, type of stairs used, how the staircases were anchored, location of the staircases, existence of TGSIs/warning signs, existence of balustrades on the stairs, presence of handrails, existence of open risers, lighting the stairwell, presence of newel posts, presence of broken edges on steps, occurrence of slippery surfaces, overhanging treads, presence of even treads and risers, handrail termination, varying widths of the staircase flights by way of handrail installation, height of handrails, headroom, depth of contrast, the steepness of the stairs, handrail extension as well as floor materials.

5.3 Study limitations

During the study, there were some limitations which included:

(a) Limited literature on staircase accidents in Uganda in terms of data available for reference limited the study in terms of expounding on the scope;

(b) Unwillingness of some staircase users to participate in the study which would make the sample bigger hence higher reliability of the results;

(c) The existence of different requirements under different codes caused indecisiveness on which code should be referenced thereby limiting it to Building Control Regulations (Uganda), BS 5395 and the UK building regulations;

(d) Limited access to data from some universities led to limited descriptive statistics as some universities either did not have the data or were unwilling to provide it; and

(e) In most universities, the designers of the buildings were usually the supervisors of the projects which limited responses from the supervising consultants and designers.

5.4 Recommendations

5.4.1 General recommendations

The design, construction and supervision of staircases as well as their maintenance are important factors that affect their quality. In respect to this, it was recommended as follows:

The designers should always adhere to the design codes and regulations during the design process of public buildings particularly stairs to avoid omisions that would affect the quality of staircases in public buildings. The contractors should also set out and construct staircases as per the designs which would lead to uneven steps on the stairs hence causing accidents.

The design and construction of staircases in particular and buildings in general in Uganda should be done in accordance with the design and construction requirements stipulated in the building codes and regulations including but not limited to the approved documents K and M of the UK building regulations, Building Control Act, accessibility standards (UNAPD), Public Health Act, Building control regulations and other related standards and regulations.

Design reviews on construction projects in general should always be carried as these would prevent any changes in the designs during the construction process which would affect the quality of the building components including staircases. Buildings should be designed to include ramps and/ or related facilities like lifts which provide access for persons with mobility problems especially those who use wheel chairs as recommended in the approved document M of the UK building regulations.

Maintenance of staircases as an important aspect which also determines the quality of staircases should always be catered for and done on staircases especially the broken edges of the steps and damaged handrails which were evident on some stairs.

Materials used in the construction of staircases especially on the handrails and flooring should be such that they do not cause accidents. Flooring materials on easy access stairs should have a high slip resistance to avoid sliding of footwear while walking on the stairs.

Staircase users should always be careful while walking on the staircases as individual user factors like hurrying, running, being on phone, absent mindedness and worn-out footwear would cause accidents which are not necessarily due to design, construction, supervision, environmental or naintenance factors. The stairs in public buildings should not be left wet and should always be clear of any foreign objects to avoid accidents.

5.4.2 Recommendations for further research

In this research study, structural engineers were not part of the respondents in the staircase design and construction survey since structural design of staircases was not part of this study hence leaving a gap for further study. Studies should be carried out on how the structural design of staircases affects their quality and its impact on the users.

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APPENDICES

Appendix 1: Data collection tools

(a) Observational survey tool/checklist

UNIVERSITY CODE:……………………………………………………………..…..

S/N	DESCRIPTION	YES	NO	REMARK/ COMMENT
1	Does the building have a staircase for accessing the upper floors?			
2	Where is the staircase located?	☐ Interior ☐ Exterior		
3	Are there any warning signs or other indicators before the staircases/ramps to show their existence? If yes, state the type of signs used.			
4	Does the staircase have balustrades?			
5	Does the staircase have landings between flights			
6	Are the nosings and treads easily visible? If no, comment on their visibility.			
7	Are the treads of the staircase overhanging?			
8	Are the risers closed or open?	☐ Open ☐ Closed		
9	Are there any objects on the staircase which hinder movement?			
10	Is the lighting in the stairwell sufficient?			

11	What kind of lighting has been provided in the stairwell?	☐ Natural ☐ Artificial ☐ Both	☐ None	
12	What method of natural lighting has been used in the stairwell?	☐ Fanlights ☐ Roof lights ☐ Large window ☐ Large vents	☐ None	
13	Are there lighting lamps along each flight of the staircase to provide artificial light? Comment if not.			
14	Are all the lighting lamps in the stairwell for artificial lighting working? If no, comment.			
15	(a) Are there handrails along the flights of the staircase?			
	(b) Are the handrails provided on both sides of the staircase?			
	(c) Are the handrails broken at some point along the staircase or continuous?	☐ Broken ☐ Continuous		
	(d) Do the handrails at the bottom of the staircase extend beyond the steps?			
	(e) Are the handrails terminated into the wall or downwards or by returning back on themselves	☐ Into the wall ☐ Downwards ☐ Returning back		

16	Is the floor surface of the staircase shiny or opaque?	☐ Shiny ☐ Opaque		
17	Is the staircase surface wet and/ or slippery? Comment on the state of the surface			
18	Does the staircase have any broken edges/steps			
19	(a) Does the building have ramp(s)?			
	(b) Where is the ramp(s) located in the building?	☐ Interior ☐ Exterior		
	(c) Does the ramp(s) have handrails?			
	(d) Does the ramp(s) have kerb rails?			
20	(a) Is there any emergency staircase or exit in case of fire outbreak?			
	(b) Where is the emergency staircase located in the building?	☐ Interior ☐ Exterior ☐ Other		

(b) Technical survey tool

UNIVERSITY CODE:……………………………………………………………………………

S/N	DESCRIPTION	MEASUREMENT/ RESPONSE	REMARK/ COMMENT
1	When was the selected storeyed building constructed?		
2	How many floors are on the selected storeyed building?		
3	What type of staircase(s) has been used in the selected building?		

