APPLICATION OF TECHNOLOGY IN REAL ESTATE BUSINESS IN MALAWI

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DECLARATION

I declare that this research report is my own, unaided work. It is being submitted in partial fulfilment of the requirements for the award of Doctor of Philosophy (Ph.D.) in Business Administration at Silenus University and no knowledge of a similar paper has been submitted before in any other academic institution.

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CERTIFICATE OF APPROVAL

We declare that this dissertation is from the student's work effort. It has been acknowledged where he has used other sources of information. This Thesis is submitted with our approval.

Supervisor……...

Signature……

Date……

DEDICATION

This research work is dedicated to my family for bearing my absence due to my studies during the period and always encouraging me to go further.

I also dedicate this work to my mother and my late father. They have been visionary and wonderful parents.

Most importantly, this work is dedicated to the Almighty God for his love and mercy in keeping me healthy and strong throughout this work.

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ABSTRACT

The real estate industry plays a vital role in economic development and societal well-being in Malawi. Embracing technological advancements is crucial to enhance efficiency, competitiveness and sustainability. The present Thesis critically examined the applications of technology in real estate and allied industries in Malawi by analysing theories and applications of technology, assess level of influence of technology on construction of houses and ancillary infrastructure, isolating construction and operations that can be adopted in real estate business and assess the extent of perceived risks in using new technology. The objectives were accomplished using qualitative and quantitative research method approach through structured questionnaires. Data was collected across four cities of Malawi and a Chi-squared test of goodness of fit was used to compare responses. Principal Component Analysis (PCA) was applied to reduce data dimensionality, identifying composite statements and variables. The analysis of theories such as social cognitive theory, task technology fit, technology acceptance model, theory of interpersonal behaviour, theory of planned behaviour and theory of reasonable action highlighted the importance of understanding human behaviour and altitudes towards technology adoption. These theories can guide stakeholders in developing strategies to promote the acceptance and successful implementation of technology in real estate.

The findings highlighted the transformative impact of modern technology on Malawi's real estate business such as technological transformation of services, connectivity and communication revolution and advancements in construction and safety. Furthermore, some Malawian real estate enterprises utilise various technologies to enhance construction processes, real estate management software, mobile apps, virtual reality tours, online payment systems, property data analytics, social media marketing, energy-efficient technologies, drones for property inspections, home automation and online booking and reservation systems.

Findings from the present study indicate that these technological applications are at a small scale and need to be supported and enhanced significantly. Several comprehensive recommendations are proposed to optimise the use of technology in Malawian real estate sector. Firstly, it's by promoting technology literacy. Secondly, there is a need for research and development efforts to be encouraged, specifically focused on adapting and developing construction technologies that are suitable for Malawi's unique conditions and requirements. Collaboration between the government, academia and industrial players can facilitate innovation. Further, it is recommended that, industrial collaboration should be fostered

especially between the public and private sectors, as well as international organizations, to facilitate knowledge exchange and access to technology resources. Findings from this study will undoubtedly guide policy makers in framing accurate policies that would promote urbanisation as stipulated in Malawi Vision 2063, Pillar 3.

ABBREVIATIONS AND ACRONYMS

AI	Artificial Intelligence
BI	Behavioural Intention
BIM	Building Information Modelling
DDE	Digitally Disruptive Environment
DT	Digital Technologies
ESG	Environmental Social and Governance
FM	Facilities Management
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GIS	Geographical Information System
IT	Information Technology
IoT	Internet of Things
KMO	Kaiser-Meyer-Olkin
MHC	Malawi Housing Corporation
MPC	Malawi Post Corporation
MACRA	Malawi Communications Regulatory Authority
MSMEs	Micro, Small and Medium-Sized Enterprises
MFIs	Microfinance Institutions
MGDs	Malawi Growth Development Strategy
PBC	Perceived Behaviour Control
PU	Perceived Usefulness
PCA	Principal Components Analysis
QoS	Quality of Service
SCT	Social Cognitive Theory
TTF	Task Technology Fit
TAM	Technology Acceptance Model
TIB	Theory of Interpersonal Behaviour
TPB	Theory of Planned Behaviour
TRA	Theory of Reasonable Action
UNESCO	United Nations Educational, Scientific and Cultural Organisation
USF	Universal Service Fund
USA	United States of America
VR	Virtual Reality

CHAPTER ONE

INTRODUCTION TO THE STUDY

1.1 Background

Construction, which encompasses real estate, infrastructure, and industrial structures, is the largest industry in the global economy, accounting for 13% of the world's GDP (Mischke, et al., 2020). Real estate is simply a piece of land plus any natural or artificial improvements that are attached or have been added (Aghimien et al., 2022). The impact of technology on real estate business is complex and requires thorough research to unlock real issues that would eventually improve the industry (Profile, 2020). Globally real estate industry is relatively resistant to change and slow at uptake of emerging operating methods (Aghimien et al., 2022). Real estate business seems less open to the expansion of innovation, due to institutional and legal limitations serving, among others, the protection of real estate transactions (Fallis et al., 2013). However, current global information shows that technology is slowly penetrating the industry and future technological expansion may overhaul real estate sector, especially marketing component (Mischke, et al., 2020). Real Estate business is generally threefold; plot development, construction of houses and maintenance of the housing units (Ameme & Wireko, 2016). The business component is thus involved in sell of plots and houses and renting out houses. Technology may improve operations of the real estate market but, while we can observe innovative solutions and new business models, we must be mindful which technology enters gradually (Profile, 2020). It is necessary to assess and analyse the absorption of new technologies by real estate companies in developed and developing countries (Fallis et al., 2013). Based on technological data, real estate firms and their involvement in e-commerce, a comparison and evaluation of the level of integration of any technologies in the real estate industry can be made (Ameme & Wireko, 2016).

Although the uptake of technology is slow by real estate business globally, the situation is worse in developing countries due to low economy and widespread poverty such that most of better conventional houses are unaffordable by most citizens and employees (Lu & Fox, 2001). Poor salaries and wages exacerbate the situation. In such circumstances real estate business organizations to provide better houses at affordable cost (Aghimien et al., 2022). This is impossible at the moment due to the higher costs of construction and operations of the business (Ameme & Wireko, 2016). If construction, improvement or renovation and operations of real

estate business were run at lower cost through identifying and use of efficient and effective technologies most citizens would afford these properties eventually promoting and improving the current situation (Aghimien et al., 2022). Real estate market is generally influenced by several factors such as cost of building or maintenance, quality, location, population, economic activities, rental charges, wages/salary or income and information/advertising (Profile, 2020). Each of the outlined factors need to be optimized in order to achieve ultimate benefit from real estate business (Ameme & Wireko, 2016).

The present research study attempts to critique and suggest how technology can boost real estate business in Malawi. Research will screen, identify and unlock appropriate modern technologies that can not only improve quality of housing but also sustain real estate business in Malawi. Findings will help to improve uptake of technology in the construction and real estate management industry in Malawi.

1.2 Problem Statement and Justification

There is an increased demand for houses in Malawi which arises from the combined effect of rapid population growth of the country estimated at 2.8% per annum and the fast urbanisation rate of 5.3% per annum (Grist, 2015; Namangale & Chimalizeni, 2022) . The Malawi Vision 2063 has also necessitated the provision of more housing infrastructure given the planned urbanisation and industrialization programs (Malawi Vision, 2063). The 2018 Population and Housing Census showed that out of 4,805,431 houses enumerated, 1,974,613 (41.1%) were permanent, 1,107,447 (23%) were semi-permanent, while 1,723,371 (35.9%) were classified as traditional. This means majority of Malawians have limited access to structurally stable, durable and affordable housing.

Most houses in Malawi's urban centres have been constructed with burnt bricks and wood is commonly used for roofing. Such methods have several disadvantages ranging from being expensive and less environmentally friendly. Recently few house constructions are achieved using cement building blocks and steel for roofing. There is limited knowledge and application of new technologies in construction and real estate business operations in Malawi. Such knowledge is necessary to ensure adequate houses and infrastructure that can easily meet the demand as well accelerate socio-economic activities. Porter (2011) reported that in order for businesses to achieve and sustain superior performance, they must be able to implement systems that are competitively superior. One of the leading industries in Malawi, Malawi Housing Corporation (MHC), has a great potential to invest in technologies and set the pace

for superior performance that could benefit Malawian population as well as supporting construction industry.

Several studies have concluded that use of technology is one of the major factors that have helped real estate and construction businesses in gaining competitive advantage worldwide, however this has not been adequately utilized in less developed countries including Malawi (Aghimien et al., 2022). Use of technology such as digital technology has a significant impact on wide range of industries and businesses such as real estate (Lizam, 2019). Technology could be a game changer that differentiates players in the real estate. For instance, PropTech digital technology may help to solve specific issues that have been associated with the industry and could improve efficiency and productivity. Thus, most businesses should aim to include technology to roll out production and meet customer demand (Li, 2011).

Several scholars have indicated that there is a significant relationship between use of new technology and gaining competitive advantage in construction and real estate business (Ameme & Wireko, 2016; Lizam, 2019; Mischke, et al., 2020). However, use of different construction technologies may be dependent on several factors such as geographical location, weather, climate and economy and economic activities of the country. As such they may be different types of technologies to be used and applied in developing, middle income and developed nations. It is therefore imperative to conduct systematic research study that would help to identify specific technology to be used and implemented in a particular country. Literature suggests that specific questions that relate to leveraging on technology to gain competitive advantage for local based real estate businesses need to be appropriately addressed. This study will therefore focus on factors for consideration for leveraging on technology to gain competitive advantage by locally based businesses in Malawi such as MHC.

1.3. Objectives

The main objective of the present study is to optimise use of technology in real estate business in Malawi. The specific objectives are four-fold:

(a) Critically analyse theories and applications of technology in real estate business and allied industries.
(b) To assess the level of influence of technology on the construction of houses and ancillary housing infrastructure in Malawi.

(c) To isolate construction and operations technologies that can be adopted in real estate business in Malawi.
(d) To assess the extent of perceived risks in using new technology in housing construction and real estate operations.

1.4 Research Questions

The research will focus on answering the following questions:

(a) What are the available theories and models on use of technology in real estate business?
(b) What are the barriers in use of technology in real estate business in Malawi?
(c) How does technology influence housing construction and operations in Malawi?
(d) What are the available technologies that are used in housing construction and operations?
(e) What is the level of influence of technology in construction and operations of real estate business?
(f) Identify perceived risks on use of technology in construction and real estate business in Malawi?

1.5 Significance of the Study

The study will be very important to various stakeholders in Malawi, as it has the potential to drive technological innovations, enhance economic growth, inform policies and contribute to the development of a more efficient and competitive real estate sector in the country.

To Government: The government of Malawi will benefit from this study by gaining a comprehensive understanding of the impact of technology on real estate industry. the government will use this this knowledge to formulate policies and regulations that promote the adoption of technology in housing construction and real estate operations. By encouraging technological advancements, the government will drive economic growth, create employment opportunities and enhance the overall living standards of its citizens.

To the Participating Companies in Real Estate Industry: The study will help in operational efficiency in real estate industry. The study will help participating companies to identify and adopt technology-driven solutions that can streamline their operations, reduce costs and improve efficiency in real estate development and management. In terms of competitive advantage, companies that will adopt and start embracing technology will gain a competitive edge in the market by offering innovative and technologically advanced real estate products

and services. Further, by understanding the perceived risks associated with new technology adoption, companies will be able to develop strategies to mitigate these risks and ensure the successful implementation of technology in their operations.

To Real Estate Industry: the real estate industry in Malawi stands to benefit from this study by gaining insights into construction and operations technologies that can be adopted to improve efficiency, quality and sustainability. By embracing new technologies, real estate companies will streamline their processes, reduce costs, enhance customer experiences and contribute to overall growth of the industry.

To investors: Investors interested in Malawian real estate market will use this study as a guide to assess the potential risks and opportunities associated with technology adoption. It will help them, make informed decisions based on an understanding of how technology influences housing construction and real estate operations in Malawi.

Chapter 2 of the Thesis provides the literature review while chapter 3 describes the general methodology used. In Chapter 4, Critical analysis of technology models and theories are presented. In Chapter 5, influence of technology on the construction of houses and ancillary housing infrastructure in Malawi are presented and discussed. Chapter 6 presents construction and operations technologies commonly used in Malawi. Chapter 7 discusses perceived risks in real estate business in Malawi. Chapter 8 provides general conclusions and recommendations of the Thesis.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This chapter's analyses various studies done by other researchers and brings forth the conclusions drawn and their relevance to this study. The review of literature is important since it looks at areas already covered and gives direction and relevant facts for this study. The problem under consideration relates to application and optimisation of technology in real estate business. The research will analyse real technologies and their application to construction and operations of real estate globally which in essence falls under the domain of facilities management.

2.2. Review of Literature

2.2.1 The Concept of Real Estate

The real estate sector is a significant force in fuelling the country's economic growth (Profile, 2020). Real estate is a form of property. Real property, a technical legal word, is the right to possess and use land for a time which may last for a life or lives or longer. Real estate is a very wide concept and it is highly affected by the macro-economic factors like Growth Domestic Product (GDP) or Foreign Direct Investments (FDI), per capita income, interest rates and employment in the nation (Fallis et al., 2013). Real Estate business is generally threefold; plot development, construction of houses and maintenance of the housing units.

Real Estate Technology (Relates) refers to technologies that impact the built environment and the real estate sector, either through business model innovation or product innovation, affecting the way we live, work and play (Technology, 2017). PropTech is an acronym that combines property and technology words. RICS define PropTech as a 'term that refers to all aspects of innovation and how this affects the built environment'. This broad definition includes software, hardware, material or manufacturing that is produced by the small start-ups companies (Lizam, 2019).Proptech is defined as "businesses using technology to disrupt and improve the way we buy, rent, sell, design, construct, and manage residential and commercial property (Deloitte, 2020). This includes software, hardware, materials or manufacturing. PropTech involves massive implementation of emerging technology within the real estate sector. A non-exhaustive list of such technologies includes home matching tools, drones, virtual reality,

building information modelling (BIM), data analytics tools, artificial intelligence (AI), Internet of Things (IoT) and blockchain, smart contracts, crowdfunding in the real estate sector, financial technologies (fintechs) related to real estate, smart cities and regions, smart homes, and shared economy (Lizam, 2019). All these relatively recent innovations have the potential to improve productivity and competitiveness, increase energy and resource efficiency and effectiveness and hence to protect the environment and provide opportunities for developed and developing countries to achieve economic growth and sustainable development in line with the 2030 Agenda for Sustainable Development (Siniak et al., 2020).

Digital transformation is the change that occurs within an industry due to the introduction of digital technology. It's an innovation that is primarily run on, or facilitated by, computer power (Lizam, 2019). Real Estate Companies refers to those entities whose core business is owning, operating or managing real estate (Li et al., 2021; Małkowska, 2020). In real estate context, technology, may be defined to include innovative software, hardware, materials, construction and design. In the current context, technology is limited specifically to the innovative and cutting-edge software solutions either in existence or imminently so (Siniak et al., 2020).

2.2.2 Technological Innovations

Innovation is a process of transforming the new ideas, new knowledge into new products and services (Siniak et al., 2020). Innovation is an activity which leads to new producing function and new products. It may be include the following but not exhaustive; introduction of a new product which can easily be sold and which is not offered in the market; introducing a new method of production which can lead to an increased output, decrease of costs per unit product; introduction of new inputs and change of existing ones like opening new markets to increase the number of customers; finding of appropriate sources of raw materials and establishing a new organization in the industry (McDaniel, 2002). Organizations today act under severe pressures by other enterprises, which offer the same or similar products and services. Organizations are also under the pressure of the customers who expect more and more from the products they consume (Ameme & Wireko, 2016). These pressures cause organizations to continuously search for new product offerings and enhancing existing ones (Gerguri et al., 2002). It is thus becoming imperative in today's highly digital world for enterprises and organizations to use electronic innovations in serving the needs and demands of their customers (Ameme & Wireko, 2016).

Technological innovation is successful implementation of creative ideas in the organisation or a process of developing opportunities into fresh ideas and applying them into widely used practice (Bigliardi, 2013). Other authors have further defined technological innovation as a process which entails technical, design, manufacturing as well as managing and commercial activities that are involved in marketing of a new or improved product and may not have to be a breakthrough or a paradigm shift (Ameme & Wireko, 2016; Subrahmanya, 2011). Overall management of technological innovations entails organising and directing human and capital resources in generating new knowledge and ideas aimed at developing new and improved products, processes of manufacturing and services, ideas into working samples and transferring them into manufacturing, distribution and use (Hitt et al., 2013). Technological innovations are regarded as an important source of sustainable advantage in an environment that is changing increasingly, because it contributes to product and process improvements (Ameme & Wireko, 2016). Technological innovations make continuous advances in enabling firms to survive and allowing them to grow quickly and efficiently to become profitable than non-innovators (Kamau, 2019). Fast pace of development across the world, technological advances and globalizations are forcing firms to invest in innovations to meet the growing need of customers (Przychodzen & Przychodzen, 2015). Thus, companies are making efforts to improve their products and services or even introduce new products or services in order to meet increasing customer needs and demand in the present dynamic environment (Zhang et al., 2016). Changes and differences in products, services and processes are critical for gaining competitive advantage and survival thus must adopt innovations so as to continuously meet the needs of customers and make reasonable profits and stay in business (Kytömäki, 2020; Reguia, 2014; Subrahmanya, 2011).

2.3 Application of Technology in Business

The meaning of "technology" has evolved significantly over the years, reflecting changes in the nature of production systems (Vandell & Green, 1996). In many countries around the globe, there has been an increase in the adoption of e-commerce in many industries including real estate. This trend has been witnessed in countries such as the United States of America (USA), China, Malaysia, South Africa, and Singapore among others. In these countries, the real estate industry is using E-commerce for property management (Zhang et al., 2016). The invention of information technology has significantly reshaped many industries globally (Zhang et al., 2016). Different types of information technologies adopted in various industries consume more than 10% of total global electricity (Powers, 2013). A greater percentage of activities in many

industries presently rely on the use of information technology, academia being one of the largest consumers (67%) in this category (Aboushady & Elbarkouky, 2015; Soyinka et al., 2016; Ullah & Sepasgozar, 2019).

Technology evolution can be traced back to the mid-1990s when the United States experienced an unprecedented increase in economic growth, employment, and personal financial wealth Ullah & Sepasgozar, 2019). The growth in the economy was based on a major expansion in corporate earnings, largely fuelled by unprecedented increases in worker productivity. These increases emerged primarily as a result of technological innovation, which had been in the development process for many years but finally came on stream in the 1990s (Aboushady & Elbarkouky, 2015). The Internet allowed individuals and organizations to communicate instantaneously through electronic mail. Emails subsequently become so ubiquitous that it is now the preferred means of communication for a large part of the world. Sensing an opportunity, business firms began developing commercial applications on Websites (McMahn, 2002).

Presently, digitalization is high on the agenda for many organizations and is often included in organizational strategies, policies, goals, structures and roles, projects or investment plans, with implicit expectations of organizational transformations and increased overall efficiency. Digitalization is associated with other major changes in trends, such as globalization, sustainability, climate change or demographics, which all have fundamental impact on the daily lives of individuals in society, and societal development (Orths et al., 2019). The interest in digitalization has to do with the fundamental nature of digital technologies. Today, an increasing number of products can collect and transmit digital data, which effectively tums them into a digital layer that is programmable, addressable, sensible, communicable, memorable, traceable, and associable (Kytömäki, 2020). These digital technologies allow products and services to become “smarter” and transform the way they are assembled, consumed and experienced, and the rapid development of digital technologies has reduced the cost of communication (Ullah & Sepasgozar, 2019).

Social media and social networking sites have redefined the way we communicate with each other in every field, in both private and business relationships. It includes accessible mobile and web instruments that allow individuals to create, share, and seek content, as well as to communicate and collaborate with one another (Profile, 2020). Five general types of social media may be categorised: collaborative projects, blogs and microblogs, virtual communities, socializing networks, the virtual world of games all of which may benefit real estate business.

The best-known categories of social media include social networking sites (e.g. Facebook, LinkedIn), multimedia content sharing sites (e.g. YouTube, Instagram, Flickr, SlideShare), blogs or microblogs (e.g. Twitter), and wiki-based knowledge-sharing tools (Profile, 2020. Through social media, business-to-customer communication takes place without any time, space or media restrictions and clients cooperate with the brand and company to create new products, services, business models and values (Aytekin & Keskin Demirli, 2017; Małkowska, 2020).

The earliest industries to go through digital transformation, and therefore the most advanced industries today, are those we use or touch on a daily basis, the best examples of which are the automotive industry and music business (Warburton, 2018). The automotive industry is an easy to understand example of an advanced, ongoing digital transformation journey. Production lines which rely on repetitive movements and processes, i.e. assembling cars, are easily controlled by robots. The faster and more efficiently those robots work, the more cars the plant can produce each day, and at a higher quality. And so, it has been that the automotive industry has ploughed huge amounts into research and development to create robots that work faster and more efficiently than humans. Today, there is not a single major car manufacturer which doesn't use robots on its production line (Holmes, 2019). This means that no time or energy has had to be wasted on trying to persuade the industry to use technology. Instead, year after year, all resources have been put into finessing the technology. And what's more, anyone old enough to remember cars made as recently as the early 90s will agree that build quality has been enhanced to a remarkable degree as a result of technology (Warburton, 2018).

Despite being one of the oldest industries in the world, the real estate sector has traditionally been regarded as a laggard from a technology adoption point of view and is typically five years behind the technology curve (Warburton, 2018). Technology ought to be viewed as a means to an end, a mechanism that can materially influence the achievement of organisational objectives. Technology is best viewed as an enabler – a tool to be leveraged to improve the effectiveness and efficiency of operational and strategic facilities management (FM). In that sense, technology is best viewed as a mechanism through which FM practitioners are able to fulfil their duties in a better, faster and more accurate manner (Warburton, 2018).
Technology has the potential to play a material role in companies' ability to meet their strategic and operational objectives. Technology can reduce costs, increase revenue and highlight inefficiencies. It can also automate, simplify and streamline processes. Perhaps most excitingly,

it can add value by enhancing users' experiences and their interactions with real estate companies (Sadowski, 2020).

2.4. Real Estate Technology

Real Estate Technology (RealTech) refers to technologies that impact the built environment and the real estate sector, either through business model innovation or product innovation, affecting the way we live, work and play (Maarbani, 2017). From a business model perspective, RealTech companies target the traditional inefficiencies and antiquated processes of the real estate sector. From a product innovation perspective, RealTech companies target innovative software, hardware and other core technologies, as well as advancements in building materials, fixtures, fittings and systems. Generally, RealTech companies fall into four categories including, Urban Planning; Design & Construction; Search, Sales & Acquisition, and Leasing & Management (Maarbani, 2017).

Urban Planning Companies focused on various aspects of urban, rural and community planning, including improving processes related to land release, planning approvals, protection and use of the environment, and the enhanced design of the urban environment (García de Soto et al., 2022). Examples in this category include Urban design software; Virtual reality and Simulation technology, Mapping platforms; Satellite technology and Beacon technology. Design & Construction Companies category focuses on the tools and processes used for the design, development and construction of residential, commercial and industrial real estate projects. Examples in this category include; Virtual reality and simulation technology; Enhanced architecture and design software; Project and cost management tools; Smart building platforms and artificial intelligence; Construction and workforce management solutions; Building material innovation; Material sourcing platforms; Beacon technology; Project finance and investment platforms (Warburton, 2018).

Search, Sale & Acquisition Companies category focuses on the tools, processes and business models for searching, marketing and acquiring new and existing residential, commercial and industrial real estate (García de Soto et al., 2022). Examples in this category include; Buyer search and discovery tools including listing portals; Agent search tools including agent lead generation and management solutions; Virtual reality and simulation technology; Online brokerage, sales and auctions, Peer-to-peer brokerage; Inspection management software; Transaction management software; Broker back-office and infrastructure; CRM and lead

management solutions; Property marketing and sales solutions like social marketing and marketing automation and Acquisition finance and investment platforms including crowdfunding, peer-to-peer lending and on-demand finance solutions.

Leasing & Management Companies category focuses on the tools, processes and business models used for the leasing and management of residential, commercial or industrial real estate, from single properties through to solutions designed for complex property portfolios. Examples in this category include; List and search services; Peer-to-peer leasing; Inspection management software; Transaction management software; Internet of things; Beacon technology; Tenant screening technology 8. Lease and revenue management software; Smart building platforms and artificial intelligence; In-venue marketing technologies; Broker back-office and infrastructure CRM and lead management solutions; Property marketing and sales solutions including social marketing and marketing automation.

Across all of the categories above, Data & Analytics tools and Sustainability-focused innovation are also having a significant impact. The following section expands upon both of these additional categories and lists examples of the technology solutions being developed in each category (Sun, 2019). Data & Analytics Companies in this category are focused on developing tools designed to identify, collate and analyse relevant data to enhance operational efficiency, inform decision making and improve the experience of participants across the residential, commercial and industrial real estate sectors. Examples include; Big data aggregation and management tools; Information crowd sourcing tools; Content, data and information portals; Tenant and visitor in-venue experience and engagement solutions; Tenant and visitor in-venue loyalty, transaction and value add solutions. industry (Warburton, 2018). Companies in Sustainability category are focused on developing tools and materials designed to: Enhance building sustainability; Enhance environmental sustainability and Improve energy efficiency outcomes industry (Goodwin & Stetelman 2013).

