# LEAN PROJECT DELIVERY SYSTEM AS A STRATEGY FOR PROJECT SUCCESS IN AFRICA: A CASE OF UGANDA'S CONSTRUCTION INDUSTRY

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**SSALI FRANCIS**

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Supervisor (Affiliation): Prof. NS Matsiliza (Signature):____ _Date: 15/08/2023

Co-Supervisor 1 (Affiliation): Prof. S Moyo (Signature): ____ _Date: 15/08/2023

Co-Supervisor 2 (Affiliation): Prof. H Alinaitwe (Signature) __Date: 14/08/2023

Co-Supervisor 3 (Affiliation): Dr. D Naturinda (Signature): __Date: 14/08/2023

**DECLARATION**

I, Ssali Francis, hereby declare that this dissertation is my original work and has never previously been presented in any other institution of learning for a degree/diploma/certificate award or for any examination purpose.

24th October 2022

Signature: Date:

Ssali Francis

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**DEDICATION**

This work is dedicated to my family, friends and all of my colleagues who contributed towards my education.

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May the Almighty God abundantly reward you.

**LIST OF ACRONYMS AND ABBREVIATIONS**

| | |
|---|---|
| AGFI: | Adjusted Goodness of Fit Index |
| BIM: | Building Information Model |
| CBOs: | Community Based Organisations |
| CFI: | Comparative Fit Index |
| CM: | Cellular Manufacturing |
| CSFs: | Critical Success Factors |
| CSOs: | Civil Society Organisations |
| CP: | Control Programme |
| df: | Degree of Freedom |
| DFMA: | Design For Manufacturing and Assembly |
| D.O.W.N.T.I.M.E: | Defects, Overproduction, Waiting, Non-utilised Talent/Resources, Transportation, Inventory Excess, Motion Excess and Extra Processing |
| DRC: | Democratic Republic of Congo |
| EAC: | East African Community |
| EMS: | Environmental Management Systems |
| F: | Factor |
| FGDs: | Focused Group Discussions |
| FMEA: | Failure Mode and Effective Analysis |
| GDP: | Growth Domestic Product |
| GFI: | Goodness of Fit Index |
| JIT: | Just-In-Time |
| KCCA: | Kampala Capital City Authority |
| KSA: | Kingdom of Saudi Arabia |
| KPIs: | Key Performance Indicators |
| LAP: | Look Ahead Planning |
| LC: | Lean Construction |
| LCA: | Least Cost Analysis |
| LP: | Last Planner |

| | |
|---|---|
| LPDS: | Lean Project Delivery System |
| LPS: | Last Planner System |
| LSS: | Lean Six Sigma |
| MoES: | Ministry of Education and Sports |
| NHC: | National Housing Corporation |
| NHCC: | National Housing and Construction Company |
| NGOs: | Non – Governmental Organisations |
| NHST: | Null Hypothesis Significance Test |
| RMSEA: | Residue Mean Square Error Approximation |
| SCM: | Supply Chain Management |
| SDGs: | Sustainable Development Goals |
| SMEs: | Small and Medium Enterprises |
| SOPs | Standard Operating Procedures |
| SPSS: | Scientific Package for the Social Scientists |
| UDHR: | Universal Declaration of Human Rights |
| UK: | United Kingdom |
| UN: | United Nations |
| UNABCEC: | Ugandan National Association of Building and Civil Engineering Contractors |
| OS: | Operating Systems |
| PDCA: | Plan, Do, Check, Act |
| PDS: | Project Delivery System |
| PPC: | Percentage Plan Complete |
| QFD: | Quality Function Deployment |
| RCA: | Root Cause Analysis |
| SCM: | Supply Chain Management |
| SMEs: | Small Medium Enterprises |
| TBL: | Triple Bottom Line |
| TLI: | Tucker Likewise Index |

| | |
|---|---|
| TQM: | Total Quality Management |
| UNRA: | Uganda National Road Authority |
| USA /US: | United States of America |
| VE: | Value Engineering |
| VM: | Value Management |
| VSM: | Value Stream Mapping |
| VSM: | Viable System Model |
| WWP: | Weekly Work Planning |

**ABSTRACT**

Lean technology has been one of the high rising concepts that came when nations and the world at large were in need of a solution against high costs, too much wastes, and delivering projects successfully within agreed time in the construction industry. Lean techniques which started in Japan by the 1950s, spread across the developed world of Europe, America and Asia. Despite the positive claims, companies in the developing countries like in Africa, particularly in Uganda are yet to adequately adopt the lean techniques to improve on their levels of project realisation and success. This study therefore assessed lean project delivery system as a strategy for project success in Africa, particularly a case of Uganda's construction industry. Five objectives were set to guide the study which included to; determine the level of implementation of lean techniques; determine the degree of success and realisation of projects; relationship between lean and project success; and to examine the general perception of the proposed strategy in Uganda's construction industry. In order to underpin the study, different theories including Last Planner theory of management were used to administer data which was collected from 316 participants from 56 construction companies. Survey questionnaire and interview guide were used to collect data from the field which were analysed using multiple methods that included AMOS, Chi-square, ANOVA, multiple regression, Cochran's Q test, Kendall's Coefficient of Concordance Test Agreement for quantitative data and content analysis for the qualitative data. The study established that there is limited form of knowledge of lean construction techniques and its design. This makes the implementation fall short among the companies. Secondly, the study found that lean technology has the ability to determine improved degree to success despite the limitations. The study also discovered that there is a significant positive relationship between lean techniques and project success. Positive results were similarly obtained from perceptions towards the last planner system as an important lean approach in the construction industry. The study concludes that, despite the constraints in applying or implementing lean construction techniques by Uganda's construction industries, it is of great value in terms waste reduction and cost decrease. The main recommendation was for companies to adopt lean construction techniques, particularly LPS, as an adequate approach to reducing challenges faced by the construction companies in order to achieve greater success.

**Key words:** Lean Construction Techniques, Project Success, Last Planner System, Africa, Uganda

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# CHAPTER ONE:

# INTRODUCTION

## 1.0 Introduction

This chapter presents the background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, scope and significance of the study.

## 1.1 Background

The purpose of this study was to examine lean project delivery system as a strategy for project success using a study of Uganda. The construction industry is one of the important sectors that has projects ranging from small to mega ones globally (Miši and Radujkovic, 2015:73). This has been achieved amidst several challenges through different approaches like pull production, quality management, preventative management and quality human capital resource in which some of the challenges have been ameliorated. Despite such efforts, wastes are still being faced and highly affect the success of projects in relation to time, cost and resources allocation (Blanco, 2017:5). Research has shown that wastes arise at any stage or cycle in the construction project delivery (Ikau, Joseph and Tawie, 2016:13; Agyekum, Ayarkwa and Adinyira, 2012:19). Perceived as inefficiency during utilisation of materials, equipment, labour and capital, wastes are unavoidable and avoidable in different projects (Luang, Intrachooto and Peansupap, 2019:18). Under unavoidable wastes, investments needed for their reduction is higher as compared to invested-costs to their creation, and costs of the latter are higher than the cost to prevent it. Ikau *et al.* (2016:15) are of the view that once wastes have been created in the construction process, it compels investors and companies to silence due to higher abating costs. While the technology of the company could have a long-lasting management approach to some of the wastes, it has never been a solution since wastes can be ignited at any point, right from design or planning process to at the end of construction stage.

Research has classified causes of waste into design or planning, procurement, material handling process, operation process and residual in order to make efficient delivery and accurate success (Asia *et al.* 2018:2). Such wastes account and affect construction differently, ranging from 30 –

70% of quantifiable effects. For example, in practice material wastes account for an input into construction activities at a range of 2.5 - 10% of the total costs of the project. The waste includes rejected structures and materials, over ordered materials or surplus requirements, as well as discharged materials. There is also a waste in differentiating between delivered and accepted materials on site of the construction. It was within this ambit of construction waste challenges and failure in project management that Lean Construction (LC) became a strategy to countermeasure construction wastes in effort to have project success in line with time, costs and effective allocation of resources. In fact, LC has been put in the middle of the ongoing construction problems as the best solution (Balkhy and Sweis, 2021:3).

Lean production was pioneered by the Japanese Toyota Motor Company in the 1980s and has since revolutionised the construction industry, taking into account environmental concerns and sustainability (Kamarudin and Nakanishi, 2017: 41). In the United Kingdom (UK) for example, Madanayake (2015:109) shows that lean thinking targets quality improvement and efficiency. According to Shakeri, Boroujeni and Hassani (2015:130 - 131), its theoretical approach challenged traditional construction management thinking towards sustainability and performance due to its environmental and sustainability components. This has attracted most innovative construction companies to rethink and change their practical work into LC perspective. In 1998, the Egan Report published a rethinking construction model, recommending the incorporation of lean manufacturing principles in the construction industry to address the prevailing construction challenges (Mossman, 2015:25-26). Ochieng (2016:1343) shows that the UK construction industry embraced lean thinking since it provided sustainable solutions resulting from the created and operated healthy built environment for resource efficiency and ecological design. As noted by Marhani *et al.* (2015: 25-28), it has become easier to absorb waste and pollution in Malaysia with the Lean Construction Strategy. The sustainability agenda in energy efficiency, non-toxics or recyclability, property value, flexibility, long service life, use of local resources, information dissemination, use of by-products, immaterial services, mobility consideration or supporting local economy came to reality in the UK. The lean thinking has been further applied in Scandinavian countries and the United States of America (USA /US) due to its successive approach and appropriate resources allocation (Mossman, 2009:25-26).

In Malaysia, initial attempts to adopt lean construction were limited due to the nature of the construction industry that was unique with various risks and one – off (Marhani *et al.* 2015: 30). However, it was accepted by various stakeholders like the government and engineering bodies owing its success to time, cost and resource allocation that maximise waste; and owing to various successful examples across the world. The holistic incorporation of lean principles into Malaysian construction industry was perceived theoretically and later trail towards the current sustainable environment. To Arif *et al.* (2013:90-92), health and safety considerations are embedded in the implementation of lean principles in Malaysia, which has had far-reaching effects in minimising wastes that have long been a challenge to human capital resources, costs, and timing. Through proper health and safety assessment on construction projects, the lean principles assisted the construction industry properly deal with the then problems, assured safety on health and risks. Rodrigues (2022: 16-17) states that in the short and long run, Malaysian Construction Industry implemented OHSAS 18001 that focuses on occupational health and safety management. It has been successful in providing workers' safety consciousness, working conditions, morale, reductions in accidents, claims, lost work days, and better preparation for regulatory inspections.

In the Middle East, Sarhan *et al.* (2017: 47-49) present successful and primacy of lean concept application through improved performance and trade level reduced wastes. They state that over the past 20 years, the construction industry in the Middle East was dominated by Kingdom of Saudi Arabia (KSA), due to the increased number of poor human resource capital allocations in which 15% of the workforce would consume 14% of the country's energy. This made the construction industry fail to measure an improvement caused by its human capital resource in relation to time (time delays), cost overruns, safety, risks and quality issues. KSA emphasised lean concepts and principles since the year 2000; and significant successful project performance and delivery have been realised. Despite the successful implementation in some projects in the Middle East, Koohestani *et al.* (2020:374) show that the Arab World complex projects have not yet witnessed successful performance which they had wanted with the implementation of lean thinking. Reasons for this include large organisational problems, social change, local culture deficiency in skills and challenges in selecting the right tools still confronts such entities to use lean rather than emanating from the lean principles.

In Egypt in particular, Shaqour (2022:2) investigated the extent to which lean construction principles have improved labour productivity. In this study, indicators to measure performance included disruption index, performance ratio and project management index. From the same nation, supporters of Lean Thinking gave an entire intervention overview towards the application of lean concepts and techniques to fabricated management processes (Sarhan *et al.* 2017b: 46 - 56). Within the two studies, the success of a lean project is presented through proper management of demand, reduced cycle of time in accomplishing the project, greater productivity, increased government revenue and company's profitability. The success of lean projects is also presented by Marhani *et al.* (2012:95) while illustrating the working procedures of lean principles in designing and installation of metal door frames for prison construction. These have been measured in reference to time, cost, and human labour. Despite various delivery and performance successes in other countries, research in Uganda is still inadequate.

Like other countries of the world, the Construction Industry in Uganda recommended adoption of lean strategy in order to improve performance and maintenance of effective service delivery (Alinaitwe, 2009: 15 -16). The motivation for this recommendation stemmed from the long-standing symptoms of waste in construction that had made the government always award construction tenders to foreign companies. These problems have been witnessed in production, innovation, slipping schedules, skilling, rework and increased construction costs. It has also been remarked that the human capital resources during construction use limited time at the facility (Almen and Kohnechian, 2014: 2). These symptoms have been associated with labour, time, capital and machinery or equipment. There is also increased lapse in completion of the contracted facility which affects contractor – client relationship since the main effect of delay increases costs. In the due course, clients suffer from loss of revenue and the psychological pressure ensued leading to lack of trust and repetitiveness to the companies that have existed in Uganda.

Cognisant of the Ugandan construction industry, and aware about the lean principles and concepts, the adoption has been perceived as the most lasting solution to delivery and success of the projects. In the geographical context however, lean thinking has never been holistically embraced. The fact that there is silence and low pace towards adoption of lean construction, the construction industry is missing something and it is high time to be considered seriously (Muhwesi *et al.* 2012:20-21).

It is upon this revelation that this study assesses the extent to which LC has been embraced in Kampala District, Uganda.

## 1.2 Problem Statement

### 1.2.1 Practical problem

According to Muhwezi, Chamuriho and Lema (2012: 12), the construction industry in Uganda is facing a significant amount of wastage. This is caused mainly by human activities that absorb resources but create less or no value. Projects are still run under the traditional thinking of concentrating on wastage of materials as the only project waste. Activities like waiting, motion, inventory among others are not recognised as non-value adding flow activities yet these may lead to wastage and hence affect customer delivered quality.

Furthermore, construction projects generally have a very poor record of project success in terms of completion within cost, time and quality objectives. In Uganda this is superlatively evidenced with the unsuccessful projects exhibited by time overruns, cost overruns and inadequate quality (Kiconco *et al*, 2019). This is generally as a result of using inadequately controlled procedures of production in the industry.

### 1.2.2 Contribution to study field

According to Abarinda, Kibwami and Tutesigensi (2019: 659) success of projects could be improved through the implementation of lean construction as a technique of reducing the wastes (non-value adding activities) during the construction processes. In literature, there are studies elsewhere revealing the importance and essential contribution of lean thinking both in theory and practice, together with the subsequent effect on wastes during the construction processes. Most of these studies have assessed lean construction and its discourse to sustainable development especially in developed nations (Marhani *et al.* 2013:3) According to Chandrasekar and Kumar (2014: 2) in countries such as UK, Australia, USA and Brazil the companies that have adopted Lean Construction techniques have gained significant benefits. Lean construction brings about an effective system to generate the kind of efficiency desired within the construction processes for

project success through the elimination of the non-value adding activities (wastes) from the processes (Ansah, Sorooshian and Mustafa 2016: 1607).

In theory and practice, lean construction has been given worldwide priority since it considers construction material quality, and waste as latent roadblock to flow of value to customers which should be totally removed. Quality materials to the construction industry that has posed a main challenge in Uganda and elimination of wastes at all strategic stages can be prevented by applying lean thinking. This leaves the main question that this study interrogates if the building companies, contractors, engineers and other stakeholders in Uganda are aware about the values of lean construction, and the extent to which it is a possible solution to wastes generated in the due course.

In literature, there are studies elsewhere revealing the importance and essential contributions of lean thinking both in theory and practice, together with the subsequent effect on wastes during construction. However, studies about lean construction and its contribution to growth and development of Uganda are limited. The insufficiency of literature addressing quality and wastes by lean, and the absence of evidence research-based are hypothesised as lack of awareness of the potential of lean construction. Hence the urgency of the study in an attempt to address this gap.

## 1.3 Objectives of the Study

### 1.3.1 Overall Objective

The overall aim of the study is to assess lean construction as a strategy for project success in developing countries – Africa, with emphasis on Uganda.

### 1.3.2 Specific objectives

1. To determine the level of implementation of lean techniques by checking general awareness and utilisation.
2. To determine the degree of success and realisation of projects in terms of client satisfaction.
3. To examine the relationship between lean techniques and general project success.
4. To propose a lean construction project delivery strategy in the construction industry.
5. To examine the general perception of the proposed strategy in Uganda's construction industry.

## 1.4 Research questions

1. What is the level of implementation of lean construction techniques in Uganda's construction industry?
2. What is the degree of success and realisation of projects in Uganda's Construction Industry?
3. What is the relationship between lean construction techniques and general project success in Uganda and the challenges involved?
4. What is the appropriate lean construction project delivery strategy for Uganda's Construction Industry?
5. What is the perception of the proposed strategy in Uganda's Construction Industry?

## 1.5 Scope and limitation of the study

The scope of this study is lean construction as a strategy for project success with focus on Construction Industry in Uganda. This study however cannot assume addressing all the domains of this content rather defining the boundaries. Therefore, the boundaries of knowledge and underlying assumptions remain key to progress. In the first instance, the choice of Uganda is based on the nations' vision 2040 that aims at sustainable construction which accommodates all groups of persons, including the disabled persons. In such a context, a lean construction project would serve the best based on its models that encompasses success with time, quality, equipment, labour, capital and minimisation of wastes (Muhwesi, Acai and Otim, 2014: 13-15).

The lean construction project delivery has been perceived as a strategy to success in lieu of optimising procurement and construction costs as well as reducing wastes and subsequent effects. The theoretical and practical evidence has pervaded in the entire world since the year 2000 with emphasis on benefits to stakeholders. Quantitative and empirical evidence has been documented on actual use, costs and benefits, especially among the developed world. Most African countries have limited knowledge due to the perception of neoliberalism, which continues to attach what Africa is to the Western World in terms of trade, technology, and way of life. It therefore remains unique in accounting the lean production human capital costs (Ahmed *et al.* 2019:199). Its needs and interests have remained outstanding in discourse of field research and findings. There are studies relating to lean manufacturing and deliberation on construction projects. But these studies

do not go extra miles to illustrate the success within ambits of lean construction organisations. The silence or low knowledge seems to have been the main cause among Ugandans. As a result, it became the main focus of this study so as to make it known. In doing so, the study solves the limitation through internal interviews in response to objectives.

Based on the nature of the study from construction industries in Uganda, and aware that the study was conducted during Covid – 19, various strategies were adopted in order to make it successful. Attempts were made to reach main sampled construction companies and their lead personnel to get the data needed. In the same period, such personnel never liked face – to – face interviews, rather opted for the phone calls and emailed questionnaires. With the due respect and morale to contribute knowledge about societal fundamentals of perception and awareness, participants eagerly contributed knowledge. They also went extra – miles to revert answers or leave them on an agreed premise to be picked by the main investigator.

The questionnaire survey conducted as part of this study as illustrated in section three was based only on Ugandan construction industry context with main emphasis on perception, understanding and awareness. This was also a limitation for the study since within literature of the country there could not be any other literature of this kind. The questioners on lean construction as designed for this study lacked any other comparative questions that would have served as a sample to this study. This limitation could not be avoided since this study was meant to be carried out for the successful analysis of results. Also, despite its advantages and usefulness, the lean construction has not been embraced by companies within the nation. In order to overcome some of these challenges within administered questionnaires, qualitative questions were designed and used so that the information could complement what is quantitative in this case study.

It was also found that responses from selected persons within the same company could differ based on individual awareness, understanding and perception. This difference is yet another indication why the lean thinking has not yet embraced to the large extent. In order to harmonise this, structured interviews would be organised and participants involved in long narrative discourse. Individual personnel from managerial to operational engineers or personnel who were interviewed from similar companies had different understanding of the concept as used in construction as indicated in the results of the survey. While some findings to this study are in agreement to

literature, and really confirm the theoretical underpinnings; it is noble to note the findings are firsthand information from participants on lean thinking from Uganda. The similarities make the lean concept outstanding to the construction industry and a solution to limitation herein.

### 1.6 Justification

Basheka and Tumutegyereise (2013:106) postulate that creating value and eliminating waste in construction through adoption of lean techniques have shown a great ability to improve the traditional production system in Africa. Yet majority companies and the construction industry in general are still resistant to adopt desired and necessary improved technology like the lean thinking (Boateng, 2020). According to Balkhy and Sweis (2021:10), change in the construction processes in South Africa is as well a must due to a number of related issues that have made fatalities and project time overrun media -headlines. This has been also witnessed in a number of countries and Uganda in particular. According to Nuwagaba (2020:11), Uganda needs improved approaches in construction if wastes and fatalities in the construction industry are to be minimised. According to Kamarudin and Nakanishi, (2017: 43) the lean concept which is not yet appropriately ventured into Uganda's construction industry is the solution.

### 1.7 Significance of the study

This study can be useful to the contractors by providing a discernment of lean construction techniques as a strategic approach to waste reduction in Africa and Uganda in particular.

Furthermore, the study adds to our understanding of lean construction and project success in developing countries. This research will also help construction companies gain a better understanding of lean construction thinking and production in order to reduce waste on construction projects while maximising customer satisfaction and profits. By the adoption of LPS in the construction processes, it can help in improving project time delivery, reduced costs of production and improved quality of the products.

The construction companies in the Ugandan construction industry will as well realise that there is a need to change their company’s objectives, goals, aims, visions and philosophy towards this new philosophy. Lean construction will help them to become more efficient, sophisticated construction

companies which will care about how they do business and the impression they leave with their clients. Once a construction company understands what lean construction is and starts to implement it in their management, they will immediately see a change that is beneficial towards the companies.

According to Martinez (2020:2-3), the success of projects could be improved through the implementation of lean construction as a technique of reducing the wastes (non-value adding activities) in the construction processes. In countries like the UK, Australia, USA and Brazil, Ahmed *et al.* (2019:2) show that companies that have adopted Lean Construction concepts have got significant benefits. Lean construction brings about an effective system to generate efficiency desired within construction processes for project success. However, there is less emphasis on lean construction and project success in Africa more so Uganda's construction industry. Hence, the urgency of the study to establish awareness and understanding about lean approach in the construction industry in Uganda. Secondly, the study seeks to develop the conceptual framework that can reveal its knowledge so that the implementers can easily internalise the lean theoretical approach to its implementation and success in project delivery.

The study is presented with the view that its developed framework can be a basis to understand the benefits of the lean thinking in the construction in Uganda, especially on wastes and approaches to minimise / manage such. Its contribution to knowledge and practical understanding sets a basis to measure and evaluate such benefits arising from the use of lean construction techniques towards sustainable construction approaches in the operation of the construction business. Thus, the outcome of this research will provide a knowledge base for companies intending to implement lean. It would also allow companies to evaluate strengths and weaknesses of their lean implementation processes based on the impact assessment results. The framework can also be used as a standard business tool for assessing a company's lean status and need.

# CHAPTER TWO:

# LITERATURE REVIEW

## 2.0 Introduction

This chapter presents the literature that has been reviewed for this study alongside the main objective in a thematic approach. It starts with the construction industry in Uganda with the main emphasis on policy and legal approaches governing construction in the nation. The section then gives an approach by the Government of Uganda and the people seeking knowledge in an effort to be aware of construction approaches and knowledge (Snyder, 2019:334).

The study is linked to business administration. Sparks (2020) defines business administration as a process of managing businesses and allocating their resources efficiently and effectively. The goal is to achieve stability, growth and profitability for a business. Additionally, Sánchez, Cruz and Ojeda (2020: 12) noted that the functions of business administration include: structuring, task allocation, coordination and supervision within businesses. This study will support the businesses administration of construction organisations to efficiently and effectively utilise construction resources (Ye, 2020: 365).

Some of the hypotheses that this study seeks to address are presented in the literature, followed by the theoretical discourse that has guided the study. It is important to note that the construction, especially houses, falls under one component that fulfils or satisfies the basic needs of man; which is accommodation (Qi *et al.* 2020:3). This has gone through various technological improvements since the creation of man to modern days with the Toyota company advancing with Lean Thinking. The building construction thinking which has been intended to provide shelter to man and is well adopted by most European and developed nations is not yet welcomed in Uganda despite various challenges to the sector. Despite this, lean thinking has a greater opportunity and Uganda seems a fertile ground for the thinking to take its roots.

## 2.1 Motivation for the Construction Industry in Uganda

Building construction in Uganda has undergone various stages of development ever since colonial days in an attempt to overcome different challenges in the construction industry (Abaho, 2019:3). The main emphasis has been to construct strong buildings and maintain efficiency for the successful projects but this has never been achieved as desired. As an industry, this study stems motivation for the construction industry in Uganda from two perspectives; the need and a right based perspective! As a need, this motivation stems from the psychological significance of housing in the work of Abraham Maslow who placed housing as one of the basic needs that is unavoidable to man. In the modern world, the need for accommodation has been commercialised especially in urban areas and this has become the basis for business entrepreneurs to seek the best approach to serve housing and construction demands. Housing therefore is under the physiological needs (Ref. Figure 2.1), which is a basic need for man's existence on the earth (Mcleod, 2018:5).

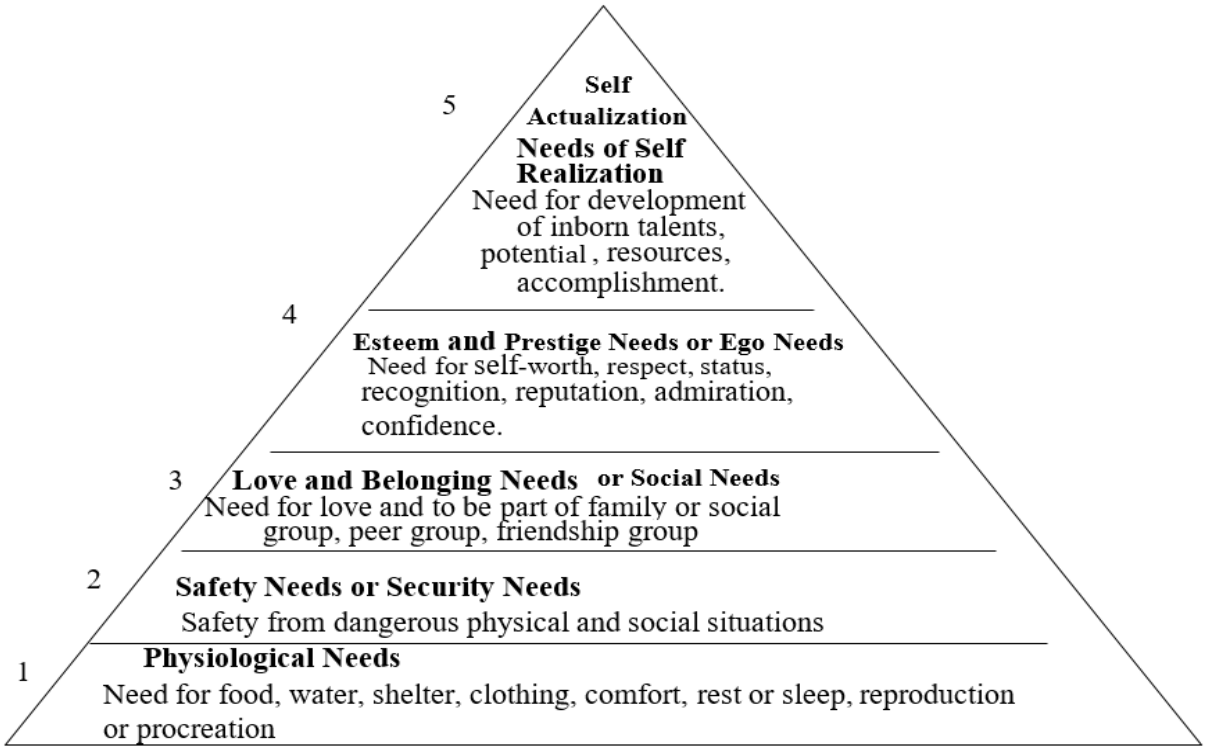


**Figure 2.1: Abraham Maslow's Hierarchy of Needs**

Source: Mcleod (2018:1)

From Abraham Maslow's needs' perspective, it is indicated the construction industry in Uganda is stimulated towards meeting human demands for development in various communities and societies. Therefore, before other developmental business can take place within Uganda or Kampala Capital City (Asibuodu *et al.* 2016:1066), the construction of houses must be done as demanded. In fact, basic human needs serve as a good foundation for the rest of human business to rest upon societal development. The physiological needs as human basic needs interact with one another vertically and horizontally. Much as food, water, clothing and reproduction are basically important, locating humans in specific housing sounds vibrant to human development in the 21st Century. According to Basheka and Tumutegyereise (2012:3), without the physiological needs (food, water, shelter, sleep, clothing and reproduction, the human race will just die out or become extinct. Therefore, the importance of the construction industry is important for the survival and sustainability of Ugandans. It is also the main water-shade in the Sustainable Development Goals (SDGs), especially goals 8, 9 and specifically goal 11 about sustainable cities and communities (Urama, Osor and Acheampong, 2014:9).