4	Which material has been used in the construction of the staircase?		
5	Which floor finish has been used on the staircase?		
6	How is the staircase anchored (simply supported or cantilever)?		
7	How far are the warning signs/tactile ground surface indicators (TGSIs) from the first step at the bottom if provided?		
8	(a) What is the height of the handrails from the edge of the nosing?		
	(b) What material has been used for the handrails?		
	(c) What is/are the diameter(s) of the handrails?		
	(d) By how much are the handrails of the staircase extending beyond the last step at the bottom?		
9	(a) How many flights are there between each of the floors?		
	(b) What is the width of each flight?		
	(c) What is the length of each of the flights? Specify the various lengths if they are different in each of the floors.		
	(d) What is the total run of each of the flights?		
	(e) What is the total rise of each of the flights?		
	(f) How many steps are in each flight? If varying, specify for each flight and floor		
10	(a) Are the risers even in height?		
	(b) What is the riser height? If they are different, indicate the various heights.		
11	(a) Are the treads even in width?		
	(b) What is the width of the treads? If they are different, indicate the various widths		
	(c) What is the width of the going? If varying, specify the different widths.		
12	What is the depth of the contrast of the nosing area?		

13	(a) If ramps are present, what are the necessary dimensions of the ramps (Length, width & height/total rise, run)?		
	(b) What is the slope of the ramp(s)?		
	(c) What floor finish has been used on the ramp(s)?		
	(d) What materials have been used for balustrades and handrails along the ramp(s)?		
14	(a) What is/are the height(s) of the headroom from the pitch line of each flight of the staircase?		
	(b) What is the height of the headroom between the landing/ground floor and the suspended floor slabs of each floor/ceiling?		

(c) Questionnaires

(i) Staircase design and construction survey questionnaire

Dear Participant,

You have been selected to participate in a survey on the **Analysis of the quality of staircases in storeyed buildings of Uganda's Universities: A case study of central region.** The survey is aimed at assessing the factors that influence the quality of staircases in public buildings in which Educational buildings like those in Universities are examples.

This survey is entirely academic and any information collected will be treated **CONFIDENTIAL** and used for academic purposes only.

You are therefore requested to spare some time to fill in this questionnaire to facilitate the completion of the task.

For more information on this survey, do not hesitate to contact **Benjamin** on **0782969564 or 0702701911.**

PART I: BACKGROUND INFORMATION

Please tick (√) the most appropriate answer representing your response.

1. Gender of the participant. [1] Male [2] Female

2. Age of the participant.

[1] 18 – 30 years [2] 31 – 45 years [3] 46 – 60 years [4] Over 60 years

3. What is your occupation/role in the construction industry?

1 Designer/Architect   2 Contractor   3 Client

4 Consultant/Site supervisor   5 Other (specify)…………………………………

4. What is your experience in the construction of staircases of public buildings?

1 Below 5 years   2 5 – 10 years   3 11 – 15 years   4 Over 15 years

PART II: TECHNICAL INFORMATION

This section gives alternative responses and numbers assigned representing each response. The extent to which you agree with the responses is represented using the Likert scale ranging from 1 = Strongly disagree, 2 = Disagree, 3 = Not sure, 4 = Agree and 5 = Strongly agree. Please tick the number which best suits your evaluation of the response given.

A. Participation in staircase design, construction and supervision of public buildings

S/N	Statement	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
A1	I have participated in the design process of staircases for public buildings	1	2	3	4	5
A2	I have participated in the construction process of staircases in public buildings	1	2	3	4	5
A3	I have participated in supervising the design process of staircases for public buildings	1	2	3	4	5
A4	I have participated in supervising the construction process of staircases in public buildings	1	2	3	4	5
A5	Designers are responsible for the quality of the staircases in public buildings	1	2	3	4	5
A6	Contractors are entirely responsible for the quality of the staircases in public buildings	1	2	3	4	5
A7	Consultants/Site supervisors are responsible for the quality of the staircases in public buildings	1	2	3	4	5
A8	Clients are responsible for the quality of the staircases in public buildings	1	2	3	4	5

B. Factors that influence the quality of staircases in public buildings during the design and construction

S/N	Factor	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
B1	Use of incompetent designers	1	2	3	4	5
B2	Non-adherence to design codes and regulations during the design process	1	2	3	4	5
B3	Negligence by the designers	1	2	3	4	5
B4	Mistakes made in the drawings during design	1	2	3	4	5
B5	Poor workmanship during the construction process by the contractor	1	2	3	4	5
B6	Use of nonstandard materials from those specified in the contract documents	1	2	3	4	5
B7	Inadequate supervision for the operatives by the contractor	1	2	3	4	5
B8	Corruption	1	2	3	4	5
B9	Inadequate supervision of the the contractor's work by the consultants/site supervisors	1	2	3	4	5
B10	Inconsistent instructions issued on site by the supervisors.	1	2	3	4	5
B11	Inexperienced site supervisors	1	2	3	4	5
B12	Limited space for the construction	1	2	3	4	5
B13	Unprofessional client demands	1	2	3	4	5
B14	Changes made on the drawings by the architect during the construction process	1	2	3	4	5
B15	Limited project finances/funds	1	2	3	4	5
B16	Inadequate design reviews of the construction projects	1	2	3	4	5