2.5 Adoption of Technology in Real Estate Business

The real estate industry is relatively traditional and conservative in its operation. This certainly results from the special nature of real estate and its performance in relation to the legal, technical, economic, spatial and social domains. Also, the real estate market itself seems be less open to the expansion of innovation, due to institutional and legal limitations serving, among others, the protection of real estate transactions. However, current global data proves

that technology is also entering this industry and future technological expansion may deeply revolutionize the whole real estate sector, in particular trading (Małkowska, 2020).

Real estate technology is defined as the hardware gadgets, online platforms and software tools used by different participants in the real estate industry, including real estate-focused lenders, brokers, property owners, investors, and managers, as well as the consumers to collect and distribute data related to the real estate industry (Goodwin & Stetelman, 2013; Warburton, 2018). However, as Warburton points out, the global industry is lagging the technology curve. Contrary to its industrial counterparts, almost a third of the global real estate industry, worth $11 trillion, is managed on spreadsheets; innovative information technology (IT) tools are missing in action. Yet innovative and information technologies are an integral part of the modern world (Hage et al., 2020; Lizam & Diah, 2019).

Although the global real estate industry has fallen behind the curve of information technology (IT)-based innovation, instead relying on traditional transaction methods, investment in real estate technologies is on the rise. This shows the business appeal of the industry to investors and potential clients. For instance, there was an average $1.5 billion global investment in 2015 and the $1.6 billion in the first half of 2016 (Zhang et al., 2016). Since 2012, global capital allocations to direct real estate have doubled, rising from US$ 166 billion in 2012 to US$ 320 billion in2016. Over the same period venture capital funding into RealTech companies increased 1200% from US$ 221 million in 2012 to $2.6billion in 2016. With the long-term outlook for direct real estate capital investment remaining positive, allocations to RealTech will continue to increase exponentially (Maarbani, 2017). If venture capital allocations into technology continues to become the new battleground for real estate projects and assets, we expect increased participation and investment volumes into RealTech companies by traditional real estate corporates (Technology, 2017).

The real estate investment management industry is undergoing a dramatic cultural shift driven by the pressures of technological innovation and climate change (Hage et al., 2020; Lizam & Diah, 2019). Real estate investments are increasingly required to meet a high level of environmental, social and governance (ESG) criteria. In addition, the fourth industrial revolution has challenged the economics of the occupier markets, illustrated by the rise of online shopping and the decline of the high street and shopping centres (Saull & Baum, 2020; Saull & Baum, 2020). In this context, the US is seen as the centre of commercial real estate and compared to other countries. Technology is one of the elements that disrupts almost every

facet of the industry and changing the traditional business model with real estate industry not an exception. Technology has changed the conduct of how business process being implemented in the whole supply chain of the Industry. It may become a threat to the present industry player who failed to adapt to the new business model and at the same time create opportunities for the start-up that are innovating new technology that is efficient and at a fraction of the cost (Lizam, 2019).

As the emergence of FinTech is currently disrupting the financial sector, so do real estate industry. Recently real estate industries have witnessed the advent of digital technology that promises efficiency and value-added to the industry players (Hage et al., 2020). For example, PropTech companies as in offer their technologies often in the form of 'dashboard' software product offering real estate players services that mainly to reduce the searching as well as administrative costs using Lizam & Diah, 2019). Most of these 'dashboard' solutions often accompanied by other supplementary products that promise to fixed problems relating to real estate investment through the application of digital technology (Lizam, 2019).

Adoption of information technology in real estate property management can be traced back to early 2000 when it first penetrated into the construction industry. During this particular duration, it was first referred to as "Tipping Point" (Ullah et al., 2018; Warburton, 2018). However, the adoption of information technology has expanded out of the construction industry to cover other related sectors such as drawing and real estate property management (Hage et al., 2020; Lizam & Diah, 2019). Information technology has also transformed the real estate industry from a very rigid traditional system to modern digital technologies industry and forecasting changes in this sector are complex and unobvious matters (Ullah et al., 2018). The real estate industry is relatively traditional and conservative in its operation. This certainly results from the special nature of real estate and its performance in relation to the legal, technical, economic, spatial and social domains (Warburton, 2018). Also, the real estate market itself seems be less open to the expansion of innovation, due to institutional and legal limitations serving, among others, the protection of real estate transactions. However, current global data proves that technology is also entering this industry and future technological expansion may deeply revolutionize the whole real estate sector, in particular trading (Małkowska, 2020). The entire real estate industry is facing significant disruption as new technology and various digital offerings change the way people live and work. Enhanced customer expectations for more and more real-time and high-quality services are a major

challenge (Deloitte, 2020). Digital technology set the foundation for PropTech development. PropTech would not be possible without the technological evolution in computing technology. Alongside with technological development, data is the foundation of the real estate industry (Lizam, 2019). Even in present-day, there are services in real estate is manually conducted with minimal assistance from technology. Real estate does have an important advantage when tackling this challenge: innumerable industries have already been through it all before, leaving behind perfect examples of success and failure in digital transformation (Aghimien et al., 2022; Pankratov et al., 2020).

The survey results showed that While 61% of companies studied have adopted a technology solution, only 28% have adopted multiple products. 33% percent have integrated one or two technology solutions, but 35% are still piloting, evaluating or assessing the market. A slim margin of 4% has not started thinking about how technology can be applied. The study cites a number of reasons for this lag in adoption, which include cost, skills sets of staff and the if-it-isn't broken don't fix it culture towards legacy systems that continue to function though not as effectively as the available technology (Grinis, 2020). The flow of information in the real estate market is increasing quickly because of the proliferation of company websites, email, cellular phones, personal digital assistants, online linkage to financing sources and other technological advances (Aghimien et al., 2022; Pankratov et al., 2020). This new information technology is transforming established institutions and opening up new venues, as many traditional brokerage activities can be delivered more quickly and with more efficiency. However, the new technology also brings forth the threat of competition from Internet-based real estate companies (Jud et al., 2002). Tenants and end-users are largely looking forward to doing more with the physical space. They are increasingly looking at innovative and personalized technology-enabled experiences (Deloitte, 2020).

While most investors probably do not have the appetite to drive change across an industry, others have spotted an opportunity to make a big impact. Over the last five years, particularly in developed economies, numerous real estate technology companies have emerged. In 2015, global venture capitalist investment in real estate technology amounted to just over $1.5bn (Aghimien et al., 2022)), while in the United States of America (US) alone, the first quarter of 2015 saw approximately $125m in investment from companies such as Google (Pankratov et al., 2020)

Focusing on real estate technology specifically, it is evident that the majority necessarily require high speed internet – from virtual 3D tours to leveraging the internet of things, almost all require broadband internet to a lesser or greater extent. High speed internet should therefore be viewed as a necessary condition for optimal real estate technology adoption. As an example of a developing country, on internet penetration alone, SA ranks only sixth in Africa with a little over 50% penetration(Warburton, 2018). In terms of internet speed, in 2014, SA ranked 131st out of 195 countries. These figures together with findings of the WEF's Global IT Report 2016 suggest that weak operational environments are likely to inhibit technology adoption. Weak infrastructure appears to offer only a partial account for the lack of investment in technology. Despite improvements in recent years, many local real estate companies continue to use manual processes and spreadsheets to manage and organize their businesses. Automating these types of processes does not necessarily require broadband internet, suggesting that other factors are contributing to a lack of technology adoption in the industry.

The real estate market is characterized by a large number of relatively small transactions that are very labour intensive both in terms of time and data collection and storage. Many stakeholders are involved in real estate transactions is traditional and conservative in its operations especially in developing and middle-income countries. Information and documentation often are not standardized and is further complicated by a maze of regulatory legislation imposed by federal, state, and local jurisdictions (Kamau, 2019; Wasiu, 2022). Currently a web of organizations and individuals operate in and around real estate markets. Users and owners of real estate are surrounded by vendors and service providers attempting to manage and facilitate the operational stages of real estate investments. Each of these groups has its own needs and expectations, each requiring a different approach, management, and communications (Kamau, 2019). In most cases, a seemingly unending paper trail and tedious communications are associated with these activities. Services such as maintenance and operations as well as financial information are often forwarded through many hands (Wasiu, 2022).

In Malawi the real estate business involves more parties other than the buyer and the seller due to limited use of technology. Some critical information is held by other players such as real estate surveyors or agents. The behaviour contributes to significant search time and cost to determine the market value as well as to match buyers and sellers. Thus, traditional models delay progress of real estate business industry. Another question related to technology

management is uncertainties related to new technologies. At the moment, several real estate owners expect others to invest in digital technologies in order to learn from the examples. The problem is that if most keep waiting, the leadership for change is in the hands of a few, and if the problem is prolonged, it may lead to a low level of overall investment in the sector (Kytömäki, 2020). Relatively little is known about the innovativeness of real estate firms, as innovation research in built environment sector has largely focused on building project management phase organizations and facility management firms. Kytömäki (2020) argues that the real estate owners have a central role and a long-term perspective on the innovation in the built environment sector as a whole, as they are clients in all building life-cycle phases. We tend to overestimate the impact of a new technology in the short run, but we underestimate it in the long run (Siniak et al., 2020). Many investment managers have wisely stood back, observing others overestimating the impact of new technologies.

2.6. Drivers for Growth in Technology in Real Estate

2.6.1. Legacy, Inefficiency and Complacency

Over the last decade, a number of industries that have a material impact on the way we live have been unimaginably transformed by technology in several examples:

• **Media & Advertising -** One of the first major sector-wide reinventions was in the media and advertising industry. From the emergence of self-publication through social media and targeted advertising driven by rich data analytics, to the proliferation of online platforms as distribution channels for niche content, the way in which media content is created, advertising strategies are implemented and media is consumed has changed forever.

• **Entertainment -** One of the most ubiquitous business model transformations has been in the entertainment industry. Major brands such as Virgin Megastore, HMV, Borders and *Blockbuster* materially underestimated the power of technology to reinvent the way consumers interact with film and music content. Companies like YouTube, Stan and Netflix have reinvented the way consumers access film and television content, rendering traditional programmed television stations almost redundant.

Travel - In the travel industry, the consumer has benefited immensely from the automation of travel industry processes (such as ticketing, booking and itinerary management) and the increased transparency in pricing and product information.

Financial Services - The global rise of mobile payments and wealth management platforms, robot advice and peer-to-peer financial products have begun to chip away at the dominance of

the major commercial and investment banks. In each of the above examples, successful disruptor brands identified and disintermediated parts of the supply chain that were ultimately not delivering real value to the consumer (Technology, 2017). The digital solutions they created generally shared one or more of the following attributes:

• **Access & Control –** they empowered the consumer with greater access to product, choice and transactional control.

• **Transparency –** consumers were given targeted information, guided by meaningful data analytics, with which to make more informed buying decisions.

• **Process –** efficient, customer-centric, frictionless & engaging transactional processes replaced tired, manual, old-school legacy processes.

• **Cost –** the disruptor brand was generally ablating reduce the cost of the end product by using technology to automate existing processes, disintermediate low-value (or no-value) processes and reduce overheads.

• **Trust –** disruptor brands managed to mitigate the perceived risks of transacting online with clever features such as sophisticated payments security and the integration of peer group validation during the consumer buying process. In the real estate sector today, many of the inefficiencies that drove the transformation of other industries continue to exist. The opportunities for the removal of low-value intermediaries, empowerment of consumers with greater access to product and transactional control, increase in transparency of information and trust, and the automation of tired legacy systems to create more user-centric processes across the sector are immediate and potentially very valuable. These dynamics represent easy wins for technology entrepreneurs and investors. (Technology, 2017).

2.6.2. Consumer Expectations

The digital solutions they created generally shared one or more of the following attributes:

• **Access & Control –** they empowered the consumer with greater access to product, choice and transactional control.

• **Transparency –** consumers were given targeted information, guided by meaningful data analytics, with which to make more informed buying decisions.

• **Process –** efficient, customer-centric, frictionless & engaging transactional processes replaced tired, manual, old-school legacy processes.

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2.7. Mobile Technology

In the last decade, smart phone penetration rates have escalated considerably. According to Ericson, there are 2.6 billion smartphone subscriptions globally. This number is expected to rise to 6.1 billion by 2020, led by huge growth in less mature markets. Factoring in internet-of-things and M2M services, mobile broadband and other basic feature phones, there will be 26 billion connected devices by 2020 (Technology, 2017).

2.8 Benefits Promise of The Technology/ Real Estate Interface

Many observers believe that effectively applied technology can open the door to more efficient communications between players, resulting in a wider range of products and services, which will ultimately provide a better quality and experience for tenants, users, and owners alike. In terms of communications, property managers now have access to a wide range of Internet enabled communication tools that allow for integrated and seamless communication with each tenant. Requests for tenant improvements, maintenance, equipment, and even office supplies can be made through extranet-types of applications that keep track of each transaction. Additionally, direct links to the financial accounting systems of the property manager allow for instant up-to-date reporting on the status of each transaction and activity with each tenant and each property. On the service side, a variety of tools increasingly provide for improved services to the tenant. Displays in elevators inform tenants and users of weather and the latest news, as well as property announcements. Interactive displays in lobbies replace largely static directories. Rooms and services can be ordered and scheduled via a building's intranet system. In retail properties, Internet connections and displays now allow for a seamless convergence between the virtual and physical, linking the shopper to both physical and online retail space, thereby enhancing the shopper's overall experience.

2.9. Impact on Physical Space

As we learn to adapt to new technologies and innovation, physical space itself may change. Examples of this metamorphosis already occurring include: Changes in the physical workplace with open planning systems, aided by technology, providing greater flexibility in an increasingly team oriented work environment. Dispersed workplace locations, linked by technology, where employees can effectively interface with their colleagues while being closer to family and other personal obligations and opportunities. Changing retail environments that combine virtual and physical shopping experiences to give shoppers more product information, match sizes and preferences better, and provide better, more competitive pricing. Regional throughput facilities, located at major transportation hubs, which speed up the movement of goods, thereby reducing inventory holding costs and accelerate product delivery to purchasers. This is enhanced by smaller re-distribution centres, where large shipments can be broken down into individual delivery packages. The "smart" residence where virtual and physical merge, effectively combining working and living environments. These are just a few examples of changes occurring in our physical environment as a direct result of the development and application of technology. The continuing development in fibre optics, wireless applications, and other promising technologies will permit us to be even more virtually accessible in the future. This should lead to additional changes in our physical environment as well.

2.10. Impact on Real Estate Transactions

Emerging technology is expected to improve the efficiency of real estate transactions in a variety of ways: n Provide a broader market of potential buyers or sellers (tenants or buildings) n Provide more information in a timely fashion to make better decisions n Provide greater transaction transparency n Reduce transaction time n Reduce transaction costs n In some cases, eliminate the service provider altogether (i.e., principal to principal) Improve reporting and process control It is anticipated that most of these benefits would initially accrue to principals in the transactions. While service providers will not be eliminated from the market, their role and value proposition with real estate principals is expected to change dramatically.

2.11. Social Media

Use of social media by Real estate company's Social media and social networking sites have redefined the way we communicate with each other in every field, in both private and business relationships. Cheng and Shiu (2020) define social media "as applications encompassing easily accessible mobile and web instruments that allow individuals to create, share, and seek content,

as well as to communicate and collaborate with one another". Kaplan and Haenlein (2010) identify five general types of social media: collaborative projects, blogs and microblogs, virtual communities, socializing networks, the virtual world of games. The best-known categories of social media are: social networking sites (e.g. Facebook, LinkedIn), multimedia content sharing sites (e.g. YouTube, Instagram, Flickr, Slide Share), blogs or microblogs (e.g. Twitter), and wiki-based knowledge sharing tools. Through social media, business-to-customer (B2C) communication takes place without any time, space or media restrictions and clients cooperate with the brand and company to create new products, services, business models and values (Aytekin & Keskin Demirli, 2017). The virtual environment may also serve to forward the message of the company to its business partners (Özturk & Batum, 2018). Today, social media have become a powerful driver of the real estate market, as real estate professionals and their clients benefit from their use. Most often, companies use social media to build their brand image, for marketing reasons, to gain insight from clients, to communicate within or outside the company, or to recruit. Marketing goals, in particular, are an area where social media generate significant benefits for real estate companies (Małkowska, 2020).

2.11.1 Social Media Marketing

Social media marketing serves as a powerful way for organizations irrespective of their industry of operations to reach customers and prospects (Ameme & Wireko, 2016; Subrahmanya, 2011) . Just in the past few years, the Real Estate sector was very different from what it is today. In the past like one and a half decades, agents used to maintain physical offices in a suburb and it is this where homes were sold. A significant amount of valuable time was spent in property lists of homes for 'rentals' and 'for sale' as well as updating the window display in the quest to entertain passers-by who stared at the information in the course of their daily routines. The office location played a critical role in an agency's success. However, following the introduction of the internet, it has caused the extinction of these techniques that were once successful. Today, websites serve as the new brochure, the new business card, and the new office window. The Real Estate agencies that failed to adapt to the internet promptly no longer exist as the industry was sorted by a natural selection. Most Real Estate firms that were successful for years shut their operations, while their counterparts who adapted to the changes in the market flourished. In the modern Real Estate market, having an office shop front is no longer important as what is essential is a strong online presence.(Kamau, 2019).

2.11.2. Use of Mobile Devices

The Real Estate industry has been revolutionized by wireless technology. Through the use of mobile devices, buyers can search for property listings at their convenient time across the globe. As opposed to traditionally where buyers used to make physical visits to Real Estate offices in order to search for available properties, with the use of mobile devices, this is no longer the case as physical visits are only done when essential. This saves on time and costs associated with physical visits while at the same time providing buyers with a variety of properties to choose from a host of agencies. The use of mobile technology in the Real Estate industry is not only beneficial to buyers, but also to agents in that it leads to flexibility while working. Furthermore, wireless technology has opened up a whole new(Kamau, 2019)

2.12 Big Data Sets Analysis by Real Estate Companies

As Diebold (2000) explains "Big Data refers to the explosion in the quantity (and sometimes, quality) of available and potentially relevant data, largely the result of recent and unprecedented advancements in data recording and storage technology." It contains both large, interconnected and developed databases, as well as processes that extract useful knowledge from raw and high-speed digital data. Currently, big data is obtained by companies from activities conducted electronically and from communication between machines (e.g. data from production processes). Moorthy et al. (2015) list a number of sources from which large companies and corporations draw data. These are, among others, call center logs, client chats, SMS texts, Instagram pictures, Click Stream on the web, social media, Barcode Scanners, YouTube, Internet of Things (IoT). The acquisition of large data by companies, often in the course of business operations, requires innovative forms of data management and processing for better understanding and effective use in the decision-making process. The challenges linked to big data were defined by Laney (2001) through the prism of three dimensions that capture the essence of them: Volume, Velocity, Variety (3Vs). Some professionals add more Vs to this list (4Vs by IBM2: Volume, Velocity, Variety, Veracity; or 10 Vs by Borne, 2014: Volume, Variety, Velocity, Veracity, Validity, Value, Variability, Venue, Vocabulary, Vagueness) (Ribeirinho, Mischke, et al., 2020). Access to information is a fundamental element of the decision-making process, and due to big data and mining techniques, the decision-making has been changing. Real estate is an information-intensive and information driven industry (Lizam, 2019) . The data on the basis of which analyses, predictions and decisions are made originates from several different sources and are of varied nature. Most of them are location-specific, reflecting the patterns of local real estate markets (Małkowska, 2020).

2.13. Interface of Technology and Facilities Management

Technology thus defined, influences real estate through three different routes. First, by affecting the production function for the inputs to the production of real estate product (T1) (Lizam, 2019). Examples of such "upstream" inputs include piping and insulation, specialized construction labour, and financial capital. In each case the net result is increased efficiency of the factors of production, which in return lowers the cost of production. Second, by altering the production function for the real estate product. This means that some amount of the land, labour, and capital are combined in new ways that that allow a higher level of production at equal or lower cost (Małkowska, 2020). This shift in the production function reflects the application of technology to the construction and operation of real estate. An example is the development in the 1960's of construction management techniques that allowed for the more efficient development of commercial buildings. Third, by affecting the production functions of tenants and unrelated firms (T3) (Lizam, 2019). Here the focus is on the downstream users of real estate and with other firms in the economy. Such technology may apply to their inputs, the production of their products, or downstream users of their products. A recent example was a San Francisco office rent increase driven by dot.com firms. Technology in this case exerted demand side pressure on real estate markets (Vandell & Green, 1996). Enterprises enjoying the fruits of technology that are not themselves tenants in a particular real estate market may nonetheless benefit the market because they create wealth in the broader economy, which indirectly serves to increase demand for real estate stock and services (Małkowska, 2020). This characterization of technology identifies and categorizes technological interventions, which helps to analyse and predict the consequences of technological change on real estate markets. There are six key manifestations of technology in real estate that have been highlighted in the popular press or in academia (Vandell & Green, 1996).

Jud et al. (2002) found that the evolution of the Internet and other forms of information technology are changing dramatically the way the real estate brokerage industry does business. The findings support a positive impact of information technology use on the earnings of real estate licensees. Warburton, (2018) considers, various technology-driven initiatives that ultimately fall within the domain of strategic facilities management which he describes as managing the interaction between people, space and technology, as below

a) Free Wi-Fi for tenants and visitors on a commercial property. This enhances the property’s appeal to both;

b) Properties utilize Wi-Fi-enabled sensory hardware to send emergency notifications to tenants' mobile devices and cell phones;
c) Installation of motion-detecting sensors in properties to ensure that electricity, heating, ventilation and air conditioning systems are only switched on when people are present in a given area;
d) Commercial leasing staff have mobile devices which show vacant houses and desired rentals are displayed diagrammatically so they can show prospective tenants their options, as well as send them relevant floorplans, leases and marketing material on the go;
e) Prospective tenants for residential development log into a portal which processes the application and makes for a relatively seamless and streamlined experience;
f) Property managers use a mobile application to take photos and make notes of a property's condition prior to tenant occupation, the tenant confirming such condition by signing using a stylus pen;
g) Tenants log into the tenant portal where they can query invoices, utility bills and lodge maintenance requests without picking up the phone; and
h) The facility manager wearing a pair of Oculus Rift glasses, shares his view with a technical expert who is remote and directs the facility manager how to solve a particular maintenance problem quickly and cost-effectively.

The above points are stated as samples of some of the practical ways in which technology and Facilities Management intersect. Today's advancement in mobile technology made it possible for automated data collection and analysis that can provide users with accurate information. Therefore, technology is a game- changer that differentiates players in the real estate industry. It is likely to disrupt the traditional business model in the real estate industry (Lizam, 2019; Lizam, 2019).

2.14. Optimization of Technology in Construction

Information Technology has extended the boundaries of construction industry and has reshaped its outlook from the rigid 2D based industry to modern Virtual Reality (VR) and 3D printing based industry (Ullah & Sepasgozar, 2019). Munasinghe (2018) observes that 3D printing of high-rise concrete structures is already changing the speed of construction, the way construction crew works and the way we think about buildings and he gives an example a 2,690 sq. ft. office building in Dubai which took 17 days to print. Every company today competes in

two different worlds: the physical world of resources and the virtual world of information (Małkowska, 2020). In analysing how, technology impact the real estate business further observes that real estate industry operates in a world where information is particularly important. She describes the main product in the real estate business as having specific character (fixed location, differentiation, permanence in time, dependence of value on the environment, high capital intensity) and turnover is determined by legal restrictions and institutional environment.

Construction is not the first industry to encounter lagging productivity and disruption across the value chain. Lessons can be learned from others that had similar traits and encountered the same challenges that construction faces now. Shifts have been analysed in four of them: shipbuilding, commercial aircraft manufacturing, agriculture, and car manufacturing. Clear patterns of the shifts are evident in all of them, and value shifted to those handling the change best. Innovation in production technology and new work methods kick-started all four of the industries' journeys. Today, across industries, winners continue to heavily invest in technology, many with focus on digitalization and data-driven products and services (Ribeirinho, Blanco, et al., 2020).

Against the macro-economic backdrop of climate change, rapid urbanisation and now COVID-19, the construction industry is facing challenges it has never seen before. Understanding how to negotiate these challenges will require collaboration, new industry standards and the application of technology. Those real estate investment managers best able to weather this storm will be those who are most innovative and best at adopting emerging technologies (Saïd Business School University of Oxford, 2021; Saïd Business School University of Oxford, 2021).

Impact of Technology on Commercial Real Estate describes three routes through which technology can be used to influence real estate business Danny Kattan, 2014; Dixon, 2005; Jud et al., 2002).

(a) Firstly, they argue that technology can be used to increase efficiency of the factors of production which in turn lowers the cost of production. The focus is on upstream inputs and examples given include piping and insulation and specialized construction labour.

(b) Secondly, by altering production of the real estate product, for example some amount of land, capital and labour are combined in new ways that allow a higher level of production at equal or lower cost.

(c) Thirdly, the focus in on downstream users and tenants through the creation of new markets and expansion of existing markets.

2.15. Digital Disruption and Digital Transformation

There are a number of theories and applications of technology that revolve around digital disruption and digital transformation in the real estate industry. Digital disruption is a transformation that is caused by emerging digital technologies and business models and that these innovative new technologies and models can impact the value of existing products and services offered by the industry (Aghimien et al., 2020; Liu et al., 2020). Digital transformation is also described as change associated with the application of digital technology in all aspects of human society. Adoption of digital disruptive technologies and innovative methods can help real estate transform its traditional rigid approach to a more up to date, advanced and smart approach (Ullah et al., 2019). This is expected to reduce the post-occupancy regrets of the real estate service users and improve the relations between various real estate stakeholders.