In the ambits of rights, the construction industry and its activities in Uganda is highly recognised owing from the international norms that emphases housing as a right (Human Right Centre, 2019:28). This starts with Universal Declaration of Human Rights (UDHR), 1948 and subsequent International Covenant on Economic, Social and Cultural Rights of 1966, Agenda 21 of 1992, Istanbul Declaration and Habitat Agenda of 1996; and the Sustainable Development Goals (SDGs) (SDGs, 2016: 2). At a regional level, the African Charter on Human and People's Right, 1986 recognised housing and shelter as one of the rights to man in light to implement UDHR in the African continent (Grotti *et al*, 2018: VII). In East Africa, the East African Community (EAC) Treaty recognises the right to housing. The fact that Uganda is signatory to these declarations and treaties; and owing from the fact that she embraced SDGs yet the construction industry still has bottlenecks, the lean thinking has a role to play (Johannes and Lombard, 1996).

### 2.1.1 Conceptualization of the Construction Industry in Uganda

The construction industry in Uganda evolved through discriminative policies between European, Asian and African's housing structures (Colonnelli and Ntungire, 2018:10). This form of policies

characterised the colonial period in which the British (senior quarters) and Asian (junior quarters) had separate physical constructed structures, and Africans as well. Mostly, the Africans had their own constructed structures at the periphery of urban centres which later led to the emergence of informal settlements and peri-urban slums (Lawrence *et al.* 2021:78). In the aftermath of the Second World War II, the construction industry was one of the sectors that received a wind of change from returned soldiers who had interacted with the whites and Asians during the war. As a result, the East African Royal Commission was established. Among others, the commission recommended for direct public intervention which characterised the construction of workers' houses in Naguru, Ntinda and Nakawa. The commission also called for relaxation of the housing standards in Kiswa and Ntinda with other parts of Kampala in an effort to have a uniform law upon construction and housing among the people living in Uganda (Opuch, 2016: 3 - 5).

From 1962, the housing structures constructed for white colonialists and other European expatriates were taken by senior Ugandan civil servants, but the general public remained un-catered for by the then construction industry (Colonnelli and Ntungire, 2020: 326 - 330). The post–independent industry therefore focused on low-income groups which made the National Housing Corporation (NHCC) set two main goals to follow since 1964. Firstly, to set construction projects that would accommodate the low-income people's housing needs for rent and houses for sale. Secondly, to have reasonable materials to be sold to individuals so that potential and capable persons would construct their own houses. Despite these, Uganda had various social–economic challenges that could not enable it to achieve the set aims. A few years later in 1979, the nation fell into the path of political instability which lasted up to the 1980s. The construction industry during the period has limited history and activities. Some housing schemes in peri-urban areas like Namuwongo – Kampala, Kasese, Entebbe and Jinja were abandoned due to insecurity and economic development (Muhwesi *et al.* 2014:1-4).

The construction industry in Uganda was later revived in the 1980s with upgrading Namuwongo and the Low – Cost Housing Pilot Project in 1987 and Masese Self-Help Women's Project in 1989 (Colonnelli and Ntungire, 2020: 326). The industry also set itself to rehabilitate war ravaged materials and buildings in different parts of the country like Arua, Masaka and Mbarara.

Following the UN General Assembly Resolution No. 41/190 of December 1987 on the International Year of Shelter for the Homeless, the construction industry which was supported by the Ugandan Government started the development of the National Shelter Strategy, adopted in 1992 with two main objectives; formulating viable shelter strategies, conducive to full mobilisation of local resources to improve shelter and living conditions; strengthen policy making and housing programming capacities of the key actors in housing delivery at all levels of administration. The National Shelter Strategy was adopted as an enabling approach, embraced by the private sector, NGOs, CSOs and CBOs to provide efficient and effective construction projects. While within 10 years of its initial plan the National Shelter Strategy had positive results in Uganda, the construction industry could not successfully deliver to the satisfaction of stakeholders in relation to time and quality (Byaruhanga and Basheka, 2017: 31 - 32).

Towards 2010, the Government of Uganda emphasised the importance of the construction industry to housing development and national economy in general (Colonnelli and Ntungire, 2020: 326). Its contribution was by 5% to Growth Domestic Product (GDP); and anticipated to rise to 13% in the subsequent years. It was also realised that with increasing population, there was an annual need for over 200,000 houses of which 135,000 were in rural and 65,000 in urban areas. It was also projected that by 2022, the population of Uganda will be above 45 million and over 500,000 housing units will be needed yearly. To improve the construction industry, the Government of Uganda came with the National Construction Industry Policy in order to regulate, coordinate and develop housing programs (MoWT, 2010) (Byaruhanga and Basheka, 2017: 31 - 32). This was intended to increase individuals' constructed houses to 80% to enable the government collect taxes and increase revenue. This however, could not be reached with the collapse of various buildings in Kampala District, limited supply of materials and lack of funds to support such private projects.

With the National Construction Policy, the Uganda Construction Industry Commission was established as the main body to regulate and coordinate activities within the local construction Industry (Mayer, 2011: 17-18). Earlier in 2006, professional institutions and trade associations had proposed a progressive approach that would enhance the construction industry in Uganda. The National Construction Policy and a corporate commission was therefore a fulfilment to this

recommendation (Ministry of Lands Housing and Urban Development, 2013:1). The extent to which the commission and its partners fulfilled the demand for housing and construction in lieu of the growing technology as a mode to deliver constructed projects and minimise waste still stood a challenge. While this still posed the main challenge, promoting new and appropriate technologies were among strategic recommendations by the national construction industry policy in order to stimulate the construction industry and its development (Ogwang and Vanclay, 2021: 4 - 6).

With Vision 2040, the government linked the National Construction Policy so as to increase investments in the housing sector; increase and manage the physical infrastructure as the road towards development (Mbabasi and Atukunda, 2020: 1-2). In fact, one of the strategic motivations for vision 2040, is transiting from low-income to middle-income countries within the 30 years with the goal of US$9, 500. The 2040 vision envisions a roadmap for infrastructure development in the transport sector so as to ease transportation of the construction materials. Since 2010, an increase from 4% to 80% by 2040 was envisioned to pave roads so as to tap other resources that would support the construction industry. The establishment of a transport infrastructure network consisting of a standard gauge railway system, road network, water and air transport modes were brought in the vision 2040 with the main emphasis to the urban areas, especially Kampala Capital City (Dimanin, 2012:12). Standardised constructed road infrastructure and upgraded road network were perceived for developed cities to network the nearby rural areas with the view to ease construction of modern buildings as a form of decent shelter. Thus, increasing planned settlement of people in rural areas as a right and basic need from 51% from 2010 to 100% by 2040.

Owing to the history of the construction industry in Uganda since colonial days, and using the lens of human rights and needs approach, the construction industry in Uganda has various limitations that always hinder efficiency and successful delivered projects (Thadani and Go, 2021: 2-3). While a lot has been done to rectify what has been wrong, there are still challenges which the industry faces in the management and time delivery. The challenges have been dissected into two at management and industrial level. These challenges show the primacy to why the construction industry would have adopted the lean thinking in the road to fulfil the needs and human right perspective in the construction.

At project management level, problems in the construction industry in Uganda start with coordinating the stakeholders, project planning, design and implementation (Mukiibi, 2011: 44-45). The most common problem which would have been solved by lean thinking is poor project performance and delivery. This comes from different factors to schedule overruns on construction projects, that accumulate during delay in assessing initial work and changes in the scope of work by the consultant, financial indiscipline/dishonesty by the contractor, inadequate contractor's experience, design errors and inadequate site investigation by the consultant. Studies have indicated different causes of schedule overruns which include delays in recruitment and payment of the workers, differences in monitoring and controls; and inadequate / inefficient equipment. In the context of Uganda and Kampala Capital City especially, cost overruns have been caused by changes in work scope, inflation, high costs of capital and human capital resources weakness, delayed payment to the contractors and fuel shortages (Nilsson, 2017: 7-8). Previous research in Uganda has indicated that delayed payments, poor project monitoring and control and cost overruns mainly surface in most projects hindering the success and delivery in time. The lean thinking and its approach to human capital approach is essentially important to harmonise such challenges towards successful and efficient project delivery.

In Kampala Capital City, the rate of overrun in the construction industries and especially road infrastructure has been mentioned over the years. Bidandi and Williams (2017:14) had noted with concern that the 21 km Kampala Northern Bypass highway project had more than 100% challenges in cost overrun (Mbabasi and Atukunda, 2020: 1-2). One of the causes has been the human capital resource in which low levels of workers become the most impacting issue. While the world has advanced in line with technology and Information Commutation, workers remained using manual approaches in the construction industry despite being key sectors that would possess a visible shift from manual to automated or computerised works. The fact that labour has been perceived problematic, there are various issues that have been studied to understand the discourses in human capital resource or labour in the construction industry. These include competence of supervisors, limited and lack of skills by the supervisors and skilled workers, lack of appropriate equipment or tools to certain pavements or nature of housing construction and poor construction methods as well (Byaruhanga and Basheka, 2017: 31 - 32).

The construction industry in Uganda has a problem of poor quality of works accomplished that always result in collapse of construction or rework. In most cases, if the construction has not collapsed in housing construction, the supervision in the aftermath results in rework (Katende *et al.* 2006:333). Both increase wastes in the construction and unnecessary costs over time. In Uganda, the significant rationale behind rework in public building construction are ineffective stakeholder management which stems from planning and designing of the whole project; insufficient and ineffective work supervision and use of non-compliant building materials. In fact, non-compliant building materials have been the main cause for collapsing of buildings across Kampala and Wakiso districts (Mbabasi and Atukunda, 2020:1-2). Insufficient skilled workmanship is also a cause of rework during the construction and operation stages of building. The mean percentage range for rework in Uganda is 12.5%-15.6% of the construction contract scope while the mean impact of rework on project budgets is 4.5% and on schedule it is 8.4%. But, the wastes in the due course are too much as compared to reworking or resumption of the work.

There is a high rate of accidents in construction in Uganda, especially in building constructions (Mukiibi, 2015:85). Studies on various causes of the accidents show that all stem from inadequate supervision by specified contractors, use of incompetent personnel and the use of inadequate construction techniques. These have been the main causes of accidents on various buildings in Kampala Capital City (Izudi *et al.* 2017: 1-2). In light of the housing and building sectors, the collapse has been increasing and more buildings have been earmarked for demolition. Although demolition comes at an early stage with less impact on human lives, the wastes in the due course remains big to stakeholders with limited or no sources of income. In terms of impact, accidents in the building industry reduce the capacity of workers of whatever level who have been involved by 37%, on average. From the economic perspective, accidents resulting in failed infrastructure means losses of investment, while the social cost is mainly in terms of lost and injured lives. Indeed, death is the ultimate loss, since human life is a source of rights, as enshrined in the 1948 UDHR.

Apart from the managerial challenges, the construction industry in Uganda has various problems that equally have hindered the industry from growth and development (Snyman *et al.* 2015: 1207 - 1209). These problems have existed beyond individual persons or engineers. Actually, there exists informal construction practices, less building materials available, cost and quality, environmental degradation, inadequate housing finance systems, a huge housing deficit, and challenges of land acquisition. These have increased with weak policy implementation and inadequacy in the workforce. Informally, constructions are never planned for and less emphasis has been put on regulating housing or the building activities. In Kampala Capital City for example, few individual persons and companies submit building plans with accompanying proof of land ownership, for approval by the city authority (Kiconco *et al.* 2019: 1-4). When the building is completed, the requirement to apply for a certificate of occupancy as proof that a building is fit for habitation is also not met. Besides, some buildings are constructed without accreditation to government agencies or by the Ugandan National Association of Building and Civil Engineering Contractors (UNABCEC). Notably, the informal construction covers more than 70% of the total buildings constructed in Kampala and over 90% in rural areas. In countries like Uganda where informal construction prevails, adherence to standard technical practices has never been guaranteed and clients do not get value for money. The number of material waste that is not accounted for is also high (Nambatya, 2015: 11-13).

The building materials that are available pause a challenge to affordability and quality to the construction industry in Uganda (Rafindadi *et al.* 2022: 2-3). A significant component of building materials (60%), especially cement and steel, is imported implying that prices of materials are susceptible to fluctuations of the Uganda shilling against international currencies. This mostly affects individual persons and start-up companies that must maximise profits and materials in order to construct. The shortage and importation of materials is responsible for high prices of materials which leads to high construction costs and an increase in the rate of waste accumulation. There is also evidence to show that poor quality materials are partly responsible for cases of low-quality construction works registered in Uganda, which has been responsible for the collapse of the buildings or rework (Kiconco *et al.* 2019: 1-2). Traditional building materials such as burnt bricks are becoming more expensive due to shrinking availability of fuel energy resources, especially

firewood and the cutting down of forests to generate firewood is causing environmental degradation and also raising concerns of sustainability for the building industry in Uganda (Snyman *et al.* 2015:1207). There are also concerns that wetlands in Kampala are being reclaimed for industrial and residential expansion, a development which compromises their economic value as well as the wetland services which they provide, such as purification and treatment of waste waters.

The construction industry in Uganda and the housing finance market has grown from a single residential mortgage since 2002 to four types of mortgages by 2011 including residential, commercial, land purchase and construction finance (Mayer, 2011: 12-13). However, there are challenges of the cost and availability of housing finance in Uganda. The interest rates charged by commercial banks in excess of 15% are high, and only five banks dominate the market (Kalema and Kayiira, 2011). In effect, these developments have affected the activities of private investors in the housing sub-sector since the 1980s despite being known by the government. Nonetheless, the nation is having a huge housing deficit estimated at over 233,000 units by 2008 (Mubiru and Ikirisa, 2021: 854 - 855). The 160,000 units of this backlog are in urban areas with Kampala alone having an estimated deficit of 100,000 units by 2008 (Hashemi and Cruickshank, 2015: 47-48). Meanwhile, the population of Kampala and its peri-urban areas like Wakiso and Mukono District is growingly rapidly at an average growth rate of 2.3% per annum over the past twelve years (Davis, 2019: 2-5). The rapid growth of population in the city has been due to high fertility, decline in mortality and migrations. Therefore, without matching housing facilities to the increasing number of the population, the housing industry remains at the threat towards the physiological needs and the right to shelter. The lean thinking is therefore justified for the case of Uganda (Kwiringira *et al.* 2021: 1-3).

### 2.2 Lean Techniques and its implementation

Since the 1950s, lean production or Toyota production system techniques have evolved and successfully implemented by Toyota Motor Company. Toyota's production system had two pillar concepts: Just in Time flow (Durakovic *et al.* 2018: 130-132) as illustrated in Figure 2.2.

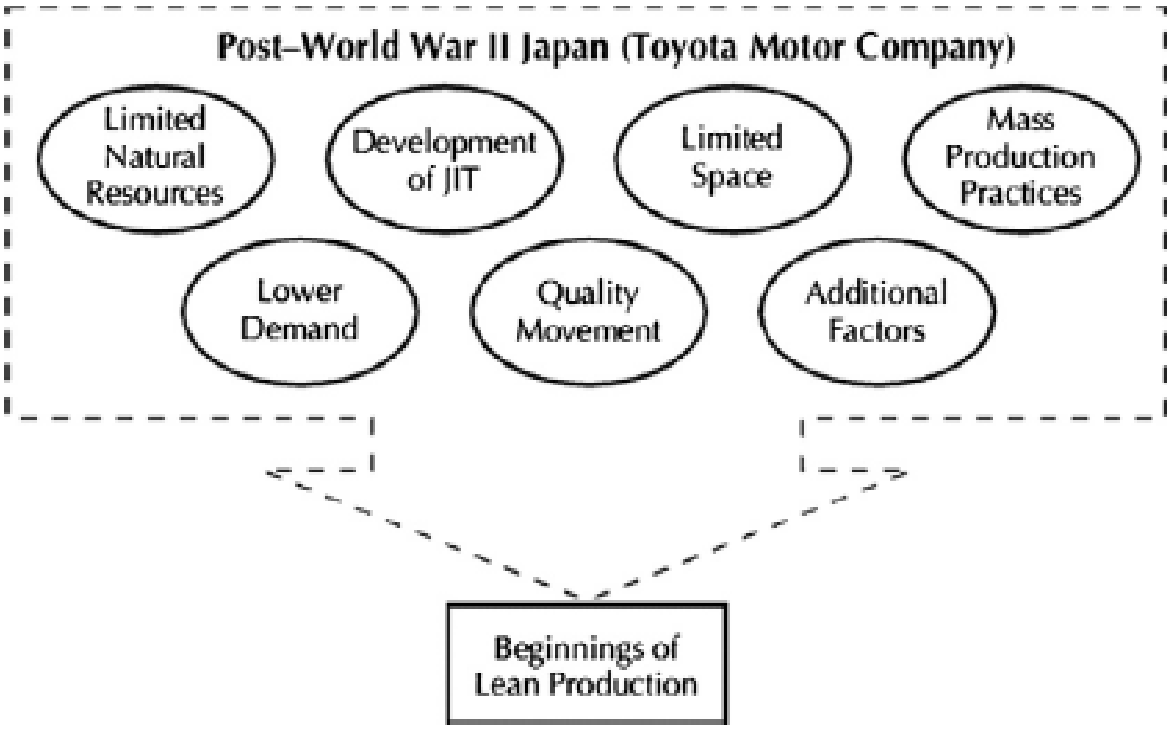


**Figure 2.2: Beginning of lean production**
**Source:** Aziz and Hafes (2013:680)

According to Elagina *et al* (2020:1-2), lean construction concepts are processes or measures that minimise non-value adding activities and make sure that the value adding activities are extensively controlled in order to increase productivity. Under the lean thinking, value is maximised towards the value-added activity like information, people or shape materials. Awareness and redefining the process are essential towards productivity with the thinking; itself, the lean thinking has a process of improvements (Pinto *et al.* 2022:2). Its implementation starts right from the start with a higher propensity of satisfying customer's requirements. Kumar (2014:235) states that elimination of waste enables product flow by establishing a rate of flow, thereby synchronising all the activities as well as focusing on the potential constraints. This makes a pull of customers to increase for companies using the lean concept in its construction approach through needed downstream. When this happens, it needs to be handled quickly with effective and quality approaches. The main

emphasis is therefore perfecting the process of quality flows, transparency and zero waste which are important components under lean thinking.

Various arguments have been raised in order to make the scholarly world to be aware about lean. Mostafa *et al.* (2013:40 - 45) had stated that to make the construction lean, there are various indicators that need to be put in place. In the first instance, the site assembly waste must be created in line with the lean techniques for dynamic construction. While this can be organised, it is imperative to divide the non-added value into two categories. These are non-value – added activities which are necessary waste with no value. They cannot be eliminated based on technology, policy or thinking. Their existence violates orderly coordination of the project implemented, regulation and the company or contractor mandate towards efficient project delivery. According to Nordin (2018: 281), the non-activity pure waste is the second form and takes resources during the construction. They create no value before the customers. These among others include waiting time, inventory, rework and excess checks during exit and entry to the construction site.

Gračanin *et al*. (2020:317) emphasised the flow of the system that supports conversion processes. They include transport and storage as well as movement with a few exceptions, as such systems do not add value. Both conversions and 'flows' expend costs and take time. Figure 2.3 shows 'Just in Time' in conjunction with 'Jidoka' a Japanese principle in waste reduction (Saputra, 2020: 83 - 84). In the figure, the roof can only be held up by Just-In-Time (JIT) and *Jidoka*, which is achieved through people's efforts and reduction of construction wastes.

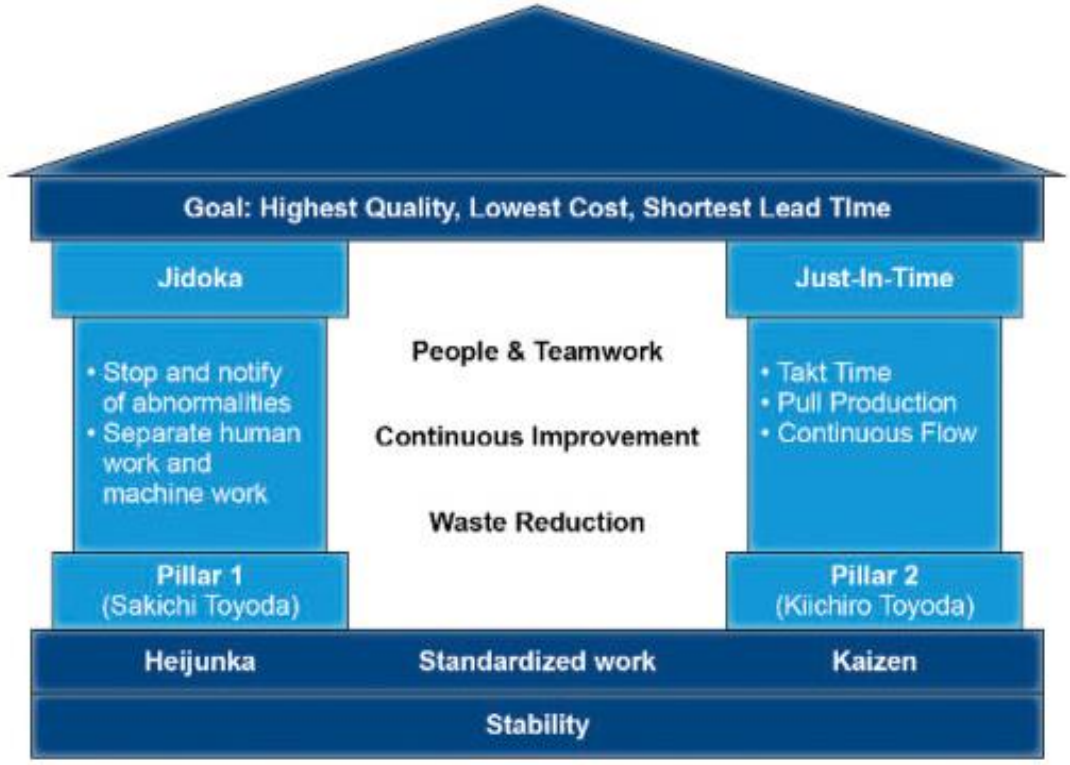


**Figure 2.3: Project success house through waste reduction**

**Source: Drawn using the idea of** Bajjou *et al*. (2019: 5)

In a survey, Afonso and Cabrita (2015:271) simplified and depicted the key concepts of lean construction and thus what makes the construction lean. These included; just-In-time, total quality management, business process re-engineering, teams, concurrent engineering and last planner system, teamwork and value-based management. These were identified as some of the commonly used techniques in the construction industry. Just In Time (JIT) is in use in the industry's supply chains in case of manufacturing of construction components and is a vital element. In order to deliver lean manufacturing, the suppliers' network must be improved (Saad and Khamkham, 2018:588). Shang and Chen (2016) stated that the main reason for adopting JIT techniques in construction is to fasten the flow of activities and make it move smoothly throughout the construction process. Accordingly, it eliminates waiting as well as the transportation waste between activities, because it focuses on finishing each activity in the project with its required resources in terms of personnel, materials as well as equipment (Vamsi *et al.* 2015: 2-4). Bajjou *et*

*al.* (2019: 5-6) mentioned that it utilises the actual required resources (pull production) according to the lean last planner system rather than forecasting resources as in traditional methods. Therefore, overproduction waste can also be eliminated. Total Quality Management (TQM) must be adopted upstream and downstream to ensure that the activities achieved are of high quality and that unnecessary processes (defects) are eliminated. Saad and Khamkham (2018:590) showed that huge efforts must be implemented to encourage the construction industry to adopt the same lean JIT systems, often company-wide, rather than being solely concerned with that part of the suppliers' operations that impacts the manufacturer.

It is imperative to assert that the lean construction principle or thinking can only be applied fully and effectively in construction by methods focusing on improving the whole process (Husaimi *et al*. 2016:363). This means that all parties must be committed, involved and work to overcome obstacles that can arise from traditional contractual arrangements. Besides, the data collection must be carried out before evaluating lean techniques. Liao (2018: 984-985) used both interview and questionnaire in various case studies for their evaluation of the lean thinking in which they found the need to embrace the whole process rather than partial approaches. In fact, evaluation of the lean construction has been conducted utilising both qualitative and quantitative methods. Results indicated that lean is essentially a thinking of quality, efficient, transparent and successful project delivery in time.

In an evaluation study by Shurrab and Hussain (2018: 6-7) among the Arab nations about the management of lean proactive construction, it was found that lean thinking was a creative approach and problem-solving service. The implemented lean thinking project involved using structured, multi-disciplinary, team-oriented approach to make explicitly the clients value the system using functional analysis and to expose the relationship between time, cost and quality. Moreover, according to Maware et al (2022) it was observed that lean techniques improve operational performance for general organizations in developing and developed countries. To Imtiaz (2019:148), the strategic and tactical decisions taken by the client and the design team are audited against the client's value system at targeted stages throughout the development of a project and/or the life of a facility. This is composed of manufactured components, where components form elements, elements form spaces, spaces reflect corporate organisation and client strategy. Further,

it is described that value engineering (technical level) is an organised approach to provide the necessary functions at the lowest cost without compromising quality and it is concerned with both client and contractor and applicable at technical level to improve design solutions. Both value management (VM) and value engineering (VE) are conducted through a workshop at an early stage of the construction project. Major stakeholders must attend the workshop to recognise the client objectives, participate in making the client value system and keep monitoring the implementation of the client value system through the whole life cycle of the construction project. From this perspective therefore, the main emphasis is the need to apply lean thinking right from the start of the construction of the facility or any building. This therefore justifies the view that the whole process of lean thinking or concept centres on satisfying the clients who take initiatives to realise the need of the facility and a discourse to right to development for different ends. The lean concept therefore remains the most engineering, technical, a need and right based approach in the construction industry due to its values that cut across different programmes, procedures and parameters.

The various questions like at what stage can lean construction be carried or implemented during the construction process have also been addressed under the lean thinking. Unlike Balkhy and Sweis (2021:2)'s view of inclusiveness and whole embracing approach, Oladapo *et al.* (2014:90). Ogunbiyi *et al.* (2013: 83-84) are of the view that lean thinking can be implemented at different stages according to the project phases in the construction industry. However, there is considerable scope for the application of lean thinking so as to remove waste from the design process. As indicated by Ochieng (2016:1344), the system or the building techniques involve reliance upon standardisation of components and prefabrication of building sub-assemblies. System building techniques are now generally viewed as failure, since many of the buildings delivered have been deemed socially unacceptable. Balkhy and Sweis (2021:3) provided that standardisation and prefabrication, together with dimensional coordination, remain key features of almost all modern construction works. The production engineering function which is conventional assumes a far greater role than what one would wish to use in construction (Womack and Jones, 1997: 1151). Moreover, the design process and philosophy of building is radically transformed so that there is greater emphasis on design for production than on what may be considered as more conventional

(Afonso and Cabrita, 2015: 371 - 372). Kamarudin and Nakanishi, (2017: 41) explained that almost all construction projects involve a high degree of mechanisation and include an 'assembly' process that combines numerous small or large factory-produced components or sub-assemblies and integrates them to yield a 'customised' or unique product. Thus, a modelling approach that seeks a lean thinking per construction project is essentially important and determines the application of the philosophy before the construction ensues (Arif *et al.* 2013: 94). The lean thinking should not be a system rather an application to different construction projects with main emphasis to clients' needs.