C. Major Indicators of staircases that do not meet quality standards in public buildings

S/N	Indicator	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
C1	Missing or damaged handrails and balusters	1	2	3	4	5
C2	Poorly constructed/installed handrails that do not meet the construction requirements.	1	2	3	4	5
C3	Poorly maintained staircases including broken steps	1	2	3	4	5
C4	Uneven risers	1	2	3	4	5
C5	Open risers	1	2	3	4	5
C6	Uneven treads	1	2	3	4	5
C7	Narrow treads	1	2	3	4	5
C8	Overhanging treads	1	2	3	4	5
C9	Too steep staircase flights	1	2	3	4	5
C10	More steps in staircase flights than recommended	1	2	3	4	5
C11	Slippery nosings or treads	1	2	3	4	5
C12	Glossy or shiny/reflective floor surfaces	1	2	3	4	5
C13	Poor lighting in the stairwell	1	2	3	4	5
C14	Poorly ventilated staircases and ramps	1	2	3	4	5
C15	Missing or damaged ramps	1	2	3	4	5
C16	Missing or damaged kerb rails along the ramps	1	2	3	4	5
C17	Obstacles/objects on the stairs	1	2	3	4	5
C18	Poorly visible nosings due to indistinct colour designs	1	2	3	4	5
C19	Lack of tactile ground surface indicators (TGSIs) or warning signs on the existence of staircases or ramps	1	2	3	4	5
C20	Lack of emergency or escape routes	1	2	3	4	5

D. Recommended materials for floor finishing of staircase surfaces in public buildings

S/N	Material	Strongly disagree	Disagree	Not sure	Agree	Strongly agree
	The following materials can be used for floor finishing of staircases of public buildings					
D1	Terrazzo	1	2	3	4	5
D2	Glossy tiles	1	2	3	4	5
D3	Non-slip tiles	1	2	3	4	5
D4	Cement/sand screed	1	2	3	4	5
D5	Timber	1	2	3	4	5
D6	Mild steel plates	1	2	3	4	5
D7	Granite	1	2	3	4	5
D8	Slates	1	2	3	4	5
D9	Carpets	1	2	3	4	5
D10	Laminated flooring	1	2	3	4	5
D11	Other materials (specify):………………………..	1	2	3	4	5

(ii) Staircase user survey questionnaire

Dear Participant,
You have been selected to participate in a survey on the **Analysis of the quality of staircases in storeyed buildings of Uganda's Universities: A case study of central region.** This survey is entirely academic and any information obtained herein will be treated **CONFIDENTIAL**.
You are therefore requested to spare some time to fill in this questionnaire to facilitate the completion of the task.

For more information on this survey, do not hesitate to contact **Benjamin** on **0782969564 or 0702701911.**

PART I: BACKGROUND INFORMATION

Please tick (√) the most appropriate answer representing your response.

1. Gender of the participant. [1] Male [2] Female

2. Age of the participant.

[1] 18 – 30 years [2] 31 – 45 years [3] 46 – 60 years [4] Over 60 years

3. What is your relationship with this University?

1 Employee 2 Student 3 Client 4 Others (specify)…………

PART II: SPECIFIC INFORMATION`

4. Have you ever used the stairs of this building?

1 Yes 2 No

5. If yes to question 4, how frequent do you use the stairs?

1 Daily 2 Weekly 3 Monthly 4 Others (Specify)………………

6. How many times do you usually use the stairs in a particular day?

1 Twice 2 Four times 3 Six times 4 Over six times 5 Not sure

7. Did your feet tend to slide over the surface of the steps while you walked on them?

1 Yes 2 No 3 Not sure

8. If yes to question 7, which of the following could have led to the sliding?

1 The surface was wet 2 Floor finishing material was slippery

3 Broken edges of the steps 4 Slippery edges of the steps

5 Was hurrying/running 6 Others (specify) …………………………

9. Did your feet suddenly/abruptly come across a step when you did not expect it while walking on the stair?

1 Yes 2 No 3 Not sure

10. If yes to question 9, which of the following best explains what could have caused the above situation?

1 The step was higher than expected 2 Was not aware of its existence

3 Was hurrying/running 4 Thought I had finished all the steps

5 Was on phone 6 Other (specify)……………………………

11. Did your feet happen to miss a step while walking on the steps?

1 Yes 2 No 3 Not sure

12. If yes to question 11, which of the following could have caused the missing of the step?

1 The steps were not properly seen 2 The width of step was smaller than expected

3 Was hurrying/running 4 The height of the step was lower than expected

5 Was on phone 6 Other (specify)…………………………

13. Was there a time when you wanted to support yourself while walking on the stairs of this building?

1 Yes 2 No 3 Not sure

14. If yes to question 13, at what point did you consider supporting yourself?

2 When walking up the stairs 3 When walking down the stairs 4 Not sure

15. From question 14, were you able to support yourself?

1 Yes 2 No 3 Not sure

16. If yes to question 15, which of the following was the reason why you supported yourself while walking on the steps?

1 Due to a health condition that I have 2 Just felt comfortable to support myself

3 To avoid sliding on the steps 4 Due to the difficulty in walking on these specific stairs

5 Due to the many steps along the entire stair 6 Other (specify)……………………

17. If No to question 15, which of the following was the reason for NOT supporting yourself while walking on the steps?

1 Missing or absence of the necessary supports 2 It was not necessary to support myself

3 The supports were damaged 4 Other (specify)………………….

18. Did your feet tend to abruptly/suddenly knock the edges of the steps while walking on the stairs?

1 Yes 2 No 3 Not sure

19. If yes to question 18, which of the following was the cause of knocking the feet on the steps?

1 Broken edges of the steps 2 Was hurrying/running

3 The steps were not properly seen 4 Did not notice the existence of some steps

5 Insufficient lighting along the stairs 6 Was on phone

7 Other (specify)……………………………………………

20. Did you notice any foreign objects placed along the stairs?

[1] Yes [2] No [3] Not sure

21. If yes to question 20, specify the object that was on the stair at that time……………

22. Did you ever meet another person moving in the opposite direction while you walked on the stairs?

[1] Yes [2] No [3] Not sure

23. If yes to question 22, do you think the space was enough for both of you to pass comfortably on the stairs?

[1] Yes [2] No [3] Not sure

24. Has the use of the stairs of the building had any effect on your health in any away?

[1] Yes [2] No [3] Not Sure

25. Have you ever seen/heard of someone else who got injured while using the stairs of this building?

[1] Yes [2] No [3] Not sure

26. If yes to questions 24 and/or 25, which of the following could have been the cause(s) of the effects/injuries/accidents? (tick as many as the causes were)