Global disruption and innovation are revolutionizing many industries and creating a digitally disruptive environment (DDE); real estate is no exception. Real estate online platforms (REOPs) are getting more attention in the era of COVID-19, where the real estate businesses must run online, and the service users are pushed to a forced digital experience adoption (Ullah et al., 2021).

CHAPTER THREE

RESEARCH METHODS AND DESIGN

3.1. Research Methods

In showcasing the importance of technology, this study through a mixed research design (quantitative and qualitative) assessed the application of technology in Malawian real estate business. In order to achieve the main aim and objectives of this study, it was essential to; first; review prior literature review related to the most influential models and theories in the field of real estate and application of technology in optimizing its core activities and business. Most objectives were achieved through questionnaire to extract relevant information.

Real estate managers or employees, Construction professionals, Real estate agents, Tenants, with substantive experience within a public or private construction organization in Mzuzu, Lilongwe, Blantyre and Zomba cities of country were surveyed through a structured questionnaire designed based on information gathered from the review of literature. Construction professionals such as architects, construction managers, engineers, and quantity surveyors participated in the survey. The selection of this set of respondents assumed that they form the core in real estate business (construction process). Real estate managers and agents were necessary to provide views that could address challenges faced by the real estate industry in Malawi. Understanding their views regarding how technology can help promote construction and business activities becomes paramount to the attainment of the main objective of present study. The choice of conducting the study in Mzuzu, Lilongwe, Blantyre and Zomba is premised that these are major cities of Malawi and have significant real estate activities thus reasonable amount of data can be collected. Since a considerable number of professionals were targeted, using a questionnaire survey was deemed necessary because of its ability to cover a wider range of participants within a short time frame. A closed-ended questionnaire designed in four sections A to D was adopted.

In analysis, the first stage was to analyse the background information of the respondents, and responses on level of agreement with each given statement using descriptive statistics such as bar graph, percentages and Likert chart. The distributions of the responses provided in the four cities were compared using the Chi-squared test of goodness of fit. For all areas of interest, consistency of the responses for the statements was checked using the Cronbach alpha test. Values of the Cronbach alpha are between 0 and 1 (Moser and Kalton, 1999). The values close to 1 indicate data is more reliable (Moser and Kalton, 1999). Redundancy among the

statements was checked using Bartlett's test of sphericity. Kaiser–Meyer–Olkin (KMO) was used to determine adequacy of samples. Bartlett's test of sphericity tests whether the variables in a data set are unrelated and therefore unsuitable for structure detection.

To reduce complexity of data principal component analysis (PCA) was warranted. PCA examines the intrinsic variation in the dataset and to obtain an overview of variation among the groups. In the present study PCA was used to reduce dimensionality of the data by identify statements/variables that are composites of the observed statements/variables. Reduced data acts as a summary and minimises computational burden and errors. PCA does not require prior knowledge on whether the variables/samples come from different groups. When performing PCA, the dimension of data is reduced by geometrically projecting the data onto lower dimensions called principal components (PCs). The aim is to use a limited number of PCs to summarise the data. The first PC is chosen to minimize the total distance between the data and their projection onto the PC. By minimizing this distance, the variance of the projected points is also maximized. The second PC is selected in a similar manner, but it has to be uncorrelated with the first PC. In the same manner the other PCs are selected (that they are not correlated with the previously selected PCs). The majority of the variance is limited to the first few PCs, hence all the PCs are not used. PCA helps in finding directions that are easy to interpret when looking at variation.

The selection of the first few PCs to be used in summarising the data was done using scree plot, eigenvalues and percentage of variation accounted for. The data with reduced dimensionality is a product of the original data and the feature vector (vector containing eigenvalues of the selected PCs). In the new data set the variables are linear combinations of the original variables.

Pairs of proportions were compared using the z-test with the assumptions that the samples are independent, and np and np (1-p) are both greater than 5. Since level of agreement with a given statement was on liked scale, ordinal regression model is used when the dependent variable is ordinal, is used to describe the relationship between level of agreement with a statement (dependent variable), and statement on why real estate firms are not interested in investing in modern technology (independent variable) and city (independent variable) [Moser CA, Kalton G. 1999. Survey Methods in Social Investigation. 2nd ed. Aldershot: Gower Publishing Company Ltd.].

CHAPTER FOUR

CRITICAL ANALYSIS OF THEORIES AND APPLICATIONS OF TECHNOLOGY IN REAL ESTATE BUSINESS.

4.1. Introduction

Several theories and applications of technology in real estate business have been developed by different researchers and such studies have helped in the advancement of real estate business to the current state where buildings are now being put up of different shapes and sizes as well as in shorter periods than before (Siniak et al., 2020). Operating of real estate businesses is also being aided by new technologies. However, the application of the different types of technology depends on several factors. This chapter critically analyses available global data on real estate business and evaluates various technology theories and their applicability to the real estate business. The chapter covers the past, the present and looks into the future in terms of application of technology in real estate.

Continuous technological transformation concurrently creates threats to established business models, at the same time offers opportunities for novel service offerings (Addo-Tenkorang & Helo, 2012; Heimly et al., 2011). Leading firms often seek to shape the evolution of technological applications to their own advantage. With the advanced and dynamic growth of technologies, how fast the consumers are accepting these technologies depends on a number of factors such as availability of technology, convenience, consumers and economic status of the country Lai, 2017; Lovelock & Wirtz, 2000). The decision of how and why people adopt or reject a particular technology has been a prominent topic in the field of information system (IS), marketing and social science (Other behaviour theories move away from the individual to focus either on behaviour itself, or relationships between behaviour, individuals and social and physical environments in which they occur (Addo-Tenkorang & Helo, 2012; Heimly et al., 2011). As a result, numerous technology acceptance theories and models have been developed and used to exploit the determinants and mechanisms of users' adoption, decisions and behaviours. It becomes imperative to have a clear comparison of these models in terms of their theoretical underpinnings (Tarhini et al., 2015). Without understanding the origins, developments, and modifications along with the limitations of these models, there can be no comprehensive and methodical research in the field (Tarhini et al., 2015).

In general, acceptance is defined as "an antagonism to the term refusal and means the positive decision to use an innovation" (Addo-Tenkorang & Helo, 2012; Heimly et al., 2011). It is the common question of both practitioners and researchers that why people accept new technologies (Billanes & Enevoldsen, 2021). Answering this question may help them to select better methods for designing, evaluating and predicting the response of the users to the new technologies (Venkatesh et al., 2007). Technology acceptance models and theories have been applied in a wide variety of domains to understand and to predict users' behaviour such as voting, dieting, family planning, donating blood, women's occupational orientations, breast cancer examination, choice of transport mode, turnover, using birth control pills, education, consumer's purchase behaviours, and computer usage (Billanes & Enevoldsen, 2021). Several researched in the field of technology acceptance, developed frameworks to assess the usage of particular developed and implemented technology (Taherdoost, 2019). The very success of technology acceptance is dependent on understanding how and why users accept new technologies (Billanes & Enevoldsen, 2021).

Technology adoption is one of the mature areas of research in information systems and is defined as the 'stage of selecting a technology for use by an individual or an organization' (Venkatesh et al., 2007). With rapid strides being made in technology innovations in every conceivable domain, the issues related to technology adoption have gained increasing prominence in recent times. Huge investments are made by organizations and governments for introducing new technologies that have the potential of bringing a paradigm shift in the life-style of the users (Venkatesh et al., 2007). However, these investments may not yield results if the innovations are not adopted by the intended users. Initial failure of diffusion of Electronic Health Record (EHR) systems in US and Enterprise Resource Planning (ERP) systems are some of the examples of the technologies that failed to take off in spite of promising start (Addo-Tenkorang & Helo, 2012; Heimly et al., 2011). Therefore, this chapter presents the literature review of the technology acceptance models and theories.

4.2. Review of Theories and Applications of Technology in Real Estate

A number of theories have proposed to explain consumers' acceptance of new technologies and their intention to use. Some of the theories and models relevant to present research study are outlined.

4.2.1. Theory of Diffusion of Innovations (DOI)

The theory of 'diffusion of innovation' brought fundamentals for conducting research on innovation acceptance and adoption. Rogers synthesized research from over 508 diffusion studies and came out with the 'diffusion of innovation' theory for the adoption of innovations among individuals and organization (Khlifi & Bessadok, 2015; Rogers, 2010). The theory explicates literature review of technology adoption models and theories for the novelty technology process by which an innovation is communicated through certain channels over time among the members of a social system". Basically, it's the process of the members of a social system communicating through certain channels over time known as diffusion. Theory of innovation and adoption happens in several stages including understanding, persuasion, decision implementation and confirmation.

Innovation Adoption Curve Technology readiness (TR) refers to people's propensity to embrace and use of new technologies for accomplishing goals in home life and at work (Erosa, 2013; Hariri & Roberts, 2015; Khlifi & Bessadok, 2015). Based on individual's technology readiness it can be classified into five technology segments including explorers, pioneers, skeptics, paranoids, and laggards. This is similar to adoption curve of innovators, early adopters, early majority, late majority and laggards. The Diffusion of innovation or Technology readiness is vital for organization implementation success because it is market focus. Individual impact refers to improved efficiency, effectiveness, and/or higher quality. The good fit between task and technology is to increase the likelihood of utilization and also to increase the performance impact since the technology meets the task needs and wants of users more closely (Lai, 2017).

The main idea of the theory is that there are four elements that influence the spread of a new idea: the innovation, communication channels, time and social system. The process of diffusion consists of five stages, namely, knowledge, persuasion, decision, implementation, and confirmation. It results in six categories of users: innovators, early adopters, early majority, late majority, laggards and the leap froggers (Hassairi, 2021; Sharma & Mishra, 2014).

DOI model examines a diversity of innovations by introducing four factors (time, channels' communication, innovation or social system) which influence the spread of a new idea. DOI not only has been used at both organizational and individual levels but also, offers a theoretical foundation to discuss adoption at a global level. DOI model integrates three major components including adopter characteristics, characteristics of an innovation, and innovation decision process. In characteristics of an innovation step, five main constructs exist including relative

advantage, compatibility, complexity, trialability, and observability which are proposed as effective factors on any innovation acceptance. In adopter characteristics step, five categories exist as well; early adopters, innovators, laggards, late majority, and early majority are defined. In conclusion, DOI focuses more on the system characteristics, organizational attributes and environmental aspects. It has less power in explanatory and less practical for prediction of outcomes compared to other adoption models (Taherdoost, 2018). The S-shaped adoption curve described above applies to most of the innovations that are coming up recently. However, its application is of special significance for adoption of communication technology. In this case, value of the innovation is enhanced for existing users of the communication system as more and more people adopt the innovation. Each addition of user has a positive effect on existing users of the system which results in acceleration of the adoption curve.

4.2.2. Theory of Task-technology fit (TTF)-

Task-technology Fit (TTF) emphasizes individual impact. Individual impact refers to improved efficiency, effectiveness, and/or higher quality. The link of TTF with other technology attributes is summarized in Figure x. The good fit between task and technology is to increase the likelihood of utilization and also to increase the performance impact since the technology meets the task needs and wants of users more closely (Tarhini et al., 2015). This model is suitable for investigating the actual usage of the technology especially testing of new technology to get feedback. The task-technology fit is good for measuring the technology applications already released in the marketplace like in the google play store or apple store app.

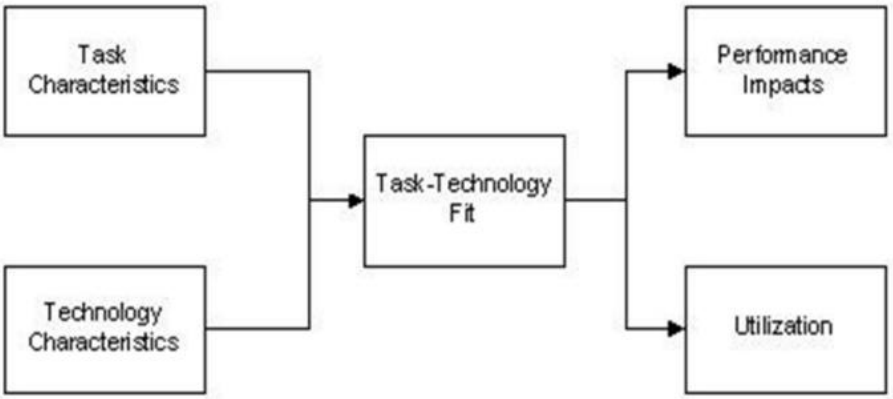

Fig 4.1: Framework of Task-Technology Fit Theory

4.2.3. Theory of Reasonable Action (TRA)

The Theory of Reasonable Action is one of the most popular theories used (Lai, 2017) illustrated in Figure 3. It is about one factor that determines behavioral intention of the person's attitudes towards that behavior. In this theory attitude is defined as the individual's evaluation of an object and belief as a link between an object and some attributes while defined behavior as a result or intention. Attitudes are affective and based upon a set of beliefs about the object of behavior such as the notion that Credit card is convenient. A second factor is the person's subjective norms of what they perceive their immediate community's attitude to certain behavior like my peers are using credit card and it's a status to have one.

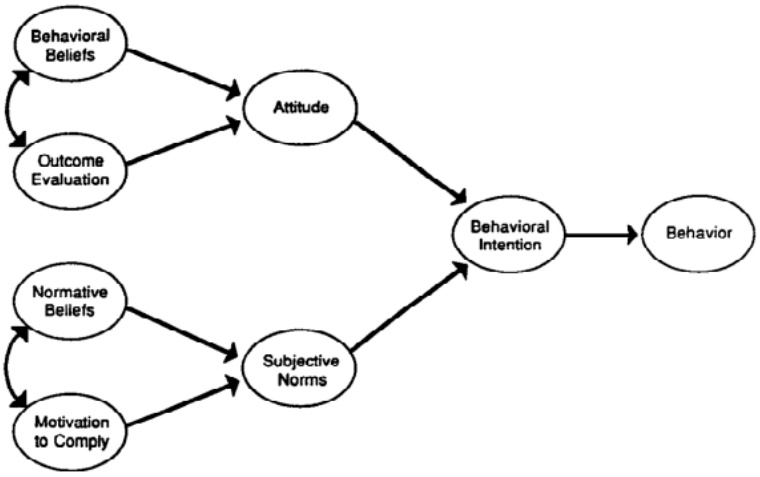

Fig 4.2: Theory of Reasonable Action (TRA) adopted from (Lai, 2017a; Lai, 2017a).

4.2.4. Decomposed Theory of Planned Behavior

Decomposed Theory of Planned Behavior (TPB) was introduced by Taylor and Todd in 1995 and consists of three main factors influencing behavior intention and actual behavior adoption which are attitude, subjective norms and perceived behavior control (Billanes & Enevoldsen, 2021). In this model, perceived behavioral control (PBC) as a new variable is added to extend TRA model. Basically, PBC is determined by the availability of resources, opportunities and skills, as well as the perceived significance of those resources, opportunities and skills to achieve outcomes. Although both TPB and TRA assumed person's behavioral intention (BI) is affecting individual's behavior, TPB is using the PBC for individual's actions which are not under volitional control. By adding PBC, not only realistic limitations are composed but also, a self-efficacy type factor is achieved. Moreover, PBC has the direct influence on actual behavior as well as the indirect affect through the behavioral intentions. Therefore, in TPB model, three main factors are affecting BI including perceived behavioral control, subjective

norm, and behavioral attitude. However, there are two main problems with TPB model. First, the one's attitudes towards information technology will not be largely relevant if a computer system is not accessible. Second, the revised TPB may be viewed as the more suitable theoretical framework which is influenced the degree of individual's voluntariness that choose or not to choose the use of information technology in the workplace (Taherdoost, 2018).

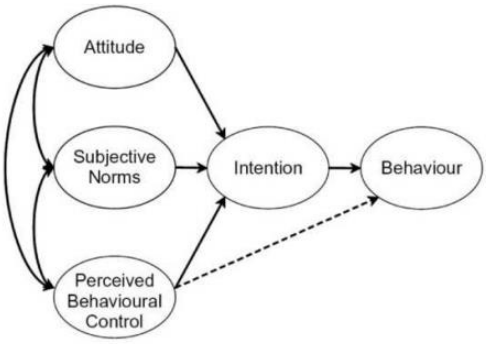

Fig 4.3: Theory of Planned Behaviour

4.2.5. Theory of Interpersonal Behavior (TIB)

This model is clarifying mainly the human's behaviour complexity which are affected by social and emotional factors (Taherdoost, 2019). Therefore, this model not only contains all aspect of TRA and TPB but also, adding habits, facilitating conditions and affect in order to improve the prediction power. The concept of social factors which is similar to the subjective norms construct in TRA contain roles, norms and self-concept. In brief, in TIB, individual is neither fully deliberative nor fully automatic, further, neither fully autonomous nor entirely social. TRA differs from TIB, in the sense that TRA interests in accounting for the most variance with the fewest variables, whereas TIB interests in accounting for the most variance in total, because even a small amount of variance may be socially important, if the behaviour in question is critical. In this model, emotions, social factors (like subjective norms in TRA), and habits are identified as the main factors to form the intention. TIB has three levels to argue the behaviour. In the first level, personal beliefs, attitudes and social factors related to the behaviour is shaped by personal characteristics and previous experiences. The second level describes how affect, cognition and social determinants plus personal normative beliefs effect on intentions to a particular behaviour. In the third level, possibility of performing a specific behaviour is predicted by behavioural intentions, situational conditions and past experience. The main disadvantage of TIB is complexity and lack of parsimony compared to TRA and TPB. Also,

TIB isn't providing simple procedure for the operational definition of the variables among model and it is left to the researcher (Taherdoost, 2018; Taherdoost, 2018).

4.2.6. Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) assumes that when users perceive that a certain type of technology is useful and easy to use, they will be willing to adopt it. Consequently, the more employees recognize that the systems will make their tasks easier to perform; the higher is the probability that they will use it and accept the new technology as being useful (Lai, 2017a). TAM model was based on the theory of reasoned action which posits that social behaviour is motivated by an individual attitude which is design to predict information system use (Lai, 2017a). Moreover, TAM adopted psychological theory known as the Theory of Reasoned Action (TRA) to explain acceptance and usage behaviour towards information technology (Davis, 1986). Davis validated the influence of perceived usefulness and perceived ease of use to users' decision of system use. Perceived Usefulness (PU) is the degree to which the user assesses that using a technology would help perform the work better. While Perceived ease of use (PEOU) is the degree to which a user considers that using a technology would be free of effort (Davis, 1989). Moreover, Davis considered perceived ease of use as antecedent to perceived usefulness. Meanwhile, perceived usefulness is strongly linked to behavioural intention to use technology.

TAM explains the motivation of users by three factors; perceived usefulness, perceived ease of use, and attitude toward use. Therefore, not only BI would be contained in TAM but also, two chief beliefs like perceived usefulness and ease of use have considerable impact on attitude of the user. These can be determined as an unfavourableness and favourableness toward the system. Sometimes, other factors known as external variables (user training, system characteristics, user participation in design and the implementation process nature) are considered in TAM model. Theory of Interpersonal Behaviour (TIB) This model is clarifying mainly the human's behaviour complexity which are affected by social and emotional factors. Therefore, this model not only contains all aspect of TRA and TPB but also, adding habits, facilitating conditions and affect in order to improve the prediction power. The concept of social factors which is similar to the subjective norms construct in TRA contain roles, norms and self-concept.

TAM found two main reasons why people adopt or reject a technology, namely perception of the technology usefulness and perception of ease of use of the technology. Determinants of

Continuous Intention to use Mobile Payments according to different scholars, it consistently explains between 40% to 50 % of user acceptance and actual usage (Surrendering, 2012; Denktash & Bale, 2008). TAM was then extended to include a possible explanation of subjective norm, perceived usefulness and usage intentions (Davis & Venkatesh, 1996). Later, TAM was extended to include perceived risk as one of the constructs as shown below.

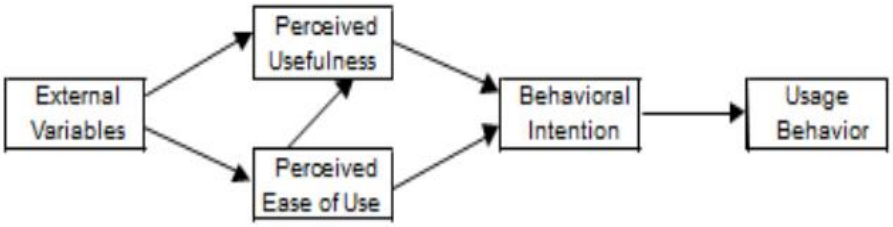

Fig 4.4. Final version of Technology Acceptance Model (TAM)

4.2.7. Technology Acceptance Model (TAM) Limitations and Criticism

Various considerations need to be considered in order to apply a theoretical framework and researchers need to be acutely aware of the multiple limitations which are inherent in order to obtain a proper understanding of the factors which promote application of IT. It is imperative to have a comprehensive theoretical and practical knowledge of the frameworks and models by means of which the use of IT is investigated. One of the limitations of the TAM concems the variable which pertains to the behaviour of users, which is inevitably evaluated through subjective means such as behavioural intention such as interpersonal influence. Nevertheless, interpersonal influence as the subjective norm is explained to mean when a person is influenced by words of mouth from a colleague, or a friend. While a superior can influence employee by directing a subordinate to perform a specific task with the use of technology, based on their IT policy, but a friend has no directive influence over staff who is a subject to the line manager. Another limitation is that, underlines of behaviour cannot be reliably quantified in an empirical investigation, owing to a number of different subjective factors such as the norms and values of societies and personal attributes and personality traits. Hence, the argument that a relative, friends could influence the use of technology through exacting social pressure is highly falsifiable. Although it may be true in theory or for personal use of technology, the five conceptualizations may not be plausible or accurate in a work environment.

Behavioural expectations should be used to predict the intentions of employees about the use of technology, rather than behavioural intention (Venkatesh et al., 2008). Furthermore, it is also anticipated that as the information management of organizations attains maturity, information formality is likely to be promoted (Daudu & Idehen, 2021). Hence, there will be a well-establish process within the company or institutions and rules to use an Information Systems (IS) that is provided by the organisation. Consequently, behavioural expectations could, therefore, be measured in relation to the levels of compliance and not solely on the basis of the perceptions of employees. Accordingly, the guiding principles or frameworks of organizations would serve as mechanisms to control the behaviour of employees and constitute a variable by means of which the extent to which technology is used by employees could be predicted. Therefore, suggesting that attitude toward the use of technology at work is based on the perceived usefulness and ease of use might have presented the TAM as a mere theoretical artefact (Ajibade, 2019). Perceive usefulness and ease of use might not influence the attitude of a librarian that must use a LIS system as complying and following the institutional and library system rules is mandatory because of the nature of services rendered. The criticism suggests that the TAM does not consider factors such as age and education as external variables which could influence acceptance of and willingness to use technology (Ajibade, 2019; Zahid, 2013). Conversely, it could be contended that it is extremely problematic to measure behaviour, as hidden personality traits often motivate behaviour. Accordingly, potential users of technology may not necessarily base their acceptance of and willingness to use new technology on their perceptions of the usefulness of IT and how easy it is to use, although the model does suggest that there may be other external factors which could be responsible for their acceptance of the technology (Ajibade, 2019).

4.2.8. Social Cognitive Theory (SCT)

Inspired from social psychology, SCT was proposed based on three main factors; behaviour, personal, and environment which are interacted bi-directionally in order to predict both group and individual behaviour. Moreover, it can identify methods which can change and modify behaviour. In SCT model, behaviour factor is chiefly focused on usage, performance and adoption issues. However, personal factor is any personality, cognitive and demographic aspects characterizing a person. On the other hand, environmental factor includes physical and social factors which both are physically external to the individual. SCT is an inseparable triadic structure that all three factors constantly influence one another, reciprocally determining each other. SCT model is integrated to evaluate the information technology usage by using some

constructs including self-efficacy, outcome expectations performance, anxiety, affect, and outcome expectations personal (Taherdoost, 2018) .

In summary, Social Cognitive Theory (SCT) applied to a wide spectrum of areas of study such as human functioning as career choice, athletics, organizational behaviour and mental and physical health. It has also been used in the areas of behaviour in the classroom including motivation, learning, and achievement. Social Cognitive Theory (SCT) provided ground-breaking concepts of self-efficacy, experience, time to study, training and social influence (later on used as subjective norms), but the theory itself cannot be generalized easily. SCT can be used as an umbrella to extend its concepts and constructs into a specific model and purpose but applying the theory itself is a very difficult task. As described earlier, SCT is not a theory specifically designed for observing human behaviour in specific areas but it is general and broad in context so it can be widely applied in many diverse areas, such as computer utilization, Internet usage and gratification. Social cognitive theory is organized based on the dynamic interplay between person, behaviour and environment. It is unclear the extent to which each of these factors into actual behaviour and if one is more influential than another. Social cognitive theory can be used to extend its concepts but applying the theory itself is a very difficult task. In addition, this theory is more related to education and motivation (Al-Mamary et al., 2016; Taherdoost, 2018).

4.3. Technology Adoption or Acceptance Case Studies in Other Fields - Research Results in Malawi.

4.3.1. Agricultural Industry

First, we consider agricultural innovations as described by Hermans and co-workers (Hermans et al., 2021). These are often conceptualized as a technical package of practices, distributed to new areas with the help of instruction with adoption rates representing a primary way of measuring success and impact of this distribution measured (Glover et al., 2016).