Therefore, the construction industry or company needs early thinking as one of the building information models (BIM). The BIM is one of the processes that can be used in generating and managing building data during the project life cycle (Sarhan *et al.* 2017b: 48). According to Erol *et al.* (2017: 241), BIM is essentially important in simulating the construction project from the start to the end and thus, it majorly contributes to project success. BIM uses three dimensions in construction and these include real-time and modelling software so as to increase the design for the building or construction and design. The BIM is mostly applied in the off-site constructions (Arif *et al.* 2013: 97). It helps the design and construction team to collaborate on a coordinated model, thereby providing team members with better insight into how their work fits into the whole project, which ultimately helps them to ensure efficiency. Mutual exchange of data between all stakeholders throughout the whole life cycle of the project is a crucial element for successful implementation of BIM. BIM has different advantages to the construction in case it is clearly applied. Some of these include; controlled production environment by modularised assembly; capability to realise continuous improvement; high capability for automation; decreases site disruption and thermal loss; high sustainability and minimisation of wastes, which is the main emphasis to lean construction.

### 2.2.1 Lean principles and cultural values

The principles and culture of lean have been discussed in light to shade awareness about the lean thinking or transformation under company or organisations (Fadnavis *et al.* 2020: 31). The general objective in principle is to create customer's value and make it flow without interruptions during

the planning, design and implementation. The lean culture can be described in terms of key canons: The first canon is the fact that a customer is the first (Svidsayi, 2021: 6107). Within the five principles of lean—specifying value, identifying the value stream, flow, pull, and perfection; a customer is understood at the strategic level and these principles are applied in all parts of a supply chain. These principles represent one philosophical perspective of lean focusing on awareness, understanding and maximising customer's needs (Aziz and Hafes, 2013: 56).

The second cultural value is continuous improvement, which is the process of making incremental improvements, and achieving the lean goal of eliminating waste that adds cost without adding value (Reponen *et al.* 2021:2). This ensures that change does not end at one radical improvement, but it involves a gradual improvement in competence of all processes and people. The third is the respect for people. In lean, a great emphasis is placed on developing and empowering people. The knowledge of individuals or suppliers is appreciated and utilised when making decisions by consensus. The secret behind Toyota's continuous success is in its deeper business philosophy and understanding of people and human motivation (Fadnavis *et al.* 2020: 31-32). Within these cultural practices, lean thinking is embedded.

Learn implementation is a discourse to practices which include eliminating waste, unevenness and overburden (Prasad and Vasugi 2023: 6434). The underlying principle of production levelling is variation in products and processes that usually cause problems; therefore, it should be eliminated to keep the system stable, allow minimum inventory and prevent further waste creation. Secondly, lean goes with standardisation which helps to define problems as gap between target and actual condition (Taherimashhadi and Ribas, 2018: 207-208). Rigorous standardisation protects systems from variation and provides a basis for continuous improvement and organisational learning— key competitive advantages to be achieved with lean. Lastly, there is a practice of visual management. In any process the ability to recognise and to remedy abnormal conditions quickly is important. As people are usually attracted by what they see, the objective here is to make communication simple and attractive so as to increase peoples' awareness of the current status of any process (Fadnavis *et al.* 2020: 34).

### 2.2.2 Lean Project Delivery System (LPDS)

The Project Delivery System (PDS) is the collaborative process by which Project participants transform the owner's goals and objectives into a fully finished infrastructure (Lerche, 2020 *et al.*, 2020). Issa (2013:3) had indicated that PDS is an inclusive process of assigning the contractual responsibilities for designing and constructing a project. In line with PDS, Lean Project Delivery System (LPDS) recently emerged as a new approach to deliver projects based on three fundamental goals: deliver a product, maximise value and minimise waste. It was developed in an environment of complex projects, uncertainty and dynamic needs of development. According to Balkhy and Sweis (2021:89), the lean project delivery is an innovation that combines strategies of Operating Systems (OS) that do not need a set of the organisational communication and authority protocols as well as new forms of contract. It developed as a countermeasure and produced immediate improvements in project construction performance. Ballard (2008:66) had stated that the main emphasis of LPDS is achieved by stating clients' want to accomplish and constraints like costs and time that hinders effort to achieve what is intended too. As illustrated in Figure 2.4, each phase in LPDS contains three project steps. Each triangle represents a project phase which overlaps, and some steps are part of two phases due to the interconnectedness of project delivery.

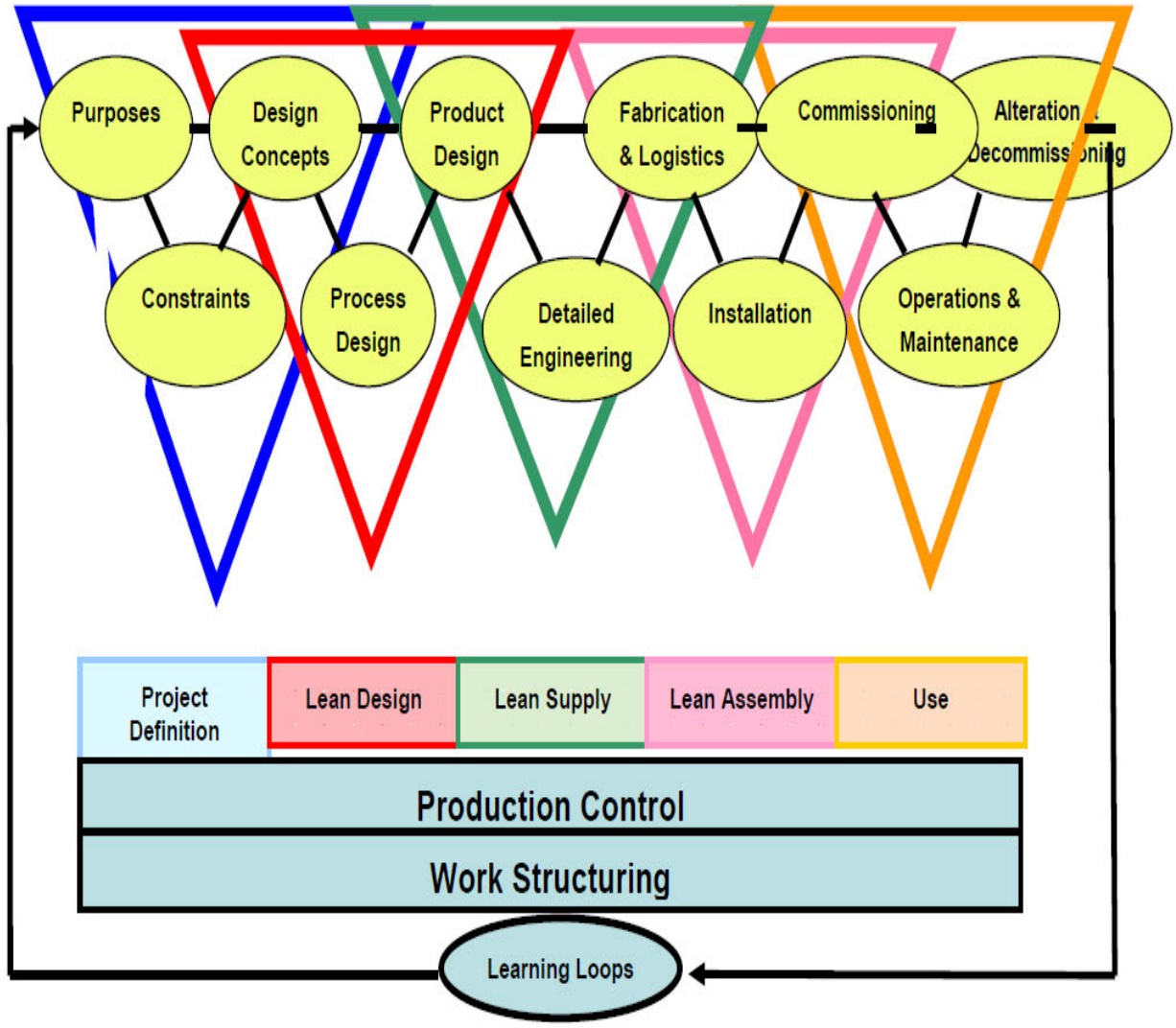


**Figure 2.4: Lean Project Delivery System**
Source: Aziz and Hafes (2013: 686)

In some instances, some customers do not know what they really want. It is therefore the role of the constructing company to help the client to establish what he/she wants in the due course. The understanding of the customers' purpose and constraints expose the company to various alternatives that would enable in the accomplishment of the purpose.

### 2.2.3 Awareness and utilisation of lean techniques

In effort to seek knowledge and assess awareness towards lean thinking, this study assessed various research works, books, journals and articles with the main discourse on whether the concept is well known. The discussion is presented based on different variables that need essential awareness in line with the lean thinking. Staats *et al*. (2009: 1-2) had evaluated the sustainability perspective and competitive advantage under lean thinking. Another study assessed the inclusion and accommodation nature in management of lean thinking in 2009 and the extent to which lean has a contribution to sustainable development (Keyes, 2013: 79-80)**.** In the two publications, it is indicated that participants were aware that there is a competitive advantage as a construction company applies the lean. In the second study, the authors found that participants were aware that a relationship contribution between corporate image and profitability are two important elements of competitive advantage.

Most of the studies have assessed lean construction and its discourse to sustainable development especially in developed nations (Marhani *et al.* 2013:3). In developing nations of Africa like Morocco, emphasis has been put on construction management and reducing delays as well as wastes (Bajjou and Chafi, 2019: 235 - 23; Hicham, Taoufiq and Aziz, 2016:194-195) In Kenya, studies have focused on factors influencing completion of construction projects with limited discourse on lean thinking (Ayuya, 2012: 10-16).

Upadhye *et al*. (2010:23) identified 14 potential benefits from lean manufacturing/management practices to shed light onto the path of sustainable development. In the same way, Pepper and Spedding (2010:1) reviewed evolution of lean six-sigma and explored awareness among companies how waste minimisation power of lean can be harmonised with quality control competency of six-sigma methodology. Authors noted that while companies would be aware of such attributes from the lean thinking, there was a lack of a standardised framework knowledge for a lean six-sigma implementation. Winter and Knemeyer (2013:1) reviewed 456 articles to discover awareness of the current state of the integration between supply chain management (SCM) and sustainability by the lean, as well as to identify future research opportunities. Dhingra *et al*. (2014:1) reviewed Journals about knowledge of Cleaner Production that was dedicated to

the discovery of synergies among lean, green, and sustainability concepts. Three recommendations were later given from the articles, one of which emphasised knowledge about the sustainability champion in companies for a successful implementation.

Johansson and Sundin (2014:3) conducted a systematic literature review on 102 journal publications to compare lean product development with green product development. The authors came up with seven propositions that were known by companies and were in favour of the synergistic relationship of two different product development concepts in terms of value creation, waste generation, implementation, education/training, tools/techniques, as well as process structures and activities. In another literature review, Wadhwa (2014:23) found knowledge of synergies of the environmental management systems (EMS), lean, and green for manufacturing Small Medium Enterprises (SMEs). The article highlighted increasing complexity in knowledge levels in various firms when these paradigms are combined as one of the barriers. Bocken *et al*. (2014:88) constructed technological, social, and organisational sustainable business archetypes in which he sought to underpin its knowledge among firms and individuals. The authors proceeded with a detailed explanation of each selected archetype to shed light on the business model innovations for sustainability.

Hallam *et al*. (2018:1) made 109 peer-reviewed articles along with data associated with 23 Baldrige Award winners to discover correlation between lean thinking and sustainable competitive advantages. They emphasised the importance of making lean actions awareness as part of business-level strategic plans to achieve meaningful outcomes in the long-term. Wichaisri and Sopadang (2017:1) observed the current trend in sustainable development and identified the need to make lean-driven Triple Bottom Line (TBL) knowledge known among the most probable directions for future research. In yet another study, Danese *et al*. (2017:1) conducted recent lean awareness research and its future imaginations among firm managers. The authors identified relationships of lean-green, and lean-social sustainability among issues to be tackled in the future research studies. According to Negrão *et al*. (2017:11), various lean tools were positively correlated with the overall performance of companies in various sectors according to reviewed 83 articles to investigate level of lean adoption across industries and impact of lean practices on

operational, financial and environmental performance. The study found a high-level utilisation of lean concepts and principles as key to success of their operations.

Garsa-Reyes (2015:1) investigated lean-green relationship and identified six research streams addressing issues such as compatibility, integration, development of awareness assessment mechanism, and impact of lean and green on organisational performance. The author also pointed out untapped potential in the field of lean-green synergies which must be utilised so that firm managers and workers have wider knowledge in the management. Another past literature review aimed at discovering knowledge about the relationship between lean and sustainable manufacturing by means of performance outcomes. A total of 58 empirical and conceptual studies were reviewed to identify the current state of knowledge of lean, as well as to determine the extent of the positive impact of lean and sustainable manufacturing on TBL pillars. The findings of the study indicate a high level of knowledge in most firms where the study was conducted. To Giret *et al*. (2015:11) the urgency of delivering solutions to sustainability issues in the manufacturing operations necessities the lean approach. Articles were categorised under three titles, namely, input-oriented approaches (proactive), output-oriented approaches (reactive), and hybrid approaches. Highlights of the study included the importance of having benchmarking tools to evaluate and control input and output parameters for manufacturing scheduling problems and the necessity of more active involvement of universities in the subject matter.

Mejías *et al*. (2016:1) answered four research questions related to best practices in Supply Chain Management (SCM) discipline from the perspective of social responsibility as applied by firms. The authors reviewed 194 publications emphasising the importance of measurement of performance in logistics operations. Potential research opportunities focusing on development of TBL performance metrics for logistics operations was also among the recommendations of authors for effective management. Additionally, Hallam and Contreras (2016:1) conducted a review study covering 60 articles published in the field of the lean-green relationship. Knowledge on the impact of lean wastes and benefits associated with the elimination of these wastes were identified from the standpoint of environmental performance. The authors of the article argued that the achieved lean-green integration was weak and relied upon indirect environmental gains of lean initiatives. The lack of an integrative knowledge framework would trigger direct gains through co-

deployment of two concepts. On the other hand, Alves *et al*. (2016:1) shows the importance of having knowledge to involve a final database of 83 papers by investigating the relationship matrix of lean, green, and eco-efficiencies. The outcomes of the study showed an increasing level of lean-green synergies and referred to sustainability as the top item in the agenda of researchers and professionals.

In the same way, Quarshie *et al*. (2016:1) investigated understanding about the state-of-the art in sustainability and corporate social responsibility within the context of SCM and business ethics. Even though the identified synergy between SCM and business ethics was determined to be limited, the future research agenda presented in the study was quite inclusive to cover a broad range of topics including, but not limited to, inter- and intra-organisational collaborations, self-regulation policies, downstream SCM issues, and the impact of globalisation. Moreover, Singh and Trivedi (2016:1) provided an insight from the research stream of green SCM by conducting an analysis of 138 articles from 29 journals in which it is presented that firms have knowledge of supply chain management in order to cover time and costs which are essential components to lean construction. The findings also confirmed a positive trend for the interest in this stream while revealing various research gaps under categories of responsible manufacturing and logistics knowledge, supplier relations, Human Resource (HR) activities, and IT systems which are all essential to lean thinking. Vieira and Amaral (2016:1) worked on a final database of 37 articles and identified internal and external barriers being faced during the implementation lean concepts. The authors discussed various strategies to overcome identified barriers. Enhanced Control Programme (CP) knowledge, organisational transformed culture, stakeholder commitment, regulations, and use of quality tools were among the listed strategies that can make successful thinking.

Cherrafi *et al*. (2016:1) reviewed 118 articles published between 1990 and 2015 to explore two- and three-way relationships among lean, six-sigma, and sustainability. The researchers identified barriers in front of effective integration of these methodologies in addition to deliberate analysis to understand potential benefits associated with integration and co-deployment of techniques. The contribution of lean and six-sigma tools to environmental and social performance were also discussed to identify the TBL effectiveness of these paradigms. The need for sustainability

performance assessment systems, frameworks and models were emphasised along with some limited focus on application of frameworks in SMEs and service industry. There are many researchers seeking to identify the current state of lean knowledge and its association with other paradigms. In whatever forms, the focus has been using lean in order to maintain a sustainable environment that is free from dangers while serving the needs of the clients.

### 2.3 Success and realisation of lean- project to client's interest

From the awareness discussion, it is indicated that various literature has been presented across the globe and companies have used the lean approach in effect to succeed in their business. The main component under lean is satisfying the clients. Alzahrani and Emsley (2013:1) refer to project success as having results much better than expected or normally observed in terms of cost, schedule, quality, safety and participant satisfaction. Furthermore, Alsahrani and Emsley (2013:11) suggest that construction project success is having everything turn out as hoped'. Identifying critical success factors would therefore assist in taking proactive measures for successful project management. Schedule, cost and quality performance is considered to be the "iron triangle" which is the criteria for determining success of a project (Tabish and Jha, 2012:20). According to Ramlee *et al*. (2016:13) a project is considered as successful in the construction industry when it is completed on time, within budget and the quality is satisfied. However, there is limited literature about lean construction and project success in Africa, and more so in Uganda. In thirty-nine semi-structured interviews conducted in several companies and projects in Finland and California during fall 2011, the main aim was to explore practitioners' perceptions of lean implementation and thereby to identify cornerstones for successful implementation of lean in construction. Results show the inter-relationship of the variables for the success of the lean project as presented in Figure 2.5.

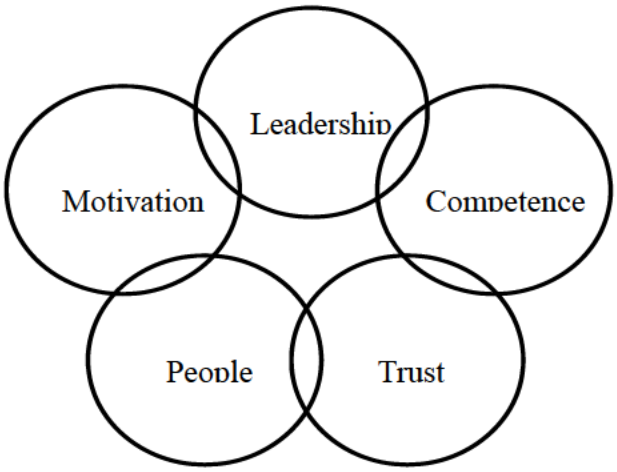


**Figure 2.5: Factors for the success of lean techniques**
Source: Ssali *et al,* (2022)

As presented in figure 2.5, leadership is important in lean philosophical thinking since it is a form of management during the implementation of the concept. Leadership has related aspects of managerial approaches and therefore, influences the success of lean technological implementation. It is leadership that takes in principle and cultural values so that the concern to client's satisfaction is achieved. Leaders must be committed to learn and understand what it means to become lean and to change their own behaviour accordingly to suit principles that constitute lean thinking. Leaders or the managers of lean need to be exemplary and ensure that clients are clearly satisfied. Secondly, the management approaches need to provide adequate resources to support a cultural transformation in the construction industry. Learning must be supported by organising training, acquiring external lean consultants if needed, and, most importantly as the benefits may not be realised immediately, by allowing enough time for people to learn.

Competence is another factor for the successful project under the lean so that the system works well as the whole. In the construction industry where time frame for learning is limited and project teams consist of people in multiple roles with different levels of knowledge and understanding of lean, training has a crucial role in supporting lean implementation. The training can be during

induction or an ongoing training. Providing knowledge is crucial since teams set themselves with assured and better approaches to success. It is competence that helps others to analyse things through a lean champion, as someone dedicated to promote lean in an organisation and its projects (guides, trainers, consultants, helpers, senses were among the other terms used by interviewees for this role).

According to Ssali *et al.* (2022:1826) people are a group or cornerstone that includes aspects of both individuals and other organisations. Starting with people, it has been evidenced that implementing lean requires people, willing to work with new concepts and come out of their silos, with social skills to work in more collaborative environments. Knowing or awareness of the partner's core competencies and interests is important since it helps to understand teams, setting project team aims and other participants based on the suitability of their skills and traits. Building trust among the companies involves developing a contractual framework to support lean so that people behave in a certain way. These are mostly motivated people ready to work in set principles and standards.

Losonci *et al*. (2011:78) had presented that the degree, and realising that success under lean has four main factors during the implementation programme. These include commitment, belief, work method and communication. Early in 2008, Radnor and Boaden (2008:1) had presented factors responsible for the successful lean project as the organisational readiness, a culture of continuous improvement, effective leadership, the availability of resources and communication strategy. The tools and techniques that are applied in the construction industry or any facility should be related to the overall need of the clients.

According to Kollberg *et al*. (2006:19), communication between stakeholders within an organisation is one of the initial visible factors for the success of the lean programme. In his assertion, Kollberg *et al*. (2006:67) had proposed major four critical factors that must be considered whilst implementing lean thinking for the successfully delivered projects. These include careful planning to keep competition among members of the implementation team but with one main aim. Secondly, a contractor who plans for the successful implementation and project delivery must review and analyse dimensions of lean construction concepts carefully. This applies

to all constructions from the building to other forms of industrial constructions. The acceptance from managers and encouraging them to cooperate with the lean programme is another stage for the success of project delivery. In most cases, this is dependent on the background relations and assurance of the contracting manager to deliver. In order to achieve this, there is a need to increase team-work since one contractor cannot successfully convince the managers about successful project delivery without a team of competent workers. Lastly, Kollberg *et al*. (2006) mentioned the need to identify and consider the interest of end-users of the lean and understand their needs as a final critical factor. The main focus at this point is client's satisfaction since all projects delivered are intended to reach and serve certain ends of the clients.

Dahlgaard *et al*. (2011:1) showed that the lack of proper corporate culture in a construction industry or any company is a source of all problems for transformed work on the constructed facility. Therefore, it is imperative to have an improved quality of culture that requires detailed understanding of problems and issues by the team or workers in the organisation, firm or company and this stems from the human resources. All employees need to be trained with skills to identify wastes, starting with the root causes, and improvement of actions because wastes can be seen everywhere at every stage; starting with planning, designing and facility construction. The staff and individual persons like clients can also identify wastes and problems. Some of these wastes start with signs of weaknesses at work that result from many business issues, long waiting time or low efficiency within the entity. The next important factor, knowing the difference between the cause and the issue by the administrator.

Dahlgaard *et al*. (2011:100) also state that the next important factor is the manager's understanding of the difference between the cause and the problem rather than assuming that the two are the same. This factor keeps the team together and knowing the extent to harmonise such causes to the problem or the problem itself. Other factors considered in determining the degree of success and realisation of projects are the understanding and approach to implementation, facilitating the implementation of lean, customer definition, feel of being engaged in the actions, quick wins, process redesign, defining clients and their needs correctly, aligning improvements with wider strategy, developing a culture of ongoing improvement, structured problem solving , getting long

term vision, and work environment (Radnor *et al*. 2012:1). Although the application of lean principles has been reported in literature, how such principles relate to successful project delivery is still limited. In construction industry and project deliveries, other determinants for the degree of success and realisation of projects have been discussed. Strategic orientation is one of the factors in the due process (Ahrq, 2014:14). In order to have success and improve performance in application of lean thinking in the long term, lean programs should be strategically connected to specificity of the intended project. Understanding of the strategy is essential for optimising lean programmes and resources to be used. The top managers must develop, direct, and communicate strategies that focus on successful delivery at any point of work. Specifically, the top managers should prepare a clear strategic deployment plan showing how the deployed personnel are intended towards achieving the lean objectives. They should also develop a communication plan, clear direction and guidance on deploying lean (Antony *et al*. 2012:8). To Holden (2011:24), there should be a common understanding between the managers of the project if solving problems and decreasing unnecessary wastes is to be effectively realised. But the lack of a common understanding among the managers makes lean benefits disruptions in the implementation and schedules. The common and shared understanding of lean benefits helps the implementation strongly and successful project delivery. The tasked managers need to create a challenging vision and motivate employees to achieve it.

It has been found that organisational culture improves working relations and methods through lean initiatives among trained employees as a roadmap to successful delivery (Antony *et al*. 2012:11). The Organisational culture embodies behaviours of selected teams and strategies that can be considered in support of organisational lean thinking objectives. Hence, the culture of continuous improvement caused by a combination of employee training can contribute to successful results of lean projects, especially the wastes reduction. Additionally, behaviour and understanding of managers affect the culture of the organisation, workers and the general system. This is crucial in the culture that is responsible for success and project delivery.

The managerial system which includes performance measurement, communication and responsibility systems are also essential towards the success and delivery of the project. Alwan

(2012:12-13) had indicated that performance measurement is one of the important tools for a sustainable improvement in construction and delivering successful projects under lean thinking. The lack of performance evaluation systems increase discouragement among workers or teams working on a project and reduce application of the technical skills towards completion of the project. Moreover, under lean, time, costs, productivity, quality and waste of the processes must be measured and modified processes must compare to the previous processes. Assessments of the success of lean implementation are usually related to measuring operational and financial performances (Losonci *et al*. 2011:33). On the other hand, a communication system which is effective at vertical and horizontal levels is an additional factor towards lean successful project delivery. Antony *et al*. (2012: 13) have revealed that there has been no shared understanding of lean project goals achieved by poor communication systems. Only through proper communication, employees get involved and cooperate as a team for lean scenario success.

In literature, it has been found that the top management is the one of the systematic groups that held responsibility for the success delivered by lean and successful projects (Noori, 2018:15). Ogunbiyi (2014:19-20) underpin the success and well delivered projects of a firm or companies to strong managerial systems and well-coordinated managers. These have been termed as enablers to the successful delivery of the projects. Without management responsibility and commitment, it is a waste of time and resources for starting lean transformation approaches. According to Yuan *et al*. (2020:1), the top management should attend lean workshops and discuss lean strategy and methodology; and have clear guidelines for the success of the lean projects. In order to involve and motivate the top management, it is vital to select projects, which are linked to customer satisfaction and cost reduction directly (Otobo, 2016:22). To Ayalew (2016:2), failure in management commitment disrupts lean projects and can lead to wastes.

Alhuraish and Robledo (2014:55) show that the success in lean projects and their visibility is highly dependent on the implementation process. The implementation process changes are dependent on the quality of the implementation process (Trkman, 2010:45). The process is always set during the planning stage and embraced by a group of managers as the roadmap to the end. Obviously, both short-term wins and long-term wins should be sought in the implementation

process before ensuing the process (Alyousef, 2019:1). The main suggestion for short-term wins is that lean achievements manifest as quickly as possible. As such, Chen *et al*. (2018:16) indicate that the lean system should have continuous support from top and middle management. They also assert that there is a need for the management to prepare an action plan that would specify lean programmes priorities and estimate time schedule to start, review and accomplish. The different time schedule is significant for the success of the lean projects and waste management. Muhwezi, Acai and Otim (2014:67) are of the view that empowering employees is essential towards achieving the lean projects and this calls for competent training always. The quality of training for those involved in a lean project is very important while deployment or recruiting should be done under a professional project management. Project managers can provide related infrastructures for lean implementation (Achanga *et al*. 2006:4).