[1] Uneven size of the steps [2] I was hurrying/running [3] Missed a step

[4] Broken steps/surface [5] Steps are not easily seen [6] Slippery floor surface

[7] Inadequate lighting along stairs [8] Slippery shoe soles [9] Was on phone

[10] Very steep steps [11] Missing or damaged supports along the stair to hold on

[12] Narrow steps [13] Other (specify)…………………………….............

27. If yes to questions 24 and/or 25, which of the following have been the effects of using the stairs of this building.

[1] Discomfort during their use [2] Fatigue due to too many steps [3] Dislocated limbs

[4] Sprains and strains [5] Spinal cord damage [6] Fractures

[7] Body cuts and bruises [8] Internal bleeding [9] Head injury

[10] Other (specify)…………………………………………………………

28. Is there any other alternative access to the building apart from the main staircase?

[1] Yes [2] No [3] Not sure

29. If yes to question 28, have you ever used this alternative access to the building?

[1] Yes [2] No [3] Not sure

30. If yes to question 29, which of the following was the reason for using this access.

[1] Used it as a shortcut [2] It is easily accessible [3] There was a fire outbreak

[4] Other (specify)…………………………………………………………

31. If No to question 29, which of the following was the reason for NOT being able to use that alternative access in the building?

[1] It is longer than the main one [2] It is not easily accessible

[3] It is usually closed [4] I just don't want to use it

[5] Other (specify)………………………………………………………………………

(d) Interview guide

KYAMBOGO UNIVERSITY

GRADUATE SCHOOL

Department of Civil and Environmental Engineering

Name of University:…………………………………………………………………

University code:……………………………………………………………………...

INTERVIEW GUIDE

S/N	Description	Response
1.	How many storeyed buildings are in this University?	
2.	How many floors are on the highest/tallest storeyed building?	
3.	How many floors are on the lowest/shortest building?	
4.	Name any two Contractors (Companies) with their locations and telephone contacts who have participated in constructing storeyed buildings in this University.	Name…………………………………… …………………………………………… Location:……………………………….. …………………………………………… Tel. contact:…………………………..... ……………………………………………..
		Name…………………………………… …………………………………………… Location:……………………………….. …………………………………………… Tel. contact:…………………………..... ……………………………………………..
5.	Name any two Design consultants/ Architects (Companies) with their locations and telephone contacts who	Name…………………………………… …………………………………………… Location:………………………………..

	have participated in designing storeyed buildings in this University.	………………………………………. Tel. contact:……………………….... ………………………………………..
		Name………………………………. ………………………………………. Location:…………………………….. ………………………………………. Tel. contact:……………………….... ………………………………………..
6.	Name any two supervision consultants/Site Engineers/Site supervisors (Companies) with their locations and telephone contacts who have participated in supervising the construction of storeyed buildings in this University.	Name………………………………. ………………………………………. Location:…………………………….. ………………………………………. Tel. contact:……………………….... ………………………………………..
		Name………………………………. ………………………………………. Location:…………………………….. ………………………………………. Tel. contact:……………………….... ………………………………………..

Information provided by

(Name):………………………………………………………………………

Designation/Title:…………………………………………………………

Date:……………………….....

Appendix 2: Introductory letter

KYAMBOGO UNIVERSITY

Department of Civil and Environmental Engineering

P. O. BOX 1, KYAMBOGO - KAMPALA, UGANDA

TEL: +256-41-4287340, FAX: +256-41-4289056/4222643

5th February, 2022

The University Secretary,

St. Lawrence University.

Dear Sir/Madam,

RE: INTRODUCTION LETTER FOR MR. MUKHWANA BENJAMIN REG: GMET/18779/PD

This is to introduce the above-named final year student who is undertaking a Master of Science in Construction Technology and Management at the Faculty of Engineering, Department of Civil and Environmental Engineering, Kyambogo University. Benjamin is undertaking a research study titled: ***ANALYSING THE QUALITY OF STAIRCASES OF STOREYED BUILDINGS IN UGANDA'S UNIVERSITIES - A CASE STUDY OF CENTRAL REGION"***. This is one of the requirements for graduation at Kyambogo University to conduct research and submit a dissertation/thesis by graduate students before awarding them a degree. The study will involve: onsite measurements in comparison with design and construction parameters, staircase user responses and staff of the selected Universities.

The purpose of this communication, therefore, is to humbly request your office and the relevant staff to assist him access the necessary information and guidance to help him successfully conduct his research at your organisation. The information will only be used for academic purposes and shall be kept confidential.

We thank you in advance for your cooperation and we hope the findings of this research will also benefit the organisation.