The processes of adoption and diffusion, that is, expanding the use of the agricultural innovation, are often characterized as 'scaling'. However, recent literature has highlighted that scaling occurs across multiple levels and dimensions, which are not always (Sartas et al., 2020; Wigboldus et al., 2016). To acknowledge these multiple ways in which scaling can take place, specific scaling types have been defined: upscaling refers to extension of the innovation to higher levels (e.g., national), out scaling to expansion within the same level (e.g., within the

community) and deep scaling to a change in the mind-set and culture (Moore et al., 2015; Schut et al., 2020).

A broad literature on the diffusion of agricultural innovation recognizes the importance of context and enabling conditions on shaping technology transfer and adoption dynamics (Whitfield, 2015; Zanello et al., 2016). Drawing on science and technology studies (STS), there is also an emergent critical response to simplistic narratives around the 'rational' adoption of successful technologies, highlighting the socially constructed and contested nature of agronomic knowledge. A focus on metrics of adoption overlooks the important processes and decision-making through which innovation happens on farms and maymiss out on considering the prerequisite conditions (Sumberg, 2010) namely if the technology is needed and suitable to potential users and local contexts. It also fails to recognize the multiple ways in which farmers do not simply adopt, but continually experiment with and adapt technologies to these contexts Whitfield, 2015). Therefore, both technology implementation constraints, and the ways in which farmers engage with these constraints, also termed tinkering are contextual and heterogeneous (Higgins et al., 2017). The various stories of individuals in these communities hold within them themes that contribute to a more nuanced understanding of adoption and innovation dynamics, which are often overlooked in linear innovation diffusion discourse. In the following section we highlight and discuss four lenses that can contribute to our understanding of farmer decision-making: social dynamics and information transfer, contextual cost and benefits, experience and risk aversion, and practice adaptation.

Decision-making does not only include economic or technical dimensions as social acceptability is also important. Family members' help on the field and their opinion make implementing agricultural practice change unlikely because they want to make ridges. Others were intimidated or mocked for being 'lazy'. This wording comes up frequently in farmer discussion, showing. Social acceptability is associated with community group dynamics

and connected flow of information. Farmers observed from the trial that support was given to start CA. This makes farmers think they need that same support to make the change work, leading to a belief that it is not worth trying on one's own. The trial farmers are part of the club and the farmers receive extension officer's attention and support. Even farmers who implemented CA on their own feel they are part of the club with access to information on modern technology. A distinct problem is that while the theory of change of demonstration trials and farmer to farmer distribution assumes homophily (i.e., people in the community are

equal) (Rogers, 2003), the group dynamics create heterophily, which makes the diffusion of innovation not as effective. There are beliefs and social dynamics in the community that are also of importance to farmers' decision-making. For example, the general belief that residues are not good for groundnut, despite data showing more harvest under CA (Bunderson et al., 2017). Similarly, the increase of planting population under Sasakawa creates the belief of higher fertilizer need. However, less fertilizer per plant leads to similar fertilizer need per area. The closeness to a trusted source of information affects the belief in the validity of the information (Fisher et al., 2018; Holden et al., 2018). Farmers in direct contact with the extension officer trust and implement more of the information, than when it comes to indirect ways such as trial observation or other community farmers. Some state that the lead farmer dissemination approach works since they are closely connected, whereas others note that this does not work. As previously reported in Brown et al. (2020), farmers report problems with information sources and lack of training due to lack of contact with extension officer and lead farmers. The closeness to a trusted source of information affects the belief in the validity of the information (Fisher et al., 2018; Holden et al., 2018). Farmers in direct contact with the extension officer trust and implement more of the information, than when it comes to indirect ways such as trial observation or other community farmers. Some state that the lead farmer dissemination approach works since they are closely connected, whereas others note that this does not work. As previously reported in Brown et al. (2020), farmers report problems with information sources and lack of training due to lack of contact with extension officer and lead farmers.

4.4. Technological Adoption Gaps in Sub-Saharan Africa.

Awareness of technologies encourages their adoption. However, several studies have suggested awareness does not necessarily translates into adoption(Barry et al., 2011). Some factors such as financial status positively affects adoption as well as intensity of adoption. Farmers tend to learn from multiple sources before they adopt a new technology, making farmers' education another important factor enhancing adoption(Higgins et al., 2017). Adoption is also affected by the availability of incentives which are important in encouraging initial adoption. Other factors that may encourage farmers to adopt technologies include access to credit, off-farm income and farmers' social networks. Risk is a major determinant when it comes to adoption of new technologies (Higgins et al., 2017). New technologies imply subjective and objective risks. Thus, lack of adoption or slow adoption of technologies should be expected when risks are high. Finally, it should be noted that the determinants of adoption vary by technology.

These include determinants like education and age, which have a positive effect on adoption of some technologies and a negative effect on the adoption of other technologies. It is therefore important to develop a comprehensive understanding of all the factors that help or constrain the adoption of new technologies. Policy makers and technology innovators should pay greater attention to the needs of all stakeholders and their ability to adopt in order to develop technologies that will suit them(Hariri & Roberts, 2015**)**. There have been many studies in the past looking at adoption of new technologies in different sectors in developing countries. A recent study reported that there is a large gap between farmers' awareness and adoption of agriculture technology in Malawi. This adoption gap means a lot of farmers are aware of agricultural technologies but only a few adopt them. Same situation may be applicable to other business field including real estate being tackled in the present study (Venkatesh et al., 2007).

4.4.1. Financial capital

In many industries such as real estate industry, income support may increase adoption by providing capital for purchasing essential for new technology. Availability of finance plays a role in adoption of improved technologies, especially those that are capital intensive (Diiro 2013; Lambrecht et al. 2013; Simtowe et al. 2010). There is significant positive effect of access to income on adoption shows that capital constraints matter for continued adoption is critical in developing countries (Lambrecht et al. 2013). In Malawi adoption rates can be enhanced by making deliberate policies for financial institutions to provide affordable credit facilities to real estate property owners to support purchasing essential devices for new technologies adoption.

4.4.2. Human capital

Empirical studies show mixed results regarding the effects of education on adoption of new technologies. On the one hand, education level is known to positively influence decision to adopt an improved technology. A number of studies (Mignouna *et al.*, 2011; Lavison, 2013) show that individuals with high level of education are able to receive, process and use information relevant to the adoption of improved technologies. For example, Ajewole (2010) analyses the socio-economic factors influencing farmers' response to adoption and use intensity of commercially available organic fertilizer in Nigeria. Results from this study show that number of years spent in formal education positively influence adoption decisions.

Another aspect of human capital is individuals' social networks. Study in Malawi using Information Diffusion Model by Beaman et al. (2018) revealed that social relationships serve

as a way through which individuals such as company managers or real estate property owners can learn and adopt new technologies. Furthermore, they show it is possible to identify individuals in the network who can trigger the diffusion process. Therefore, with proper targeting, technology diffusion can be enhanced thereby increasing adoption of improved technologies.

4.5. Risks Associated with Technology Adoption

Risk plays an important role in decision (Ramsey et al., 2016). Most investors such as property owners are risk-averse and so tend to adopt technologies that have lower risks (Meinzen-Dick et al., 2004). There is an extensive literature on how risk and uncertainty influences businesses in terms of production and marketing decision. Findings from the present reveal that perceived risks are a major factor that impedes the adoption of technology in real business in Malawi as highlighted in details in the preceding chapter.

4.6. Technological Infrastructure and Resources in Malawi

Malawi has very poor and substandard technological infrastructures like telecommunications, and computers with the lowest levels of technology access in learning organisations in African universities (African Digitalization Maturity Report 2017). This situation negatively affects business and education in the country. For instance, access to tertiary education in Malawi remains very low due to acute shortages of teaching and learning resources, inadequate classrooms and library spaces, and a shortage of human capacity (Namangale & Chimalizeni, 2022). The quality of HEIs in Malawi measured through an analysis of infrastructure, information and communication (ICT) facilities, teaching and learning resources and finance is very challenging needing much improvement (Zozie & Chawinga, 2018). This situation is attributed to poor technological infrastructure in tertiary education in Malawi. The Centre for Online Distance and e-Learning at MZUNI was established to deliver programmes through print media, radio, television, multimedia, Internet-based media, and web-technology ((Batzilis et al., 2010). Ten years down the line, as Chawinga and Zozie (2018) ascertained, nothing online or technological about it can be spotted as findings reveal that the university has not yet adopted these technologies. The difficulty is the lack of technology infrastructure at national level with little attention being given to improve the conditions of infrastructure by the government amid financial challenges(Matidza et al., 2020).

4.6.1 Poor Internet Connectivity and Cost

Malawi has very poor bandwidth and internet connectivity which is very expensive (Chetcuti et al., 2022; Kapondera & Namusanya, 2017). The little bandwidth available becomes even less valuable for investigation. High cost of internet connectivity is a key challenge in implementing e-learning in Sub-Saharan African countries such as Malawi(Barry et al., 2011). Effectiveness of e-learning programmes in Malawi's HEIs as the availability of computers and Internet at University of Malawi, Catholic University of Malawi, University of Livingstonia and Lilongwe University of Agriculture and Natural Resources was rated poor with MZUNI rated very poor (Zozie & Chawinga, 2018). According to Chawinga and Zozie (2018), the average connection speed of internet had dropped from 1.8 megabites per second (Mbps) in 2016 to 1.3 Mbps per second in 2017, contrary to the average global connectivity of 7.0 Mbps per second. According to the Inclusive Internet Index 2020 report, Malawi ranks very poor on all four of its indicators: internet availability, affordability, relevance, and readiness with the number of Mbps in Malawi regarded as the lowest and the least growing rate in the world, making it hard to facilitate expressive growth in many industries and business organisation, education being the worst (Barry et al., 2011). Interestingly, Zozie and Chawinga (2018), observed that smartphones and laptops, are a common sight amongst students and lecturers in public universities meaning scholars are trying their best to have internet gadgets only frustrated by quality of internet service and exorbitant pricing. Most Malawians and business organisations cannot afford internet rates and tend to survive on subsidised data bundles. (Kapondera & Namusanya, 2017).

4.6.2 Insufficient Power Generation Output

Malawi has insufficient power generation output to support its swelling population (Matambo, 2023) The unreliable power and exorbitant costs of generators further limits the use of ICT services and makes Internet connectivity and access difficult for most users (Batzilis et al., 2010; Matidza et al., 2020; Zozie & Chawinga, 2018). Electricity outages as the main challenge in adopting technologies in universities in Malawi. Chawinga and Zozie (2018) found that 86.6% of distance learning students preferred university-learning manuals because they are comprehensive, cheap to access, and does not require electricity. This is why e-learning adoption has been so low in Malawi.

4.6.3 Inadequate Financial and Technical Support

Education remains an increasingly top spending priority for the government of Malawi over the past few years absorbing the lion's share of the budget with $285 million (18%) in 2017/2018, $451 million (23.5%) in 2018/2019 and $541 million (25%) in 2019/2020 of the total budget thus depriving other sectors such as real estate Malawi Housing and Corporation which are equally important for economic development of any nation. Increasing budgetary deficits, governments find it hard to finance organisations such as MHC and education beyond operations and technical requirements. In many countries, such challenges are exacerbated due to over dependence of organisations on government funding. Organisations such as Real Estate and Education should be able to invest in technological and ICT infrastructure for long term benefits (Barry et al., 2011). A plethora of studies have also revealed the lack of managerial and technical support from governments in developing countries on ICT and e-learning development and implementation (Chetcuti et al., 2022; Eriksson et al., 2017).

4.7 Conclusion and Recommendations

Underdeveloped ICTs and power infrastructure are the most common impediments for business and education as reported by many studies followed by the lack of clearly policy and knowledge to use ICTs.

- The Malawi government should; invest more financial resources, develop and implement appropriate policies and regulations to support business and education requiring e-learning programmes. Provision of seed capital to organisations and universities with performance-based budget allocation mechanisms to be more innovative, competitive and efficient and expand electricity generation capacity.
- Malawi Communications Regulatory Authority and Internet service providers namely: Malawi Telecommunications Limited, Telecom Networks Malawi and AIRTEL Malawi should revise downwards the rates charged on Internet services which are considered the highest in the Southern African Development Community region.

4.7.1. Low ICT Adoption and Use

Literacy skills, attitudes and perceptions, acceptance and use of ICT devices and services by majority of Malawians remain a big challenge and this has an overarching implication to resistance to change. Resistance to change has been reported by many studies as the major obstacle to e-government implementation both in developed and developing world. Similarly,

in Malawi majority of government employees, see that e-government initiatives as threat to their positions and they fear of losing jobs and power.

4.7.2. Lack of Collaboration.

Collaboration and cooperation between and among all private partners, civil society, Non-Governmental Organizations are critical drivers of e-government implementation processes (ICT4D Policy, 2006). Though Malawi government has shown a lot interest in Public-Private-Partnership (PPP) concept in other sectors, the link to e-government is not well coordinated.

4.7.3 ETrade Readiness Assess

Real estate business can be readily enhanced through strengthening and adoption of ETrade (Eriksson et al., 2017). The current Malawian national development plan, MGDS III, recognises ICT's role in accelerating growth of other sectors as enabler for poverty reduction and wealth creation. However, it does not explore the specific contribution of e-commerce and the digital economy as key drivers to sustain the Malawian developing economy, and neither has the country adopted a focused stand-alone e-commerce policy and strategy. Nonetheless, following the National ICT Policy of 2013, a number of polices and strategies address issues related to e-commerce, especially in the areas of e-government and the development of a legal framework for electronic transactions and e-payments uptake (Namangale & Chimalizeni, 2022). The overall e-commerce enabling environment in Malawi faces challenges however, hampering its further development. The main challenges include the population's lack of trust in online systems, low level of Internet access by the population, low technology adoption by firms, lack of access to financing, and weak IT skills across the population (Namangale & Chimalizeni, 2022). Government capacities to strategize and implement a digital economy development agenda are weak, and organizations representing e-commerce businesses and consumers are neither very visible nor structured in their lobbying efforts. Policy coordination and dialogue among different stakeholders in the e-commerce ecosystem needs to be organized. These challenges mean that the e-commerce ecosystem is still relatively embryonic (Eriksson et al., 2017). ICT infrastructure and services Less than 14% of Malawians use the Internet according to ITU estimates (Eriksson et al., 2017).. Affordable access to the country's ICT networks has been identified as one of the key areas slowing down the adoption of e-commerce in Malawi. The cost of Internet access, although decreasing, remains high by African standards and inaccessible for most Malawians. ICT infrastructures have only recently improved with support from the World Bank, fibre-optic backbone is now in place, but last-mile connectivity

is still very limited. Over the last two years, telecom operators have started rolling out 4G coverage, mainly in large urban centres(Grist, 2015; Namangale & Chimalizeni, 2022). In addition to limited funding for infrastructural upgrading, power supply hinders efforts to expand the network and improve the performance in Quality of Service (QoS) indicators. Taxation, market, and regulatory structures that do not encourage competition slow down efforts for price reductions in mobile data packages and extension of broadband coverage(Grist, 2015). Nonetheless, the telecom regulator, MACRA, and the recently established Universal Service Fund (USF) are driving efforts towards greater access and affordability of ICT services. In the private sector, the demand for ICT services is relatively thin and the few local ICT service providers are mostly outward-looking to fuel their growth(Namangale & Chimalizeni, 2022).

E-commerce businesses are poorly developed, and the sector is characterised by a proliferation of informal operators and a low survival rate for companies (Grist, 2015; Namangale & Chimalizeni, 2022). Trade logistics and trade facilitation in general, transport infrastructure suffers from low levels of investment, minimal private sector involvement, and limited competition in some subsectors, hindering the opportunities for building an integrated multi-modal network, which is particularly relevant for countries like Malawi to become effectively land-linked1. The market of postal and logistic services for e-commerce is nascent, and most active operators have not yet structured a coherent offer that would suit e-commerce business models. Investments are also hindered by the lack of an addressing system and the small size of the market. The Malawi Post Corporation (MPC), despite the existence of an e-Post strategy, is still focused on its universal service mandate and has yet to fully embrace a digital modernisation process. Malawi has however prioritised trade facilitation reforms and implementation of the WTO Trade Facilitation Agreement, including the establishment of a National Single Window, which is currently underway (Grist, 2015; Namangale & Chimalizeni, 2022). This should provide a renewed impetus towards paperless trade and e-payments. Payment solutions Malawians are still reluctant to use cashless solutions when buying goods and services remotely. The booming use of mobile money in Africa has not left out Malawi, and although overall uptake in the country is below the continental average, it is still a key driver for financial inclusion. Over the last few years, regulatory dynamism - driven by the Reserve Bank of Malawi - has laid the foundations for banks and other financial services providers to experiment and launch new products with mixed records of success (Namangale & Chimalizeni, 2022).. While integration between mobile money and online banking is gaining ground, sustained by the establishment of a National Switch and regulatory intervention to

allow interoperability of payment instruments, third-party applications from fintech and start-ups are struggling to enter a market dominated by strong incumbent's telecom operators and banks (Grist, 2015; Namangale & Chimalizeni, 2022)..

Credit cards still suffer from security concerns, use of PayPal faces some challenges despite some improvements. In general, more needs to be done to sensitise and build awareness about the advantages of e-payments and stimulate their use, starting by shifting government payments to digital channels. Legal and regulatory framework Malawi adopted a key law in 2016, the Electronic Transactions and Cyber Security Act, containing the main elements ensuring and developing e-commerce related services (Grist, 2015; Namangale & Chimalizeni, 2022). However, there is a need to enact regulations and to create awareness of the existing legal framework across the private sector and society at large. The trust in buying and paying for goods and services online is currently very low. Cross-border transactions, personal data protection and dispute resolution mechanisms to manage consumers' complaints are all areas requiring particular attention from lawmakers to fill gaps in the legal framework. On top of this, red-tape plus costly and time-consuming procedures make the overall business environment quite cumbersome for start-ups and Micro, Small and Medium-Sized Enterprises, lowering the incentive to quit the informal economy and build robust e-commerce marketplaces. Skills development for e-commerce Limited connectivity and lack of trust in e-commerce is also translated into low use of the Internet for business purposes, signalling a general need for the support of digital adoption and literacy. Higher education and training programs have not yet embraced curricula suitable to develop e-commerce skills; they mostly target traditional ICT engineering or business administration tracks. Technical and vocational education training is also focused on traditional trades. The result is that an important skills gap needs to be addressed through a new education and training offer for Malawian graduates to increase their employability and self-employment opportunities. A dynamic start-up environment supported by a number of business incubators and accelerators has boosted Malawians' digital entrepreneurship, but start-ups' growth and their profitability remain critical, particularly for e-commerce business development projects. The business and trade development support system must rethink its structure and integrate support for digital transformation. Access to Financing The last major area of challenge identified in this rapid assessment relates to the difficulty of accessing funding options by companies, particularly MSMEs, because banks' assets are concentrated on a few borrowers and, together with

microfinance institutions (MFIs), banks are not serving the credit needs to sustain companies' growth and innovation investments.

4.8 Conclusion

Technology adoption and diffusion in the developing world are best measured in terms of their impact on socio-economic development (as measured by human development indices). As it stands, Sub-Saharan Africa remains in the doldrums in most world human development indices. When it comes to Internet dialup, only a paltry 150,000 out of the 690 million people in the region had the service as of 2013. That is, only 2 out 1,000 people could access to this luxury privately, compared to developed regions of the world such as the United States, where the internet dialup access for the same period stood at 3 per 10 people. Illiteracy remains a serious problem for most of Sub-Saharan Africa. The problem of illiteracy is amplified by the deteriorating education system, including dilapidated school buildings and serious shortages of supplies across the region. The region is saddled with many negative-impact forces or factors with negative interactions and consequences on socio-economic development and therefore on technology innovation, diffusion, and adoption across much of Sub-Saharan Africa

Most research on innovation adoption and diffusion, especially in the rapid growth area of Information Technology, focuses on developed countries. Most of technology adoption research presumes that technology is readily available, and that the responsibility for accepting or rejecting it resides with the end user. This assumption falls short of realities in the least developed regions such as Sub-Saharan Africa. Countries in this region lag behind the rest of the world in basic socio-economic factors which are pertinent to the day to-day use of modern technologies. Despite the many models and studies on technology adoption in mainstream IS research, studies on technology adoption and its precursors in the sub-Saharan African context such as Malawi are still scarce.

CHAPTER FIVE

5.1. INFLUENCE OF TECHNOLOGY ON HOUSING CONSTRUCTION

Abstract

This paper summarises the optimization of technology in real estate business focussing on the impact of technology on the real estate business. Real estate industry is characterized by several disadvantages in comparisons to other industries, understanding the impact of technology is crucial to the industry on whether technology will distract the industry or complement business process. Real estate industry in Malawi is undergoing a transformation fueled by technological advancements. This study aimed to assess the level of influence of technology on the construction of ancillary housing infrastructure in Malawi. To achieve this objective, a questionnaire was formulated in which several assertions related to the impact of technology on Malawi' real estate business was presented and data were collected from various stakeholders in the real estate sector of Blantyre, Lilongwe, Mzuzu and Zomba. The study focused on examining how technology has impacted real estate firm's services, client interactions, property advertising, construction process and overall efficiency. The findings revealed the multifaceted impact of technology in the industry, in their three components, namely, Technological transformation of real estate services, connectivity and communication revolution and construction and safety advancements.

Keywords: *Real Estate, Technology, Construction, Ancillary infrastructure, Firm services*

5.1.1. Introduction

The construction industry contributes significantly to the socioeconomic growth of any country. The industry does this by transforming different resources into constructed economic and social infrastructures and its product is essential to other industries within any given country (Hansen, 2010). Despite its significance, the industry is characterized by poor performance in the delivery of its products in most developing countries including Malawi. Unlike other industries, the engineering and construction sector has been slow to adopt new technologies, and has certainly never undergone a major transformation(Eriksson et al., 2017). As a result, productivity has stagnated over the last 40 years, or in some cases, even declined(Aytekin & Keskin Demirli, 2017). Technological advancement promises solution to this age-long problem of poor project delivery of the construction industry (Eriksson et al., 2017). While other industries have adopted the use of technology, the construction industry is

yet to fully embrace it in the delivery of its services(Ullah & Sepasgozar, 2019). This has significantly affected the industry, especially in developing countries, as no major transformation is evident within their construction sector (Aghimien et al., 2022). Buildings are complex systems that cannot be conceived as serial products, such as an automobile for example (Gramazio et al. 2014). Each building is designed and constructed according to specific conditions and stakeholder decisions, making automation harder to implement when compared to other industries like manufacturing(Lynn et al., 2011).

In Sub-Saharan Africa it is almost impossible for a client's dream to come to complete reality with respect to affordable descent home(Li, et al., 2021). This is because of some shortcoming in the delivery of projects to budgeted cost, estimated schedule and agreed specification(Reza et al., 2020). The case is no different with Malawi, as most construction services are still being delivered using traditional methods. This has adversely affected the growth of the industry, the quality of services rendered, and the satisfaction thereof. There is no industry that can effectively succeed in solving its growth problems unless its goals and strategies towards achieving these goals are accompanied by knowledge creation, and driven by technology(Pankratov et al., 2020).

Technology has a great influence on construction and development of real estate industry especially in the delivery of new housing globally(Kang' & Kamau, 2019). In developed countries such as UK, private house builders dominate new housing production, with the majority new homes produced annually(Zhang et al., 2016). Building industry plays a vital part in the key processes by which the housing stock changes and adapts to new economic, social and cultural trends. Nevertheless, the organization and structuring of modern houses vary significantly across western countries (Lynn et al., 2011). Unlike other industries, there is a distinct lack of globalization in house building(Stetelman, 2012). The way in which housing production is organized tends to be specific to individual countries. Thus, its characteristics as an industry and activity can vary and take on very different institutional forms between countries(Hariri & Roberts, 2015). In looking at the features and differences of house building industries, a focus will be placed upon the performance of these industries; the roles house builders occupy and the functions they undertake in the housing development process; and the structure and characteristics of different industries and of the firms that operate within them. In explaining the distinctive nature of housing production, a key theme that emerges is the role

of broader institutional structures, particularly the different relationships between the market and the state (Lynn et al., 2011).

The adoption of modern technology including digital technologies (DTs) such as building information modelling, promises better project delivery specifically in terms of cost and time as clashes in designs are noticed early and the possibility of faulty design and rework cum their associated cost and time wastage is eliminated (De Carolis et al., 2017). The use of the Internet of Things promises to solve the issue of poor communication in project delivery (M. J. A. Zahid et al., 2013). In the same vein, big data analytics promise improved predictions of the future construction project delivery (Zanello et al., 2016) as patterns from previous projects can be identified and informed decision can be made early before a project commences (García de Soto et al., 2022; Stetelman, 2012). In developed nations, 3D printing and autonomous robots promise a reduction in labour and material costs, reduction in site injuries and fatalities, improved productivity, and even the creation of more job opportunities (Ammar et al., 2018; Eriksson et al., 2017). In the nearest future, autonomous robots will function side by side with the traditional construction system and in the process create greater variability in jobs and establish new roles for construction workers(Venkatesh et al., 2008). Aside these, other features such as cloud computing wherein scalable IT-related capabilities are provided as a service over the internet to multiple external customers, and augmented reality, which is an innovation that gives an augmented view of objects or designs using specific gadgets exists(Moorthy et al., 2015). Furthermore, De Sotoet al. (2018) noted the importance of digital technologies in improving construction delivery through a digital building system that can aid successful delivery of projects right from the selection of the plot for construction, down to handing over of the project (García de Soto et al., 2022). According to Aghimien et al. (2022) and (De Carolis et al., 2017) when compared to other industries, construction is slow in terms of the adoption of these DTs. Significant adoption of these technologies has been noted within the manufacturing industry, banking, education and telecommunication of most developed and some developing countries around the world (De Carolis et al., 2017; García de Soto et al., 2022). However, the case is different for the construction industry as evidence of the full adoption of certain DTs can only be seen in developed countries, while the developing ones still lag behind (Eriksson et al., 2017). In the present study, the influence of technology on housing construction was evaluated in Malawi.