Alhuraish and Robledo (2014:8) gave a summary for the success factors in implementing Lean and Six Sigma. These have been essential to other successful projects. These include the top management involvement and commitment; linking method during project implementation to supplies; Organisational cultural; organisational infrastructure; leadership and management; linking methods to business strategies; project prioritisation basing on design and selection, reviews and tracking; linking method of implementation to customers' needs or satisfaction; linking method of implementation to human capital resources; understanding tools and techniques within methods; project management skills; education and training; reward system; communication; consultant participation; skill and expertise; project prioritisation and selection, reviews and tracking; and lastly, monitoring and evaluation of performance.

### 2.4 Linking lean construction techniques and project success

The main key drivers of lean techniques are waste elimination, process control, flexibility, optimisation, people utilisation, continuous and efficient improvement, and value to customer e (Kundu and Manohar, 2012: 302-305). These have been the mainstream to successful projects across entities that have applied lean techniques. The lean construction technique has also been adopted as a means of supply chain improvement so as to achieve the ends and intended objectives e (Fernandes, 2022: 735). Furthermore, the core elements of lean construction can be grouped into

six core elements: waste reduction, process focus in production planning and control, end customer focus, continuous improvements, cooperative relationships, and systems perspective (Maleka, 2014: 26-27).

The lean construction techniques efforts can be divided into three different stages. Pace (2019: 56-57) showed that lean stage one focuses on waste elimination from a technical and operational perspective. The second stage focuses on eliminating adversarial relationships and enhancing cooperative relationships and teamwork among supply chain actors. Removal and enhancing these parameters in lean techniques is essential for project success and delivery. Aspects related to stage two according to Al-hajj and Zraunig (2018: 22) are: limited bid invitation, soft parameters, long-term contracts, collaborative tools, and broad partnering team. Lean stage two does not go beyond the concept of partnering since it is about eliminating waste derived from sub-optimisations and adversarial relationships through increased integration and collaboration. The third stage identified is the most sophisticated, involving a structural change of project governance. Its essential parts are: information technology, pre-fabrication, last planner (LP), bottom-up activities and emphasis on individuals, a rethink of design and construction, decreased competitive forces, long-term contracts, training at all staff levels, and a systems perspective of both processes and the product. The principle of lean is primarily aimed at eliminating waste in every process activity to reduce process cycle, improve quality, and increase efficiency as reflected in the final success (Alhuraish and Robledo, 2014: 2).

Lean can be attained through a combination of the following practices, including just-in-time (JIT), total quality management (TQM), total productive maintenance (TPM), continuous improvement, design for manufacturing and assembly (DFMA), supplier management, and effective human resource management (Hughes *et al*. 2020: 38). Knol *et al*. (2018: 3956) explained lean production as an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimising supplier, customer and internal variability. In project success, Dave *et al*. (2013: 2) used five lean principles for eliminating waste in organisations as some of the indicators leading to successful project and these include; specifying value from a perspective of a customer; identifying the value stream to the project; create flow of resources to the successful project;

allowing customer demand to the pace and pull production; and manage continuous improvement and purse perfection of the project.

Marsouk *et al*. (2011:1) assessed the impact of applying lean principles to design processes in construction consultancy firms to aid in decision making at early stages of construction projects using a computer simulation tool. It was concluded that applying lean construction principles to the design process significantly helped to improve process efficiency, in terms of reduced process durations and increased resource utilisation. Another empirical study by Horman and Kenley (2014:1) revealed potential and profitability of using lean principles to promote sustainable success in the construction and requirement framework. Through this study, it was found that implementation of lean production concepts into construction is a major factor in eliminating accidents. The use of lean production concepts has been identified as a strategy for other successful issues to the project and these include: designing, controlling and improving engineering and construction processes to ensure predictable material and workflow on site; improving safety management and planning processes themselves to systematically consider hazards and their countermeasures; and to improve safety related behaviours – that institute procedures to minimise unsafe acts.

Successful projects of lean have been linked to sustainability of environmental quality, reduction in waste, health and safety. Benefits like increased competitiveness by utilisation of resources, while improving quality, reducing cost, and increased responsiveness all come from the lean techniques (Ssali *et al.* 2022:1829). Vrchota *et al*. (2021: 2 -3) submit that many lean and sustainability practices, such as efficiency, safety, productivity, and waste minimisation are interconnected. In fact, Barnes (2017:42) showed the relationships between successful sustainable projects and lean concepts from a perspective of a small construction project. After realising the success, the scholars developed a framework for integrating and implementing lean techniques and sustainability in a construction project.

Salem and Simmer (2005:61) discussed whether lean manufacturing principles can be applied to construction and if similar benefits could result. They concluded that lean practices do indeed hold potential for improving construction after creating a lean 92 assessment instrument with six case studies. Salem *et al*. (2005:1) carried out an evaluation on lean

construction tools such as increased visualisation, daily huddle meetings, first run studies, 5S process, and fail safe for quality and safety. The benefits from implementation of 5S include improved safety, productivity, quality, and set-up-times improvement, creation of space, reduced lead times, cycle times, increased machine uptime, improved morale, teamwork, and continuous improvement.

Ballard and Howell (2004:1) also noted that use of lean based tools like LP reduce accident rates. According to Thomassen *et al*. (2003:71), crews used in lean construction tools had about 45% lower accident rate than crews in the same company, performing similar work. To Dents and Blanford (2007:6), the initial results from early industry practice show that the use of lean tools has great potential to boost efficiency and quality of industrialised homebuilding operations. The integration of lean and sustainability results in reduction of waste (both process and material waste), reduction in energy consumption, reduction in water usage, reduction in cost and lead time and improvement in environmental quality.

### 2.5 Lean construction strategies for successful project delivery

The decline in profit margins alongside increased competition in the construction industry has led to continued search for possible and friendly strategies for eliminating waste and increasing profit margins in delivering the projects. Although numerous approaches have been developed to improve efficiency and effectiveness in the construction processes, not all of the strategies have been applied. Whilst there are a number of reasons for and against different strategies, this section presents various strategies and later recommends the best for the case of Uganda.

#### 2.5.1 Traditional strategy

The traditional designs of project delivery owe its strength from the fact that there is a need for working against schedule and budget in order to achieve specific results (Forbes and Ahmed, 2011:15). At the end, results are achieved by stakeholders while administering the construction process and collaboration to ensure the success of the project objectives. These stakeholders include Project sponsor, Design team, Main contractors, Project team, Suppliers and clients. Although there are several strategies or models used in project delivery under traditional approach, this study reviews only four that have been found commonly used in different perspectives. These

include Design bid build, Design build, Construction management at risk and integrated project delivery.

#### 2.5.1.1 Design Bid Build

Peter *et al*. (2012: 24) state that design bid build is a form of contract implemented by the design team from an identified firm where the project has been established. The main role of the design team is to perform a function of design process, construction detail and specification and put them together for bidders to bid. The successful contractor is awarded the contract based on submitting the lowest bid price which is further dependent on his bid being responsive. This type of project delivery system is mostly considered in the construction industry while it is deemed to be the traditional delivery method at the global level. Forbes and Ahmed (2011:7) had remarked that design bid build has shortcomings which are a protracted process to do programming, design, bidding and bid award before construction commences. The shortcomings always delay the extended project duration which in turn result in budget overrun as the time extends. When this happens litigation and disputes set in the delivery process because of dissonance between the expectations by clients to the contract which include owner/sponsor, designer and contractors.

#### 2.5.1.2 Design Build Projects

Under this design, an arrangement is made between designer and construction professional either from the same firm, company or by a joint venture. The design team forms a joint venture with a construction firm to offer service to the owner or sponsor. This form of contract is organised with a single construction firm early in the pre-construction stage which takes the project from conceptual design through the construction process to its completion. This systemic design is always called Turkey (Darwish, 2017: 60). To Forbes and Ahmed (2011: 7), the design build projects accelerate delivery through concurrent design and construction activities, which ensures preliminary design as well as cost and schedule proposals for the overall project. Under this design, the owner has an opportunity to review proposals from various organisations where legally binding agreements are entered into with a single organisation that provides the most appropriate proposal.

Furthermore, once the proposal has been accepted by the owner, the successful firm is given access to the site to commence the construction process as soon as the legal agreement is established. However, the design build has the potential of providing better quality, regarding to various factors like: (a) Communication is simplified and accelerated, as the owner has one point of contract (b) the adversarial nature of the three way relationship in design bid build project is avoided (c) Conflicts over the intent of the specifications and their deployment are resolved internally (d) the accelerated completion of design build projects lends itself to greater owner satisfaction (e) Cost growth is minimised for the owner.

Nonetheless, the following are advantages and disadvantages of a design built according to Forbes and Ahmed (2011:81): its deliverables are completed at the fast pace; participants in the project deal with conflict without involvement of the sponsor. On the other hand, the construction firm can adopt ways of cutting cost on the project as a way to improve savings; the sponsors' interference is limited; and there is reduction in quality may be compromised as a result of profit margin of the builder.

#### 2.5.1.3 Construction Management at Risk

This basically involves preconstruction service where the sponsor employs the service of selecting a contractor even before the design process is completed. Before the delivery however, the construction manager and the designer are concurrently nominated earlier at the beginning level of contract. The construction manager provides advice to review alternative mind sets used in production, cost and other recommendations. There is a reduced uncertainty by having the construction manager involved in the management of the design phase, in a way that involves the selection of sub or specialty contractors to assume the risk of successful completion (Forbes and Ahmed, 2011:10). The construction management at risk works under a maximum guaranteed price which requires that the project contains cost and bear the overrun cost. The construction manager bears the risk of pricing and directly contracting with the respective contractors. Moreover, the contract type of the construction manager is not as amenable to quality initiatives. Therefore, immediately after the guaranteed maximum price

is established the construction manager begins to allow overlap of design and construction phase to advance action to schedule activities.

As soon as the construction starts, the general manager assumes his duty as the general consultant. The risks associated with the contract are borne by the construction manager for any cost exceeding the guaranteed maximum price. Forbes and Ahmed (2011:10) presents advantages to this method of delivery as: it establishes preliminary cost of the project to enable cost effectiveness for the sponsor; the construction management at risk is accountable for the management of production process with connections over subcontractors; and the sponsors risk can be eliminated with the involvement of the construction management at risk in a complicated project. Its disadvantages include the fact that supervision of the construction project is done by the construction management which is an additional cost; there is a lot of conflict of interest when one firm acts in the position of manager and contractor is responsible for administration of the contract.

#### 2.5.1.4 Integrated Project Delivery

This is a multi-party form of agreement signed by all participants. It puts an emphasis on promoting collaboration among the key project participants like Sponsors, Architecture, Engineers and lead contractors of the construction industry. However, agreements provide a shared financial incentive, collaborative decision making, lean construction principles and provision to prevent litigation. Contractors have a high-level participation in the design process under the integrated project delivery than the construction management at risk. The integrated delivery of project success includes commitment to collaboration of all the project's participants. Participants in integrated project delivery require flexibility in adapting to new and evolving disciplines. Any member of the integrated team can make comments on any aspect of the design while the participants in the design team collaborate to ensure a collective effort to decide to amend and resolve matters in the design phase.

### 2.5.2 The lean strategies / models

This study reviewed various strategies under lean that include just in time (JIT), quality system, work teams, cellular manufacturing as well as the various tools and techniques to implement lean principles to an industry such as: Total Productive Maintenance (TPM), Total Quality Management (TQM). Failure Mode and Effective Analysis (FMEA), 5S, Quality Function Deployment (QFD) Kaisen, Kanban, and Value Stream Mapping (VSM) (Umarali, 2017: 342). Aziz and Hafes (2013: 3) noted that all the designs under lean aim at minimising waste of materials, time and generate maximum possible amount of value. Some techniques proposed by Aziz and Hafes (2013: 3) is the use of concurrent engineering which seek to describe as parallel execution of various tasks by multidisciplinary teams with the goal of obtaining most favourable products concerning functionality, quality, and productivity. Planning parameters under lean include scheduling concurrent activities within specified time, quantity, and risk. It focuses on communication and information sharing for discovering new ideas while partnering with subcontractors and suppliers.

The application of lean principles leads to utilisation of resources especially labour and material. It also results in better construction quality in completed facilities, greater owner/client satisfaction, higher level of safety, and ultimately greater profitability for clients, builders, and design professionals. Lean construction uses production management techniques to make significant improvements particularly on complex, uncertain and quick projects (Forbes and Ahmed, 2011: 2). Therefore, the following are strategies applied under lean thinking.

#### 2.5.2.1 Value Stream Mapping

VSM is a tool for depicting the flow of material in a manufacturing process (Layeequddin and Khatoon, 2017: 17). VSM is a strategy to improve material and information flow by coordinating activities performed by manufacturers, suppliers and distributors to deliver products to clients. Layeequddin and Khatoon (2017:1) also state that VSM is a collection of all actions value-added and non-value added that are required to bring a product or a group of similar products from raw material clients or customers. To Carvalho *et al*. (2019:11),

VSM is designed over the years to manage and follow spot ways and identify and remove waste.

There are benefits associated with VSM. It allows a wide view of flow that assists identification of waste; identifies relationship between material and information flow; provides simple standardisation as a way to treat procedures; makes decisions more visible; allows possible changes and improvement in previous discussion; forms the basis of an action plan. In management, VSM involves the understanding, measuring and improving flow of materials and information with interactions of all tasks to ensure cost, services and quality products competitively (Dal-Forno *et al*. 2014: 6).

#### 2.5.2.2 The 5S System

This is a method to improve efficiencies and enhance the management performance (Flilip and Marascu-Klein, 2015:1). It is a methodology of creating and maintaining organised, clean, high effective and high-quality workplace with the following significance; separates or removes the unnecessary things by necessary tools; set order by putting in logical order each item that is often used properly in place and storage in a well-established location; shine – perform and maintaining a deep cleaning, eliminate sources of dirt and simplify cleaning process; established rules and storage areas by making simple visual rules along with training of maintain standards to reduce search time and avoid mistakes; support continuous evaluation and improvement in order to respect and maintain the results of the implemented 5S method (Crisóstomo and Jiménez, 2021: 267)

#### 2.5.2.3 Just in Time Principle

This is an inventory system under lean management strategy that aligns raw material orders in the suppliers directly with production schedules. As a delivery system in construction, JIT is an inventory management approach designed to eliminate waste by receiving goods only as they are needed in the production processes. While JIT delivery is most often correlated with combating the issue of inventory waste, it is also perfectly applicable to the elimination of D.O.W.N.T.I.M.E and all eight (8) waste of lean in construction. These wastes include;

Defects, Overproduction, Waiting, Non-utilised Talent/Resources, Transportation, Inventory Excess, Motion Excess and Extra Processing.

Companies use this strategy to increase efficiency and decrease waste by receiving goods only as they need them for the production process, which reduces inventory costs. This method requires producers to forecast demand accurately (Banton, 2019: 7). It has the following advantages and disadvantages;

a. It has lower inventory holding costs – with inventory purchased or produced at short notice. There is no need to have unsold inventory taking up valuable warehouse space.

b. It improves cash flow without the need to store large volumes of inventory at all times; capital expenditure is reduced and cash can be invested elsewhere.

c. It has less dead stock since inventory levels rely on customer demand. Thus, there is less risk of unwanted stock left sitting in the warehouse.

**Its disadvantages include;**

a. It is always associated with problems with order fulfilment. If a customer orders a product and a firm fails to deliver, yet it is within the stock, a firm runs a risk of not being able to fulfil timely fashion orders.

b. fIt is limited with little room for error or doing. JIT means having accurate demand forecasts and insights to customers' buying habits at all times. Miscalculation has a significant negative impact on business operations.

c. It contains less time for price shocks. With the JIT system, a firm does not have the luxury or time for waiting around for the best prices on goods. When prices go up, profit margins go down.

### 2.5.2.4 Kanban System

This is a process that focuses on envisaging flow and minimising work in progress to reduce idle time in process within the construction industry (Ahmad el al., 2018:18). To Mayilsamy and Pawan-Kumar (2014:19), it is a system which is imagined for demand of specific product, with a specific quantity and delivered to a specific process. Its advantages include; Visualising work; limit work in progress; focuses on flow of materials and resources; continuous improvement of the whole system; reduces manual card handling and order entry activities; clarifies communication with suppliers; enables real time visibility of demand signals; speeds analysis of supplier performance; allows efficient analysis and adjustment of quantities and simple as compared to the traditional strategies.

### 2.5.2.3 The Last Planner System

This is a system for project production planning and control that is aimed at creating a workflow that achieves reliable execution of a project (Cwik and Roslon, 2017: 30). To Aziz and Hafes (2013: 4) show that LSP is meant for collaborative managing the network of relationship and conversations required for programme coordination, production planning and project delivery, by promoting conversations between trade foreman and site management at appropriate levels of detail before issues become critical. Aziz and Hafes (2013: 11) go on to reveal the fact that LPS is the most effective way to increase efficiency of the construction industry and actually, it improves planning and control processes. Under LPS, planning defines the criteria and creates strategies required to reach project objectives, while controlling makes sure that each event that occurs follows planned sequence.

LPS is the best lean principle that has been demonstrated as a very useful tool for management of construction process, and continuous monitoring of the planning efficiency, to assist in developing foresight, smoothing workflow, and reducing or removing uncertainties during the construction processes. Whilst using LPS, work flow control is accomplished primarily through look-ahead process, and production unit control is accomplished primarily through weekly work planning. As a strategy, LPS is based on two objectives; to make better assignments to direct workers through continuous learning and corrective action; to cause

work to flow across production units in the best achievable sequence and rate. Integrated components of LPS are: master plan, phase planning, look-ahead planning, weekly work planning,

It is assumed however, that when a project team improves its planning, it reduces variation. Thus, it can become more productive by matching its production resources more closely to demand for them and the end point is reducing waste. Most companies or firms that utilise LPS have been able to maintain projects on time and budget, as well as having a stress-free production planning and control process. Another area of importance to the use of LPS is the benefit during the implementation. These include smooth workflow; predictable work plans; reduced cost; reduced time of project delivery; improved productivity and greater collaboration with field personnel and subcontractors. LPS is always liked due to its four elements that include programming workshop; creation and agreeing production sequence; making- projects ready (making tasks ready so that they can be done when a company wants to do them); Production Planning: Collaboratively agreeing production tasks for the next day or week; and Continual Improvement (learning about and improving the project, planning and production processes). The summary of the strategy / model specification is presented in Table 2.1.

**Table 2.1: Summary of model specifications and values to use**

| TRADITIONAL STRATEGY / MODEL | | | |
|---|---|---|---|
| **Model / strategy** | **Literature** | **Advantages** | **Disadvantages** |
| **Design Bid Build**<br>Designed by the identified team of a firm where the project has been established. | Peter H. Anders B. Per L. J. Pia B. 2012. *International Journal of Operations and Production Management,* 32(7), 829 – 849 | • Award contract based on lowest bid price | • Protracted process to:<br>• Programming<br>• Designing bidding<br>• Bid award |
| **Design Build Projects**<br>It is made by a designer and construction professional either from the same firm, company or by a joint venture. | Forbes, L. H., and Ahmed, S. M. 2011. Modern construction: *Lean project delivery and integrated practices.* New York: USA, CRC press Taylor and Francis group | • Deliverables are completed faster.<br>• Participants in the project deal with conflict without involvement of the sponsor. | • Construction firms adopt ways of cutting costs on projects of improved savings.<br>• Sponsors' interference is limited<br>• Reduction in quality compromise results in the profit margin of the builder. |

**Table 2.1 *(Continued):* Summary of model specifications and values to use**

| | | | |
|---|---|---|---|
| **Construction Management at Risk**<br>It involves preconstruction where sponsors employ selected contractors even before the design process is completed. | Forbes, L. H., and Ahmed, S. M. 2011. Modern construction: *Lean project delivery and integrated practices.* New York: USA, CRC press Taylor and Francis group | • Establish preliminary cost of the project<br>• Sponsors' risk can be eliminated within management | • Calls for additional supervision cost.<br>• Conflict of interest is paramount |
| **Integrated Project Delivery**<br>It is a multi-party agreement signed by all participants. | Abdullah, S. Rasak, A. Bakar, A. Hassan, A. and Sarrasin, I. 2009. *The Barriers in Implementing the Lean Construction Approach. Building*, 1–15 | • Require flexibility in adapting to new and evolving discipline | • Any member of a team can make comment on any aspect of design |
| **THE LEAN STRATEGIES / MODELS** | | | |
| **Value Stream Mapping**<br>It is a tool for depicting flow of material in a manufacturing process. | Layeequddin, K. and Khatoon, S. 2017. *International Journal of Engineering Trends and Technology* Vol. 45 | It allows identification of;<br>• Waste, relationship between material and information flow. | |

**Table 2.1 *(Continued):* Summary of model specifications and values to use**

| | | | |
|---|---|---|---|
| | | • Provide simple standardisation as a way to treat procedures | |
| **The 5S System**<br>This is a method to improve efficiencies and enhance the management performance | Filip, F. C. and Marascu-Klein, V. 2015. The 5S lean method as a tool of industrial management performances, IOP Conf. Series: *Material Science and Engineering 95, Modern Technologies in Industrial Engineering*. Pp-1-2 | • It creates and maintains a clean, high effective and quality workplace.<br>• Establish rules and storage areas by making simple visual rules along with training of high standards to reduce time and avoid mistakes. | |
| **Just in Time Principle**<br>This is an inventory system under lean management strategy that aligns raw material orders in suppliers directly with production schedules. | Banton, C. (2019) Corporate Finance and Accounting, Access on 10th May, 2019. https://www.investopedia.com/terms/j/jit.asp | Has:<br>• Lower inventory holding costs<br>• Less dead stock | • Associated with problems order<br>• Limited with little room error or doing.<br>• Contains less time for price shocks. |

**Table 2.1 *(Continued):* Summary of model specifications and values to use**

| | | | |
|---|---|---|---|
| | | • Provide simple standardisation as a way to treat procedures | |
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**Table 2.1 *(Continued):* Summary of model specifications and values to use**

| | | | |
|---|---|---|---|
| **Kanban System**<br>It is a process that focuses on envisaging flow and minimising work in progress to reduce idle time. | Ahmad, M. O. Dennehy, D. Conboy K. and Oivo, M. 2018. *The Journal of Systems and Software*, vol. 137, pp. 96-113 | • Visualising work<br>• Allow efficient analysis and adjustment | • |
| **Last Planner System**<br>This is a system for production planning and control, aimed at workflow that achieves reliable project execution. | Abdullah, S. Rasak, A. Bakar, A. Hassan, A. and Sarrasin, I. 2009. *The Barriers in Implementing the Lean Construction Approach. Building*, 1–15 | • LPS is the best lean management of construction process, and continuous monitoring of the planning efficiency, processes | |

Source: Ssali *et al.* (2022)

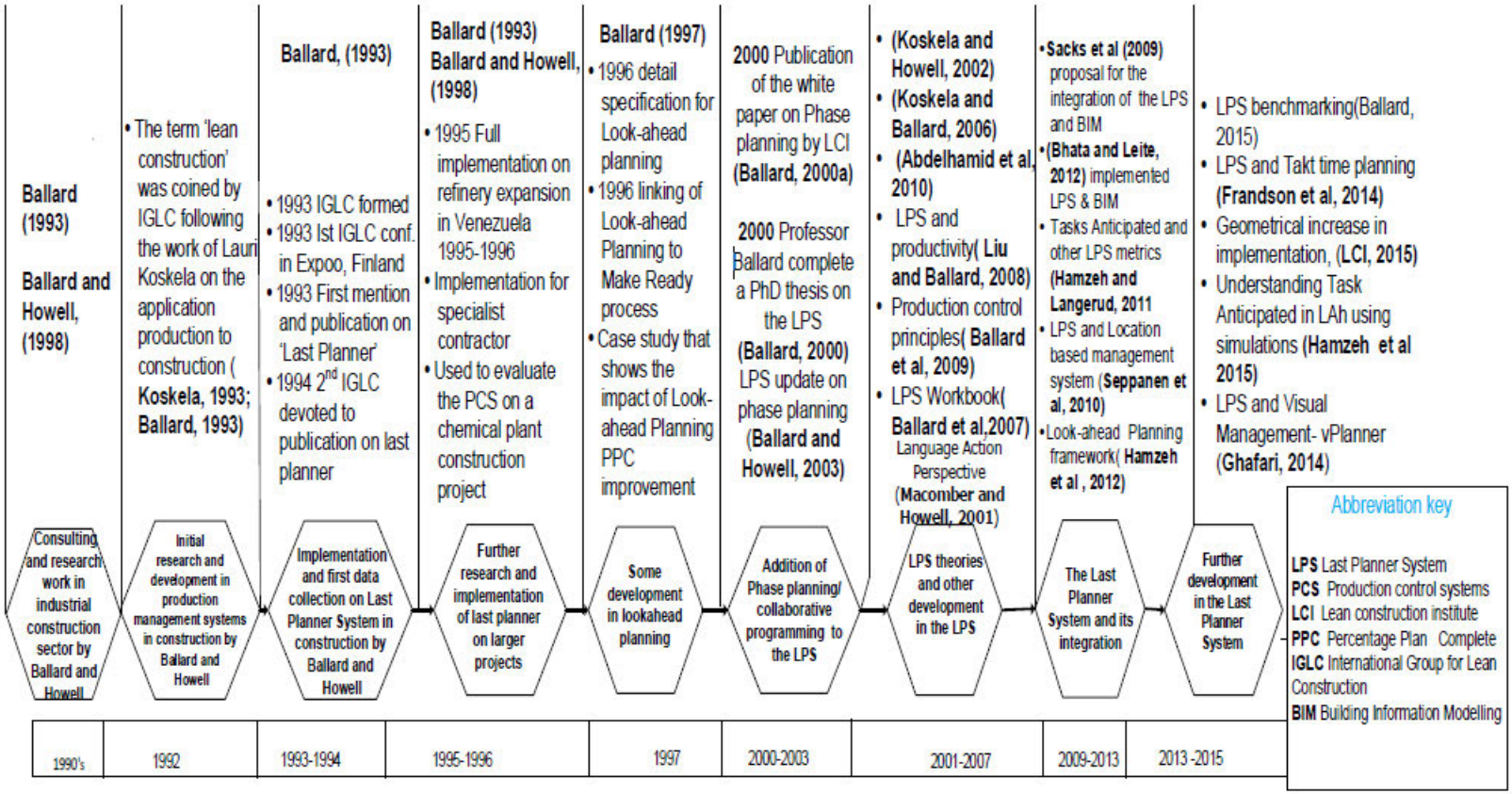
Based on literature and subsequent summary presented in Table 2.1, the last planner system strategy is best proposed for project delivery for Uganda's Construction Industry. The justification stems from Cwik and Roslon (2017: 14)'s eight (8) reasons. Firstly, fast planner system strategy delivers the projects more safely and creates a more predictable production programme. The strategy also reduces project durations and informs well contractors to better manage costs; to reduce stress on the project management staff and helps to improve the overall production process. Above all, the last planner system helps to make projects a reliable venture for just-in-time deliveries; and works in a way that traditional critical path method does not. As a result, the strategy is more appropriate for the conditions in Uganda for improved project success, where construction sites have long been a hazard to workers, as well as the industry's ever-increasing waste rates.

## 2.6 Conceptualization of the Last Planner System

Last Planner System (LPS) is one of the lean strategies for delivering successful projects. It was developed by Ballard and Howell (2003b: 12) as a system for production planning and control to assist in smoothing variations in construction workflow, to develop planning foresight and reducing uncertainty in construction operations. With the introduction of LPS, most of the construction projects under lean thinking that tend to apply it got reliable plan, predictable workflow and an improved production performance (Ballard *et al*. 2007: 10).