Yours faithfully,

KYAMBOGO UNIVERSITY HEAD OF DEPARTMENT 05 FEB 2022 DEPARTMENT OF CIVIL & ENVIRONMENTAL ENGINEERING

Delivered on 14/02/2022

Dr. Muhwezi Lawrence

Senior Lecturer and Head of Department,

Civil and Environmental Engineering

Faculty of Engineering, Kyambogo University

Tel. +256772 402883/702 402883

Email: lmuhwezi@kyu.ac.ug/lmuhwezi@hotmail.com

Appendix 3: Request letters for data

Kyambogo University
P.O Box 1, Kyambogo
Tel: 0782969564/0702701911

8th February, 2022

To: The Chairperson,
Mulago Hospital Research and Ethics Committee.

RE: REQUEST FOR DATA/STATISTICS ON ACCIDENTS DUE FALLS AND STAIRCASE ACCIDENTS IN UGANDA

I hereby submit my request to your office as per the above reference.

I am a final year student of Masters of Science in Construction Technology and Management at Kyambogo University. I am carrying out a research study titled: **"Analyzing the quality of staircases of storeyed buildings in Uganda's Universities: A case study of Universities in central region"**. In this study, I will be investigating the factors that affect the quality of staircases and the impact of poor quality staircases on the users of the buildings including accidents due to tripping and sliding hence causing injuries to the users. These will be correlated with the quality of the existing staircases in the selected places to come up with the conclusion on the causes of staircase accidents.

The data/statistics obtained from your office will be used as a secondary source of data which will be used in expounding on the justification for the research and literature review in the Ugandan context as there is not much literature or publications on such accidents in Uganda. The data/statistics/reports availed will be used for academic purposes only.

This is therefore to request you to avail me with any existing data/statistics and/ or any other related literature/reports on the accidents as stated below.

(a) Accidents due falls in general.

(b) Accidents due staircase falls in particular.

I will be glad for your positive response towards this request.
Attached to this request is my introductory letter, Identity card and Research proposal.

Yours faithfully,

Mukhwana Benjamin Khabusi
Tel: 0782969564/0702701911

Kyambogo University
P.O Box 1, Kyambogo
Tel: 0782969564/0702701911

8th February, 2022

To: The Chairperson,
Mulago Hospital Research and Ethics Committee.

RE: WAIVER OF CONSENT TO USE SECONDARY DATA FOR MY RESEARCH

Refer to my letter dated 8th February, 2022, requesting for data on staircase accidents.

I am Mukhwana Benjamin Khabusi, a final year student of Masters of Science in Construction Technology and Management at Kyambogo University.

Am requesting your office to allow me use secondary data for my academic research

The purpose of this letter is to request for a waiver of consent because am going to use secondary data.

I will be glad for your positive response towards this request.

Yours faithfully,

Mukhwana Benjamin Khabusi
Tel: 0782969564/0702701911

Kyambogo University
P.O Box 1, Kyambogo
Tel: 0782969564/0702701911

National Council for Higher Education
★ 28 JAN 2022 ★
RECEIVED

27th January 2022

TO: The Executive Director,
NCHE

RE: REQUEST FOR AN OFFICIAL LIST OF UNIVERSITIES IN CENTRAL REGION

I hereby submit my request to your office requesting for the list of both Public and Private Universities in the central region as per the above reference.

I am a final year student of Masters of Science in Construction Technology and Management at Kyambogo University. I am carrying out a research study titled: **"Analyzing the quality of staircases of storeyed buildings in Uganda's Universities: A case study of Universities in central region".**

As part of the process towards collection of the required research data, I need an official, signed and stamped list of the Universities within the geographical scope (central region) to be able to finalize on the sample size. This list will also become a supporting document for the thesis. The list will be used for academic purposes only.

This is therefore to request you to avail me with the above list so that I can be able to start on the process of data collection.

I will be glad for your positive response towards this request.

Attached to this request is my introductory letter.

Thanks,
Yours faithfully,

Mukhwana Benjamin Khabusi
Student, Msc. in Construction Technology and Management (KYU)
Tel: 0782969564/0702701911

Appendix 4: Acceptance letters

NDEJJE UNIVERSITY

Fear of God brings Knowledge and Wisdom

Directorate of Research and Innovations
P. O. Box 7088, Kampala – UGANDA
Tel: +256 414 663 680
Email: @ndejjeuniversity.ac.ug
Website: www.ndejjeuniversity.ac.ug

Date : 21ST February, 2022

To : Mukhwana Benjamin
Kyambogo University
P.O Box 1, Kyambogo

Dear Mr. Mukhwana Benjamin

RE : <u>PERMISSION TO CONDUCT RESEARCH AT NDEJJE UNIVERSITY</u>

Reference is made to your letter dated 5th February 2022, requesting for permission to collect data for your study "Analyzing the quality of staircases of storied buildings in Uganda's universities-A case study of central region" at Ndejje University.

This is to inform you that permission is hereby granted to you as per your request. However, you will be expected to follow the Uganda National Council for Science and Technology research COVID-19 guidelines and strictly provide proof of a Research Ethical clearance from National Council of Science and Technology or any other registered REC center.

By copy of this letter, the University Security and Estates department are informed and requested to accord you the necessary support. You are expected to meet the Estates Department Staff to accord you the necessary support you need for this study.

Yours Sincerely,

Dr. Primrose Nakazibwe (PhD)
Director Research and Innovations

Cc : Head Security, Ndejje University
Cc: Head Estates Department, Ndejje University

KAMPALA INTERNATIONAL UNIVERSITY

Ggaba Road, Kansanga * PO BOX 20000 Kampala, Uganda
Tel: +256709654233/+256774393791 Fax: +256 (0) 41 – 501974
E-mail: dhdrinquiries@kiu.ac.ug * Website: http://www.kiu.ac.ug

Directorate of Higher Degrees and Research
Office of the Director

CONFIDENTIALITY AGREEMENT (The Agreement dated this ..21st...... day of ..Feb...2022
BETWEEN

Mukhwana Benjamin of ... Kyambogo University
(The Researcher)

AND

James S. Busingye ...... of KAMPALA INTERNATIONAL UNIVERSITY
(The representative of the University/Site)

Background
The researcher is currently or may be allowed to conduct the study in this institution and may be granted access to . STAIR CASES OF STORIED BUILDINGS .... In addition to this activity, this agreement covers the researcher's responsibility to keep all information attained from this institution confidential and use it for Academic purposes ONLY. The researcher at the end of the study shall share the findings of this study with the institution.