5.2. Methodology

In trying to unlock and boost real estate business, this study through a quantitative research design assessed the influence of Technology in Construction Industry in Malawi. Samples/Respondents were drawn from four main cities of Malawi, Mzuzu, Lilongwe, Blantyre and Zomba between February and March 2022. The factors that could hinder the adoption of technology as well as the inherent benefits in the successful construction were considered. Construction professionals and employees from different real estate firms and varied experience within a public or private construction organization in Malawi were surveyed through a structured questionnaire designed based on information gathered from the review of literature. Construction professionals such as architects, construction managers, engineers, and quantity surveyors participated in the survey. The selection of this set of respondents assumed that they form the core of the construction process. Understanding their view regarding how technology can help promote real estate business of their routine activities becomes paramount to the attainment of the objectives of this study. The choice of conducting the study in these sites is premised on the fact that they are the only cities in Malawi and have highest number of construction activities, real estate agents, organizations and professionals in the country. Since a considerable number of professionals were targeted, using a questionnaire survey was deemed necessary because of its ability to cover a wider range of participants within a short time frame (Tan 2011). A closed-ended questionnaire designed in four sections was adopted (Appendix 1). The first section sought answers on some defined background information on the respondents. Information in this section served as a quality check for the answers given in the other sections. The second section focused on assertions of present chapter concerning the impact of technology on Malawi's real estate business in construction organizations. Other sections of the questionnaire (third to fifth) were designed to address objectives three to five respectively. The second section was equipped with sufficient questions for comprehensive data regarding impact of technology on construction in Malawi.

A 5-point scale questionnaire was employed. A snowball approach was adopted in getting respondents for the study since it was difficult to get the exact number of professionals with the set years of experience and practicing within the city from the onset of the research. It has been noted that this approach has the potential to significantly increase the sample size of a study (Atkinson and Flint 2001) since it is based on referral (Heckathorn 2011). Based on the approach adopted a total of 90 respondents including professionals with varying work

experience and currently practicing within the construction domain in the study area participated in the survey.

In analysis, the first stage was to analyse the background information of the respondents, and responses on level of agreement with each given statement using descriptive statistics such as bar graph, percentages and Likert chart. The distributions of the responses provided in the four cities were compared using the Chi-squared test of goodness of fit. For all areas of interest, consistency of the responses for the statements was checked using the Cronbach alpha test. Values of the Cronbach alpha are between 0 and 1 (Moser and Kalton, 1999). The values that are close to 1 indicate that the data is more reliable (Moser and Kalton, 1999). Redundancy among the statements was checked using Bartlett's test of sphericity. Kaiser–Meyer–Olkin (KMO) was used in determining the adequacy of the samples. Bartlett's test of sphericity tests whether the variables in a data set are unrelated and therefore unsuitable for structure detection and finally Principal Component Analysis (PCA) was employed. PCA reduces the dimensionality of the data by identify statements/variables that are composites of the observed statements/variables. The data with a reduced dimensionality acts as a summary. With dimensionality reduced, computational burden and errors are reduced. The advantages of PCA is that it does not require prior knowledge on whether the variables/samples come from different groups. When performing PCA, the dimension of data is reduced by geometrically projecting it onto lower dimensions called principal components (PCs). The aim is to use a limited number of PCs to summarise the data. The first PC is chosen to minimize the total distance between the data and their projection onto the PC. By minimizing this distance, the variance of the projected points is also maximized. The second PC is selected in a similar manner, but it has to be uncorrelated with the first PC. In the same manner the other PCs are selected (that they are not correlated with the previously selected PCs). The majority of the variance is limited to the first few PCs, hence all the PCs are not used. PCA helps in finding directions that are easy to interpret when looking at variation.

The selection of the first few PCs to be used in summarising the data was done using scree plot, eigenvalues and percentage of variation accounted for. The data with reduced dimensionality is a product of the original data and the feature vector (vector containing eigenvalues of the selected PCs). In the new data set the variables are linear combinations of the original variables. Pairs of proportions were compared using the z-test with the assumptions that the samples are independent, and np and np(1-p) are both greater than 5. Since level of agreement with a given statement was on Likert scale, ordinal regression model

was used when the dependent variable is ordinal to describe the relationship between levels of agreement with a statement (dependent variable) on the impact of technology on real Malawi's estate business (independent variable).

5.3. Results and Discussion

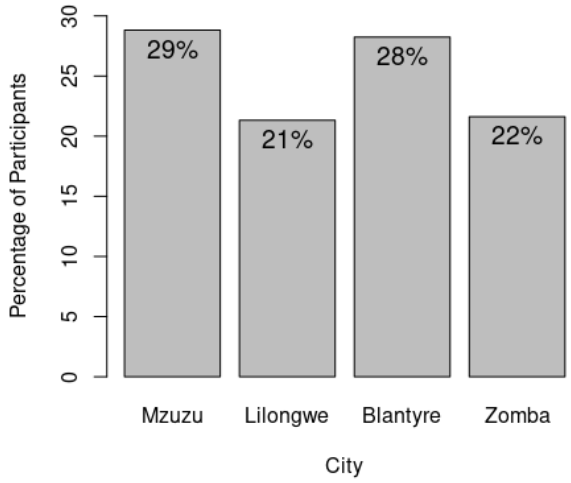

Fig 5.1: Distribution of the participants in four cities where survey was conducted.

The analysis of the background information revealed that Mzuzu city had more participants (29%) in the study followed by Blantyre (28%) while Lilongwe had the least (21%). Nevertheless, these differences are not significantly different. Such results imply that the target respondents for the study were adequately represented. The first aspect of questionnaire evaluated the impact of technology on Malawi's real estate business. Results concerning level of agreements on a scale of 1 to 5 (1- strongly disagree, 2- disagree, 3- moderate, 4-agree, 5-strongly agree) are presented and discussed in the next section. The pairwise comparisons of the distributions of the responses on the statements concerning the impact of technology on Malawi's real estate business, indicates that there were no significant differences in terms of responses of the respondents from all the cities of Malawi since the alpha level was found to be equal to 1, as provided in Table 5.1.

Table 5.1: Pairwise comparisons of distributions of responses for cities on concerning the impact of technology on Malawi's real estate business.

	Mzuzu	Lilongwe	Blantyre
Lilongwe	P = 1		
Blantyre	P = 1	P = 1	
Zomba	P = 1	P = 1	P = 1

5.4 The Impact of Technology on Malawi's Real Estate Businesses

In determining the impact of technology on Malawi's real estate business, respondents were provided with 10 possible assertions identified from the literature. The respondents were asked to rate the impacts on a 5-point scale with 1being strongly disagree, 2 disagree, 3 moderates, 4 agree and 5 strongly agree. The frequency of their perspective of those working within public and private organisations is presented in the figure 5.2. The first statement wanted to establish if the use of technology has resulted in an increase of real estate service sales. The result revealed that majority of the respondents (37%) agreed while 27% respondents disagreed and the remaining percentage (35%) neither agreed nor disagreed. The high percentage could mean that technology has enabled real estate firms to reach a wider audience, showcasing properties effectively and streamline their sales processes which can contribute to increased sales. The second assertion was for the respondents to score on whether clients and other films have been able to quickly acquire information about real estate firm's services through websites with portals. From the scores, majority of the respondents (38%) agreed, 30% disagreed while the remaining respondents (32%) were undecided. The higher score on this assertion could mean that online platforms and websites have made it significantly easier for clients and businesses to acquire detailed information about real estate services and available properties. On the impact of technology, in terms of allowing rental residences and property sales being advertised using contemporary technologies, 42% of the respondents agreed to the assertion while 31% and 27% of the respondents disagreed and had neutral stands respectively. Digital advertising has become a standard practice in the real estate industry according to (Ullah & Sepasgozar, 2019), and this has enabled more efficient and widespread promotion of rental properties and property sales. This may be attributive to high percentage of respondents agreeing to the statement. Further, the participants were asked if personalised responses to clients are now possible due to modern technologies. Results revealed that most of the respondents (39%) agreed of its impact, while 31% indicated that they do not agree with the statement and only

30% of the respondents showed no stand on the assertion. Comparatively, this could mean that firms have embraced technology to better understand client preferences and provide more personalised responses while improving customer satisfaction.

Another statement wanted to establish if buyers can use their mobile phones to browse property listings quickly and efficiently. The result revealed that majority of the respondents (44%) agreed to the statement while 29% disagreed and the remaining percentage (27%) had a neutral ground. Respondents were also asked to assert if the use of technology such as mobile phones saves time and money compared to actual visits. About (37%) of the respondents agreed while 35% and 27% of the respondents disagreed and had moderate views respectively. Another assertion was for the respondents to agree on whether clients the use technology has allowed real estate firms to work in a more flexible setting or not. From the scores, majority of the respondents (35%) agreed, 34% disagreed while the rest of the respondents (31%) could not agree or disagree to the assertion. Namangale & Chimalizeni, (2022) revealed that technology has introduced remote work capabilities, enabling real estate professionals to work more flexibly and efficiently, even outside of traditional office. This reason could have necessitated to the higher score in term of the respondents who agreed to the assertion. Furthermore, the respondents were asked if technology has influenced ability of contacting potential consumers and vendors using technology such as phones. The result revealed that most of the respondents (44%) disagreed to the statement, 33% were very sure about the simplicity while the rest (23%) of the showed moderate views.

On the impact of technology in terms of allowing clients to use modern technology by simply sending information from the worksite, such as when placing a material order, 37% of the respondents agreed to the assertion, 34% disagreed to the assertion while 29% had neutral stands. Finally, another statement wanted to establish if technology has allowed real estate films and business owners to monitor workers and other aspects of interest such as suitable location for house development by using modern technology. The result revealed that majority of the respondents (44%) agreed to the statement, 34% disagreed to the statement and the remaining percentage (22%) neither agreed nor disagreed.

5.5. Discussions

The findings of the study highlighted the significant impact of technology on the real estate sector in Malawi. The adoption of the modern technology has resulted in the increased sales, improved accessibility and enhanced client interactions. Digital platforms such as websites and

portals have played a crucial role in reaching a wider audience and showcasing available properties. This result is in tandem with Małkowska, 2020)**,** who also revealed that the proliferation of online platforms and property listings websites has made it easier for both real estate firms to a wider audience and clients can browse through listings from the comfort of their homes. This not only expedites the buying process but also enhances transparency in the market. Additionally, (Lizam, 2019) asserted that tools like virtual tours and 3D modelling have allowed potential buyers to explore properties in-depth before making physical visits. The results further revealed that clients and other firms can quickly acquire information about real estate firm's services through websites with portals. This eases of access to information has improved transparency and trust in the industry (Saull et al., 2020). For Malawian real estate firms, this assertion underscores the need to invest in well-designed and informative websites. Such platforms not only serve as a digital storefront but also as a means to establish credibility and trust with potential clients.

Accessibility of information through online portals serves time and effort for clients seeking real estate services, contributing to a positive customer experience (Małkowska, 2021). It has also streamlined property advertising, construction process and overall efficiency in the industry. The shift towards digital platform for averting and information dissemination has expanded the reach of real estate firms. The impact of technology is also manifested in the Malawian real estate business as it has been revealed that rental residences and property sales are extensively advertised using contemporary technologies. Digital advertising has become the norm, offering a cost effective and efficient way to reach to potential buyers and tenants. Clients and firms are able to easily access relevant information, leading to more informed decisions. Aghimien et al., (2022) add that, digital marketing offers real estate firms the advantage of reaching a broader audience at a lower cost compared to traditional advertising. Social media platforms, search engine marketing and email campaigns are now commonplace tools for promoting properties (Reza et al., 2020)**.** In Malawi, the adoption of digital advertising has opened up new avenues for making real estate, potentially attracting internation al investors and buyers. Personalization and efficient communication have become possible, further boosting customer satisfaction. Respondents acknowledged that modern technologies have enabled personalized responses to clients. This has enhanced customer satisfaction and strengthened relationships between real estate firms and their clients. In a similar study by Ajibade, (2018), it was revealed that the use of mobile technology has revolutionalised property browsing and on-site data sharing, making the real estate process more convenient and cost

effective. Buyers can efficiently browse property listings using their mobile phones, saving time and money compared to physical visits (Kytömäki, 2020). Mobile technology has become a powerful tool for property seekers. Additionally, technology-driven analytics and monitoring have improved decision-making, leading to better location choices and construction management. Automated massaging and accelerated construction processes are clear indicators of industries technological evolution. Automated messaging has been developed by real estate agencies in Malawi to inform customers about new homes on the market. This proactive approach keeps clients engaged. Similar results have been reported by Mohammed et al., (2021) in which a realisation was made that a good number of real estate agencies are embracing mobile connectivity for enhanced collaboration and customer engagement. Further, the study has also revealed that, some real estate agencies in Malawi, are able to stay in touch with customers and coworkers through mobile devices, fostering collaboration and real-time updates.

5.6. Conclusions and Recommendations

5.6.1 Conclusions

The present comprehensive study multifaceted impact of technology on Malawi's real estate industry. Three overarching components emerged from this analysis: (1) Technological transformation of real estate services, (2) Connectivity and communication revolution and (3) Construction and safety advancements. On technological transformation of real estate services, the integration of technology into Malawi real estate sector has brought about a profound transformation in the delivery of services. Several key elements highlight this component. The online accessibility and information dissemination. The real estate firms in Malawi have embraced websites and online portals to disseminate information about their services. This shift has resulted in increased sales as clients and other businesses can quickly access information about properties, rental residences and property sales. These platforms allow for easy browsing of property listings, ultimately saving time and money for clients. On the same vein, real estate firms now use modern technology to monitor workers and various aspect of interest, such as suitable location for house development. Automated messaging systems notify customers about new homes on the market, streamlining communication and information dissemination.

The second component is connectivity and communications revolution. The advent of technology has brought a significant revolution in connectivity and communication within the Malawian real estate sector. Technology especially mobile phones has enhanced connectivity,

enabling estate agencies to connect with customers and coworkers more effectively. This connectivity allows for prompt responses to inquiries, updates on property listings and efficient coordination among team members. On the same, real estate firms have harnessed digital systems such as social media platforms to advertise newly completed homes and properties. This approach has expanded their reach, as social media provides a cost-effective and efficient marketing channel.

The third component is construction and safety advancements. Technology has played a pivotal role in advancing construction practices and ensuring safety within the Malawian real estate sector. Technological advancements have led to the acceleration of the construction process. The use of modern tools and techniques such as 3D printing and prefabrication, has streamlined construction timelines and reduced costs. In terms of safety, measures have been significantly enhanced in the construction through technology. Real estate agencies priorities the safety of workers and occupants by implementing digital safety and monitoring systems.

The fact that simple majority (less than 50%) of the respondent supported positive contribution of technology to real estate industry in Malawi means that more still need to be done in order to optimize the influence of technology in Malawi. Challenges could be addressed through appropriate deliberate policies because technology is key to speedy development of real estate infrastructure that can easily meet the rising demand due to increased population globally where Malawi is not an exception.

5.6.2 Recommendations

The impact of real estate business in Malawi is profound and transformative. The three main components identified; technological transformation of real estate services, connectivity and communication revolution and construction and safety advancements, underscore the breadth and depth of these changes. To thrive in this evolving landscape, the following recommendations have been made; real estate firms should invest in user-friendly websites and portals, ensuring that the property information is up-to-date and easily accessible. Continued maintenance and optimization of online platforms are crucial for success. Another recommendation is that, real estate firms should leverage customer relationship systems and mobile apps to provide tailored services to clients. Training in effective mobile communication can further improve interactions. Finally, it is recommended that there should be continuous investment in monitoring systems and automation tools to improve efficiency and customer engagement. Regular updating clients with relevant information is essential.

CHAPTER SIX

6.1 CONSTRUCTION AND OPERATIONS TECHNOLOGIES USED IN REAL ESTATE BUSINESS OF MALAWI

Abstract

The real estate industry in Malawi stands a pivotal juncture, poised for growth and transformation. In the pursuit of optimization of technology within this sector, this thesis explored the role of technology in enhancing construction processes, with a focus on Malawian real estate enterprises. This component was achieved through questionnaire which sought views from respondents. The distribution of responses provided in the four cities were compared using Chi-squared test of goodness of fit. Principal Component Analysis (PCA) was used to reduce the dimensionality of the data by identifying the statements or variables that were composites on the observed variables. The data with reduced dimensionality acted as a summary. On the results, three overarching themes have emerged: integrated construction technology solutions, advances construction material utilisation and prefabrication efficiency. The optimization of technology within the Malawian real estate business holds the promise of improved efficiency, sustainability and competitiveness. By embracing integrated construction technology solution, advanced construction materials and prefabrication efficiency, the real estate industry in Malawi can drive positive change, reduce costs and contribute to the nation's overall economic development. It is imperative for all stakeholders, including the government, industry players and educational institutions, to work collaboratively and diligently to implement these recommendations and usher in a new era of innovation and progress in the Malawian real estate sector. This effort contributes significantly to the Malawi vision 2063, pillar number 3 (Urbanization). Decent and affordable accommodation can easily achieve through application modern technology in real estate industry.

Keywords: *Application of Technology, Real Estate, Construction, Operations, Malawian Situation.*

6.1.1. Introduction

The real estate industry plays a crucial role in the economic development of countries by providing essential infrastructure and contributing to employment and investment opportunities (Eriksson et al., 2017). In Malawi, as in many developing countries, real estate sector has been gaining momentum due to urbanisation, population growth, and increased foreign direct investment (Awonusi & Wasiu, 2020). The integration of technology in this

sector has the potential to enhance operational efficiency, reduce costs, and improve decision-making processes (Aytekin & Keskin Demirli, 2017). This study aimed at isolating construction and operations technologies that can be adopted in Malawian the real estate business to enhance its performance, sustainability, and competitiveness.

Malawi has been experiencing rapid urbanization and population growth in recent years. This has led to an increased demand for housing, commercial spaces, and infrastructure facilities (Awonusi & Wasiu, 2020). The real estate industry, traditionally reliant on manual processes, faces challenges in meeting these demands effectively. The construction and management of properties involve complex tasks that require accurate planning, efficient resource allocation, and effective communication among various stakeholders (Ajibade, 2018).

The integration of technology in the real estate sector has transformed various aspects of the industry globally (Khlifi & Bessadok, 2015; Yang, 2012). Construction technologies such as building information modelling, fabrication techniques and green building practices have been adopted to streamline construction processes, enhance collaboration among project teams and improve sustainability (Heimly et al., 2011; Taherdoost, 2020.). On the operations side, technologies like property management software, internet of Things devices for smart buildings, and data analytics have enabled efficient property management, cost optimization, and enhanced users' experiences (Vigren et al., 2022).

Numerous studies have highlighted the construction and operation technologies that can be adopted by real estate businesses (Barkham et al., 2018). On the technology adoption in emerging economies, casing real estate in sub-Saharan Africa, Sulaiman et al., (2020) explored the challenges and opportunities of adopting technology in the real estate sector in sub-Saharan African countries. While with specific to Malawi, it provides insights into the general trends and barriers related to technology adoption. In a similar context, Mohammed et al., (2021), assessed the adoption of automated valuation models in Malawi based on the values perceptions. The researcher used a descriptive study design with qualitative data collection and analysis methods. Respondents were asked how they perceived the automated valuation method approach to rating valuation compared to traditional valuation methods regarding its accuracy, reliability, and easiness. One school of thought gave the automated valuation method the benefit of doubt for future incorporation into the profession if modified to suit the local environment. On the other hand, automated valuation method was considered a threat to the valuation profession since anyone may be deemed qualified to carry out property valuation.

However, the values were of the perception that the models will never replace traditional valuation methods, hence suggestions to incorporate automated valuation methods a supplement to traditional valuation methods so that the former is used as a verification and auditing tool for the latter.

While technology adoption in the global real estate industry is well established, its specific implications and potential in the context of Malawi remain unclear. The unique social-economic and infrastructural conditions of the country may influence the feasibility and effectiveness of adopting various construction and operations technologies. Therefore, a comprehensive investigation into the technologies suitable for the Malawian real estate business was essential.

6.2. The aim

The main aim was to isolate construction and operations technologies that can be adopted in real estate business in Malawi.

6.3 Methodology

In showcasing the potential of optimizing technology in real estate business in Malawi, this study through the quantitative research design assessed the technology and performance of real estate business in Malawi. The respondents were drawn from four many cities of Malawi which are Blantyre, Lilongwe, Zomba and Mzuzu, between the month of February and March 2022. The technology and the performance of real estate business was considered. Construction professionals, and employees from different real estate firms and varied experience within a public or private construction organisation in Malawi were surveyed through a structured questionnaire designed based on the information gathered from the review of literature. Constructional professionals such as architects, construction managers, engineers, and quantity surveyors participated in the study. The selection of these set of respondents assumed that they form a Cole of the construction process. Understanding their views on technology and performance of real estate business in Malawi can help to promote real estate business of their routine activities which becomes important to the attainment of the objectives of this study. The choice of conducting the study in these sites is premised on the fact that they are the only cities in Malawi and have highest number of construction activities, real estate agents, organisations and professionals in the country. Since a considerable number of professionals were targeted, using questionnaire survey was deemed necessary because of its ability to cover

a wide range of participants within a short time (Donald & Schindler, 2014.). A closed-ended questionnaire designed in four sections was adopted (Appendix 1). The first section sought answers on some defined background information on the respondents. Information in this section served as a quality check for the answers given in the other sections. The second section focused on assertions of present chapter concerning the impact of technology on Malawi's real estate business in construction organizations. Other sections of the questionnaire (third to fifth) were designed to address objectives three to five respectively. The second section was equipped with sufficient questions for comprehensive data regarding technology and performance of real estate business in Malawi. A 5-point scale questionnaire was employed. A snowball approach was adopted in getting respondents for the study since it was difficult to get to the exact number of professionals with the set years of experience and practicing within the city from the onset of the research. It has been noted that since this approach has the potential to significantly increase the sample size of the study as it is based on referral. Based on the approach adopted, a total of a total of 90 respondents including professionals with varying work experience and currently practicing within the construction domain in the study area participated in the survey.

In data analysis, the first stage was to analyse the background information of the respondents and responses on level of agreement with each given statement using descriptive statistics such as bar graph, percentages and Likert chart. The distribution of the responses provided in the four cities were compared using Chi-squared test of goodness of fit. For all areas of interest, consistency of the responses for the statements was checked using the Cronbach alpha test. Values of the Cronbach alpha are between 0 and 1 (moser and Kalton, 1999). The values that are close to 1 indicate that the data is more reliable (moser and Kalton, 1999). Redundancy was checked among the statements using Bartletts test. Bartletts test of sphericity tests whether the variables in a data set are unrelated and therefore unsuitable for structure detection.

Thereafter, principal component analysis (PCA) reduces the dimensionality of the data by identifying the statements or variables that are composites on the observed statements/variables. The data with reduced dimensionality acts as a summary. With dimensionality reduced, computational burden and errors are reduced. PCA does not require prior knowledge on whether the variables/samples come from different groups Sasin Karamizadeh1, Shahidan 2013. When performing PCA, the dimension of data is reduced by geometrically projecting the data into lower dimensions called principal components (PCs). The aim is to use a limited number of PCs to summarize the data. The first PC is chosen to

minimize the total distance between data and their projection onto the PC Karamizadeh1, Shahidan 2013. By minimising the distance, the variance also of the projected points is also maximized. The second PC is selected in a similar manner, but it has to be uncorrelated with the first PC the majority of the variance is limited to the first few PCs, hence the all the PCs are not used. PCA helps in finding directions that are easy to interpret when looking at variation Mark Richardson 2009. The selection of the first few PCs to be used in summarizing the data was done using screen plot, eigenvalues and percentage of variation accou nted for. The data with reduced dimensionality is a product of the original data and the feature vector. In the new data set the variables are linear combinations of the original variables. Pairs of proportions were compared using the z-test with the assumptions that the samples are independent and np and np (1-p) are both greater than 5. Since the level of agreement with a given statement was on Likert scale, ordinal regression model was used when the dependent variable is ordinal to describe the relationship between levels of agreement with a statement on why real estate films are not interested in investing in modern technology Mark Richardson 2009.

6.4 Results and Discussions

6.4.1. Potential Construction and Operation Technologies in Real Estate Business in Malawi

Table 6.1: Pairwise comparisons of distributions of responses for cities on how Malawian real estate enterprises use technology to boost construction.