Ballard and Howell (2003:22) asserted that LPS focuses on planning and production control rather than a cybernetic approach in the traditional project management approach. The use of traditional project management was equated to the cybernetic model because of their standard of performance and the approaches used to measure the obtained performance during output. In its initial stages, LPS was developed to solve challenges in the workflow and improve the plan reliability. But it was used in a lot of developments in the later stages and this led to further development principles. Hamseh *et al*. (2012: 24) noted that the five key principles are planning tasks; in detailed closer to their execution dates; with people who are actually meant to execute them; to identify and remove constraints before execution of particular activity; make secure and reliable promises and; learn from failures to prevent reoccurrence. In history, LPS has evolved through stages as presented in table 2.2.

**Table 2.2: History and developments of LPS**




Source: Ballard (2020)

From table 2.2, LPS evolved from the industrial sector where Ballard and Howell worked in the early 1990s. They developed the last planner system while unhappy with the working system they were dealing with (Ballard 2020: 18). Initially, LPS was to improve workflow and improve the planning reliability and over the years, various other principles have been added with the help of research and development in the field of Lean construction.

From the historical perspective, Ballard and Howell were the main forces behind the foundations and development of LPS. In 1993, it was expressed that thoughts against the conversion process model were based on sequential thinking in order to manage construction projects. Since then, the conversion process model seemed outdated especially in projects where engineering, procurement and construction overlapped with time. Ballard had to replace the conversion process model through Lean construction techniques. This improved production planning and control of construction projects. Marhani *et al*. (2015: 89) called the process Last planner system. However, the bad logistics and delivery of resources prevented the creation of quality assignments even when a contractor could spend a huge amount of his time seeking approaches to get resources. Therefore, it becomes a responsibility to everyone above the last person in the chain to give quality results as shielding workers.

The term shielding is used in LPS to distinguish what “should” be done, from what “can” be done, and what “will” be done. Therefore, SHOULD – WILL – CAN process became essential parameters in scheduling time in LPS as indicated in Figure 2.6.

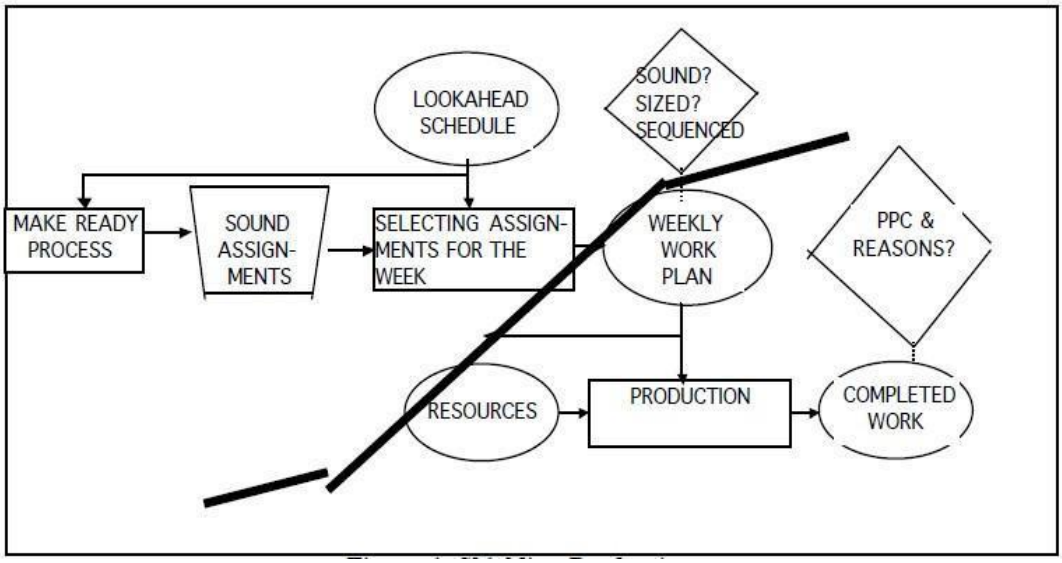



**Figure 2.6: Shielding the production units**

Source: Ballard and Howell (2014: 6)

The importance of shielding is therefore to give quality assignments by the site team who execute the assignments in the construction project. In case this fails, delays results inform of bad sequencing of activities, reworks, waiting for work fronts. The end result is the delay of the assignment at hand. For the LPS to be effective, shielding of workers is mandatory.

### 2.6.1 Systemic Understanding of LPS

At a systemic level, LPS has three main components that include planning, monitoring and control, through which the lean construction principles such as JIT delivery, Value Stream Mapping (VSM) and pull scheduling are achieved (Koskela *et al*. 2010: 539). Despite its greatness in construction, LPS compels constructors to create a complex web to integrate tools or mix solutions which, at last, create challenges to an implementing company or contractor. The sample of the systematic complex web is presented in Figure 2.7.

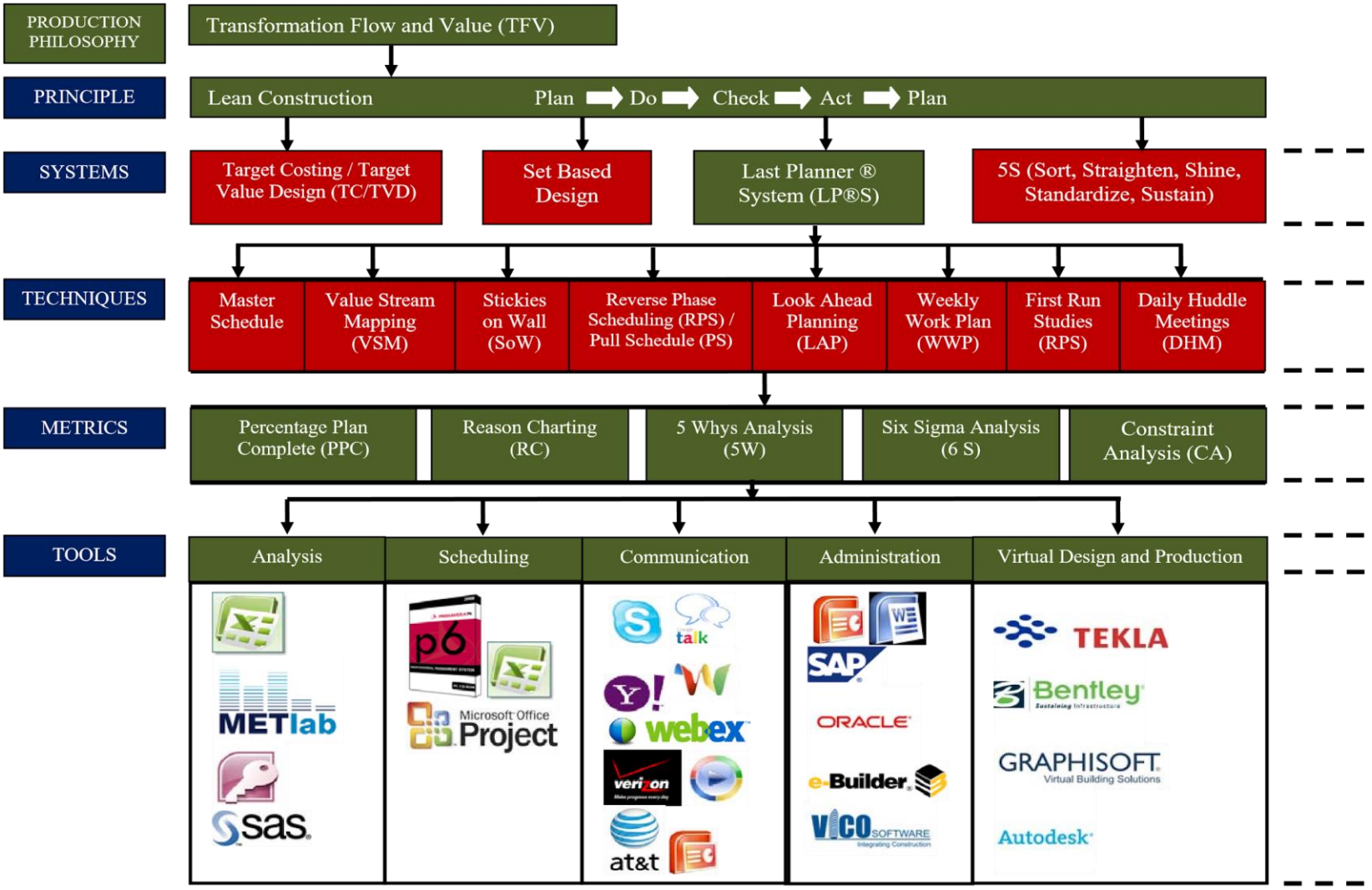



**Figure 2.7 A systemic view of lean management showing position of LPS in construction**

Source: Koskela *et al*. 2010: 544)

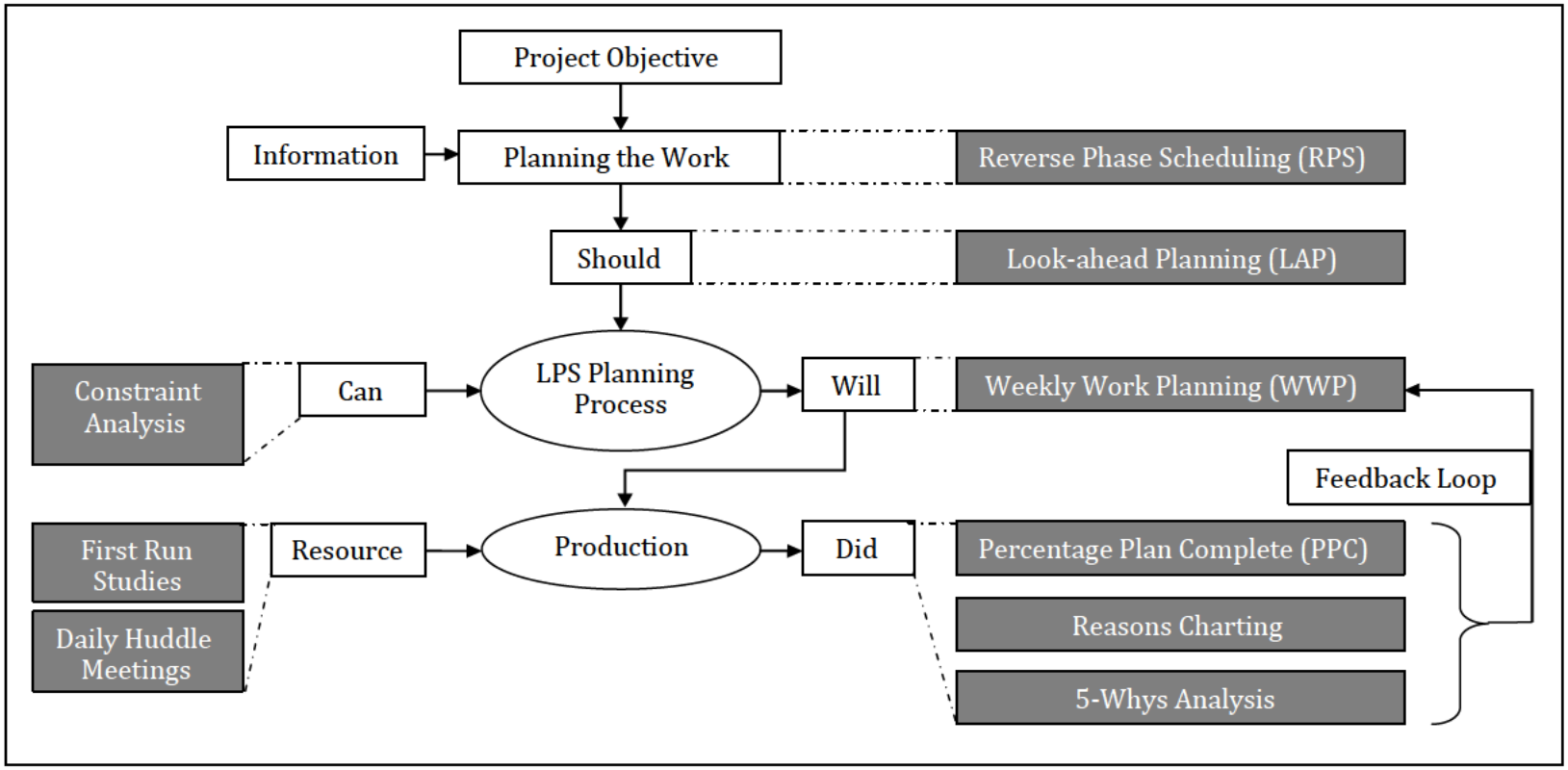



**Figure 2.8: LPS and its Components**

Source: Transformed from Aziz and Hafes (2013)

Figure 2.7 presents a complex web for LPS that stems from the bigger lean construction diagram. The integrated tools and solutions create new problems for the implementer. In Figure 2.8, the main emphasis is to contextualise the LPS with its main components of master schedule, look – ahead and commitment or weekly work plan. Howell and Ballard (2008:1) had indicated that this process is fulfilled under the lean construction planning technique. Clearly, the weekly planning is a stage for maximising resources for a specific task of intent. As already indicated, LPS's basic function remains planning, monitoring and controlling of resources in the due course of construction. Its peculiarity in construction is the ability to incorporate pull scheduling that compromises with discourses of *SHOULD, CAN* and *WILL*. This makes the construction under lean an integral part of LPS (Koskela *et al*. 2010: 540).

The key principles of LPS were identified as follows;

1. Plan with much details as getting close to contracted work
2. Produce plans in collaboration with contractors / persons to do the work
3. Work as a team to remove all constraints from the planned task
4. Make and secure reliable promise to the clients
5. Make good lessons from the breakdowns

Some functions of LPS were identified as the following;

- It supports individuals to collaborate in planning
- It supports readiness of work, and helps constructors to identify constraints before initiating the work.
- Through breakdown of tasks and designs, LPS enables contractors to commit themselves to the work.
- LPS is essential in controlling flows and identifying crucial point areas in the construction.
- Fiallo and Revelo (2002) have noted that LPS is important in identifying the root causes of the problems, and supports the approach to make timely decisions in adjustments and options or alternatives in case.

### 2.6.2 Components of LPS

The components of LPS are well detailed when analysing LPS techniques and the metrics measurements. The following are therefore discussed under this study as the main components of LPS.

#### 2.6.2.1 Phase Scheduling

This is a collaborative planning process for the team to:

1. Define the phase of the project which is called the milestone
2. Break down different parts of the project activities
3. Schedule different activities ahead of them as stated in the milestone

It is a phase under the LPS in which the team tasks itself to perform with the emphasis of the milestone. The organisation of the phase schedule is one of the integral parts of the LPS since it integrates different ideas from other companies and works into the project at hand. Planning for this part can take six hours of constant work as contractors seek to reach an agreed procedure.

#### 2.6.2.2 Look Ahead Planning (LAP)

This is an outcome of mid-term planning that is used to show the activities at the process level and eventually at the level of operation (Limenih *et al*. 2022: 2). This is mostly used in the construction industry to determine the work of the supervisor in the due process. In accordance with Seppänen, Ballard and Pesonen (2010: 45). this section is scheduled with primary hierarchical rules in the LPS as indicated herewith;

1. Allow scheduled activities to remain in master schedule unless positive knowledge exists that the activity should not or cannot be executed when scheduled.
2. Allow scheduled activities to remain in the look – ahead window only if the planner is confident that the activity can be made ready for construction execution as scheduled.
3. Allow scheduled activities to be released for selection into weekly work plans only if all constraints have been removed; i.e., only if the activity has in fact been made ready**.**

#### 2.6.2.3 Analysis of constraints

Constraints analysis is essential and important to any project that is identified. Importantly, different constraints have various constraints which are either similar or different. Some of these constraints stem from the whole contract, design, submittals, materials, prerequisite work, space, equipment, labour; and an open-ended category for all other constraints.

In the construction industry, analysis of constraints needs competent suppliers of goods and services if the production delivery is to be managed. It is also important to inform the suppliers about the pending challenges before initiating the process. This information is intended to inform the supplier and then maintain their readiness to do the work (Aziz and Hafes, 2013: 681).

#### 2.6.2.4 The Weekly Work Planning (WWP) / Planning commitment

This is one of the most detailed parts of LPS in the project planning. Seppänen, Ballard and Pesonen (2010: 50) showed that plans are developed by a collaborative team during the weekly meetings in which the last planners represent the interest of the most stakeholders. These are the meetings of the team leaders, frontline workers and supervisors who apportion different activities among themselves in the planning process. The main reasons for these weekly meetings are to increase reliability in planning, promises, making quality assignments, clear requests and increased total commitment to the end. The important front liners cannot miss such meetings since they are vital to the construction.

#### 2.6.2.5 The daily huddle meetings

Sacks (2009: 1) shows that the meetings are avenues through which team members quickly give their status, attitude, status and perception of the work. The focus of these variables on what could hinder timely and successful delivery of the work. As a tool used in lean planning, it is important since most employees are given opportunities to make their assertions in reference to the construction project or any industrial work

#### 2.6.2.6 The first run studies

As presented Seppänen, Ballard and Pesonen (2010: 51) this is used to redesign critical management, part of continuous improvement effort and include productivity studies, and review the approach towards redesigning. The use of video files, photos, or graphics to show the process and illustrate the progress of work are among the common instructions. The first run of a selected craft operation needs to examine details, bringing ideas and suggestions for the alternative ways of doing the work.

A Plan, Do, Check, Act (PDCA) is always used in the development of the study in which the team refer to: plan as a selected work process to study, assemble human capital resource, analyse process and steps, brainstorm various approaches to eliminate steps, check for safety, quality and productivity; Do is trying the ideas for the first attempt or run; whilst check illustrates measure that always happen. Act refers to reconvene the team, and communicate the improved method and performance as the standard to meet.

#### 2.6.2.7 Percentage Plan Complete (PPC)

It is commonly used in determining reliability of the system. They are referred to the number of planned activities that have been completed, thereby divided by the total planned activities. Normally, it measures the extent of the front-line supervisor's commitment will be (WILL) realised (Seppänen, Ballard and Pesonen, 2010: 55).

In fact, it measures whether the planning system is able to reliably anticipate and what will actually be done. It is also used to determine whether assignment has been completed or not, in line with mandatory plan calculations. Analysis done weekly by PPC is important since it is used for identifying some of the reasons for the disruptions in due course of work. It therefore contributes to a systematic learning at the site of the job, and generates effects that are geared towards competitions of companies in the work schedules.

#### 2.6.2.8 The Feedback Loop

The main concern for the feedback loop is to identify that planned work was not done and reasons underpinning the action. This normally is the responsibility of engineers, supervisors or any person responsible for the implementation of the plan. It is mostly used for various reasons and among which include; in case there is faulty or information from the last planner about the incorrectness of the system; failure to apply quality in assignments as stipulated in the criteria or procedure; failure in coordination the shared resources that needed in the whole project exercise; other reasons include priority change and design errors.

#### 2.6.2.9 Five - whys – root cause analysis

This is done based on the root causes in which ‘why’ is asked for various times in order to establish reasons for non-complying with the designed plan. The Root Cause Analysis (RCA) is a method that is used to identify the problem for any kind of behaviour during the construction.

### 2.7 Perceptions of Last Planner strategy / model

This study uses the term perception to mean cognitive weighing of various stakeholders who have used and opt to use LPS in the construction industry. The section gets various examples from different studies which have been conducted across the globe with anticipation to relate it with perception from the study findings.

It is imperative to assert that perception or attitudes are personal and differ from contractors or workers within the same industry or similar to the same. One of the important elements of LPS is the basic element of coordination process which has attracted many planners to positively think that it brings team and stakeholders together on board.

As presented by Aziz and Hafes (2013: 689), coordination in LPS is provided by a closed loop which connects more than two parties. These are in most cases the performer who promises to satisfy the need or request by the client or customer. With reference to figure 2.9, the loop is presented between two persons (performer and the customer). The main activities taking place within the loop include requests by the customer, and this opens for the negotiations. The performer or the contractor makes promises to the satisfaction of the customer, which psychologically means that terms of the contract have been fulfilled by the two parties.

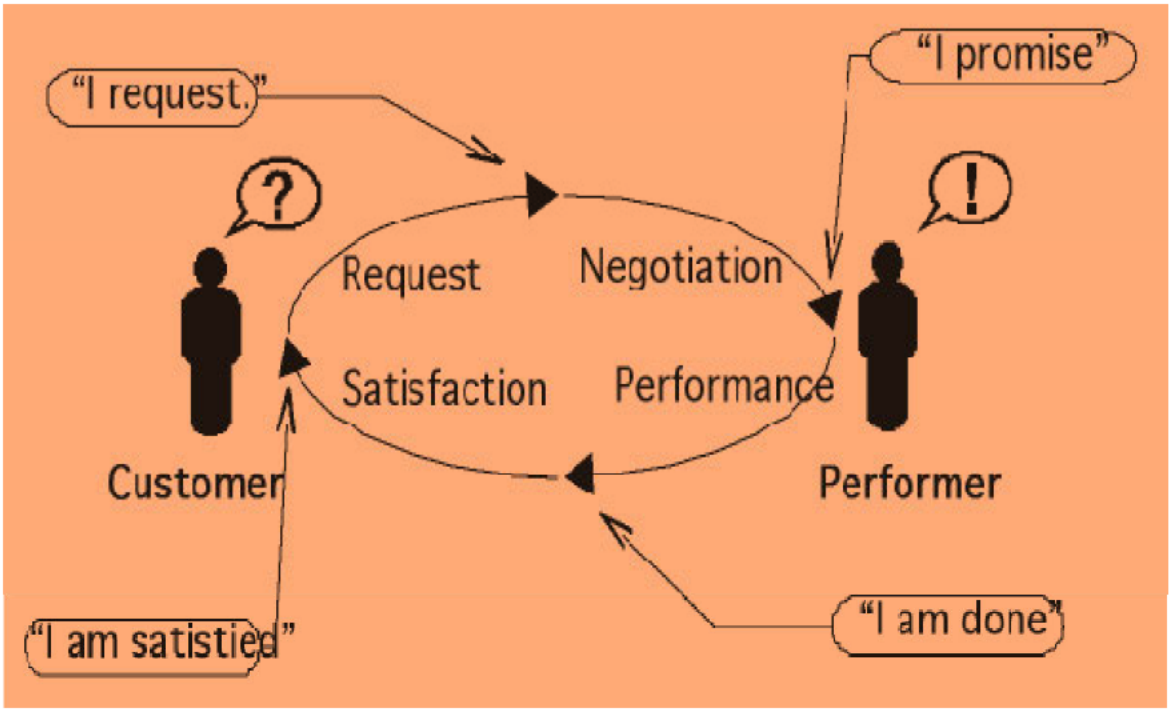



**Figure 2.9: Illustration of Loop connection between customer and performer**

Source: Transformed from Aziz and Hafes (2013: 689)

As indicated by Aziz and Hafes (2013: 689), LPS is perceived as one of the construction models that fulfils the moral obligations between stakeholders involved in the construction project. Information is positively conveyed through the loop and the chain calls for the total commitment for successful delivery of results. In a study conducted by Sacks and Harel (2006:1) from Santiago in Chile, the game theory was used to underpin the modelled behaviour of the general contractors and subcontractors. It was deduced that the sub-contractors would request fewer resources as compared to the general contractors' project manager. It was found that through sharing the

information, the equilibrium of the two parties in contract can easily change which improves honest and high performance to project delivery.

LPS has been perceived as a strategy with successful delivery of the projects. Hill *et al*. (2007:23) show that Sutter Health headquartered in Sacramento, California, used LPS to implemented five pilot projects (David Medical Office Building, Modesto 8 Storey Bed Tower, Delta, Roseville Emergency Department, Roseville Parking Structure) in the process to use the lean thinking initiative. This led to the use of LPS which compelled the application of different approaches like training, and theoretical justification of the workers with main emphasis to practical work since they had gained skills. According to Koskenvesa and Koskela (2005: 33), the use of LPS improved productivity, safety, equality and schedule benefits.

In a study conducted by Shingo (1989:1) from Toyota, it was found that LPS improved coordination among contractors on multi- storied buildings. LPS reduced the batch size in the contractor roles which increased positive interaction of the contractors and the managers. In Brazil, Conte *et al*. (2002:1) show that the deployment of production managed models based on lean production principles and techniques such as LPS led to average reduction of the expected construction time between 20% and 30% of the initial estimate, and a reduction of the production cost between 5% and 12% of the total amount can be achieved in totally different projects, like the construction of McDonald's stores or churches or the execution of horizontal residential condos.

McGraw-Hill (2013:1) identified major benefits of Lean practices in the form of improved safety, higher quality of construction, reduced project schedule, greater productivity, greater profitability, and better risk management. Within the same set of practitioners, it was found that LPS was the most heavily used Lean construction strategy. More specifically, weekly planning and involving workers in daily huddles were used to achieve higher efficiency by the contractors. A study conducted by Fernandes-Solis *et al*. (2012:28) supported the findings of the Smart Market Report and listed several benefits experienced by projects using LPS: smooth workflow; predictable work plans; reduced cost; reduced time of project delivery; improved productivity, and greater collaboration with field personnel and subcontractors. Lean Construction Institute and Dodge Data and Analytics (2017: 26) among 81 owners of capital projects, the respondents reported 79% of the projects using Lean tools such as LPS were ahead of schedule or did not show variance in

comparison to 39% of the projects that were not using Lean tools. In terms of budget performance, 77% of the projects using Lean tools such as LPS were under budget or did not show any variance in comparison to 52% of the projects not using Lean tools.

LPS has provided a more formal structure to coordinate actions among multiple trades that was undermined by the transformation-dominated traditional construction planning. One way to coordinate action among multiple trades and increase their accountability is to increase the participants' involvement. The participants of any construction project can be perceived as purposive actors with specific interests and varying degrees of control over events and resources in the construction projects (Andersen *et al*. 2008:12). In projects utilising LPS, the possibility of conditional cooperation among participants drastically increases, and along with that, likelihood of the number of cooperative participants reaching a critical mass also increases so that cooperative behaviour itself becomes a self-enforcing strategy.

### 2.7 Hypothetical pathways

Emuse and Ungerer (2014: 27) demonstrate that awareness about lean techniques and construction in Africa and South Africa especially is still low. In Uganda, awareness of the lean project is a challenge in the construction industry and this has affected the contractors. Based on the literature that this study has reviewed; it is clearly hypothesised that; the level of implementation of lean construction techniques is not positively significantly determined by checking awareness and utilisation of concepts. Whilst awareness was assessed using tools especially the administered questionnaires with five Likert scale, the utilisation was highly realised through some observations made by visiting onsite activities during the data collection. It was during the data collection that this study established that part of the lean thinking has been implemented unknowingly. This however did not / does not qualify such form of construction into lean techniques because adoption is always declared in all situations and companies.

Secondly, this study assumed a no significant degree of success and realisation of projects in Uganda's construction in terms of clients' satisfaction. This came from the fact that the historical perspective of the construction industry in Uganda revealed various challenges that makes one question the extent to which the lean thinking and its strategies like LPS have been applied in lieu to time and resources. Besides, a lot of constructions in Kampala Capital City have been collapsing

whereas others have been recommended for demolition. In Such situation, the need to determine the extent to which such events (collapse and demolition) reach clients' satisfaction in the pursuant to their accommodation needs has been examined. While critiquing this hypothesis, the notion about human needs paradigm has been discussed owing from Abraham Maslow.