STRICTLY, information on . ALL OTHER THING EXCEPT AS STATED is too private and will be handled with anonymity strategies.

SIGNED

Researcher's Signature: .... [signature] ....

Name : .. MUKHWANA BENJAMIN ....

Institution : .... KYABGBOGO UNIVERSITY ....

Telephone and Email Address: .... 0782969564 / 0702701911 ....
bmukhwanak@gmail.com.

Permission Granted By:

Name : ... James S. Busingye ....

Signature : ... [signature] ....

Designation : ... University Secretary ....

KAMPALA INTERNATIONAL UNIVERSITY
FEB 2022
DVC FINANCE AND ADMINISTRATION
BOX 20000, KAMPALA

"Exploring the Heights"

KYAMBOGO UNIVERSITY

P. O. BOX 1 KYAMBOGO
Tel: 041 -286237, 285001/2 Fax: 041 -220464, 222643
Email: uskyu@kyu/www.kyu.ac.ug

Office of the University Secretary

In any correspondence on this subject please, quote No: **KYU/R/03**

Date: 9th February 2022

Dr. Muhwezi Lawrence
Senior Lecturer and Head of Department
Civil and Environmental Engineering
Faculty of Engineering, Kyambogo University
P. O. Box 1
KYAMBOGO

Dear Dr. Muhwezi

PERMISSION TO COLLECT DATA IN KYAMBOGO UNIVERSITY

Reference is made to your letter dated 5th February 2022, introducing ***Mr. Mukhwana Benjamin Reg. GMET/18779/PD*** for permission to collect data purely for academic purpose, entitled ***"Analyzing the Quality of Staircases of Storeyed Buildings in Uganda's Universities – a Case Study of Central Region"*** as a partial fulfillment for the award of Master of Science in Construction Technology and Management at the Faculty of Engineering, Department of Civil and Environmental Engineering, Kyamogo University.

This is to inform you that permission is **granted** to ***Mr. Mukhwana Benjamin Reg. GMET/18779/PD*** to conduct the above research at the University. Liaise with the Academic Registrar or relevant Faculty Deans and Head of Departments to guide you on the way forward.

Thank you

UNIVERSITY SECRETARY
10 FEB 2022
KYAMBOGO UNIVERSITY
P.O. BOX 1, KYAMBOGO - UGANDA

Arthur Katongole
FOR UNIVERSITY SECRETARY

CC: Mr. Mukhwana Benjamin

TELEPHONE: +256-41554008/1
FAX: +256-414-5325591
E-mail: admin@mulago.or.ug
Website: www.mulago.or.ug

IN ANY CORRESPONDENCE ON THIS SUBJECT PLEASE QUOTES NO.................

MULAGO NATIONAL REFERRAL HOSPITAL
P. O. Box 7051
KAMPALA, UGANDA

APPROVED
APPROVAL DATE 14 FEB 2022 EXPIRY DATE 13 FEB 2023
MULAGO RESEARCH ETHICS COMMITTEE
IRC

14th February 2022.

Mr. Mukhwana Benjamin
Principal Investigator
Department of Civil and Environmental Engineering
Kyambogo University

Dear Mukhwana,

Re: Approval of Protocol MHREC 2208: "Analyzing the Quality of Staircases of Storeyed Building in Uganda's University- A Case Study of Central Region".

The Mulago Hospital Research and Ethics Committee reviewed your proposal referenced above and granted approval of this study on 14th February 2022. The conduct of this study will therefore run for a period of one (1) year from 14th February 2022 to 13th February 2023.

This approval covers the protocol and the accompanying documents listed below;

- Waiver of consent to use secondary data
- Observational survey tool/ checklist
- Questionnaires

This approval is subjected to the following conditions:

1. That the study site may be monitored by the Mulago Hospital Research and Ethics Committee at any time.
2. That you will be abide by the regulations governing research in the country as set by the Ugandan National Council for Science and Technology including abiding to all reporting requirements for serious adverse events, unanticipated events and protocol violations.
3. That no changes to the protocol and study documents will be implemented until they are reviewed and approved by the Mulago Hospital Research and Ethics Committee.
4. That you provide quarterly progressive reports and request for renewal of approval at least 60 days before expiry of the current approval.
5. That you provide an end of study report upon completion of the study including a summary of the results and any publications.
6. That you will include Mulago Hospital in your acknowledgements in all your publications.

I wish you the best in this Endeavour.

DR. NAKWAGALA FREDERICK NELSON
CHAIRMAN- MULAGO HOSPITAL RESEARCH & ETHICS COMMITTEE

Vision: "To be the leading centre of Health Care Services"

National Council for Higher Education

Our Ref: NCHE/U/02

8th February 2022.

Mr. Mukhwana Benjamin Khabusi,
Msc. In Construction Technology and Management,
Kyambogo University,
P. O. Box 1.
Kyambogo – Kampala.
Tel: 0782-969564/0702-701911

Dear Benjamin,

RE: LIST OF UNIVERSITIES IN CENTRAL REGION

Reference is made to your letter dated 27th January 2022 requesting for an official list of both Public and Private Universities in the central region as part of your research.

This is therefore to forward to you the list of universities (attached) as requested for your use.