	Mzuzu	Lilongwe	Blantyre
Lilongwe	p = 1		
Blantyre	p = 1	p = 1	
Zomba	p = 1	p = 1	p= 1

In determining the construction and operations technologies that can be adopted in real estate business in Malawi, respondents were provided with 10 statements. The respondents were asked to rate the statements on a 5-point scale with 1being strongly disagree, 2 disagree, 3 moderates, 4 agree and 5 strongly agree. The first statement wanted to establish whether energy efficient alternatives are employed during construction. The result revealed that majority of the respondents (77%) agreed to the statement while 14% of the respondents disagreed to the

statement and the remaining percentage (10%) neither agreed nor disagreed. The second assertion was for the respondents to score on whether strong and durable raw materials achieved through Morden technology are used in most circumstances. From the scores, majority of the respondents (73%) agreed to the statement while 16% of the respondents could not agree or disagree to the assertion and 11% disagreed that strong and durable raw materials achieved through Morden technology are used in most circumstances. When the respondents were asked to assert if increasing efficiency in its construction activities, the firm incorporates technology such as on-site drones and building information modelling, 73% of the respondents agreed to the assertion while 11% and 16% of the respondents disagreed and had neutral stands respectively. Further, the participants were asked if prefabrication is used by the firm to increase production and lower expenses. The result revealed that most of the respondents (78%) agreed, while 12% indicated that they do not agree with the statement and the remaining percentage 10% neither agreed nor disagreed.

Another statement wanted to establish if constructors utilise creativity to create Morden and energy efficient structures. The result revealed that majority of the respondents (69%) agreed to the statement while 16% of the respondents had a neutral ground and the remaining percentage (15%) disagreed. Respondents were also asked to assert if the firms use superior construction technologies for improved quality and safety. About 62% of the respondents agreed while 21% and 17% of the respondents had a moderate answer to the statement and disagreed respectively. Another assertion was for the respondents to agree on whether virtual reality is used by the firm to allow potential consumers to experience the designs and spaciousness of dwelling units before the construction process begins. From the scores, majority of the respondents (66%) agreed to the statement while 19% of the respondents could not agree or disagree to the assertion and 15% of the respondents disagreed that they have adopted virtual reality technology. Furthermore, the respondents were asked if the firms create Morden, inexpensive housing that is both roomy and economical. The result revealed that most of the respondents (59%) agreed to the assertion while 23% of the responses showed moderate stand and 18% disagreed. The summary of the responses on how Malawian real estate enterprises use technology to boost construction is provided in Figure 6.1.

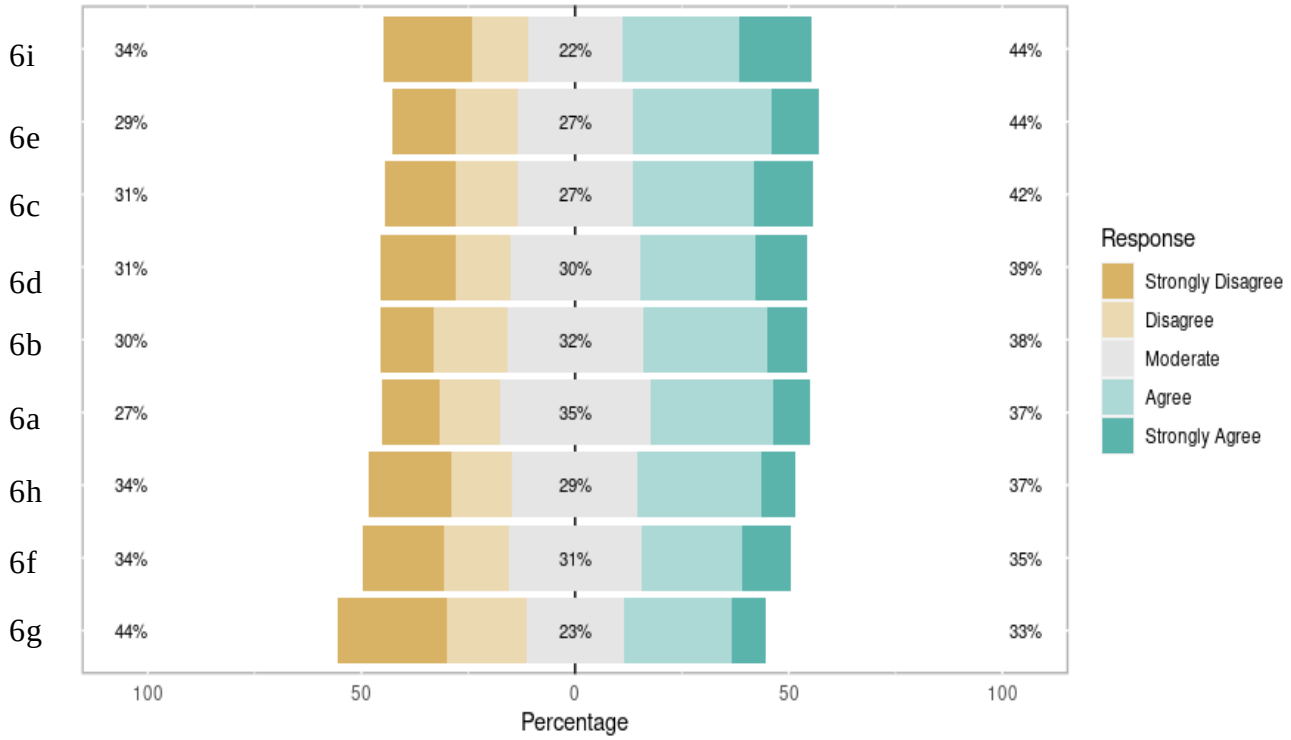

Fig 6.1: Summary of responses on how Malawian real estate enterprises use technology to boost construction.

Internal consistency among the statements on how Malawian real estate enterprises use technology to boost construction was high as observed using Cronbach's alpha which yielded a value of 0.882, and indication that the data gathered was reliable. Bartlett's test of sphericity with a p-value of 0 indicates redundancy among the statements. Kaiser-Meyer-Olkin yielded a value of 0.89 which indicates that the samples were adequate. The function princals, in R statistical package, was used to perform principle component analysis. Table 6.2 provides a summary on the principle components obtained. Internal consistency among the statements on why real estate firms are not interested in investing in modern technology was checked using Cronbach's alpha which yielded a value of 0.888. Bartlett's test of sphericity yielded a p-value of 0, indicating redundancy among the statements. The value 0.91 was obtained for Kaiser-Meyer-Olkin, which indicates that the samples were adequate. PCA was performed using the function princals, in R statistical package. Table 6.2 provides a summary on the principal components obtained.

Table 6.2: Principle components and their respective variances accounted for on how Malawian real estate enterprises use technology to boost construction.

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9
Eigenvalues	4.16	1.18	0.73	0.65	0.59	0.53	0.45	0.39	0.32
Variance	46.26	13.12	8.08	7.23	6.61	5.85	4.95	4.33	3.57
Cumulative Variance	46.26	59.38	67.46	74.69	81.30	87.15	92.10	96.43	100.00

The first three principal components have their eigenvalues close to or above 1, and their cumulative variance explained is about 67%. The scree plot in Figure 6.2 has an elbow at PC3. The first three PCs were considered. The factor analysis was conducted using principal component analysis with varimax rotation. A total of 3 extractions with eigenvalue of 1 and above were generated. The percentage of each of the components extracted includes 46% for component 1, 13% for component 2 and 8% for component 3. The final statistics of the PCA and the components extracted accounted for 67% of the total cumulative variance, which is well above 50% limit stated by Stern (2010). Pallant (2005) suggested to look at the scree plot in order to determine which component or factor to retain. In doing this, an elbow in the shape of the plot is identified, and only components above this point are retained. The scree plot in Figure 6.2 has an elbow at PC3. The first three PCs were considered. From Figure 6.2 change can be observed from the third component, confirming the retaining of the three extracted components. The three components and their variables are indicated in Table 6.2.

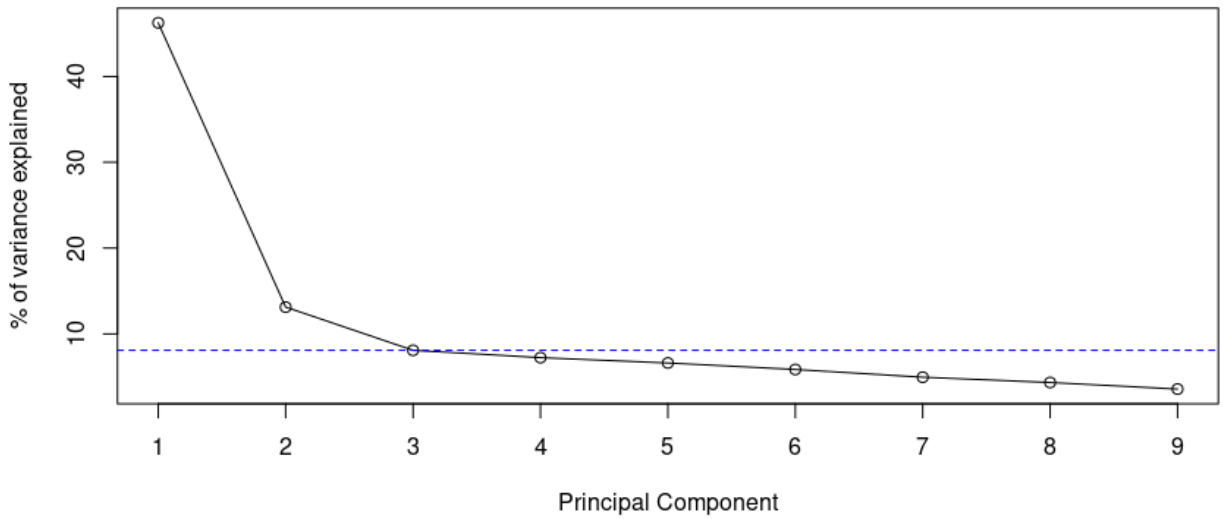

Fig 6.2: Scree plot of the principle components on how Malawian real estate enterprises use technology to boost construction.

Table 6.3: Loadings of the statements on how Malawian real estate enterprises use technology to boost construction. A cut-off of 0.5 was used.

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9
6c	-0.731								
6e	-0.758								
6f	-0.799								
6g	-0.579				-0.510				
6h	-0.759								
6i	-0.769								
6a	-0.526	0.538							
6b		0.768							
6d	-0.548		-0.614						

From Table 6.2, statement 6a had high loadings into multiple PCs (PC1 and PC2) and the statement was removed. The statements 6c, 6e, 6f, 6g and 6i highly loaded into PC1.

Statements 6b highly loaded into PC2 and statement 6d highly loaded into PC3. In the process of dimension reduction, the following variables were created on how Malawian real estate enterprises use technology to boost construction. The first extracted component accounted for 46% of the variance explained with five variables loading heavily on it. These variables are the abilities of the firms to incorporates technology such as onsite drones and building information modeling thereby increasing efficiency in its construction activities, constructors utilizing creativity to create modern and energy-efficient structures, usage of superior construction technologies for improved quality and safety by the firms, virtual reality being used by the firm to allow potential consumers to experience the designs and spaciousness of dwelling units before the construction process begins and the ability of the firms to use real time technology to exhibit and report on the status of properties under construction as well as completed units. Considering the similarity of these variables, this component was named "***integrated construction technology solutions".*** This name encompasses the various ways in which technology is employed with Malawian real estate enterprises to enhance construction processes, improve quality and provide better experiences for both constructors and potential consumers.

The second extracted component accounted for 13% of the variance explained with one variable loading heavily on it. The variable being, strong and durable raw materials achieved through modern technology are used in most circumstances, and this component was named "***Advanced construction material utilisation***." The final extracted component accounted for 8% of the variance explained with one variable loading heavily on it. The variable concerns prefabrication by the firms to increase production and lower expenses and this component was named "***Prefabrication efficiency***".

For the variables 6S1, 6S2 and 6S3 the Cronbach's alpha is 0.72 and the Kaiser-Meyer-Olkin measure of sampling adequacy is 0.64. Pairwise comparisons of the distributions of the responses for the created statements 6S1, 6S2 and 5S3 in the four cities were performed using the Chi-squared test of goodness of fit. Figure 6.3 provides the summary of the responses with regards to the statements 6S1, 6S2 and 6S3.

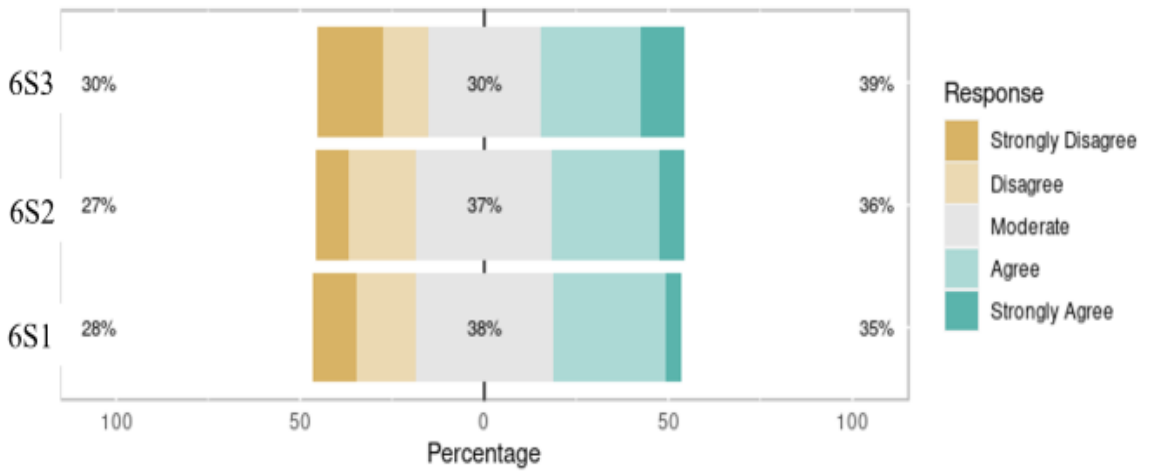

Fig. 6.3: Responses on how Malawian real estate enterprises use technology to boost construction for the created statements.

For statements 6S2 and 6S3 the comparison of the proportions of those that agreed or strongly agreed with the statement, and those that disagreed or strongly disagreed with the statement yielded ($p < 0.05$, z-test). The difference between the two proportions for each statement is significant. For the statement 6S1 ($p > 0.05$, z-test), an indication that there is no significant difference between the proportions of those that agreed or strongly agreed with the statement, and those that disagreed or strongly disagreed with the statement.

6.5. Discussions

PCA results regarding how Malawian real estate enterprises use technology to boost construction revealed several key factors that contribute to industries adoption of technology. Some of these organisations have engaged in the use of modern technology. In terms of how Malawian real estate enterprises use technology to boost construction, the findings revealed the existence of integrated construction technology solutions in Malawian construction sector. The integrated construction technology solutions are manifested through virtual reality and customer engagement, real time technology for monitoring, superior construction technologies, creativity and energy-efficiency as well as efficiency through technology integration. The virtual reality is being used to allow potential consumers to experience designs and spaciousness before construction begins. This aligns with a growing trend in real estate marketing where VR is used to enhance customer engagement and decision-making. Research by Warburton, (2016) highlights the effectiveness of VR in the real estate industry for improving customer satisfaction and decision making. On the superior construction technologies, to improve quality and safety, the finding is consistent with studies on the global

construction industry, where the adoption of advanced construction technologies has been linked to better quality and safety outcomes (ScholarWorks & Timothy Anene, 2021.). A study by Siniak et al., (2020) established that drones can enhance project monitoring, reduce costs and increase safety. The findings of this study indicate that Malawian real estate firms are using technology like onsite drones and building information modelling to increase efficiency in their construction activities. This aligns with a global trend where technology integration in construction has been shown to improve project efficiency.

The results of this study support the notion that Malawian real estate enterprises are leveraging technology to improve various aspects of construction. These findings are consistent with global trends in the construction and real estate industries, where technology plays a pivotal role in enhancing efficiency, creativity, quality, safety, customer engagement and real-time monitoring. By adopting these technological advancements, Malawian firms are likely to stay competitive and meet the evolving demands of the market.

In the same vein, the study revealed the utilisation of a advanced construction material by some of the real estate organisations in Malawian. The use of advanced construction materials such as high-strength concrete, steel alloys and composite materials ensures that buildings are more resilient to wear and tear, environmental factors and time (Siniak et al., 2020b). This translates to longer life spans for structures, reducing maintenance costs and enhancing overall value (Aghimien et al., 2022; Pankratov et al., 2020). The adoption of advanced construction materials and technology in Malawian real estate businesses is promising trend that aligns with global construction industry advancements Ullah & Sepasgozar, 2019b). It does not only enhance the quality and durability of structures but also promotes sustainability, energy efficiency and long-term cost savings, contributing to the growth and competitiveness of real estate sector in Malawi. Prefabrication efficiency improve production and lower expenses in Malawi. Prefabrication techniques lower expenses, streamline construction, improve productivity and reduce overall construction costs. Manufacturing building elements in bulk and under controlled conditions, real estate firms can benefit from economies of scale (Sun, 2019). Such strategy reduces costs compared to traditional on-site construction. Prefabrication efficiency is acritical variable in Malawian real estate businesses effort to leverage technology construction. Further prefabrication accelerates production, lowers cost of production, improve quality and optimises labour. By adopting prefabrication techniques, these businesses can enhance their competitiveness, deliver projects more efficiently and contribute to the growth and sustainability of the construction sector in Malawi.

6.6. Conclusions and Recommendations

This study focussed on application of technology in boosting construction within Malawian real estate industry. Through quantitative approach and application of the PCA three key components emerged, integrated construction technology solutions, advanced construction material utilisation and prefabrication efficiency. These themes provide valuable insights into the current state of technology adoption in the Malawian real estate sector and offer a roadmap for future improvements.

6.6.1 Conclusion

Integrated construction technology solutions underscore the importance of adopting a holistic approach to technology in the real estate industry. This component highlights the need for real estate enterprises in Malawi to invest in comprehensive technology solutions that streamline various aspects of construction projects. Such integrated solutions encompass everything form project planning and design to construct management and maintenance. Malawian real estate industry has seen some progress in the adoption of integrated technology solutions. However, there is room for improvement. This study indicates that some enterprises are still operating with fragmented systems, resulting in inefficiencies and communication gaps. To address this issue, it is recommended that real estate companies in Malawi invest in fully integrated construction management software. These software platforms can facilitate seamless collaboration among project coordination. Further, prefabrication efficiency highlights the potential of off-site construction methods to improve efficiency and quality in the real estate sector. Prefabrication involves manufacturing building components in a controlled environment before assembling then on-site. This approach results to reduced construction time, cost savings and construction quality. Malawian real estate enterprises should be explored the possibilities of prefabrication, especially for larger and more complex projects. However, for this to be successful, there is a need for investment in prefabrication facilities and training for local construction workers. Government support in the form of incentives and regulations that promote the use of prefabricated components can also play a crucial role in encouraging adoption.

The optimisation of technology in the Malawian real estate business is a critical step towards achieving sustainable and efficient construction practices, by adopting integrated technology solutions, advanced construction materials and prefabrication efficiency, reduce costs and contribute to the country's economic development. It is imperative for stakeholders, including

the government, industry players and educational institutions to collaborate and take proactive steps to implement recommendations for maximum benefits by all stakeholders.

6.6.2. Recommendations

Real estate companies in Malawi should prioritise the adoption of integrated construction technology solutions. This includes investing in comprehensive construction management software and promoting the use of building information modelling technology. It is also recommended that government should enact regulations that encourage the adoption of technology, the use of sustainable materials and the implementation of prefabrication methods. Incentives such as tax breaks and subsidies can further promote these practices. The study further recommends that there is need for a collaboration between government, academia and private sector is essential to drive innovation and best practices in the Malawian real estate industries. Partnership and knowledge sharing can accelerate technology adoption and sustainable construction practices.

CHAPTER SEVEN

7.1. PERCEIVED RISKS IN USING TECHNOLOGY IN MALAWI REAL ESTATE INDUSTRY

Abstract

The real estate sector in Malawi, like many others globally, stands on the precipice of technological transformation. This study delved into the intriguing question of why real estate firms in Malawi have restrained in embracing modern technology. Through a quantitative approach, the study unearthed a multifaceted web of challenges that have blocked the integration of advanced technology in this crucial industry. In data analysis, the distribution of the responses provided in the four cities were compared using Chi-squared test of goodness of fit. Principal Component Analysis (PCA) was used to reduce the dimensionality of the data by identifying the statements or variables that were composites on the observed variables. The data with reduced dimensionality acted as a summary. The study revealed several impediments to the adoption of modern technology in Malawi's real estate sector. Foremost among these hurdles are the issues of high cost resource constraints, operational challenges, regulatory and approval issues with the Malawian real estate sector deters firms from embracing technological innovations. The study underscores the complex interplay of factors hindering the adoption of modern technology in in real estate businesses Malawi. Addressing these challenges will require a multi-prolonged approach including incentivizing cost-effective technological solutions, providing knowledge and material support, offering financial solutions for sustainable practices and streamlining regulatory processes. Only through concerted efforts to overcome these barriers can Malawi's real estate sector realise its full potential in the digital age and contribute significantly to the nation's social economic development.

Keywords: *Perceived risks, Technology Transformation, Real Estate, Challenges, Malawi.*

7.1.2 Introduction

The integration of new technology in housing construction and real estate operation has been an ongoing process driven by advancements in various fields such as materials science, construction techniques, automation and information technology (Lynn et al., 2011; Warburton, 2016b). The introduction of new technology has the potential to revolutionize the way buildings are constructed, managed and operated, leading to improved efficiency, sustainability and cost effectiveness (Kang' & Kamau, 2019). Howerver, adoption of new technology also involves various risks and challenges that may hinder its implementation and

performance. Therefore, it is important to assess the extent of perceived risks in using new technology in housing and real estate operation and to identify the factors that influence the risk perception of different stakeholders. Over the past decade, researchers around the world have shown a growing interest in understanding the extent of perceived risks in using new technology in the context of housing construction and real estate operation. There interests stem from the recognition that technology adoption is not solely a matter of technical feasibility, but is heavily influenced by human perceptions, altitudes and beliefs (Lai, 2017).

Different studies have explored the types and resources of risks associated with new technology in housing construction and real estate operation such as technical, financial, legal, organisational, social, environment and ethical risks (Sun, 2019). Some of the common risk factors include lack of knowledge and skills, high initial costs, uncertain returns, regulatory barriers, contractual disputes, resistance to change, user dissatisfaction, negative impacts on health and safety and ethical dilemmas (Azaliah et al., 2020; Pankratov et al., 2020). However, the perception of risk may vary depending on the characteristics of the technology, the project and the stakeholder (Mohammed et al., 2021). For example, studies indicate that perceived risk of new technology are influenced by the level of innovation, complexity, novelty and uncertainty of the technology (Kytömäki, 2020). Moreover, the perceived risks may also depend on the type, size, scope, duration and location of the project. Further, different stakeholders may have different perceptions of the risks based on their roles, interests, expectations, performances, altitudes, beliefs, values and experiences Prof Greg Clark.

Numerous studies have explored the perceived risks associated with new technology adoption in the construction and real estate sectors. For instance, Lizam & Diah (2019) conducted a comprehensive survey of construction professionals to identify the perceived risks of using building information modelling (BIM) technology. The study found that the concerns related to data security, interoperability and the learning curve were significant factors affecting the adoption of BIM. In the real estate sector, research by Li et al. (2029) examined the perceived risks of using online platforms for property transactions. The study highlighted concerns about privacy, data accuracy and the potential to fraud as major barriers to the widespread adoption of online real estate platforms. Similarly, a study by Mohammed et al. (2021) investigated the potential of information, perceived risks and communication technologies in real estate management and valuation practices. The researchers found that uncertainties about the long-

term performance of these technologies, coupled with initial cost considerations, were key factors influencing decision-making among construction stakeholders.

Despite the potential benefits of new technology in housing construction and real estate operation, there is lack of empirical evidence in Malawi on how different stake holders perceive the risks associated with new technology. This gap hampers the development and implementation of effective risk management strategies for new technology projects. The integration of new technology in housing construction and real estate operations holds immerse potential for transformative change. However, alongside the benefits, stakeholders perceive various risks that may hinder the widespread adoption of these innovations. The empirical evidence underscores the multifaceted nature of perceived risks, encompassing technical, financial, organisational, regulatory and market related concerns. By zooming into perceived risks, the present study seeks to contribute to a more understanding of the complex dynamics surrounding technology adoption. The main aim was to assess the extent of perceived risks in using new technology in housing construction and real estate operations in Malawi.

7.2 Methodology

In showcasing the potential of optimizing technology in real estate business in Malawi, this study through a quantitative reseach design assessed the extent of perceived risks in using new technology in housing construction and real estate operations in Malawi. The ministry of lands, Malawi housing corporation, real estate companies and films with at least five years' experience and property owners in the cities of Blantyre, Lilongwe, Mzuzu and Zomba were surveyed through a structured questionnaire designed based on the information gathered from a review of literature. Employees and management stuff of all the targeted institutions participated in the survey. The selection of the set of respondents assumed that they form a core of the real estate industry in Malawi. The choice of conducting a research in Blantyre, Lilongwe, Mzuzu and Zomba city was premised on the fact that these are the major cities in Malawi with a lot of private companies and government institutions all indulging in real estate business. Since a considerable number of companies were targeted, using a questionnaire was deemed necessary because of its ability to cover a wider range of participants within a short time frame. A closed-ended questionnaire designed in four section was adopted. The first section sought answers on some defined define background of the respondents. Information in this section served as a quality check for answers given in the other sections. The second sought answers to technology and performance of real estate business in Malawi. The second section

was the answers on the real estate business and use of technology in construction. Finally, the questionnaire was designed to obtain answers for the extent of perceived risks in using new technology in housing construction and management in real estate business. A 5-point scale was employed for the second, third and fourth sections of the questionnaire. A snowball approach was adopted to in getting respondents for the study since it was difficult to get the exact number of professionals with the set years of experience and practicing within the cities from the onset of the research. It has been that this approach has the prospective of significantly increase the sample size of the study since is based on the referral. Based on the approach adopted, a total of 90 participants from all the four selected cities participated in the study.