This study established that while some of the constructions have collapsed and others subjected to demolition, there are some of the buildings or constructions which have been delivered to clients successfully. Thus, the need to ascertain the relationship between lean construction techniques and general project success in Uganda. The main emphasis and questions which this assumption sought to address remained whether the success of various buildings has been due to lean techniques, principles or other thoughts like traditional approaches. The study found that despite various challenges ranging from finance to land tenure in Uganda, there were construction activities that took place before initiation to lean thinking in the world. Besides, engineering companies in Uganda have remained sceptical about lean techniques as an approach to construction. Recalling that some of the constructed structures are old enough, satisfaction delivered from the construction and insisting on other fashions of construction leads the study to another hypothetical thinking. Thus, there is no significant lean construction project delivery model / strategy for Uganda's Construction Industry (bearing in mind the LPS). In such circumstances, the study established the perception towards LPS using the construct of a 5-point Likert scale and mean index. These assumptions as emanate from the literature have been underpinned by

## 2.8 Overview of Managerial theories

This study was underpinned by managerial theories which were applied to illustrate issues pertaining lean thinking in the context of Uganda. These theories include the system theory, two human resources theories (administrative management and human behaviour theories) and project management theory (Nhema, 2015:167). The theories were used in pursuit to provide answers to raised assumptions as well as research questions which could not be answered by only one theory (Augustine, 2013: 2010 - 2015).

At the level of implementation of lean construction techniques, this study focused on checking awareness and utilisation concepts. The system theory was used to answer all the questions and seek to find solutions related to underlying assumptions (Nadrifar *et al*. 2016: 83-85). The theory

reveals how technological thinking evolved in the form of a systemic order to serve rising needs of accommodation among people across the globe and Ugandans. As a global system, it has been welcomed by various countries while others implement its components unknowingly. In itself, the theory gives how different items like time, reduction of west and cost effectiveness are joined to form lean thinking. However, the theory remains blind about drivers or human resource (managers) that make the system run. In fact, while the theory shows the link between departments, it leaves various questions like at what degree/level can one determine realisation of success. Who drives the system or departments and for what purposes? Such a narrative leads the study to seek for an answer towards success and realisations through administrative management theory advanced by Henri Fayol (Ghoshal, 2005: 75).

The administrative management theory has been linked with Maslow's theory to answer gaps within the system theory (Ferdous, 2016: 1 - 4). The two managerial theories answer questions about who manages the system's department and for what purpose. The theories also give explanations about the relationship between lean construction techniques and general project succession (Baloch *et al.* 2019: 164). Upon this perspective, this study established that as long as Ugandans have alternative means to satisfy accommodation needs, the lean thinking has less position in the adoption process. Fayol shifts the discussion from systemic lean techniques to an industry where human capital resources interact at different levels towards success. However, his theory does not explain the motivation behind different categories of workers interacting at different levels in departmental projects. Maslow explains this into five categorical needs (Kwok, 2015: 29 - 35).

In selecting a strategy or a model, the study presents project planning and its success provides satisfaction to customers. This is mainly used for last planner strategy which is in congruence with the project management theory. At this level, there is a shifting paradigm from workers within the system or industry to clients. Companies are presented shifting their main concern from their workers to satisfy clients if they are meant to remain in business and working as well.

### 2.8.1 Historical foundation of the theories

Management and human resource theories evolved alongside one another since the first humans populated the Earth (Augustine, 2013: 2911 - 2012). In various ancient groups, mobilisation could

be planned for defined tasks. According to Kwok (2015: 30), this started within prehistoric hunting societies where survival of different groups depended on skill coordination and management efforts to hunt animals. This management was especially dominant within the African continent where groups could embrace communal work for the success of any task (Eisenmann *et al*, 2012: 814). Singh and Masuku (2014: 368) stated that this was mainly witnessed among Egyptians towards construction of great pyramids.

Hoppál (2019: 63) stated that among the Romans, management strength of skills was observed through construction of cities and roads, and Chinese also found management of skills a necessity to construct strong cities to justify their leaders. By 378-298 BC, a systemic model of management had been developed in China and the author named it a production management technique (Saatci, 2014: 350 -351). The focus was to produce goods and services to people and satisfy their needs. Mencius, the mother of production management technique, focused on division of labour based on skills if work is to be cost effective, completed in time and to be relevant to the needs (Scheidel, 2007: 1). Sun Tsu recommended management strength of skills as an approach to success and that defeated soldiers are due to management weakness. In his book, "*The Art of War*" in 6$^{th}$ BC, the scholar believed that management strength is an art of military personnel towards victory (Dimovski *et al*. 2012: 152 – 153).

Among the ancient Greeks, management by division of labour was more emphasised by Plato between 427 – 347 BC (Margaret *et al*. 1985: 89: Scott and Freeman, 2021: 787). Plato believed that it is through division of labour that resources are utilised effectively towards human ends in a republic. In Europe and Italy in particular, the writer of "*The Prince*" Niccolo Machiavelli, wanted leaders to use fear as strength to reveal their power rather than hatred (Macaulay and Lawton, 2003: 4 - 6). Fear helps to maintain control, dignity and respect (Harris, 2000:11).

The history of management is therefore very long and it has evolved over past centuries to modern understanding. There are four main shifts in which the theory evolved to current days. The first shift was witnessed when employees started working in factories for wages and salaries. The managers had the duty to organise their employees in different departments and shifts so as to be cost effective, save time and manage wastes. Secondly, with the industrial revolution, the management techniques shifted to the use of machines. This was mainly adopted to increase

production in factories together with employees. A combination of using workers and machines made some managers find no difference between employees and machines but regarded them as tools. Within this setting, problems of workers' dissatisfaction ensued and made managers to start focusing on employee satisfaction. Lastly, with the global economy which led to the need to consider cultural differences and practices at work, concerns about technical persons and expatriates who could work in companies beyond individuals and one's country rose with the main focus on time, wastes, cost effectiveness and delivery. The lean thinking is therefore a trans-boundary thought among companies that employ various workers with different cultures.

In the 18th Century, Adam Smith became the mother of labour management strategy by clearly specifying its application towards productivity and profits, with emphasis on specialisation (Godłów-legiędź and Godłów-legiędź, 2019: 175). He wanted managers to break down work into simple manageable tasks to different specialised persons with skills in order to save time (Kucukaksoy, 2011:108 - 109). His book "*An Inquiry into the Nature and Causes of the Wealth of Nations*" in 1776, Smith presented the following in relation to labour and saving time. He stated that each individual "*strives to become wealthy.*" Secondly, productivity increases the division of labour, the free market provides the best environment for wealth accumulation; while property rights are important towards the concept of free market. To work within the limit standards by Smith, principles under lean philosophy cannot be avoided. Apart from Smith, there are other writers whose work reveal application of managerial theories and lean thinking. Ricardo in his "*Letter to T.R. Malthus, October 9, 1820*" asserted that;

> *"Political Economy … should be called an inquiry into the laws which determine the division of produce of industry amongst classes that concur in its formation. No law can be laid down respecting quantity, but a tolerably correct one can be laid down respecting proportions."*

According to Draper (2002: 2 -3) (Cited from Bentham, 1789), there are cardinal principles of morals that can bring workers to succumb to management. Among others include the goodness or badness of the law that can either increase general happiness of population; secondly, at whatever level can one derive happiness from his/her action; actions of people can be judged how their outcome affect general utility; people are the best judges of their own action; lastly, whether hired or not, peoples' happiness is always reconciled with morality.

According to Kucukaksoy (2011:108), Smith and Bentham were interested in capitalistic principles that always result in various management of persons at different stages towards production. This form of management was supported by Karl Marx who found such managerial breakdown under capitalism necessary and inevitable (Rosen, 1883:8). However, basing on evolution, Karl Marx quickly asserted that like other modes of production which could consume themselves in order to give birth to others, capitalism would give birth to socialism in which peoples' interest would be states' interest. Therefore, capitalistic management would give way to states' interest (Adler, 2011: 6). Besides, the free-market systems where companies operate freely to determine which management or construction strategy to apply would lead to a controlled market system for the benefit of the society as a whole rather than individual owners and managers of the companies.

An engineering philosopher and researcher known as Charles Babbage was also concerned about division of labour in his book "*Economy of Machinery and Manufactures*" in 1832 (Lewis, 2007: 248 - 250). His main questions were about strategies that lead to production to a certain level, the nature of organisation and economics (Lewis, 2020: 251). For example, what are the principles underlying lean thinking in the production process? What is the organisation of lean thinking within the company; and what are the economics of scale under which the company operates or adopting the techniques? Like preceding scholars, Babbage advanced the breakdown of jobs into tasks and costing each task individually with relevance to time, cost, waste and delivery. In case an employee underwent on-job training, the process and methods could be quantified. Building from the work of Babbage on managerial strategies, Towne came up with the concepts of "*shop management*" and "*shop counting*" in the United States America in the early 20$^{th}$ Century. The activities by both Babbage and Towne subsequently lead to modern scientific theories used in this study.

### 2.8.2 The Systems Theory

Systems theory as advanced by Bartaliffy in 1956 is a complex of interacting elements (Mele *et al*. 2010:2). The theory assumes that the behaviour of a single autonomous element is different from its behaviour when it interacts with other elements. It also assumes that there is exchange of energy, matter, people and information with the external environment of an open system. And, there is no exchange of information and matter in a closed one; while there is no exchange of

elements in an isolated system (Mele, Pels, and Polese, 2010: 126 - 127). Proponents of the theory asserted that a system is a combination of multifaceted systems or departments functioning under one autonomous entity.

Under Open System (OS), the main focus is placed on the relationship between departments and how they interact with the information from the environment (Gerus-Gościewska and Gościewski, 2021: 75). It assumes that entities or departments are able to process information about their own specific environment by showing more adaptive skills to shifts in contextual conditions. The focus of an open system is the ability of departments to adopt changes within the environment through information systems.

There are two adaptive levels that must be adopted in an open system as departments interact with one another (Mele, Pels, Polese, *et al*. 2010:127). These are counteraction and amplification. Counteraction relates to ability working through personal purposive behaviour as geared to organisation aims and amplification relates to constructivism theory with the main intention to self-organisation. Research has found that an organisation which is open is built on input – out and force coming from output reactivates work of the system. Such systems have been perceived in two ways; a social component with people, and technical with technology and machines. Under the model of an open system, the main concern is the interactive process between people and the technology for the system to function.

The system theory also has a Viable System Model (VSM) which shows a system as an entity that works towards a purpose in order to survive in a changing environment (Carayannis *et al*. 2016: 2). The illustration of the model applies to an autonomous organisation with cybernetic description. The fact that cybernetics represents an interdisciplinary study within the system, the main focus is the extent to which actions within the system institute changes in its environment. Cybernetics also allow adaptation from one place to another in different conditions with the changing behaviour. The fact that the system and environment have different levels, their difficulty also varies. In terms of the organisation, the cybernetics model seeks to use conceptual tools in redesigning through change management and capturing the fact that management is an integrated design. It is also used in assessing important functions of implementation, interactions, policy and intelligence.

Dunst (2016: 54) showed that the last model under system theory is Viable System Approach (VSA). It reconciles strategic management and organisation within subsystem and supra-system. The difference between sub- and supra systems is the fact that sub-system focus on the internal relationship within an organisation; whilst supra seeks to rectify connections between organisations/departments, and internal as well as external factors that influence the system.

Regarding the lean techniques under the technical perspective, it is clear that there is technology and machines. The extent to which these machines and technology are being run and administered is what the theory leaves not answered. As a system, the lean techniques remain systemic with the department and less is highlighted on the interaction of the people. The focus remains on the intercourse of departments without shading light how people within these departments are being administered and for what purpose. Even system theory is silent about the nature of interaction within the project's success.

### 2.8.3 Administrative management theory by Fayol

This theory has been used in order to illustrate how work within the lean techniques should run (Nadrifar *et al*. 2016: 84). The theory assumes that for effectiveness of the systemic organisation, the managerial or administration must plan, organise, lead, coordinate, control and exhibit staffing qualities (Mcnamara, 2009: 63). Fayol identified fourteen (14) principles of management of the workers which include; division of labour with the main emphasis to specialisation since it could lead to greater efficiency in operation. Secondly, Fayol wants managers to have authority and exercise it in accordance with the organisation's principles in order to have work done. The third principle is discipline of the members, which must be applied in respect towards rules and regulations governing an organisation (Poperwi, 2018: 809).

The fourth principle is unity of command in order to avoid conflicts and confusing instructions; secondly, unity directs managers and workers to be effective by avoiding clashes; and seeks to have subordinates who are interested in the common good (Uzuegbu, 2016: 59). There should be renaturation and centralisation of the financial roles which must be designed under a top-down form of management, that follows order at work in order to avoid wastage of time. Fayol also called for equity in which all organisation workers and managers work in a friendly environment and spirit; there must be stability at work so as to end turnovers; and such subordinates must be

given freedom to make decisions and plan making with the spirit of teamwork. The existence of a system or organisation and having effective managerial or administration do leave the question of why unanswered. This calls for the human behaviour theory by Abraham Maslow.

### 2.8.4 The theory of needs by Maslow

Maslow became the pioneer in the management of human behaviour in systems or organisations (Jerome, 2013: 39). He suggested that there are five sets of human goals that make individuals change behaviours or engage in different activities. They are physiological, safety, love/sense of belonging, self-esteem, and self – actualisation or self-fulfilment. These are the needs of man that compel him to seek and work in the world (Kaur, 2013: 1061).

The physiological needs at work include hunger, thirst, sleep among others. The satisfaction of these calls for safety and protection from danger or deprivation; which in turn lead to the need for love or belonging for the man to function upright. The satisfaction goes one by one up to self-actualisation. It is within an attempt to satisfy the basic needs of man, that the lean technique was born (Gao, 2019: 156). As indicated in Figure 2.8, the lean construction techniques do not start from nowhere rather in a situation where people have been staying in the already constructed house. It has also been introduced in an already existing system of construction. Its success or not success of the project under its formulation calls for project management in line with the Last Planner of management.

### 2.8.5 Last Planner as a theory of project management

The theory of project management is a transformative approach in its operation focused on delivery in time and limited wastes (Ballard and Tommelein, 2021: 11). Despite the existing methods and theories used to satisfy needs by construction as well as clients, the lean technique calls for the effective transformed service with project delivery. This applies to administration of human beings as well as systemic approaches and institutions. This is the Last Planner Theoretical model for project delivery (Bosc, 2012:14).

As a theoretical model, Last Planner calls constructors to cope up with all situations in order to have effective project delivery (Kalsaas, 2012: 89-90). It emerged from the effort of Ballard and Howell (1998:77), as an inductive approach to a series of industrial experiments. At the construction site, Last Planner does not follow conventional project management in reference to

planning, execution and control. Importantly, it is organised within a system where administrators seek to satisfy the human needs as advanced by Maslow. Evidence shows that Last Planners has construction production benefits of 10% – 40% and 30% being the median level. These benefits also include reduction of time spent in the project and safety to human resources involved.

As a theory, Last Planner refers to the chain of hierarchical steps of planners in which the acts of a planner interface the execution. Its main emphasis is detailed planning rather than the process in planning (Santos, 2017: 309). Last Planner distinguishes planned tasks in reference to Can, Should and Will approaches. In its form of planning, the Should category goes higher as opposed to Can category. In the look ahead category, pre-requisite of the upcoming assignments is made ready and transferred to the Can category. It acts as a pull – system in ensuring the prerequisite assignments. Conventionally, the plan pushes tasks towards execution in which Should category are recognised and executed.

The Last Planner theoretical model embraces a buffer of tasks for each crew at work in each department. If a signed task seems to be impossible at the moment, the crew turns to another task altogether. This is an important principle in effort to avoid lost production (due to starving or sub-optimal conditions). Theoretically, look-ahead planning aims at alignment of plans and situations. "Should" represents the tasks in the plan, and "Can" represents those tasks that realistically will be possible to start in the situation. Thus, look-ahead planning subscribes to the view of human action as situated - a foundational assumption of managing-as organising, while also acknowledging the significance of plans for action - as advocated by managing-as-planning.

#### 2.8.5.1 Theoretical execution under Last Planner

Last Planners calls for structured weekly tasks to be dispatched in orderly procedure, in which the site manager, sub-contractors and crews decide which task to be carried (Olivieri *et al*. 2019: 1). This follows the principle that assignments should be sound based on their importance and prerequisites to organisation and clients. In this approach, there is no work that could ensue until all items that are required are completed. Only tasks in the Can category are transferred to the Will category. After the week in question has gone, the crews inform the management or site manager whether they have realised assigned tasks or not.

This procedure contrasts to conventional project management, where execution just consists of task authorisation without a down-up approach. The site manager also notifies the sub-contractor or the crew that the task should be started based on the time schedule. Theoretically interpreting, the execution phase in Last Planner is similar to the language/action perspective model in that communication is a two-way process, and commitment is created for the realisation of the tasks within the planning conversation where plans prepared by one crew are understood as promises to others and through the obligation to report on the completion of the task.

#### 2.8.5.2 Theoretical control under Last Planner

Control under Last Planner consists of measurement of realising rate of assignments as per project, investigation of causes for non-realisation and elimination of those causes of wastes. The metrics at this stage is called Percent Plan Complete (PPC) and it is used to effect controls by measurements. In conventional project management, main control consists of comparing progress with the performance baseline as expressed in terms of money or hours taken at the project. Theoretically, the interpretation of Last Planner is a scientific experimentation model of control that emphasises measurements within the controlled project.

#### 2.8.5.3 Theoretical project delivery under Last Planner

Under Last Planner, tasks are the central unit of analysis with the main focus towards project delivery. Even though flows are not directly represented in Last Planner, the principles used contribute to the generic principles of flow management. Last Planner facilitates avoiding both variability propagation and unnecessary penalties of variability. The focus on plan realisation diminishes the risk of variability propagation to downstream flows and tasks reducing the need for large material buffers on site. Last Planner effectively combines control and improvement to fight back against variability and the waste caused by it. Thus, Last Planner combines the flow and the transformation view in short term planning, execution and control. Therefore, Last Planner can be used as a conventional project management system, and as a control through thermostat model that can be realised concurrently, if required. The diagrammatic illustration of the project theory is well illustrated in Figure 2.10

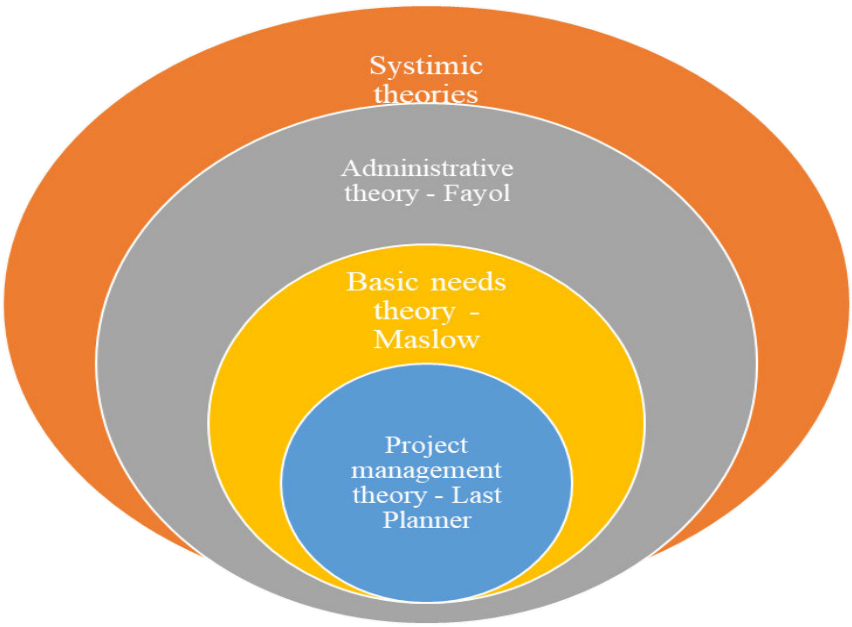



**Figure 2.10: Theoretical Illustrations**

Source: Developed from Ballard and Tommelein (2021: 11)

### 2.9 Implication of the theories to management and project delivery

The implication of the theories has been captivated under knowledge, value, quality, environment, relationships, adaptation, and complexity in the systemic approach and project delivery. Under knowledge for example, the theories show that an organisation's vision is a learning and working item that requires the technical personnel to have required skills and competences in order to produce or have results tailored upon its vision. The organisation, therefore, is a cognitive system and it is established on creating information and activating skills of its human resource in order to have continuous learning processes. This knowledge is dynamic since it embodies management, administration, needs of all workers and focuses on satisfying clients through project delivery in time.

From the theories applied to this study, value remains the most essential item towards achieving a holistic system which is characterised by a high degree of integration between factors intervening in a process of value creation. This applies systemic value, management and administrative value, need based value and project success value. Through such a perspective of value, a company embracing lean techniques has a potential existence, development and evolution. Its construction business is related in sub-system (through quality management, project activities, internal

execution, controls, feedback, daily research and evaluation) and supra-system (through cooperation logics and asset improvement in terms of technical, cognitive, relational and adaptive aspects). This is essential for individual workers to understand the intention of the system or a company towards their needs that surround their intention in project success and delivery.

The rigorous theories that have been used to underpin this study aim at quality results as one delivers his or her results. When discussing quality issues under the construction company in Uganda, it is necessary to focus on the link between technical quality management or timely quality management and lean techniques. In this, the systemic conception of a company is strengthened by emphasis on important relationships of parts and goals to be reached. Under the technical management of the firm, every size unit, from individual to team to company is susceptible for review and effort to rework is also set with. to the region and nation, can learn how to learn. What is important in all these is improvement of human needs through administrative approach with a mail goal towards project success.

Supporters of lean techniques believe that it's the environment that matters most rather than any other narrative. Therefore, if a company is the system at the micro level, then the environment is the system at the macro level. In the systems' approach, by analysing the structure of the system and structure of supra-systems, decision makers employ attenuating and amplifying actions of the kind needed for survival of the environment where the company or company's project has been situated. At this point, a company is situated within two categories of environment: the objective environment and the enacted environment. In the first case, the environment corresponds to some freestanding material entity that is independent of the observer, concrete, external and tangible values. On the other hand, scholars adopting the second approach reject the notion of an external objective reality; the environment is thought of as a "*mental representation embodied in a cognitive structure which is enacted in retrospect and fashioned out of the discrete experiences of managers*. From this approach, the company and environment are labels for patterns of activities that generate human actions and their accompanying efforts to make sense out of the activities of the workers in order to have project success and delivery. Therefore, managers need to be considerate towards the environment out and within so that the successful environment is beneficial.

# CHAPTER THREE:
# RESEARCH METHODOLOGY

## 3.0 Introduction

This chapter describes the research methods used in the study. It begins with the research design as the study's master plan and the philosophical paradigm that underpins the study. As a result, this is the main focus in order to shape the narrative. The section also gives the urban setting of Kampala as the study area with various companies under the population of study. The sample determination and selection were also presented with the main narrative to assess the participants whilst putting into consideration the COVID-19 standard operation procedures during the research. The section also highlights the discourse of quality control of the instruments in a situation of COVID-restrictions in Kampala. In such a situation, the access to participants was not simple but the investigator used possible means to collect the data that were later analysed as presented in this thesis. Importantly, three methodological approaches were used during the study; starting with review of literature or desk review. The second was a questionnaire survey under a cross-section survey design for data collection on objectives 1 – 3. The narrative's main focus was on how lean construction was used by all of the businesses, which was clearly examined and yielded similarly positive results. The second narrative was peculiarity of the Last Planner as a lean construction technique in construction (More and Fulse, 2021: 504). Determining the perception and knowledge about the goodness of the last planner technique amongst all the participants.

## 3.1 Research design and approach

Selecting a design and strategy were the two primary tasks under this section (Williams, 2007:66). The dissect was perceived stemming from research methodology and focusing on appropriate research methods. This study established that the two are different despite being commonly united and used as one in many researches. This study perceives research methodology as a broader version for understanding strategy or an approach to be applied in answering research questions (Pastore, 2017: 257). According to Busetto *et al*. (2020: 9), these approaches include qualitative, quantitative, induction, and deduction. It is an explicit procedure upon which guidelines and informed claims to knowledge are based and proved with evidence from the objectives.

### 3.1.1 Research designs

Researchers use various designs in their investigative approaches to find new information and add knowledge to the existing body of knowledge. A design is the form of a skeleton or an initial plan that illustrates the roadmap to success or failure. This means that even whichever pathways, there must be design governing implementers. Some of the designs in research include; descriptive, experimental, correlational, explanatory, and diagnostic research (Busetto *et al*. 2020: 10 -15). Moreover, Fellows and Liu (2008) highlight the research styles normally used in construction management as experimental, survey, action research, ethnographic research and case studies. This section therefore reviews the research designs that this study would have followed and later gives the choice or priority of the selected one.

#### 3.1.1.1 Case study designs

Case study designs are most common in various research that are carried out in the social sciences or humanity studies (Ridder, 2017: 282). To Crowe *et al*. (2011: 1), it is a design that has been employed by sociologists from a positivist, interpretivist and pragmatist point of view as a means to focus upon social life, physical and theoretical perspective. The basic idea behind the case study is to have a detailed study for a variety of purposes and research questions with the main emphasis to develop full understanding of the case studied so as to add knowledge to the already existing information. In fact, Schoch (2020: 247 - 248) shows that the main underlying issue with the case study is that new knowledge a researcher can explore and the extent to which the phenomenon of investigation impacts the social, physical and the theoretical order. There are three case study designs that are well applied by researchers across the world (Sainal, 2007: 2-3). These include intensive case study design, instrumental case study design, and collective case study design. Under intensive case study, there is no attempt to generalise beyond a single case but within the instrumental case study, the phenomenon examined is solely for the insight and to revise the generalisation that is essentially meant to be studied in a different perspective. Collective case study is an investigative design and most case studies fall under this perspective in order to investigate the case with the central focus of generalisation of the phenomenon (Mahadi and Husin, 2021: 39 - 40).

Research from various disciplines use the case study design in order to build the theory, produce a new theory, dispute the theory, explain the situation, provide a basis to apply a solution, explore or describe an object or the phenomenon (Teegavarapu *et al*. 2008: 2). One of the advantages of the case study design is the fact of their application to real-life situations, contemporary life, human solutions, and public accessibility through written reports. The case study results relate directly to the common reader's everyday experience and facilitates the understanding of the complex phenomenon (Heale and Twycross, 2018: 7). The case study designs are always depicted from the topic guiding the investigated phenomenon with the main narrative to establish the new knowledge in the due course of research (Takahashi and Araujo 2020: 101 - 103). Despite the efficacy of case studies and relations to this study, it was exempted on the ground that the main concern was not only on the lean technologies, or the construction industry in Uganda; rather the awareness of lean techniques and the extent to which construction companies understand the concept towards delivered services or projects.

#### 3.1.1.2 Ethnographic design

This is a design to study both explicit and tacit cultural knowledge with the main extent about how such explicit paradigms influence the social norms (Slabbert, 2012: 37 - 38). For example, the adoption of lean construction techniques is one of the explicit paradigms that companies would have applied in order to deliver projects in time. Besides, there are no company managers that feel alright with construction wastes, high costs and untrained employees. The fact that principles of lean techniques attract almost all companies, it becomes obviously explicit. Under ethnography, researchers interact with groups in their cultural settings, as well as the natural setting over a specific period of time (Leshkowich, 2014: 142 - 145). In this perspective, a cultural group can be any group of individuals that share common social experience, location, or the social characteristics. This would have been the best design for this study, but it has some flaws in relation to this study. Ethnographic research has traditionally been defined by the exploration of phenomena rather than the testing of hypotheses. tendency to work with unstructured data and analysis of data involving explicit interpretations of meanings of human actions via verbal explanation (Boru, 2018: 24). However, this study has been constructed on testing the hypothesis and other quantitative qualities that are not implicitly or explicitly welcome with ethnographic research design. Moreover, the study was as well carried out under strict COVID-19 standard

operating procedures, the interactive perspective in which an investigator would have immersed himself within the cultural setting of the organisation was highly limited. This design was also exempted.