Yours sincerely,

Pius C. Achanga, PhD (Cranfield)
DIRECTOR, QUALITY ASSURANCE & ACCREDITATION

Plot M834, Kigobe Road, Kyambogo P.O. Box 76 KYAMBOGO, Kampala-Uganda
Tel: +256-393-262140/1 Fax: +256-393-262145
E-mail: ed@unche.or.ug, info@unche.or.ug, Website: www.unche.or.ug

National Council for Higher Education

Recognized Universities in Central Region

1. PUBLIC UNIVERSITIES

S/N	*Name of University/Address*
1.	**Makerere University (Mak)** P.O. Box 7062, Kampala vc@admin.mak.ac.ug www.mak.ac.ug +256 414542803
2.	**Kyambogo University (KYU)** P.O. Box 1, Kyambogo Tel: (+256)-41-4-286238 vckyu@kyu.ac.ug/ arkyu@kyu.ac.ug www.kyu.ac.ug

2. UNIVERSITY WITH SEPERATE ACT OF PARLIAMENT

S/N	*Name of Institution/ Address*
1.	**Islamic University in Uganda (IUIU) – Kampala & Female campus (Kabojja)** P.O. Box 2555, Mbale Main campus (Mbale) Tel: + 256 701 386 400/778 007 077/ 0393 512103 registrar@iuiu.ac.ug www.iuiu.ac.ug

3. PRIVATE CHARTERED UNIVERSITIES

S/N	*Name of Institution/ Address*
1.	**Uganda Christian University (UCU)** P.O. Box 4, Mukono, Uganda Tel: +256 312 350 800 /880 Email: info@ucu.ac.ug Web: www.ucu.ac.ug
2.	**Uganda Martyrs University (UMU)** P.O. Box 5498, Kampala Main Campus (Nkozi) +256 382 410611 pro@umu.ac.ug www.umu.ac.ug
3.	**Nkumba University (NU)** P.O. Box 237, Entebbe Uganda +256775037833/+256772446510 +256782741948 ar@nkumbauniversity.ac.ug www.nkumbauniversity.ac.ug
4.	**Kampala International University (KIU)** P.O. Box 20000, Ggaba Road, Kansanga, Kampala +256 392 001 816/+256 752 800 802 admin@kiu.ac.ug www.kiu.ac.ug
5.	**Ndejje University (NDU)** P.O. Box 7088, Kampala, Uganda +256-392-730324 info@ndejjeuniversity.ac.ug vc@ndejjeuniversity.ac.ug
6.	**Bugema University (BMU)** 32Km along Gayaza - Zirobwe Road. P.O. Box 6529, Kampala +256 312 351400 vc@bugemauniv.ac.ug

	www.bugemauniv.ac.ug
7.	**Kampala University (KU)** P.O. Box 25454, Kampala +256-772-450601/+256-703624974 / +256-773198341 ambprobdk@yahoo.com pro@ku.ac.ug / ssekatawajulius@gmail.com
8.	**Africa Bible University (ABU)** P.O. Box 71242, Clock Tower Kampala +256-414-201507/ 757-353799 info@abu.ac.ug www.abu.ac.ug
9.	**ISBAT University (ISBAT)** 11A Rotary Avenue, Lugogo By-Pass P.O. Box 8383, Kampala Tel: +256 414 237 524/5/6 Email: info@isbatuniversity.com www.isbatuniversity.ac.ug
10.	**Victoria University (VU)** Victoria Towers Plot 1-13, Jinja Road P.O. Box 30866, Kampala +256 417727000 info@vu.ac.ug www.vu.ac.ug

4. PRIVATE UNIVERSITIES WITH PROVISIONAL LICENCE

S/N	*Name of Institution/ Address*
1.	**Aga Khan University (AKU)** Plot 9/11 Makerere Road, P.O. Box 8842, Kampala +256414 349494 Email: sonam.ug@aku.edu www.aku.edu
2.	**St. Lawrence University (SLAU)**

	P.O. Box 24930, Kampala- Uganda +256414-270082/+256756949551. info@slau.ac.ug www.slau.ac.ug
3.	**Muteesa I Royal University (MRU)** P.O. Box 14002, Kampala Registrar@mru.ac.ug +256 704-941-363 / +256 434-251-459 www.mru.ac.ug
4.	**Clarke International University (CIU) formerly International Health Sciences University** Plot 46/86 Kisugu P.O. Box 8177 Kampala +256-312307400/256 750000600 info@ciu.ac.ug
5.	**Cavendish University Uganda (CUU)** Plot 1469 Ggaba Road, Nsambya (Opp. American Embassy) P.O. Box 33145, Kampala +256 414531700, +256 700652010 / +256 700652020 / +256 700652030 / +256 700652040 / +256 700652050 Whatsapp: +256 706 695369 info@cavendish.ac.ug www.cavendish.ac.ug
6.	**International University of East Africa (IUEA)** Plot 1112/1121, Kansanga-Ggaba Road, P.O. Box 35502, Kampala +256 417722300/+800 335 335 +256 705722300/+256 770564247| info@iuea.ac.ug www.iuea.ac.ug
7.	**Islamic Call University College (ICUC)** Plot 23/25 Old Kampala Road, UMSC-Headquarters P.O. Box 72568, Kampala +256 772 472 354/+256 702472354 info@icuc.ac.ug www.icuc.ac.ug