In data analysis, the first stage was to analyse the background information of the respondents and responses on level of agreement with each given statement using descriptive statistics such as bar graph, percentages and Likert chart. The distribution of the responses provided in the four cities were compared using Chi-squared test of goodness of fit. For all areas of interest, consistency of the responses for the statements was checked using the Cronbach alpha test. Values of the Cronbach alpha are between 0 and 1 (Moser and Kalton, 1999). The values that are close to 1 indicate that the data is more reliable (moser and Kalton, 1999). Redundancy was checked among the statements using Bartletts test. Bartletts test of sphericity tests whether the variables in a data set are unrelated and therefore unsuitable for structure detection. Thereafter, principal component analysis (PCA) reduces the dimensionality of the data by identifying the statements or variables that are composites on the observed statements/variables. The data with reduced dimensionality acts as a summary. With dimensionality reduced, computational burden and errors are reduced. PCA does not require prior knowledge on whether the variables/samples come from different groups. When performing PCA, the dimension of data is reduced by geometrically projecting the data into lower dimensions called principal components (PCs). The aim is to use a limited number of PCs to summarize the data. The first PC is chosen to minimised the total distance between data and their projection onto the PC. By minimising the distance, the variance also of the projected points is also maximized. The second PC is selected in a similar manner, but it has to be uncorrelated with the first PC the majority of the variance is limited to the first few PCs, hence the all the PCs are not used. PCA helps in finding directions that are easy to interpret when looking at variation.

The selection of the first few PCs to be used in summarizing the data was done using screen plot, eigenvalues and percentage of variation accounted for. The data with reduced

dimensionality is a product of the original data and the feature vector. In the new data set the variables are linear combinations of the original variables. Pairs of proportions were compared using the z-test with the assumptions that the samples are independent and np and np(1-p) are both greater than 5. Since the level of agreement with a given statement was on Likert scale, ordinal regression model was used when the dependent variable is ordinal to describe the relationship between levels of agreement with a statement on why real estate films are not interested in investing in modern technology.

7.3. Results and Discussions

7.3.1. Reasons for Low Uptake of Modern Technology in Malawi's Construction Industry.

The pairwise comparisons of the distributions of the responses on the statements on why real estate firms are not interested in using modern technology construction of houses shows that there were no significant differences in terms of responses of the respondents from all the cities of Malawi since the alpha level was found to be equal to 1, as provided in Table 7.1.

Table 7.1: Pairwise comparisons of distributions of responses for cities on why estate firms are not interested in using modern technology in construction of houses.

	Mzuzu	Lilongwe	Blantyre
Lilongwe	p = 1		
Blantyre	p = 1	p = 1	
Zomba	p = 1	p = 1	p = 1

In determining why real estate firms are not interested in investing in modern technology, respondents were provided with 10 possible assertions identified from the literature. The respondents were asked to rate the impacts on a 5-point scale with 1being strongly disagree, 2 disagree, 3 moderates, 4 agree and 5 strongly agree. The frequency of their perspective of those working within public and private organisations is presented in the figure 7.2. The first statement wanted to establish very high initial cost is required during construction. The result revealed that majority of the respondents (77%) agreed to the statement while 14% of the respondents disagreed to the statement and 10% neither agreed nor disagreed. The second assertion was for the respondents to score on whether most Morden construction plants and equipment requires a high energy source. From the scores, majority of the respondents (73%) agreed to the statement while 19% could not agree or disagree to the assertion and 11% of the

respondents disagreed that most Morden construction plants and equipment requires a high energy source. When the respondents were asked to assert if most Morden technologies require a stable energy supply, 73% of the respondents agreed to the assertion while 11% and 16% of the respondents disagreed and had neutral stands respectively. Further, the participants were asked if Morden technology needs highly trained and skilled personnel to operate construction equipment's. The result revealed that most of the respondents (78%) agreed, while 12% indicated that they do not agree with the statement and 10% of the respondents showed no stand on the assertion.

Another statement wanted to establish if maintenance of equipment is a challenge. The result revealed that majority of the respondents (69%) agreed to the statement while 19% of the respondents had a neutral ground and the remaining percentage (15%) disagreed. Respondents were also asked to assert if scarcity of raw materials for construction of modern houses in one of the hindering factors to adopt modern technology in house construction. About (62%) of the respondents agreed while 16% and 15% of the respondents had a moderate answer to the statement and disagreed respectively. Another assertion was for the respondents to agree on whether maintenance of houses is a challenge in terms of availability and cost of raw materials. From the scores, majority of the respondents (66%) agreed to the statement while 15% of the respondents could not agree or disagree to the assertion and 19% of the respondents disagreed that maintenance of houses as a challenge. Finally, the respondents were asked if there is limited support from academic and research institutions. The result revealed that most of the respondents (59%) agreed to the assertion while 23% of the responses showed moderate stand and 18% disagreed.

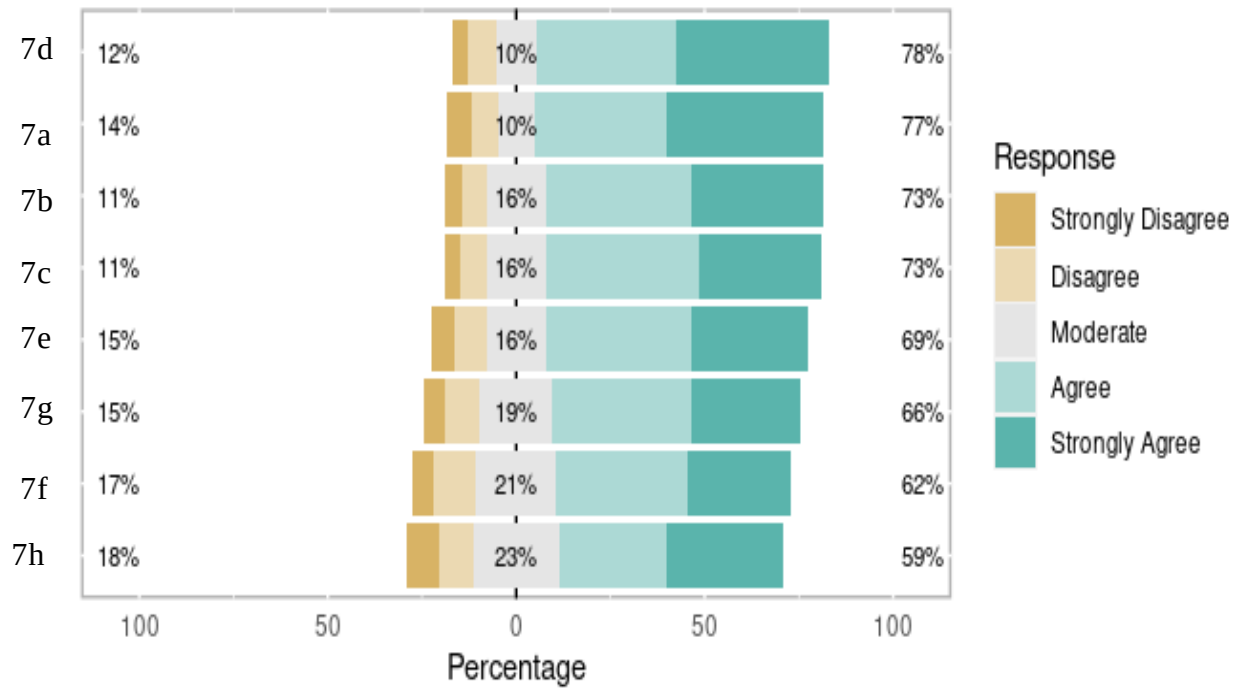

Figure 7.1: Responses on why real estate firms are not interested in investing in modern technology

Internal consistency among the statements on how Malawian real estate enterprises use technology in construction of houses was high as observed using Cronbach's alpha which yielded a value of 0.882, and indication that the data gathered was reliable. Bartlett's test of sphericity with a $p = 0$ indicates redundancy among the statements. Kaiser-Meyer-Olkin yielded a value of 0.89 which indicates that the samples were adequate. The function princals, in R statistical package, was used to perform principle component analysis. Table 7.2 provides a summary on the principle components obtained.

The internal consistency among the statements on why real estate firms are not interested in investing in modern technology was checked using Cronbach's alpha which yielded a value of 0.888. Bartlett's test of sphericity yielded a p-value of 0, indicating redundancy among the statements. The value 0.91 was obtained for Kaiser-Meyer-Olkin, which indicates that the samples were adequate. PCA was performed using the function principals, in R statistical package. Table 7.2 provides a summary on the principal components obtained.

Table 7.2: Principal components and their respective variances accounted for on why real estate firms are not interested in investing in modern technology in construction of houses.

Principal Component	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
Eigenvalues	4.055	0.83	0.80	0.59	0.49	0.48	0.42	0.33
Variance	50.69	10.38	10.03	7.41	6.16	5.97	5.29	4.08
Cumulative variance	50.69	61.07	71.10	78.51	84.66	90.63	95.92	100.00

From the table above, the first two principal components have their eigenvalues close to or above 1, and their cumulative variance explained is 61%. We considered the first two PCs was considered as also observed in the scree plot (Figure 7.2).

The factor analysis was conducted using principal component analysis with varimax rotation. A total of 2 extractions with eigenvalue of 1 and above were generated. The percentage of each of the components extracted includes 50% for component 1 and 10% for component 3. The final statistics of the PCA and the components extracted accounted for 61% of the total cumulative variance, which is well above 50% limit stated by Stern (2010). Pallant (2005) suggested to look at the scree plot in order to determine which component or factor to retain. In doing this, an elbow in the shape of the plot is identified, and only components above this point are retained. The scree plot in figure 7.2 has an elbow at PC2. The first two PCs were considered. Looking at figure 7.2, change can be observed from the second component, confirming the retaining of the two extracted components. The two components and their variables are shown in table 7.2 below with reference to the questionnaire provided in the appendix.

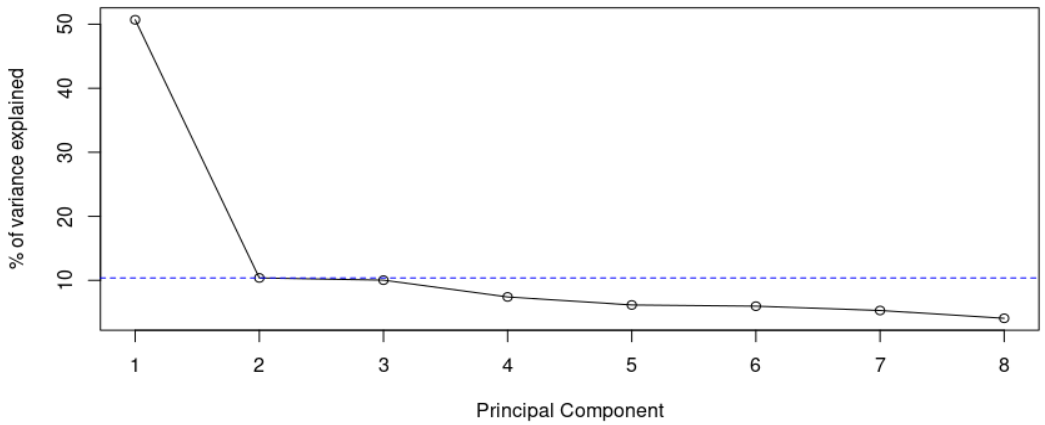

Fig 7.2 Scree plot of the principle components on why real estate firms in Malawi are not interested in investing in modern technology in construction of houses.

Table 9.2: Loadings of the statements on why real estate firms are not interested in investing in modern technology. A cut-off of 0.5 was used.

PC	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8
7a	0.724							
7b	0.866							
7c	0.695							
7d	0.855							
7e	0.599	0.520						
7f		0.624						
7h		0.632	0.502					
7g	0.562					0.594		

From Table 7.2, statement 7g had high loadings into multiple PCs and the statement was removed. The statements 7a, 7b, 7c, 7d and 7e highly loaded into PC1. Statements 7f and 7h highly loaded into PC2. In the process of dimension reduction, the following variables were created on why real estate firms are not interested in investing in modern technology. The first extracted component accounted for 50% of the variance explained with 5 variables loading

heavily on it. There variables are the requirements of very high initial cost, most modern construction plants and equipment requires a high energy source, modern technologies require a stable energy supply, modern technologies need highly trained and skilled personnel to operate construction equipment and challenges in the maintenance of equipment. Considering the similarity of these variables, this component was named "***High production cost".***

The second extracted factor accounted for 10% of the variance explained and has 2 variables loading on it. These variables are scarcity of raw materials for construction of modern houses and limited support from academic and research institutions. This component was subsequently named "***Insufficient knowledge and material support"***

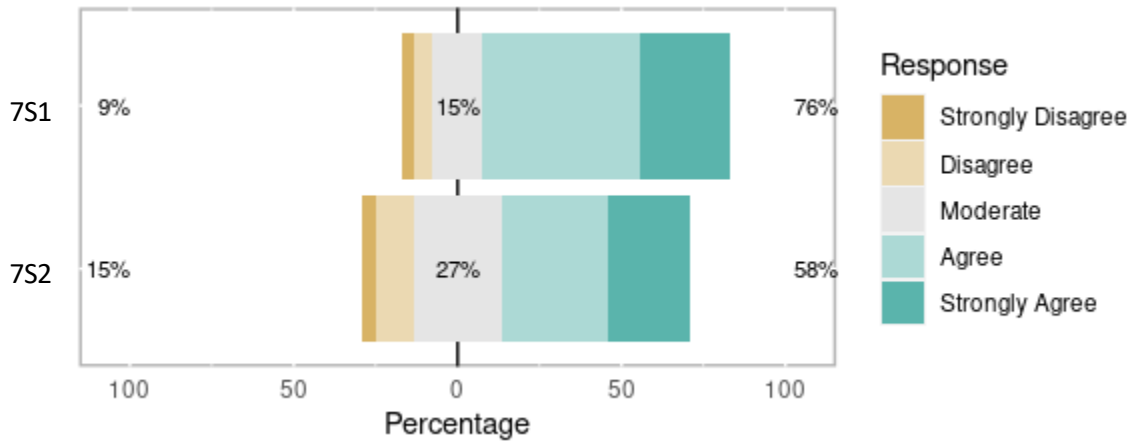

Fig 7.3: Responses on why real estate firms are not interested in investing in modern technology for the created statements

For each the comparison of the proportions of those that agreed or strongly agreed with the statement, and those that disagreed or strongly disagreed with the statement yielded p = 0 (z-test). The difference between the two proportions for each statement is significant. An ordinal regression model was used to determine the association between the dependent variable level of agreement, and statement on why real estate firms are not interested in investing in modern technology and city which were independent variables. Logit I (P= B0+B1Statement+B2 City. B0, B1 and B2 are the coefficients; level of agreement is the dependent variable and it takes the values strongly disagree, disagree, moderate, agree and strongly agree; Statement is an independent variable and it takes the values 7S1 and 7S2; and city is another independent variable which takes the values Mzuzu, Lilongwe, Blantyre and Zomba. Results are in Table 7.4.

Table 7.4: Results of regressing level of agreement on statement and city using ordinal regression model.

		95% Confidence Interval
Statement:	9S2	[-0.7708549, -0.2200469]
City:	Lilongwe	[0.1059742, 0.9113128]
	Blantyre	[-0.4591750, 0.2629338]
	Zomba	[-0.5035554, 0.2661072]
p = 0.0		

Holding the variable City constant, the levels of agreement with statements 7S1 and 7S2 are significantly different ($\alpha = 5\%$). The probability of agreeing with statement 7S1 is higher than that of statement 7S2, as summarized in Figure 7.4 in terms of odds.

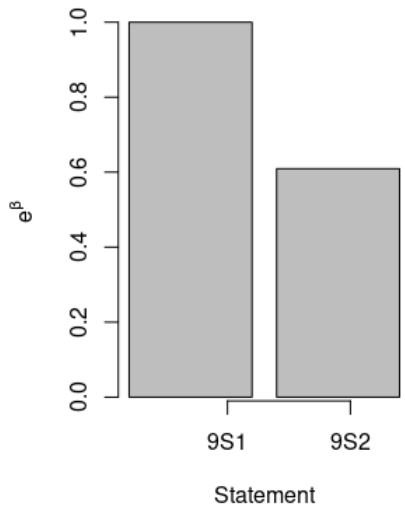

Fig 7.4: Comparison of the odds of the statements 7S1 and 7S2.

Holding the variable Statement constant, levels of agreement with a given statement on why real estate firms are not interested in investing in modern technology for the cities Blantyre and Zomba are not significantly different from that of Mzuzu ($\alpha = 5\%$). The level of agreement for Lilongwe is significantly different to that of Mzuzu ($\alpha = 5\%$). The probability of agreeing with

a statement on why real estate firms are not interested in investing in modern technology is significantly higher compared for Lilongwe to the other cities (alpha = 5%). A summary containing the odds-on agreement with a given statement on why real estate firms are not interested in investing in modern technology are provided in Figure 7.5.

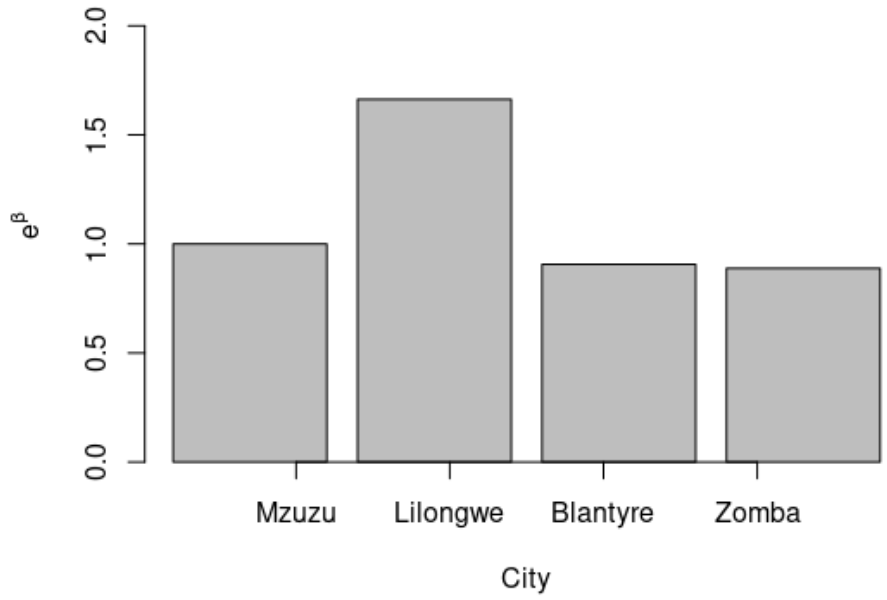

Fig 7.5: Comparisons of the odds of agreeing with a given statement in the four cities.

The independent variables explain only 1.26% of the variation in the dependent variable. The model is useful in describing how the selected dependent variable and independent variables relate. Due to the low percentage of variation explained, the model may not be used in predicting.

7.3.2. Low Uptake of Modern Technology in Management of Real Estate Business

The pairwise comparisons of the distributions of the responses on the statements on why real estate firms are not interested in using modern technology in management of real estate business shows that there were no significant differences in terms of responses of the respondents from all the cities of Malawi since the alpha level was found to be equal to 1, as provided in Table 7.5.

Table 7.5: Pairwise comparisons of distributions of responses for cities on why estate firms are not interested in using modern technology in management of real estate business

	Mzuzu	Lilongwe	Blantyre
Lilongwe	p = 1		
Blantyre	p = 1	p = 1	
Zomba	p = 1	p = 1	p = 1

In determining why real estate firms are not interested in investing in modern technology in Malawi, respondents were provided with 14 statements. The respondents were asked to rate the statements on a 5-point scale with 1 being strongly disagree, 2 disagree, 3 moderates, 4 agree and 5 strongly agree. The frequency of their perspective of those working within public and private organisations is presented in the figure 7.6. The first statement wanted to establish very high initial cost is required during construction. The result revealed that majority of the respondents (72%) agreed to the statement while 15% of the respondents disagreed to the statement and 13% neither agreed nor disagreed. The second assertion was for the respondents to score on internet is slow for an active website. From the scores, majority of the respondents (67%) agreed to the statement while 18% could not agree or disagree to the assertion and 14% disagreed that internet is slow for an active website. When the respondents were asked to assert if the internet is very expensive for showcasing real-time promotions, 68% of the respondents agreed to the assertion while 17% and 14% of the respondents disagreed and had neutral stands, respectively. Further, the participants were asked if monitoring gadgets including CCTVs and accessories are expensive. The result revealed that most of the respondents (75%) agreed, while 17% showed no stand on the assertion and only 8% indicated that they do not agree with the statement.

Another statement wanted to establish if management of monitoring gadgets could be expensive. The result revealed that majority of the respondents (70%) agreed to the statement while 18% of the respondents had a neutral ground and the remaining percentage (12%) disagreed. Respondents were also asked to assert if maintenance and updating websites could be time consuming and expensive. About (66%) of the respondents agreed while 19% and 15% of the respondents had a moderate answer to the statement and disagreed, respectively. Another assertion was for the respondents to agree on whether there are limited skills of developing attractive websites. From the scores, majority of the respondents (64%) agreed to the statement

while 20% of the respondents could not agree or disagree to the assertion and 16% of the respondents disagreed to the assertions. Furthermore, the respondents were asked if there are poor services from internet providers. The result revealed that most of the respondents (66%) agreed to the assertion while 28% of the responses showed moderate stand and 17% disagreed.

Another statement wanted to establish if regulators in the country do not approve modem technology applications in real estate business. The result revealed that majority of the respondents (52%) agreed to the statement while 26% of the respondents disagreed to the statement and the remaining percentage (22%) neither agreed nor disagreed. Finally, the respondents were asked to respond on the assertion if there are limited or inactive regulations supporting modern technology application in the real estate business in Malawi. Majority of the respondents (62%) agreed while 21% showed a neutral stand to the assertion in which nobody agreed or disagreed, however, 17% disagreed to the statement. The percentage of the responses are summarised in the Figure 7.6.

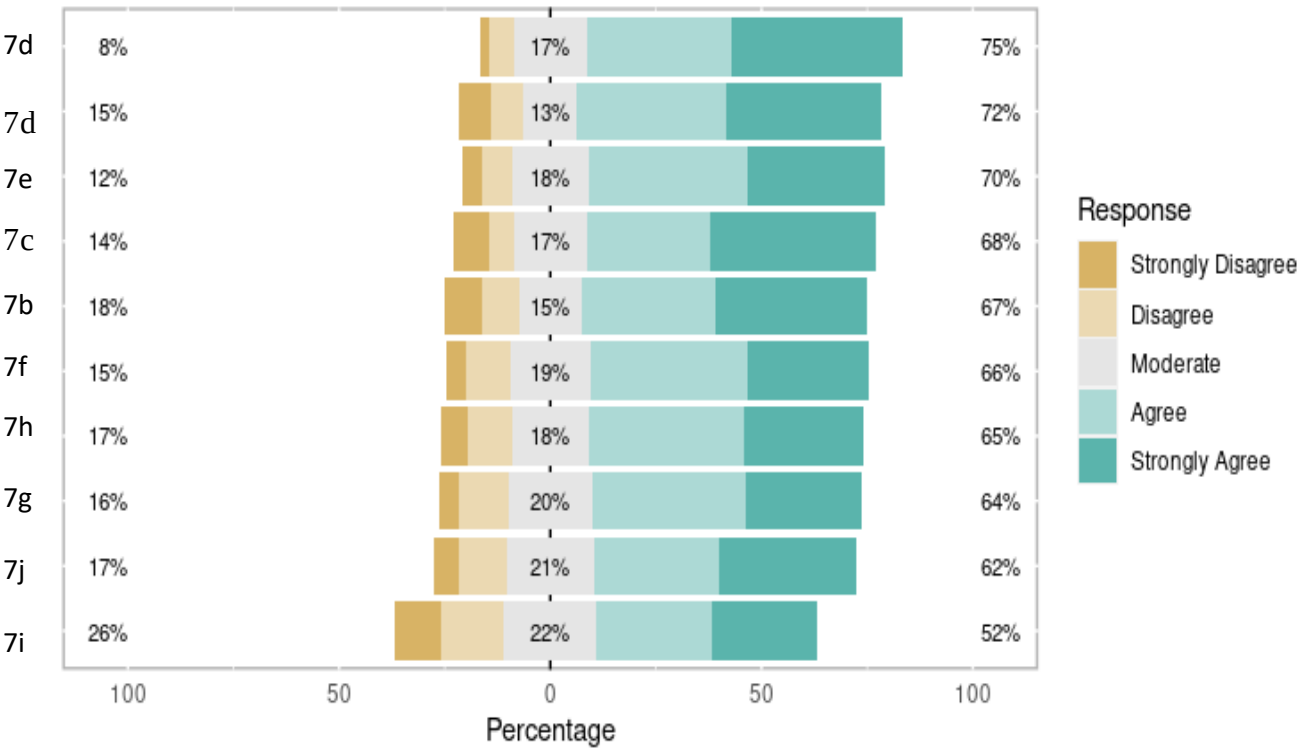

Fig 7.6: Responses on why real estate firms are not interested in using modern technology in management of real estate business.