#### 3.1.1.3 Phenomenological design

Phenomenology is conducted to examine the human experience through detailed description of the people, event or concept being studied (Groenewald, 2014: 3- 6). The main focus is to understand the lively experience of individuals being studied. The advantage of phenomenological design is the fact that it is an approach that involves studying a small group for a long period of time (Thani, 2011: 26 - 27). The fact that it focuses on a small group of people with related features even if not related, it was also exempted.

#### 3.1.1.4 Cross – section design

This is one of the approaches that this study embraced due to its nature that embodies some of the other designs (Zangirolami-raimundo and Oliveira, 2018: 358). It has been built on the fact that the construction sector in Uganda has many companies that are implementing some of the components of lean techniques. Therefore, a cross-section design was used in order to cover some of these companies so that the concept case study could be investigated. The choice for cross – section stems from the design of the construction companies to be studied. They are distributed across Kampala Capital City and this study established the need to select various participants to give their ideas to all the employees of the company. This was applied on the assumption that employees have taken a long period working with selected companies and therefore would be knowledgeable to give information about the lean techniques (Levin and Levin, 2014: 24 - 25).

In Uganda, the construction industry is one of the most important sectors since it is linked to one of the basic needs of man. Its importance permeates to other needs which are fully attained with accommodation or housing. The activities of the construction industry are inclusive to design, manufacturing and construction which are not only for specific persons rather to all people as stakeholders (Alhuraish and Robledo, 2014: 3 - 6). The companies in construction are the main stakeholders at national and international levels. Under the construction sector, this study identified the concern towards lean techniques which has been well illustrated in chapter two. Its importance in research circles started with the 1950s and it has evolved over the years. Despite its importance as technology towards the construction industry, lean techniques in Uganda have been

constructed on a weak theoretical foundation. The common critical research has been lean technological mixed approach that embraces lean techniques principles and principles of other technologies (Hughes *et al*. 2020: 36 - 39). Despite this, the main focus of this study is the extent to lean techniques. Embracing a cross-section design is therefore essential as the information would come from varied companies rather than one case study of a company. The design, strategies and methods adopted for this study are summarised in Table 3.1.

**Table 3.1: Summary of Study's research design and methodology**

| Methods | Definition | Application |
|---|---|---|
| **Theoretical approach**<br>● Systems (Mele *et al*. 2010: 127)<br>● Administrative theory (Baloch *et al.* 2019: 157)<br>● Needs theory (Mcleod, 2018: 2)<br>● Project planning – Fast Planner (Pace, 2019: 58) | Provides detail description and explanation of systemic lean techniques as a concept and at the company level, management of workers and people, needs / aspiration, nature of the project and its delivery | Under this study, lean techniques create and provides an enquiry surrounding itself as technology, people and aspirations |
| **Research Paradigm / philosophy**<br>● Pragmatism paradigm (Parvais *et al*. 2016: 68)<br>● Positivism (Park *et al*. 2020: 690)<br>● Interpretivism (Wang, 2020: 725) | Provides essential ideas of the study and its requirements as a source of knowledge. Underpins the primacy to qualitative, quantitative as well as mix approaches. | This has been applied in measurements and analysis that reduced it quantitatively through confirmatory tests. The content analysis also comes from such underpinning of research study. |
| **Cross – section method**<br>● Over - many construction companies to be studied. | Qualitative and quantitative investigations using administered questionnaires and interviews. | Using the lean techniques – last planners is the central focus across selected employees in selected companies |
| **Actions**<br>● Problem solving | Problem led research solved by investigators or part of the community | Lean investigators engaged participants in order to condense the problem |
| **Interviews**<br>● Administered questionnaires<br>● Interview guide | Quantitative and qualitative tools or methods to investigate research questions | Lean investigators interviewed implementers |

Source: Adopted from Jacobs (2011)

### 3.1.2 Research approach

Like the logic approach emphasised by Plato in order to establish knowledge, the logic of research starts with methodology in an abstract form and goes through principles and processes to field study and investigations (Bhartiya, 2019: 811). In order to arrive at the methods to be used, there must be an approach that informs a method to be applied. To Eyisi (2016: 92 - 93), the underlying questions as one seeks an approach include; is it qualitative or quantitative approach that can lead to needed means or tools to be used in the study? The approaches are commonly referred to as strategies, processes, and end-to-end direction / method. Thus, the logic procedure is research methodology, design, approach, and methods. It is within these approaches that a philosophy is designed to underpin the study. The approach also informs what methods or specific tools to be designed in order to access or collect data from the field (Hossain, 2011: 146).

Norani and Ismail (2014: 2-3) used a qualitative approach to assess the implementation of lean techniques for the reduction of inflow variation and the findings became instrumental informing implementers to focus on qualitative attributes to workers. Pinto *et al*. (2022: 6-7) adopted a mixed research approach using both qualitative and quantitative at the same time under the case study to assess the extent to which the technology serves the purpose in line with its principles. There are also various studies that use only literature and correspondences like emails, mobile phones and telegrams to collect research studies about lean techniques. These studies disregarded observation methods since the main ideal was the knowledge about the technology. In China, Changa and Sun (2007: 3-4) collected data through correspondences about teaching and learning of lean techniques. Saragadam (2020: 12519) mentioned Sacks *et al*. (2009) to have conducted an extensive review of literature to assess Building Information Model (BIM) based on lean production and construction principles. All these studies proved essential to knowledge about lean techniques.

The literature herewith justifies the extent to which lean techniques are friendly to research and applicable to various areas and approaches in the due course. This therefore is enough evidence that the selection of appropriate approaches stems from research questions as well as hypotheses. It can also accrue from intensive review of literature that determines the similarity and differences in what the previous scholars have applied and what is intended to be applied. There are many researchers in lean techniques who have decided to apply a single approach but majority would use a mixed approach since one compliments the other. The most important is selecting an approach that is in line with the research design, questions and hypothesis as well. Such focus becomes essential to achieving the stated objective and this saves time of an

investigator during the study. Under this study, the mixed approach was also applied, that is to say qualitative and quantitative approaches.

### 3.2 Choice of cross - section design

Based on the nature of this research, especially the topic, objective, research questions and hypothesis; a cross-section design was adopted (Wang and Cheng, 2020: 566). This was because it relates with various procedures that this study sought to follow to select companies and participants. Within a multiplicity of companies under the construction sector in Uganda, companies were selected and studied. It was adopted so that it could enable close and detailed work of companies at both national and company levels (Maguiña *et al*. 2021:179). This enabled the researcher to capture responses of participants, the manner and extent to which they apply some of the concepts of lean, and the circumstances under which they apply such. A few observations were made that were useful in determining whether the application of some lean techniques has been given the same priority as it is in principle; whether its application yields same results, whether there is consistent managerial support for lean techniques; and whether the application of few principles under lean techniques can really deliver results as recommended under lean philosophy. A cross-section design was also useful for this research because it allowed the extension of experienced managers to qualitatively inform the study, which added the strength to what is already known through previous research studies (Hemed, 2015: 4). In fact, like other research studies that are conducted in order to increase and add information to the already existing knowledge, the design enabled the investigator to add something that is essential and needful for lean techniques in Uganda.

### 3.3 Research philosophy

The structure of inquiry has been presented under this section in order to show why selected few and not the rest. This calls for first illustrating philosophies in order to justify the choice (Khatri, 2020: 1436). These philosophies are at times referred to as the research paradigm and worldwide recognised as scientific beliefs that provide a model to the problem and solution. There are various researchers who believe that good research is shaped by paradigm and subsequent assumptions. The paradigm is also essential in determining good methods and methodologies under which the research thrives.

A paradigm is a philosophical preposition in which a study is revealed in terms of beliefs and what could guide its actions to the end (Bianchi, 2021: 33). Other researchers have perceived a research paradigm as many beliefs and practices that regulate an investigation or inquiry through lenses, frameworks or processes (Bawa, 2017: 29). In fact, the assumptions set the trajectory towards research action from introduction to conclusion. A paradigm has been used and worldwide recognised as a concept representing various views.

The commonly used paradigms include pragmatism, positivism, interpretivism, post-positivism and critical theory (Tombs and Pugsley, 2020: 1-2). These have been selected to be reviewed since they relate with what this study seeks to answer and underpin.

In other research, paradigms have been referred to methodology and classified into three (Matta, 2021: 3-5). These classifications include positivist social science, interpretive social science and critical science. Positivist and interpretive approaches are commonly used in social research, and they embrace pragmatic philosophy (Park *et al*. 2019: 690). This is because pragmatism embraces qualitative (interpretive) and quantitative (positivism) methods of research. Positivism is the oldest paradigm used form of beliefs in sciences especially experimental and quasi (Major, 2017: 173). Interpretivism is commonly used in narratives that always embrace social science discourses in the world with less focus on sciences (Kelliher, 2021: 123). On the other hand, critical social science is always used and commonly seen in published journals in action research, evidence-based research and applied ethics. The differences in these philosophies are found in the presentation of beliefs, measurements and understanding of social reality. Besides, they have been described by different authors which defends their differences in presenting the world's ideas and orders.

Stern *et al*. (2004: 14 -15) describe such philosophical approaches in terms of positivism and post-positivism, social constructivism and critical realism. These approaches cut across mixed approaches of qualitative and quantitative; and equally embrace pragmatic thinking. The other main narrative to describe the main philosophical underpinning has been using the lens of epistemology and ontology. Using these pathways, it is clear that rhetoric assumption has been used as a common narrative. Therefore, researchers apply philosophical assumptions or beliefs under different designs of research with focus to have conclusive evidence without diversion to another assumption.

In accordance to Bawa (2017: 28), philosophies or use of certain philosophy is symbolically an inference of knowledge claims about what the nature of knowledge (Ontology); how people come to know (epistemology); of what values to (axiology) and how is written (rhetoric); and the process through which such knowledge is studied (methodology). Using this assertion therefore, choosing a framework or research philosophy is essential in order to underpin all the narratives surrounding knowledge. In the common place, the rhetoric of the authors forms the basis of methodology (Kura, 2012: 1-2). Other scholars show that the framework to the research paradigm follows ontology, epistemology and axiology. These schools of thoughts are essential to any study despite the silence that is always given to them in research. Epistemology, ontology, axiology and methodological are cardinal in all research assumptions or beliefs

selected. Writers like Nudsor (2009: 115 - 119) hailed and commented on positivism (quantitative) and phenomenological (qualitative) paradigms with common assumption that they are worldwide applied in all research yet writers claim the use of a single paradigm. Phenomenology uses qualitative and naturistic narratives towards an inductive and holistic understanding of human experience in specific settings of study. It underpins a phenomenon in a particular context and explains using the narrative lens of qualitative inquiry. As a philosophical assumption, it dismisses all the external influence of assumptions towards the phenomenon. The "how" analogy of the epistemology, ontological and axiology is presented as follows in Table 3.2 for quicker consumption.

**Table 3.2: The "how" analogy of Epistemology, Ontology and Axiology**

| **Philosophy** | **How about itself** | **Method** |
|---|---|---|
| Epistemology (Singh and Walwyn, 2017: 2-3) | How we think about the world | Influence |
| Ontology (Al-ababneh, 2020: 78) | How we see the world | Direct and shapes |
| Axiology (Rangel, 2019: 103) | How we act towards the world | Reflects |

Source: Adopted from Rangel (2019)

Ontology deals with the nature of the social world (Aliyu and Adamu, 2015: 13-14). However, there is an ongoing social debate about the existence of social reality and how it can be presented. In this respect, the question surrounds the real nature of the world (realism), its material perspective (materialism) and the ideal perspective (idealism). From the conceptual perspective of this study, assuming lean techniques is a philosophy (Serhatli and Alpaslan, 2014: 659). The underlying question of ontology remains: how real are the lean techniques? What are the material representations of lean techniques and what are its ideas (lean thinking / philosophy)? Research has posited that the main focus of realism is to navigate the nature of what is real and how it relates to other domains of actuality and empirically. It has been found that realism is the existence of external reality regardless of what knowledge that exists and beliefs (Ceusters *et al*. 2003: 3-4). Materialism on the other hand is an expression of what is actually real in material perspective. It is therefore only the human mind that socially constructs these prepositions in the real world. In fact, what is real to one mind may not necessarily or necessarily be the same. To understand the material nature of the lean techniques, there are features underlying it that are different from other technologies used in construction (Basili *et al*. 2003: 1-3). These are observable features rather than the conception of the mind.

From the standpoint of materialism, what is real is already in the mind; as a socially constructed meaning as known (Goldkuhl, 2012:3). Under this perspective of social construction, Park *et al*. (2020:692) state four philosophical paradigms as post-positivism (this is what he calls quantitative) constructivism;

advocacy (where researchers have to inquire needs to be intertwined with politics and political goals); and pragmatism. As the world is constructed, the lean techniques are pragmatic, real and material. It is an idea in mind, whose reflection is typically materialistic in the form of pragmatic (qualitative and quantitative) revelation. To Reves and Borges (2019: 2-3), pragmatism is a mythology that is indeed real and materially to explain the lean techniques. It underpins its ideality in mind, and brings the concept to the practical world among the companies or implementers who find value in it. The question is, where can we find it?

Research has found that under epistemology, there are two opposing forces of interpretivism and positivism (Bawa, 2017: 27). Positivism calls for the utilisation of empirical methodologies from natural science to understand the phenomenon. It encourages explanation between variables and the phenomenon as well as their model relationship as used in quantitative research. Supporters of the philosophy believe that using natural science, one can equally establish the social issues among men since laws have been used as a natural discourse to determine human behaviour. According to interpretivism however, natural science approaches are unsuitable for social inquiry since most law – like regulations that are put in place to regulate mans' behaviour do not have law-like features (Goldkuhl, 2012: 6). This means that the lean technique has properties of epistemology since it can be quantitatively found as a phenomenon in a certain context. The lean as a technology can be well determined by its existing laws and principles that hardly intermingle with other forms of technology used in the construction. Therefore, this study embraces the narratives from epistemology; positivism, interpretivism, critical social science and pragmatism. These have been discussed further in the following presentation**.**

### 3.2.1 Positivistic philosophy

This is a philosophical assumption held for natural science with many versions of positivism (Evered and Roger. 2022: 138). It has a long history of existence together with science, and since science evolved over centuries with man, its associated scientific theories have similar history. It has been used in different studies that have embraced social science realities under the heading of theoretical framework, rational choice and structural – functional. In some empirical research, it is described as an interpretation of science with key concepts being theory, data, verification, principles or law – like statements, inductions and deductions (Park *et al*, 2020:690). For the case of this research, all these are embraced toward lean techniques and the extent of success towards project delivery. Like other researchers therefore, positivism has several similarities with other data-oriented methods.

In research under positivism, it is the duty of an investigator to gather data in a systematic way, analyse it so that meaning can be attached too. While positivism follows a thrust of quantitative data collection and

presentation, it has never been fully presented without bias to qualitative investigation. Antwi *et al*. (2015: 217) had stated that quantitative data use various approaches that are mostly used in qualitative investigations. Mostly, they include surveys and quasi experiments while experimental and statistics prefer pure quantification. The latter two however, also embrace qualitative approaches through literature (Johnson *et al*. 2017: 9-10). Reviewing literature has never been the case of qualitative, rather quantitative. In some research, positivist researchers embrace rigorous, accurate measures to research objectives and hypotheses. Although most of them prefer research hypotheses, the use of research questions has been integrated into positivistic investigation that always embrace quantification. According to Caetano (2018: 1316 - 1317), the narrative of research question and hypothesis has been a central question to qualitative and quantitative investigation. Although quantitative investigation can use both, qualitative researchers have insisted only on research questions. The discourse is always ideal rather than materialistic. Nonetheless, there are common features that a positivist researcher should embrace. Among others include formal prepositions, quantifiable variables and measurements, hypothesis testing which are not common to qualitative investigations. Otherwise, direct conclusions made at the end of quantitative research fall into the same case of qualitative research although the narratives differ.

### 3.2.2 Interpretivism philosophy

This is a social scientist narrative that relates hermeneutic approach / theory that started in the 19$^{th}$ Century (Hiller, 2016:103). Its main discourse follows the view that data have been collected well, and mainly focuses on interpretive analysis of people's perception of causal - effect social world and a phenomenon that always occurs in the context. Under interpretivism, the main concern is idealism since the interpretation of one investigator does not necessarily mean to be the same to another one. Critical theory of the two findings by two investigators will however show some similarities and few differences since mind and level of interpretation and perception differs (Matthews and Ross 2010: 134). For example, in the context of this research, literature shows that even if some companies in Uganda have been applying content which resembles those of lean techniques, the concept has not yet been embraced. Applying such contents does not necessarily mean that companies have embraced lean techniques. However, another interpretive research will quickly assert that due to such approaches taken by companies, there are lean techniques in Uganda; while another can assert that lean is taking a low rate. The common ground in the three assumptions is the fact that lean techniques components are being integrated among works of companies in Uganda.

Under interpretivism, field research – data collection and observations are most commonly used to get data (Dean, 2018: 3-4). At the high point, interpretivism finds ethnographic research best for data collection. Under interpretivism, social constructivism is socially constructed (Ryan, 2019: 9). Constructivism is used here as an approach to social reality and part of interpretivism. Social constructivism is not a theory – oriented rather, it focuses on how social phenomena are socially constructed. That is why observation as well as ethnography are essential in the narrative of interpretivism. From this perspective, as long as interpretivism uses social constructivism, it ceases to be an individual work, rather communal or work of many observers so that evidence based meaningful conclusions can be reached. Additionally, constructivism is an anti-reduction approach that is mostly held in different studies. In itself, constructivism embraces ontological discourse in which humans are related with short lived products of their social activities. At this stage, an interpretive approach is associated with symbols in nature with the main discourse to existence as well as life. These symbols are associated more to qualitative investigations as opposed to quantitative studies. Despite this assertion, Bawa (2017:30) shows that reality is created by peoples' interaction with beliefs. The creation of lean techniques is therefore real according to the statement by Bawa (2017:30) and its adoption is the right option for the companies. An explanation why has not been well embraced in Uganda is the main focus of this study.

### 3.2.3 Critical social sciences

This applies two concepts: nomothetic and idiographic approaches in research studies. At once, the approach agrees with interpretivism and opposes positivism; and at a certain point, it disagrees with interpretivism. The disagreement with interpretivism does not call for the agreement with positivism. Research has found that the agreement goes with the underlying patterns of nature as evidenced in research and law. While there are disagreements and agreements, studies have indicated that critical approach is much subjective and relative to nature. It takes the conditions of human beings as instrumental as opposed to the event or phenomenon that has occurred in social situations. This raises a question of quantitative and qualitative. Thus, how quantitative or qualitative can critical social sciences become a philosophy over nature and phenomenological discourse.

Under critical realism, such questions are bridged and therefore provide no bias towards research. In this narrative, the realists assert that social structures are real and exist due to power, others object to the driver by power in causing the existence of social structures. According to this assertion, social structures exist within humans and do not necessarily relate to power. This critical approach can be due to social – economic

perspective which is independent of power. However, there is an agreement that where there is power influence, the social structure becomes a reality. In brief, the existence of power is a source of social structure. It has been found that critical thinking seeks to understand the ongoing process rather than phenomenology or any event that can take place in society. Therefore, lean techniques are an ongoing process that needs to be studied rather than a phenomenon that is currently taking hold in the world.

### 3.2.4 Pragmatism philosophy

Pragmatism as a research paradigm seeks to embrace plurality and it is based on a preposition that researchers should apply methodological approach to investigate a problem (Maarouf, 2019:5). Pragmatism is associated with the mixed – methods where the focus is upon the consequences and research questions. It also gives the option to employ formal or informal rhetoric or both. Its origins are in the United States of America, and its proponents oppose the notion that scientific research should be measured quantitatively or qualitatively, preferring to utilise both approaches. They assert that human actions can be separated from the past experiences and form a belief from those experiences. Therefore, human beings and their actions are linked to experiences. The main contention of pragmatism which also is one of the focuses of this study is the fact that human action and beliefs are found in consequences. Pragmatists post that external forces cannot determine humans, rather humans are able to shape their experience through actions and intelligence (Johnson *et al*. 2017: 4). In other words, the understanding of lean techniques is highly found in delivery of the project. This must be reached as contractors reduce wastes, consider costs, and think of time in their actions. Pragmatists also assert that reality is not static! It changes over time and within the contest. This applies to the world which is never static; and the same to lean thinking.

Pragmatism embraces three main ideas and these include; "*actions cannot be separated from the situations and contexts in which they occur*" (Morgan 2014a: 24). Under this statement, it is indicated that the world is an interesting universe. Rather than universal truth, there are various beliefs that influence the action of men for similar outcomes. Secondly, "*actions are linked to consequences in a way that are open to change*" (Morgan 2014a: 26). Lastly, "*actions depend on the worldwide views which are socially shared sets of beliefs*" (Morgan 2014a: 27). Using these statements, it is easy to assess the reasons for adopting the lean techniques indirectly in Ugandan companies while others remain unaware of lean.

### 3.2.5 The chosen paradigm

It is essential to assert that the research philosophy or paradigm selected is related to this study and pins the narrative requirements. As presented in the preceding philosophical presentation, the paradigms most used in this study are pragmatism, positivism, interpretivism, post-positivism and critical social theory. In line with the lean techniques and narratives under positivism, it clearly observed that the narrative is based on rigid rules of logic measurements, truth, obsolete principles and predictions. Under this paradigm, there is only one reality which can be captured through observation of the context and the phenomenon. The level of enquiry is free and causality follows linear discourse. This form of principles and rules govern the lean techniques and the method to access / get data was free and the linear structuring has been presented in the preceding chapters.

This study was therefore carried as a matter of proof about the underlying paradigm – positivism. The question underlying the application of other paradigms was dependent on the flexibility of positivism. However, the nature of rules and principles under lean techniques were important to determine if the applied concept is lean or not. Besides, it was important to illustrate if company participants understand or are aware of the lean techniques. And aware of the context of Uganda, and cognizant of challenges in the construction industry, recommendation of the last planner was made.

The study also incorporated interpretivism philosophy in research design. This shares a qualitative methodology as the foundation under which interpretivism is based with perspective of truth in research and data collection. What is already observed is the fact that positivism is not enough and cannot work in isolation without other philosophies. The concerns of lean techniques as assessed in this study cannot be fully analysed using quantitative methods without qualitative. For example, the study has been set to determine the level of implementation of lean construction techniques in the construction industry by checking general awareness and utilisation of concepts. Looking at this statement, it is clearly indicated that there are some ideal issues that need qualitative inquiry. Above all, research has revealed that awareness and decision making are typically examples of realism since they cannot be seen or expressed materially. To get information on such ideas, a participant needs to be given ample time to illustrate his mind in relation to the tools. The type of paradigm that is needed here is what can embrace both qualitative and quantitative nexuses.

The nexus through which interpretivism interfaces with positivism in a study research is generally pragmatism philosophy (Hiller, 2016: 103). The interface of the two is essential to bring the end rather than leaving gaps in discussions. What is clear is the fact that the qualitative approach of inquiry seeks to disclose the uncovering contents among the people in particular circumstances. For example, while this study is assessing the level of awareness in 2021, it could change the attitude towards the implementation of lean techniques in future. The approach used to inquiry and methods to get data are essential and call for positivism, interpretivism and pragmatism.

Therefore, a combination of interpretivism and positivism form the paradigm used in this study. One would call them pragmatism in summary. However, there are some of the ideal aspects that pragmatism cannot fix well as compared to positivism and interpretivism as well as post – positivism. What is clear is the fact that the combination of these paradigms was essential to the study design and tools that collected data that were later analysed. The lean techniques as used in this study have rigid principles and rules that really need a positivistic approach. However, its application through companies is a course of mind that needs to be interrogated qualitatively.

### 3.3 Research methods and approaches

In common understanding of research, research design rotates around ethical consideration of research, data collection and analysis in order to answer research questions and hypotheses (Abuhamda *et al*. 2021: 74). This therefore is dependent on different theoretical or conceptual frameworks one chooses to use in the study. In order to have a clear methodology, it is imperative to focus on the research objectives. In this case, qualitative and quantitative methods were applied in this study with the perception that they could help one another in illustrating the concepts underlined. Qualitative and quantitative have been selected since they suit the philosophies that have been used in this study as well as the central position of investigation – lean techniques. This combination is what most researchers call a mixed method. It is mixed since it used both qualitative and quantitative ago. The axiology perspective of qualitative and quantitative is found in the study research whose objectives, research questions, hypothesis are the cardinal and the central position. In fact, the two approaches complement one another as they have fixed nature from the other (Antwi *et al*. 2015: 221).

### 3.3.1 Quantitative method

Quantitative research has been perceived by various researchers as an approach of inquiry to human problems based on testing hypotheses or a theory as per the design of research. It is used in measuring the numbers and statistical procedures in an attempt to discover if the hypothesis set or the underlying theory is true. Researchers like Eyisi (2016: 95) have remarked that there are various groups of investigators who primarily use positivism and post-positivism to add knowledge to the existing body of knowledge through the use of quantitative methods. The focus is put on testing the hypothesis, causal – effect research, use of measurements and observations which have stood over the test of time. These are found in baseline surveys, experimental and quasi designs. The use of quantitative is instrumental in research since it calls for the appropriate measures that assess significance and importance of objectives that have been used in the study.

Experiments, content and statistics analysis and observations have been key as most quantitative methods or techniques. An investigator can decide which method to apply in an enquiry of knowledge which remains instrumental in assertion. Aware that quantitative ignore cultural perspectives that are commonly found in ethnographic designs and assume a value free report, this research found it important to determine values without discourse to cultures (like the organisational cultures). Under quantitative, it is clear that pure statistics emanate from the research hypothesis which suits the case to this study. The research hypothesis as set in the first chapter were tested by a statistical enquiry so as to get needed findings as presented in the preceding chapters. Whereas the application of quantitative methods was essential, without the use of qualitative methods, quantitative methods would have failed to study the mind (opinion) or what is actually ideal in reality. Based on this assertion, reality is qualitatively collected since quantitative methods have proved inaccurate. There are also some of the environmental factors that cannot be captured using quantitative methods which surround this study design; these illustrations and explanations require more meaningful methods of research.

### 3.3 2 Qualitative methods

This involves the use of a variety of empirical materials, personal experience, material case – studies, artefacts, cultural texts, observation, historical narrative, routine descriptions and meaningful events as described narratively by participants (Hossain, 2011: 146). It is a systematic enquiry that seeks to establish qualitative information of study especially through the grounded theory of empirical findings. It mostly uses generalisation that does not depend on statistical inferential, rather than plausibility and cogency of the logical reasoning used in describing the results from the cases and in drawing conclusions from them.

It is a form of a method that welcomes interpretivism and naturalistic approach in the logical discourse of truth and honest knowledge. The onus remains on the investigator to describe or present what has been collected as the fulfilment of what was intended to reach. Therefore, the natural setting and phenomenology are essential and important if qualitative methods have to be applied. The use of a qualitative method commands few individuals that would be having too much information on a phenomenon or concept of the study. For example, one person can provide the needed information from which an investigator feels a saturation point. Therefore, the fact that both qualitative and quantitative techniques were applied, it becomes imperative to assert that a mixed method was used in this study.

### 3.3.3 Mixed methods

The study therefore combined both qualitative and quantitative approaches to investigate lean techniques on companies in Kampala Capital City, Uganda. Varied arguments have been put forward by authors that the methods are so different in their philosophical and methodological origins and they cannot be effectively blended together and used within a similar inquiry. Similarly, Eyisi (2016: 92) argued that quantitative and qualitative research are themselves rooted in particular ontological and epistemological foundations (i.e., objectivism and constructivism, and positivism and interpretivism respectively). However, many other authors suggest that value can be achieved in bringing the two methods together having considered the differences from ontological and epistemological bases of the two approaches. Other scholars maintained that quantitative data can be used as supplementary evidence for interpretive study or quantitative data and that the adoption of both qualitative and quantitative methods offers a richer contextual basis for interpreting results. According to Hameed (2020: 4-5), the relationship between qualitative and qualitative methods is complementarity; the use of either quantitative or qualitative can have its own pros and cons. Yet, such disadvantages can be bridged by one of them.