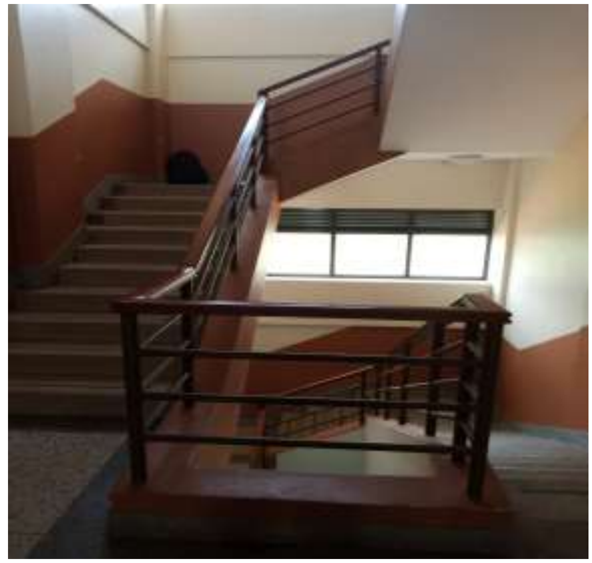
8.	**King Ceasar University (KCU) formerly St. Augustine International University** Plot 30/31 Bunga Hill, P.O. Box 88, Kampala +256 705 444 540/+256 704429441 info@kcu.ac.ug www.kcu.ac.ug
9.	**Nexus International University (formerly Virtual University of Uganda)** Plot 425 Zzimwe Road, Muyenga P.O Box 70773 Clock Tower Kampala +256 393 202 136 / 137/ +256 772202138 infoniu@niu.ac.ug www.niu.ac.ug
10.	**Uganda Technology and Management University (UTAMU)** Plot 6, Erisa Road, Kiswa, Bugolobi; P. O Box 73307, Kampala +256-778-055-710/ +256-750-599-736 info@utamu.ac.ug www.utamu.ac.ug
11.	**African Renewal University (AfRU)** Buloba town, Mityana Road P.O. Box 35138, Kampala +256-701-598347/782-598347 info@afru.ac.ug www. afru.ac.ug
12.	**University of Kisubi (UniK)** P.O. Box 182, Entebbe, Uganda +256 312225400 | +256 312225444 +256 752499980 info@unik.ac.ug
13.	**Team University (TU)** Plot 446 Kabaka Anjagala Road, Mengo P.O. Box 8128, Kampala +256 31263840/414346139-753564779/775006054/701963280 info@teamuniversity.ac.ug

	www.teamuniversity.ac.ug
15	**Avance International University (AIU)** Plot 3312, Block 203, Nabweru-Wakiso P.O. Box 12385, Kampala +256 758 569669 info@aiu.ac.ug www.aiu.ac.ug
16	**Limkokwing University of Creative Technology** Plot 771/772, Block 165, Namataba P.O. Box 683, Mukono +60123733804/+256 774046070 gallp@limkokwing.educ.my/ihomex@gmail.com www.limkokwing.net
17	**UNICAF University Uganda** Plot 53B Ntinda II Rd, Kampala info@unicafuniversity.com
18	**Equator University of Science and Technology (EQUSaT)** Kasijagirwa Road, Masaka City. P.O. Box 37633 Kampala (U), +256 0200911690/0200911670 / +256 702 976 933 info@equsat.ac.ug, www.equsat.ac.ug

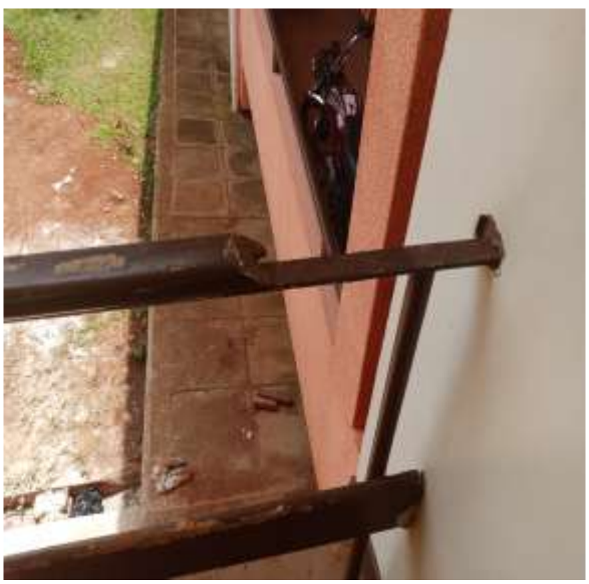
Appendix 5: Photographs

(a) Handrails

Photograph 1: Showing broken handrail



Photograph 2: Showing continuous handrail

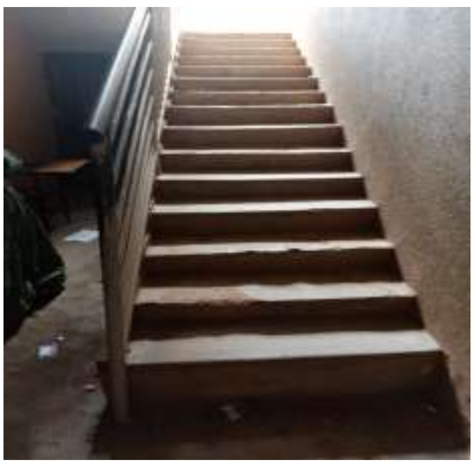


Photograph 3: Showing a damaged handrail

Photograph 4: Showing handrails on one side

(b) Risers and treads

Photograph 5: Showing steps with a triangular barrier at the landing



Photograph 6: Showing uneven steps

Photograph7: Showing steps with broken edges

Photograph 8: Showing stair flight with uneven risers

Photograph 9: Showing treads in a flight

(c) Ramps

Photograph 10: Showing a well constructed ramp

(d) Nosing constrast

Photograph 11: Showing faded nosing contrast

Photograph 12:Showing visible nosing contrast


Photograph 13: Showing stair flisght with open risers