Internal consistency among the statements on why real estate firms are not interested in using modern technology in management of real estate business was checked using Cronbach's alpha

which yielded a value of 0.88. Bartlett's test of sphericity yielded a p-value of 0, indicating redundancy among the statements. Kaiser-Meyer-Olkin yielded a value of 0.89, an indication that the samples were adequate. Table 7.6 is a summary resulting from performing principle component analysis using the function princals available in R statistical package. Table 7.6: Principle components and their respective variances accounted for on why real estate firms are not interested in using modern technology in management of real estate business.

	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13
Eigenvalues	4.45	1.14	0.87	0.66	0.62	0.56	0.51	0.47	0.37	0.34
Variance	44.51	11.41	8.67	6.59	6.25	5.63	5.09	4.73	3.74	3.38
Cumulative Variance	44.51	55.93	64.60	71.19	77.43	83.06	88.15	92.88	96.62	100.00

From the table above, the first four principal components have their eigenvalues close to or above 1, and their cumulative variance explained is 71%. The scree plot in Figure 7.7 has the second elbow at PC4. The first four PCs were considered.

The factor analysis was conducted using principal component analysis with varimax rotation. A total of four extractions with eigenvalue of 1 and above were generated. The percentage of each of the components extracted includes 44% for component 1, 11% for component 2, 8% for component 3 and 6% for component 4. The final statistics of the PCA and the components extracted accounted for 71% of the total cumulative variance, which is well above 50% limit stated by Stern (2010). Pallant (2005) suggested to look at the scree plot in order to determine which component or factor to retain. In doing this, an elbow in the shape of the plot is identified, and only components above this point are retained. The scree plot in Figure 7.7 has an elbow at PC4. The first four PCs were considered. Looking at Figure 7.7, change can be observed from the fourth component, confirming the retaining of the four extracted components. The four components and their variables are shown in Table 7.7.

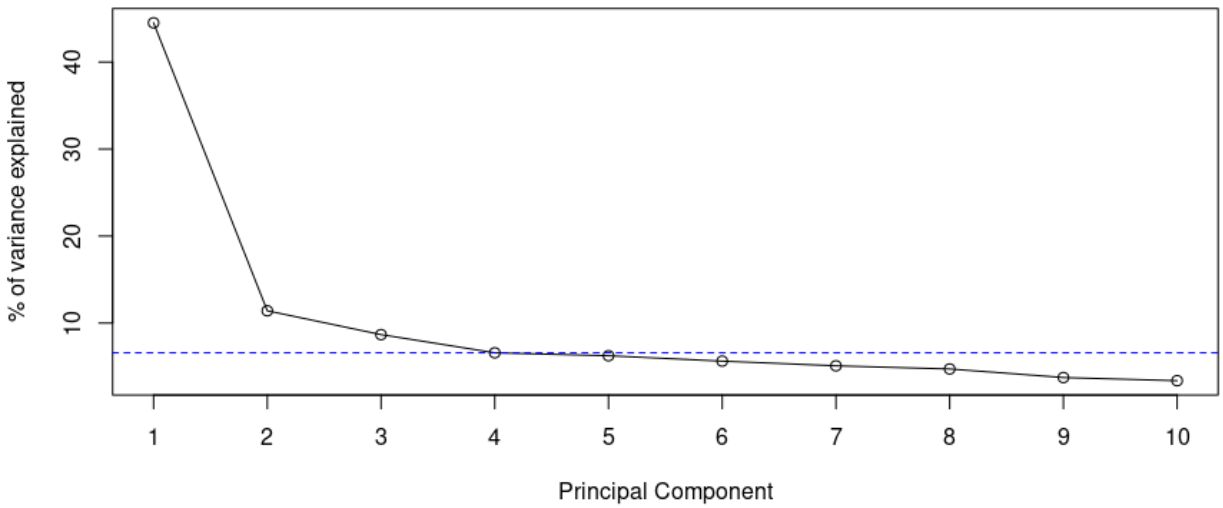

Fig 7.7: Scree plot of the principle components on why real estate firms are not interested in using modern technology in management of real estate business.

Table 7.7: Loadings of the statements on why real estate firms are not interested in using modern technology in management of real estate business. A cut-off of 0.5 was used.

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10
7b	0.719									
7c	-0.692									
7d	-0.643									
7f	-0.785									
7g	-0.722									
7h	-0.750							0.519		
7i	-0.638									
7e	-0.605	0.628								
7a			-0.693							
7j	-0.551			-0.657						

From Table 7.7, statement 7b, 7c, 7d, 7f, 71g, 7h, and 71i had high loadings PC1. The statement 7e highly loads into PC2. The statement 11a highly loaded into PC3 and the statement 7j highly loaded into PC4. In the process of dimension reduction, the following variables were created on why real estate firms are not interested in using modern technology in management of real estate business. The first extracted component accounted for 44% of the variance explained with 6 variables loading heavily on it. These variables are slow internet for active website, very expensive internet for showcasing real-time promotions, expensiveness of the of the monitoring gadgets including CCTVs and accessories, expensiveness and time consuming in terms of maintenance and updating websites, limited skills of developing attractive websites and reluctance of regulators to approve modern technology applications in real estate business. Considering the similarity of these variables, this component was named "**Cost resource constraints".**

The second extracted factor accounted for 11% of the variance explained had 1 variable loading on it. The statement was that, management of monitoring gadgets could be expensive and the component was named ***"Sustainability cost issue"***. The third extracted factor accounted for 6% of the variance explained and had 1 variable loading on it. The variable is high initial cost, and this component was subsequently named "***operational challenges".*** The fourth extracted component accounted for 6% of the variance explained and had 1 variable loading on it. The statement was limited or inactive regulations supporting modern technology application in the real estate business and this statement was named "***Regulatory and approval issues***"

For the statements 7S1, 7S2, 7S3 and 7S4 the Cronbach's alpha was 0.74, and the Kaiser-Meyer-Olkin measure of sampling adequacy was 0.68. Pairwise comparisons of the distributions of the responses for the created statements 7S1, 7S2, 7S3 and 5S4 in the four cities were performed using the Chi-squared test of goodness of fit (Table 7.8) provides the results).

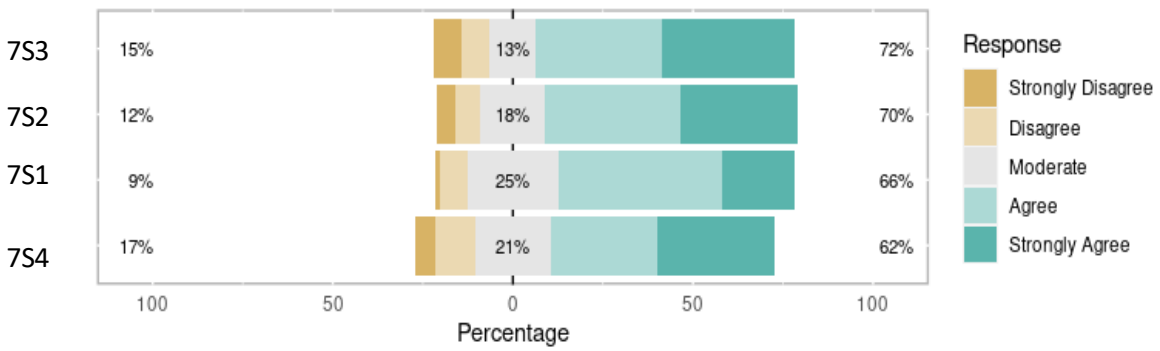

Figure 7.8: Responses on why real estate firms are not interested in using modern technology in management of real estate business for the created statements.

For each statement the comparison of the proportions of those that agreed or strongly agreed with the statement, and those that disagreed or strongly disagreed with the statement yielded a p = 0. The difference between the two proportions for each statement is significant (z-test).

7.4 Discussions

The findings of the study revealed that the use or investment in modern technology when constructing houses in Malawi is not a common process for the construction organisations in the study areas. Many of these organisations have never engaged in the use of sophisticated equipment's when constructing houses due to different perceived risks that comes with the use of new technology. In terms of why real estate firms are not interested in investing in modern technology in construction of houses, the findings revealed that high cost of production is one of the major hindering factors. The high production cost is manifested through the requirements of high initial cost, most modern construction plants and equipment requires a high energy source, modern technologies require a stable energy supply, modern technologies need highly trained and skilled personnel to operate construction equipment and challenges in the maintenance of equipment. Because most of the developing countries like Malawi, are filled with small real estate firms or organisations which lack enough power to make a real progress in construction due to different factors including cost constraints, short-term profit focus and risk aversion. Hage et al. (2020) Lizam & Diah (2019) revealed that, one of the primary reasons is the high initial cost associated with modern construction technologies. Advanced construction methods and technologies often require significant upfront investments in equipment's, materials and skilled labour. In many developing countries like Malawi, there may be limited access to financing or reluctant to commit to large sums of money for technology adoption.

In the same vein, insufficient knowledge and material support, being necessitated by the scarcity of raw materials for construction of modern houses and limited support from academic and research institutions has been found to be the influencer, of why the estate firms are not interested in investing in modern technology in construction of houses. These findings are in tandem with past studies that revealed the hindering factors disallowing real estate firms not to invest in modern technology in construction of houses (Donald Jud et al., 2002; Li, et al., 2021). These findings are also in line with the submissions of Billanes & Enevoldsen, (2021),

Taherdoost (2019) and Billanes & Enevoldsen (2021) which noted that some of the hindering factors is marketing demand, in which the demand for technologically advanced homes may be limited in some developing countries. Therefore, if the market primarily consists of price sensitive buyers who are not willing to pay a premium for advanced features, developers may be less inclined to invest in such technologies. The findings further helped to note that, the reluctance to invest in modern technology during construction may vary from one developing country to another and from real estate developer to another (Munasinghe, 2015). Some firms may indeed see the value in adopting these technologies for improved efficiency, quality and sustainability while others may continue to prioritise cost cutting and traditional methods (Billanes & Enevoldsen, 2021).

One of the major factor that could act as to why real estate firms are not interested in using modern technology in management of real estate business is cost resource constraints which is manifested by slow internet for active website, very expensive internet for showcasing real-time promotions, expensiveness of the of the monitoring gadgets including CCTVs and accessories, expensiveness and time consuming in terms of maintenance and updating websites, limited skills of developing attractive websites and reluctance of regulators to approve modern technology applications in real estate business. According to Maarbani (2017), implementing modern technology in real estate management often requires a substantial upfront investment in hardware, software and training. Real estate films, especially smaller ones, struggles to allocate the necessary funds for these expenses. In addition to the initial investment, maintaining and upgrading technology systems can also be costly. Real estate businesses might not have the financial resources to cover operating expenses. Similarly, Ullah & Sepasgozar (2019) revealed that, in some cases, real estate firms operate in highly competitive markets and the pressure to reduce costs to remain competitive can lead to a reluctance to invest in new technology. Further, the findings of the study revealed sustainability cost issues as another factor hindering real estate films not to be interested in using modern technology in management of real estate business. Lizam & Diah (2019) notes that, some real estate firms perceive technologies as too expensive or risk to invest in, or may not see the long-term benefits of reducing emission of energy consumption. However, some studies have shown that technology in real estate can yield higher rents and sales premiums as well as lower operating costs and better occupant satisfaction. Mcmahan (2020) asserted that some real estate firms may be concerned about how adopting sustainable technology will affect

their market perception. There is perception that sustainable buildings are more expensive, which could lead to concerns about their higher rents or reduced occupancy rates.

Another major factor contributing to resistance of real estate firms to adopt modern technology in management of real estate business in Malawi is operational cost. It is crucial to understand that some real estate firms may face difficulties in adopting new technologies due to concems about data security, loss of face-to-face interactions, integration of data and workflow, employee buy-in and time to learn new technologies (Donald Jud et al., 2002b). According to Mohammed et al. (2021), new technology often requires ongoing maintenance and updates, therefore, films need to allocate resources for this, which can be seen as an operational burden. He further noted that, employees may lack necessary skills to operate and maintain new technology. Training can be costly and time consuming and films may be hesitant to invest in this aspect. These challenges can be overcome by choosing reliable and secure platforms, providing training and support, enhancing communications and collaboration and leveraging innovation (Jud et al., 2002; Ullah & Sepasgozar, 2019; K. Vandell & Green, 2001; Warburton, 2016). The study further revealed that regulatory and approval issues has necessitated the decline in the adoption or usage of modern technology by real estate firms in Malawi in the management of estate businesses. Real estate is one of the heavily regulated sectors in Malawi, therefore, adopting new technology may require firms to navigate complex regulatory frameworks. They may be concerned about potential legal hurdles, compliance issues or facing fines for non-compliance. The findings are in tandem with Warburton (2016) who noted that some challenges arise from approval processes, in which the implementation of new technology often involves a series of approvals from various stakeholders, including local governments and regulatory bodies. Therefore, delays in obtaining approvals can impact project timelines and budgets, discouraging firms from adopting modern technology. On the same note, Małkowska (2013) confirmed that real estate is a long-term investment, and many firms are risk-averse. They may be hesitant to experiment with new technologies that could introduce uncertainties and potential risks to their projects.

7.5 Conclusion and Recommendations

In the quest to optimise technology in real estate business in Malawi, this study has delved deep into the reasons why real estate firms in the country have been hesitant to invest in modern technology for the construction of houses and management of real estate businesses. Using the quantitative approach, it has become evident that several significant factors are hindering the adoption of modern technology in this sector. These include high production costs, insufficient

knowledge and material support, resource constraints, sustainability cost issues, operational challenges and regulatory and approval issues.

7.5.1 Conclusion

The real estate sector in Malawi stands a crucial juncture where embracing modern technology is no longer an option but a necessity for sustained growth and competitiveness. The present study has elucidated a multitude of challenges that have deterred real estate firms from investing in modern technology. High production cost has proven to be a formidable obstacle, pushing firms to opt for traditional methods that may be more cost-effective in the short term but are ultimately less efficient and sustainable. Moreover, insufficient knowledge and material support have left many industry players in the dark about potential benefits of technology adoption, leaving them hesitant to make the transition. Resource constraints, including financial limitations, have further exacerbated the situation, preventing firms from making the necessary capital investments in technology. Sustainability costs have been a concern, as firms grapple with the perception that modern technology may require substantial ongoing expenses. Operational challenges, both technical and logistical, have also hindered the integration of technology into everyday practices. Lastly, the cumbersome regulatory and approval processes in Malawi have discouraged firms from navigating the bureaucratic landscape associated with technological innovations.

7.5.2 Recommendations

To address the issue of insufficient knowledge and material support, it is imperative that the industry stakeholders, including government bodies, real estate associations and education institutions, collaborate to provide training and awareness programs. These initiatives should educate real estate professionals the benefits of modern technology and how it can be applied effectively in their businesses. Additionally, for strong partnership with technology providers and creating accessible resources for industrial players can help to bridge the knowledge gap. On the financial support and incentives, the government and financial institutions should explore revenues for providing affordable loans, grants or tax incentives specifically tailored to promote technology adoption. This can help alleviate the financial burden associated with acquiring and implementing modern technology. Further, it is recommended that there should be technical assistance and support. To address operational challenges, it is essential to establish technical support centers or hotlines that real estate firms can access for guidance and troubleshooting. These centers can help in implementing and maintaining technology

solutions, ensuring a smoother transition for businesses. It is also recommended that government should stream line regulatory processes. Government agencies should work collaboratively with real estate industry to simplify and expedite regulatory and approval processes. This can be achieved through digitalization, online platforms and the creation of specialized task forces dedicated to addressing technology-related concerns.

The path to optimization of technology in Malawian real estate industry is multifaceted and requires concerted efforts from various stakeholders. By addressing the identified challenges through a combination of awareness, financial support, regulatory reform and collaborative initiatives, Malawi's real estate sector can overcome the barriers to technology adoption and pave way for more efficient, sustainable and prosperous future. Embracing modern technology is not merely an option but a strategic imperative to position Malawi's real estate industry on the global stage and enhance its contribution to the country's economic growth.

CHAPTER 8

8.1 GENERAL DISCUSSIONS AND RECOMMENDATIONS

This Thesis sought to optimise the use of technology in real estate business in Malawi, and it achieved its objectives by critically analysing theories and applications of technology in the industry, assessing the influence of technology on construction and housing infrastructure, identifying technologies for adoption and evaluating perceived risks in the Malawian real estate sector. Firstly, the analysis of theories such as social cognitive theory, task technology fit, technology acceptance model, theory of interpersonal behaviour, theory of planned behaviour and theory of reasonable action highlighted the importance of understanding human behaviour and altitudes towards technology adoption. These theories can guide stakeholders in developing strategies to promote the acceptance and successful implementation of technology in real estate. Secondly, the study revealed that technology has brought about significant transformation in real estate services, fostering connectivity and communication revolution and enhancing construction and safety advancements. These advancements underscore the potential for technology to improve efficiency, transparency and safety in the industry. Thirdly, the research identified specific construction and operations technologies that can be adopted in Malawian real estate business, these include integrated construction technology solutions (real estate management software, mobile apps, virtual reality tours, online payment systems, property data analytics, social media marketing, energy efficient technologies, drones for property inspections, home automation and online booking and reservation systems), advanced construction material utilisation (high performance concrete, fibre-Reinforced concrete, green roofs, advanced insulation materials, advanced steel alloys, 3D-printed construction, recycled materials modular and prefabricated construction) and prefabrication efficiency. Embracing these technologies can lead to cost savings, higher-equality construction and foster project completion. Lastly, the study highlighted challenges or perceived risk such as high cost constraints, insufficient knowledge and material support. Addressing these challenges is crucial foot the successful integration of technology in housing construction and real estate operations in Malawi.

The findings of the study, generally indicates that the majority of the real estate companies in Malawi are not adopting modern technology, and are in contrast to the goals outlined in Malawi vision 2063. The vision emphasizes the need to embrace technology in every sector, including real estate, to achieve the transformation of Malawi into a wealth and self-reliant industrialised country. Given this disparity, it can be concluded that there is a significant gap between the

current state of technology adoption in Malawi's real estate industry and the desired state outlined in the vision. To bridge this gap, it is crucial for real estate companies to recognise the importance of technology and take proactive steps to integrate modern technological solutions into their operations. By embracing technology, real estate companies can enhance their efficiency, improve customer experiences, and unlock new opportunities for growth. This may involve adopting digital marketing strategies to reach to a wider audience, leveraging virtual reality technologies for property tours or incorporating smart home technology into properties, among others.

Based on the findings, several comprehensive recommendations are proposed to optimise the use of technology in Malawian real estate sector. Firstly, it's by promoting technology literacy. To address the challenges related to insufficient knowledge, it is essential to invest in technology literacy programs for industry professionals, workers and stakeholders. Training and education should be provided to ensure that these individuals are well-equipped to use and leverage technology effectively. Secondly, there is a need for research and development efforts to be encouraged, specifically focused on adapting and developing construction technologies that are suitable for Malawi's unique conditions and requirements. Collaboration between the government, academia and industrial players can facilitate innovation. Thirdly, the study recommends financial support. Options for providing financial support or incentives to real estate developers and companies willing to invest in technology adoption. This can help to mitigate the initial high production costs associated with advanced technology adoption. Further, it is recommended that, industrial collaboration should be fostered especially between the public and private sectors, as well as international organisations, to facilitate knowledge exchange and accessto technology resources. Market awareness. Launch awareness campaigns to educate potential homebuyers and investors about the benefits of technology driven real estate services, enhancing market demand for tech-enabled solutions, finally, there is a need for continuous evaluation. Regularly assess the impact of technology adoption in the sector and adjust strategies accordingly. This will ensure that the real estate industry remains aligned with technological advancements and best practices.

Therefore, optimising the use of technology in Malawian real estate business holds significant potential for improving efficiency, reducing costs and enhancing the overall quality of housing and infrastructure. By implementing these recommendations and addressing the identified challenges, Malawi can position itself for a more prosperous and technologically advanced real estate sector.

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APPENDICES

Appendix 1: QUESTIONNAIRE # 1

Jordan Andrew Chipatala,
Selinus University of Science and Literature,
00152-Roseau Valley
Commonwealth of Dominica, Italy

Dear Respondent,

REF: REQUEST FOR YOUR PARTICIPATION

I am a PhD student at the Selinus University of Science and Literature. I am pursuing a Doctor of Philosophy Degree (PhD) by Research at the above institution. You have been chosen to participate in my study as a respondent, and I am writing to ask for your assistance and participation in completing the questionnaire. The information you provide will be treated with the highest confidentiality and used solely for academic purposes. Please specify if you would like a copy of the research after it is completed by providing your email address at the reverse side of the questionnaire.

Yours sincerely,

Jordan.

QUESTIONNAIRE

Kindly tick appropriately

Part A: General Information

1. State your gender

Male []
Female []

NB. **If you are a real estate manager/employee please start from question 2 otherwise go to** part B

2. How long have you been with the firm?

a. 0-2 years []
b. 3-6 years []
c. 7-9 years []
d. Above 10 years []

3. Please state your educational level.
a. Certificate []
b. Diploma []
c. Bachelor's Degree []
d. Master's Degree []
e. Doctorate []
f. Others…….

4. How long have you been working in your current position?

a. 0-2 years []

b. 3-6 years []

c. 7-9 years []

d. Above 10 years []

Part B: Technology and performance of Real Estate business in Malawi

5. How much do you agree with the following assertions concerning the impact of technology on Malawi's real estate business?

Using the scale 1- strongly disagree, 2- disagree, 3- moderate, 4-agree, 5-strongly agree.

Number	Statement	1	2	3	4	5	Comment on response
a.	**The usage of technology has resulted in an increase in real estate business service sales.**						
b.	**Clients and other firms can quickly acquire information about real estate services through websites with portals.**						
c.	**Rental residences and property sales are advertised using contemporary technologies (digital).**						
d.	**Personalized responses to clients are now possible due to modern technologies.**						
e.	**Buyers can use their mobile phones to browse property listings quickly and efficiently.**						

f.	**The use of technology, such as mobile phones, to look for available properties saves time and money compared to actual visits.**						
g.	**The use of technology allows real estate firms to work in a more flexible setting.**						
h.	**It is simple to contact potential consumers and vendors using technology such as mobile phones**						
i.	**When clients use modern technology, they can simply send information from the worksite, such as when placing a material order.**						
j.	**Real estate business owners can monitor workers and other aspects of interest, such as a suitable location for house development, using modern technology.**						
k.	**Automated messaging has been developed by real estate agencies to inform customers about new homes on the market.**						
l.	**As a result of technological advancements, the construction process has accelerated.**						

m.	**Using mobile devices, agencies may stay in touch with customers and coworkers due to modern technology.**						
n.	**Real estate business owners employ digital systems such as social media platforms to advertise newly completed homes**						
o.	**Safety is number one priority during technological construction**						

6. Please list any further positive effects of technology on performance of real estate business in Malawi.

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Part C. Real Estate Business and use of technology in construction

7. What is your level of agreement with the following assertions regarding how Malawian real estate enterprises use technology to boost construction? Using the scale 1- strongly disagree, 2- disagree, 3- moderate, 4-agree, 5-strongly agree

Number	Statement	1	2	3	4	5	Comment on your response
a.	**Energy-efficient alternatives are employed during construction**						

b.	**Strong and durable raw materials achieved through modern technology are used in most circumstances**						
c.	**To increase efficiency in its construction activities, firms incorporates technology such as onsite drones and building information modeling.**						
d.	**Prefabrication is used to increase production and lower expenses.**						
e.	**Contractors utilize creativity to create modern, energy-efficient structures.**						
f.	**They are use of superior construction technologies for improved quality and safety**						
g.	**Virtual reality is used to allow potential consumers to experience the designs and spaciousness of dwelling units before the**						

	construction process begins.						
h.	**They are use of real-time technology to exhibit and report on the status of properties under construction, as well as completed units.**						
i.	**During construction there is sharing of information while maintaining security.**						

8. Indicate any other usage of technology by Malawian real estate business owners in the construction of houses.

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Part D. The extent of perceived risks in using new technology in housing construction and management in real estate business.

9. What is your level of agreement on the following statements about why real estate firms are not interested in investing in modern technology in construction of houses?

Using the scale 1- strongly disagree, 2- disagree, 3- moderate, 4-agree, 5-strongly agree

No.	**Statements**	1	2	3	4	5	Comment on your response

a.	**Very high initial cost is required**						
b.	**Most modern construction plants and equipment requires a high energy source**						
c.	**Most modern technologies require a stable energy supply**						
d.	**Modern technologies need highly trained and skilled personnel to operate construction equipment**						
e.	**Maintenance of equipment is a challenge**						
f.	**Scarcity of raw materials for construction of modern houses**						
g.	**Maintenance of houses is a challenge in terms of availability and cost of raw materials**						
h.	**Limited support from academic and research institutions**						

10. **Indicate any other factors that may influence application of modern technology in construction.**

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11. What is your level of agreement on the following statements about why real estate firms are not interested in using modern technology in management of real estate business? Using the scale 1- strongly disagree, 2- disagree, 3- moderate, 4-agree, 5-strongly agree

No.	**Statements**	1	2	3	4	5	Comment on your response
a.	**Very high initial cost is required**						
b.	**Internet is slow for an active website**						
c.	**Internet is very expensive for showcasing real-time promotions**						
d.	**Monitoring gadgets including CCTVs and accessories is expensive**						
e.	**Management of monitoring gadgets could be expensive**						
f.	**Maintenance of and updating websites could be time consuming and expensive**						
g.	**There are limited skills of developing attractive websites**						
h.	**Poor services from internet providers**						
i.	**Regulators may not approve modern technology applications in real estate business**						
j.	**There are limited or inactive regulations supporting modern technology application in the real estate business in Malawi**						

12. **Indicate any other factors that may influence application of modern technology in management of real estate business in Malawi.**

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