The choice of mixed method came after realising that there are differences, strengths and weaknesses as well as the philosophical and realistic reasons with each selective method (qualitative and quantitative). The research objectives and literature used are among other factors that made the option of the mixed method since the two would complement where one is limited. The aim of this study is dominantly concerned with in-depth understanding of the lean techniques as being applied in Uganda. In addition, the concept under investigation (lean techniques, which is one of the ways for delivering construction projects) is open to a wide variety of interpretations and context-dependent since the construction in Uganda is under private ownership. Furthermore, investigating the implementation of lean techniques compel construction companies to seek for professionals and research to be taken in a natural setting. Therefore, considering the

overall discussion within this section, the combination of quantitative and qualitative approach (mixed method) was taken to be suitable to achieve the aims of this research.

### 3.3.4 Reasons for choosing mixed method approach

Suffice to note is the fact that the use of mixed approach calls the combination of qualitative and quantitative methods of research. The content area to this study is lean techniques and the extent to which it has been used towards delivering projects and success. As already noted, there is pause in literature about lean techniques and this applies to its methodology. Ugandans at the monument have limited knowledge about determining or ascertaining the lean. The fact that the lean techniques have such pause in knowledge, it is onus to this study and the main investigator to contribute to the body of literature and methodology in particular. The fact that there is a lack of methodological literature about the lean, mixed methodology is the best in order to reveal that the two are possible with lean techniques.

Studies have revealed that research in lean is a construction of concepts versus application under its success. Under this narrative, the success or project delivery is a subject to the underlying technology. This aim for choosing the two approaches were therefore intended to reveal the extent to which knowledge can be qualitatively and quantitatively constructed. Construction stems from theories which consider human resources important to any organisation, system or content. It is upon this consideration that lean techniques make it an emblem of qualitative and quantitative as mixed methods. Quantitative approach normally goes with epistemology and adopts scientific enquiry to provide an answer to research questions. The information from cross section studies use tools that suit this purpose. It was this discourse that made this study carry in order to bring results into this line of understanding. On the other hand, qualitative methods are supported by interpretive tools that enable an investigator to interact with participants in a face-to-face exercise to collect narratives, conversations, photographs and recordings that suit material world descriptions. Under qualitative, an induction approach is always applied but its generalisation is an authentic process that needs induction and deduction. This authentication became one of the driving forces to the choice of mixed method in this study.

The choice was also based on the view that a combination of two methodologies would act as a leading strategy for starting the research under lean techniques in a nation whose literature has been silent. As a starting strategy, it is anticipated that the future researcher would either choose to use the same, or apply either qualitative or quantitative methods in the same content inquiry. Research has indicated that most studies with qualitative methods produce results with data that is highly reliable. Additional quantitative approach therefore, makes the whole situation much higher and accurately reliable. In order to get trusted

and highly reliable results, the use of mixed methods came first. According to Abuhamda *et al*. (2021: 76), the application of mixed methods in research strengthens results that an investigator can obtain from the field.

It has been remarked that practical lean techniques draw much from underlying philosophies that are normally applied in the due course of inquiry. Therefore, the study and results from lean techniques would be fully recognised if the two are applied. The significant choice of the mixed approach is also embedded in the discourse of the construction management where lean techniques were contextualised. The theory of practice and implementation by management companies becomes a full process when the two approaches are applied. This is because the management of the construction companies have observatory, explanatory and exploratory. Besides, the two seek to fall under epistemological philosophy of organisational knowledge and organisational knowing. There is therefore explicitly not implicitly, yet tacit knowledge at both individual and groups persons within the companies implementing lean techniques. In order to get such knowledge, it was imperative to apply a mixed method of data collection.

Patton and Cochran (2002: 2) suggested that inquiries in lean techniques or philosophy need a dual approach in order to be understood. These are knowledge and practical action. Whereas this is an application of pragmatism, it is imperative an epistemological philosophy to underpin the narrative. Significantly, assuming that information about awareness of the lean design, technology and principles can be obtained by applying one approach is misleading since one cannot obtain the needed information. The deeper understanding of the information is therefore essentially important which can be through exploratory and literature.

Under mixed research methods, there are many strategies and sources of data that one can apply in an investigative manner. Awareness of lean techniques and success in its project delivery is not something one can achieve using experimental minds. It is only through case studies, questionnaire surveys, interviews and triangulation that should be employed in an explorative way to reach to the end. These have been applied differently by different researchers in their studies in order to reach the results or the end. The contribution survey questionnaire to this study is therefore undisputable. This went hand in hand with observations and interviews that made this study successful.

Using the extensive literature review, attempts to theoretically understand the lean techniques were made. The concept would have been the solution to the challenging issues within the context of the study but its awareness still overlapped with individual persons having a high level of knowledge while others were ignorant about the concept. The knowledge gap and literature stood as most barriers to penetration of lean

techniques in the construction industry of Uganda. Nonetheless, the review helped to identify various tools that could be used to collect the data, especially the questionnaire survey which was essential in collecting quantitative information. Rather than a case study, this study applied a cross-section survey of various companies whose individual persons were selected to give their views on the needed information. The locus of fact was a case study of lean techniques in a cross-section context. The vertical and horizontal investigations were therefore made (vertically, on the case study while horizontally, on the cross-section). The scrutiny involved study progress and implementation of lean which has been applied unknowingly. Therefore, qualitative methods were applied to answer various questions of how, why, and juxtaposing opinions of individuals in various companies.

### 3.4 Research ethics

Considering research ethical issues is one of the fundamental steps in research and a proof that the study was conducted in a manner agreed by a body of researchers. In a situation where the study seeks to explore awareness of the people on a certain case study or content like lean techniques, which has been implemented indirectly, there are various issues which participants would refuse to reveal. Some would also feel that the topic is new and people have not been able to assimilate the content. Therefore, it is important to give participants opportunities to engage in the study at their free pace during the study. Ethical considerations were necessary in order to promote the research quality, guard against inappropriateness and protect the participants' will and positions in the companies of origin. It is imperative to ascertain the entire research was undertaken with high respect to integrity and confidentiality of the participants. This confidentiality started with concealing the name of the companies and later participants. While the companies would have wanted to be identified with the study by revealing their names, this could not be possible since most of them were still grabbing various features that fall under lean techniques. The management and directors of such companies never wanted their companies to be named, which the investigator granted.

Honesty of being a student at Durban University – South Africa was also informed about the participants. The level of study was also mentioned at the PhD and this formed the basis of trust in some of the participants although it raised money issues as some participants wanted to be paid for their information. The investigator was however frank that the study was purely academic and their participation remained voluntary without any coercions. Participants were also informed that they would not expect anything like payment or cash for their contribution. They were also informed about their voluntary withdrawal from the study any time of their will or anguish.

Ethical procedures in the form of documents or letters also accompanied the investigator. Ethical letters like the gatekeepers' letter, authorising the PhD students into the field study was sought from the Durban University and granted as attached in the appendix III. The letter to conduct a study with the construction industry was also received from the (UNABCEC) in Uganda (see appendix III). The justification of being a student overseas, conducting a study in my home country was endorsed by the Ministry of Education and Sports (MoES).

### 3.5 Study area

The study was conducted from Kampala District which forms Uganda's main Capital City (ref. Figure 3.1).

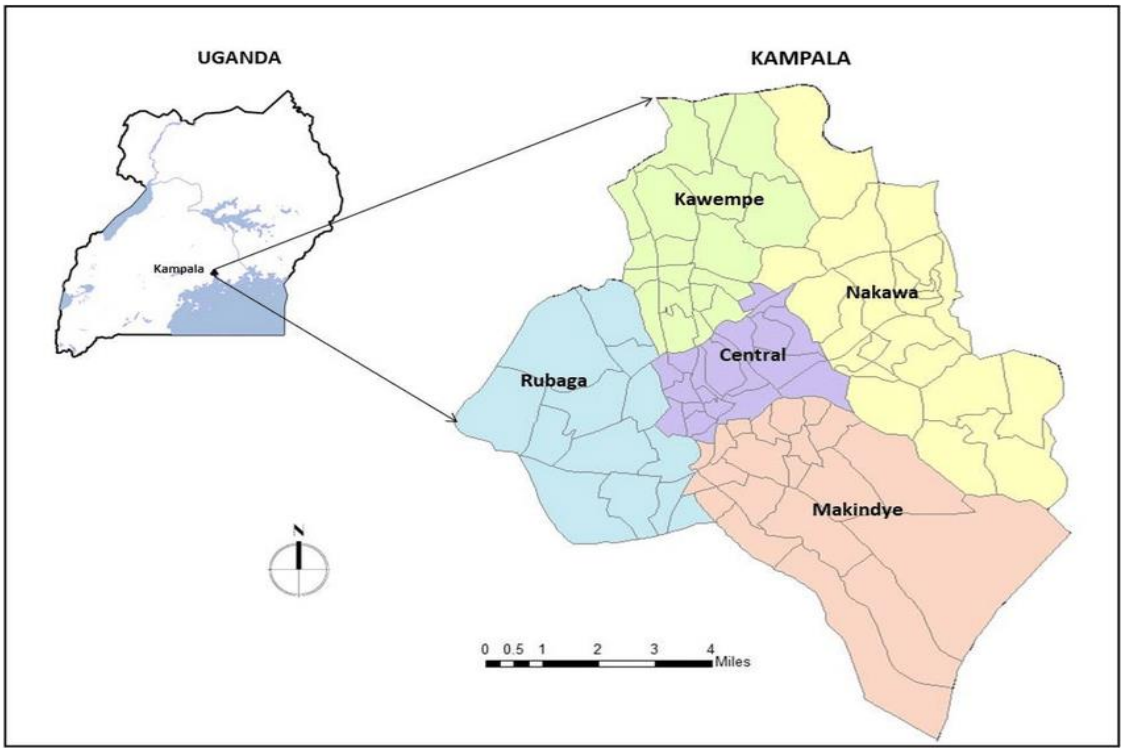



**Figure 3.1: Locating Map of Kampala in Uganda**

Source: GIS Analysis (2021)

It is a landlocked country, found in Eastern Africa (ref. Appendix IV). The country borders South Sudan from the North; Kenya from the East; Tanzanian from the South; Rwanda from the South – West; and the Democratic Republic of Congo (DRC) from the West. The road to construction of modern housing started with the British colonists before the independence of Uganda in 1962. During the period, construction of houses of civil servants was the main priority. The colonists started planned housing with modern materials and facilities based on race, colour and occupations. Despite being essential towards improving housing

and construction, such colonial policy led exclusive developed houses in urban centres and rural areas remained under grass -searched houses, constructed with mud and wattles.

A National Housing and Construction Company (NHCC) was established in the 1960s with the mandate of building houses in response to the prevailing demand for houses. This also increased with the Housing Finance Company of Uganda or Housing Finance Bank that sought to provide mortgage finance. Since 1962, a series of housing and construction policies have evolved in the country up to present. This evolution has taken route with the changes in political governance that characterised Uganda. For example, in the 1970s and early 1980s', the housing and construction sector in Uganda retarded due to the economic crisis and civil wars. However, the demand for houses and other consulted facilities have continued at an increased rate and no government has satisfied the demand for houses from the public.

The Housing and Construction sector rejuvenated with the rise of the National Resistance Movement (NRM) in 1986. During its era and especially in 1987, the United General Assembly adopted a Global Strategy for shelter under the UN – General Assembly Resolution No. 41/190 of December 1987 on the International Year Shelter for the Homeless. In 1992, the then government of Uganda commenced development on the National Shelter Strategy with greater emphasis on mobilising local resources for shelter and to improve the living standards among Ugandans. The policy also aimed at housing management and development of accommodation to all people living in Uganda. This domestication of the UN-Resolution increased the rate of construction among private formal and informal sectors, individuals, families, non-governmental and community groups.

UBOS (2016:33) shows that by 2016, Uganda had 7.3 million households living in 6.2 million housing units of 4.7 persons. The occupancy density has been estimated at 1.1 per housing unit which gives a total backlog of 900,000 housing units that were substandard and never prepared to accommodate humans. UBOS goes on to indicate that out of 1.6 million housing units in the nation, 210,000 units were in urban areas whereas 1.395 in rural areas. In the same year, the parliament passed the National Housing Policy guide housing and construction in the country. The policy aimed at increasing adequate housing and accommodation to Ugandans from the then 60,000 to 200,000 housing units by 2022. The policy also aimed at increasing the existing housing stock; increase energy consumption in houses; improve land tenure and mechanisms towards housing development as well as management.

As a result, construction companies increased since then by engaging into different modes of construction with different styles. Emphasis has been towards affordable housing for the people living in urban and peri-urban areas with the main focus to reduce shanty slums. Despite the policy approach and increasing

companies, the construction and housing still face various challenges due to increased demand for houses. Such demand has been responsible for faster construction which has led to increased wastes, starting with planning; procurement and actual process of housing and construction. Under the National Housing Policy 2016, the backlog was 1.6 housing units; 1390,000 in rural areas; and 210,000 in urban centres. Most housing and construction companies work under the private real housing estates that could be subsidised by the government in order to increase housing and accommodation. Other companies are contracted by various individual persons who seek to invest in land and housing. In urban areas and Kampala Capital City (Kampala District), there is still a challenge of land tenure which affects acquisition of land. With the increase of migrants from the rural areas seeking new opportunities in the city, the question of affordable houses also still exists. This has been one of the reasons for the development of shanty houses in peri-urban areas, especially in areas surrounding Kampala District.

### 3.5.1 Kampala District / Capital City

Specifically, the study was conducted from Kampala District that makes Kampala Capital City under Kampala Capital City Authority (KCCA) as a governing institution. For easy administration, the district has been divided into five divisions: Kawempe, Nakawa, Makindye, Rubaga and Central Kampala (Metropolitan). It is under the Lord Mayor whose term of office is five years, elected by the majority of people living in the five divisions. Kampala District is also led by a Minister of Kampala, who is appointed by Presented on the approval of Parliament of Uganda. Today administrative duties of Kampala have been under an Executive Administrative Officer of KCCA. The district is surrounded by Wakiso District to North West, Mukono District to the West, Kalangala Island and Lake Victoria to the South, and Mpigi District to the South – West as illustrated by Figure 3.2

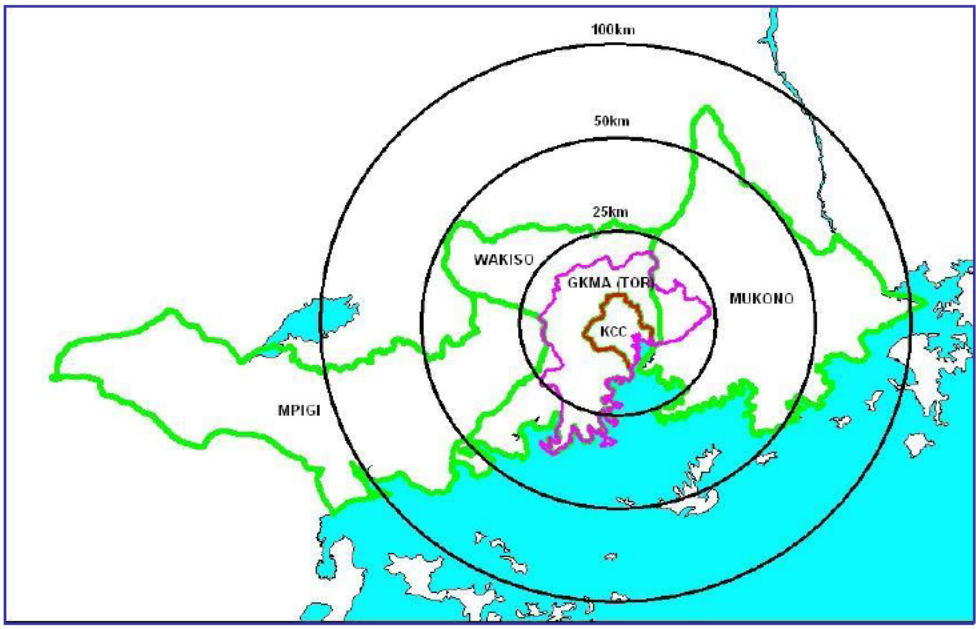



**Figure 3.2: Illustration of Kampala District**

Source: GIS Analysis (2021)

### 3.5.1.1 Topography

The topography of Kampala is described by 12 hills and water-logged valleys as illustrated in Figure 3.3.

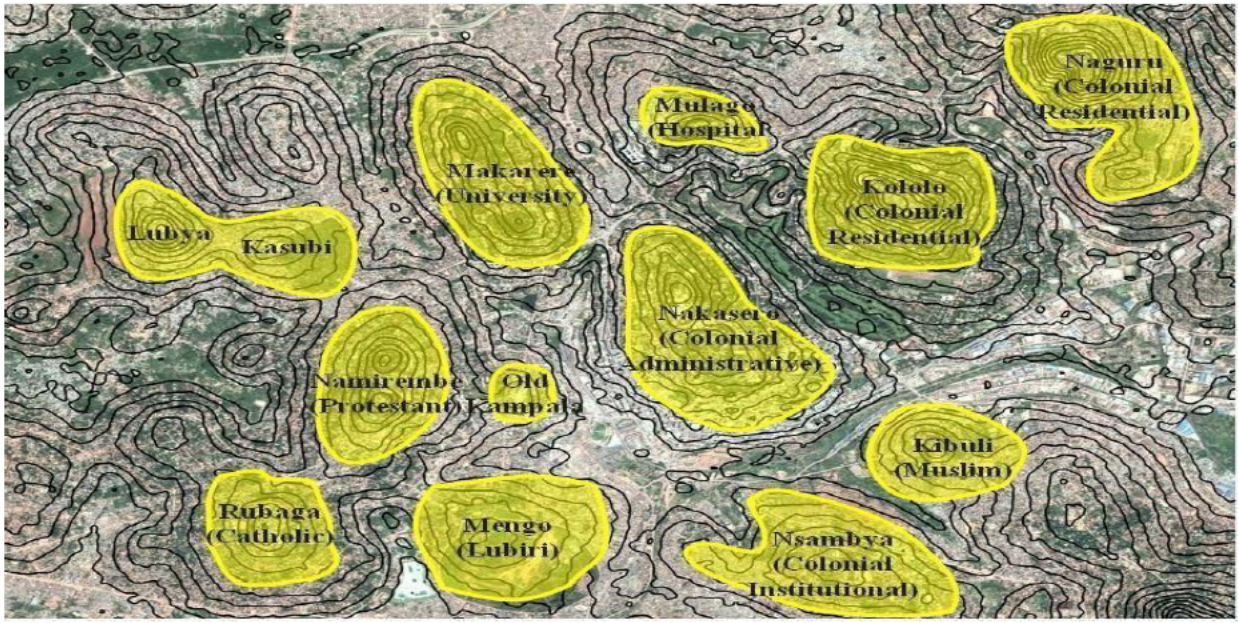



**Figure 3.3: Topography of Kampala**

Source: GIS analysis (2021)

There are various routes within the valleys and hills that connect one another through constructed roads for different transactions such as business within the Kampala District. Lake Victoria is one of the catchments for many internationally known rivers like River Nile. Such valleys and sources of water bodies are rarely protected by a group of investors and nationals who seek to construct houses for different activities within catchments. The district or Kampala also lacks a structured, contiguous protected open space system and green gardens due to the increased construction and housing that have been taking place in the city. The disrespect of such sources and lack of green public gardens with the city always makes the sky of Kampala contested with hasy outlook, especially during the evening hours as illustrated in Figure 3.4

**Figure 3.4: Hasy sky-outlook of Kampala**

Source: Ssali *et al.* (2022)

### 3.5.1.2 The settlement patterns

Kampala capital City or District has grown and expanded over the years. Growth has continuously extended along the primary movement of human routes, especially roads. This growth can be described into four sections: growth of city centre; inner suburbs; outer city suburbs; peripheral towns; and the peri-urban. The metropolitan city is composed of main buildings for the businesses and offices. There are also people living within the city centres among some of the affordable houses. Within the city centre of Kampala, inner city suburbs exist in different areas occupying minor groups of un and semi-educated persons. Most of the areas are congested with limited supply of water, poor electricity connected and living under corrugated iron

sheets. Due to the nature of iron sheets as well as building styles, these houses are too hot with undesirable conditions. The sanitation is poor with daily run-overs which attracts poor odour. In fact, most of these areas have been associated with various disease conditions like malaria, typhoid, bilharzia, tuberculosis, respiratory complications and other non-communicable diseases.

Within the same city, there are outer dormitory towns and suburbs. These are also found within Kampala District as one moves towards the surrounding areas like Wakiso and Mukono districts. These include areas like Nansana trading town, Kira Municipality, Bweyogerere, Bwayise and Kawempe areas. The peripheral towns surrounding Kampala District which include Mukono and Wakiso. While these have been important towards decongesting Kampala Capital City, the weaknesses in administering such neighbouring districts have been some of the causes of laxity in administration. However, they have remained significant peri-urban areas to the growth and building construction in Kampala. The migrant workers who desert the rural life in favour of urban standards, always start liking such areas, especially the youth as they seek redress to work in the city. The general description of the settlement within the city centre can be termed as non-residential houses and activities as well. The study established that there is still contested land between various stakeholders in Kampala.

#### 3.5.1.3 Markets

Markets have a key role to the growth and development of Kampala. Most of the markets are strategically located within the city centres and suburbs; supplying fresh foods to the people; durable products, clothing and household products and utensils. These markets employ over 5% of the people living in Kampala and desired by the un- and semi-illiterate individuals. Due to lack of employment opportunities, especially among graduate youths, markets have become one of the employment areas for such youths. These markets are normally called the colourful areas of Kampala with majority vendors and population of women. However, most of the markets lack facilities for the modern markets. The housing in such places is still local with various individuals using simple shades like umbrellas to conduct their simple businesses as illustrated in Figure 3.5.

**Figure 3.5: Illustration of the markets in Kampala**

Source: Ssali *et al.* (2022)

### 3.6 The population

Kampala District has a growing population with a rapid rate of 4.5% - 5.0% per year. This infect, has been one of the reasons why the population has overwhelmed housing and construction facilities and utilities. This has been described as a "*demographic tsunami*" and it has risen inappropriately with the housing demands and housing construction by the companies. The district has a population of 3, 652, 000 million people in 1,000,000 household units (UBOS, 2021). This population has been blamed on natural growth, migration from other regions of the country and neighbouring nations due to economic integration. The structure of the population in Uganda is well illustrated by the socio-economic ladder as illustrated in Figure 3.6.

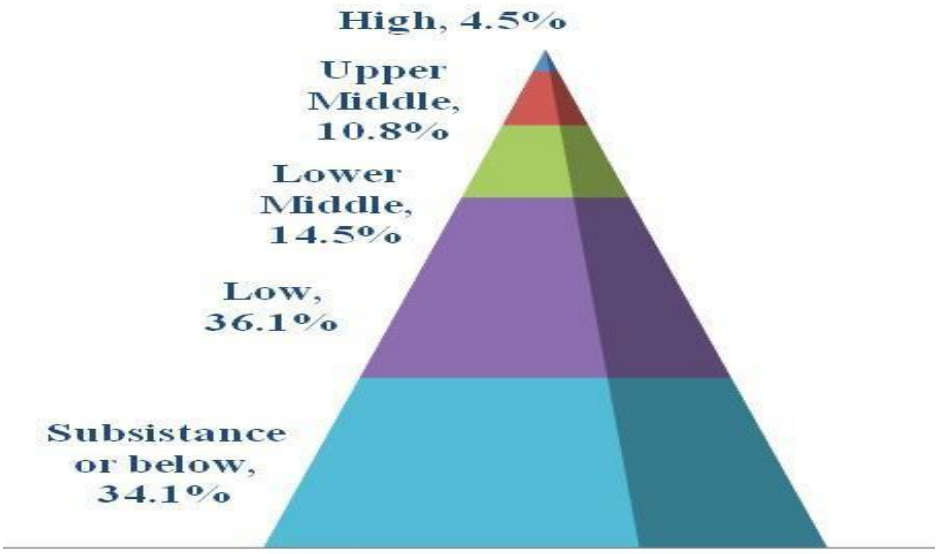



**Figure 3.6: The socio-economic ladder of population**

Source: UBOS (2016)

These population categories have many housing and lifestyle conditions such as slums, cheap rental housing, overcrowding and an ever-growing demand for work opportunities and housing particularly among the young adults (Uganda Vision 2040: 21). The middle- and working-class households are generally headed by salary earners in governmental and formal sectors, generally living in basic-inadequate housing. Over one-third of all households in Kampala District live in inadequate or inappropriate housing, associated with harsh living conditions, with the majority depending on the daily labourers or working in the informal sector. It is anticipated that with increasing population in the city, the housing demand will also continue to increase making the housing facilities scarce by 2040.

### 3.6.1 The Contextual gap

In Kampala, 69% of all the households reside in rental accommodation which is not exceptional in large cities in most developing countries. It is also an indicator that the people living in Kampala need housing facilities that would accommodate them and their needs decently. The extent to which such conditions necessitated the companies to adopt lean techniques so that it becomes a solution to the riding need was the main concern to this study. As contextually observed, the lean techniques would have been the best approach to increase the housing facilities within the conditions of Kampala. The extent to which the construction companies have been aware about its significance to delivering the projects successfully has been cardinal to be assessed in this study. The context reveals that there is limited accommodation and housing facilities as the increased number living in the city continue demanding for the same. It has also

been found that despite the government's 2016 policy which aimed at increasing the housing facilities, there is still a need across all classes in the Kampala District. While the policy approach would have been good amidst increasing demand from the prevailing conditions, the policy was inaccurate in itself since it does not spell out the type of technology to be used in delivering housing and accommodation.

In Uganda, residential property ownership is a primary medium for capital accumulation among the middle class. The purchase of a home is usually the largest and most significant investment for an average middle class family, yet is the utmost challenge to the lower class in Kampala. Whereas mortgage payments are generally the most significant form of savings for this cause, the number of middle-class populations that can afford payments is limited. Besides, the immature property and financial markets have been generally common and hinder the purchase of land for construction or housing residential property. The only financing available is short-term small sum loans secured against salary income in addition to savings and familial resources if available. Such conditions still challenge any narrative that would seek to apply a construction technology for delivering appropriate and quality housing facilities. All these construction challenges have increased with lack of appropriate, available land for the incoming population and growing youths due to the pre-existing land tenure system; overwhelming scale of rural in-migration lacking realistic alternatives for urban; poverty levels due to unemployment and underemployment; absence of mortgage financing; absence of appropriate housing alternatives; incapacity of formal sector, both developers and contractors, to build on any scale approaching needs; and extensive infrastructural gaps.

### 3.6.2 The study Companies

According to the Uganda National Association of Building and Civil Engineering Contractors (2020: 11), there were 111 building contractor companies registered with Uganda National Association of Building and Civil Engineering Contractors (UNABCEC) as of August 2020, under the various classifications. Non registered companies were not used because they lacked the adequate organisation and hence in most cases it would have been hard to trace their work progress records appropriately as would be required for the study. The classifications that were adopted by the study were based on the company annual turnover and experience in the construction industry. The highest classification was A-1 International (Multi billion) and the lowest being A-5 (Below 1 billion Uganda Shillings). The companies had staff and non-supportive staff, ranging from 10 – 60 employees from where the sample was selected. These companies have been formed by the local Ugandans whilst others are foreign owned operating in Uganda. The companies' offices were located in the middle of the city, occupying certain premises at a rental understanding. The companies had chartered engineers and were licensed to operate within the city centres.

### 3.6.3 Sampling procedure and techniques

This is a subject or part of the target population which has been selected by the investigator to access and get information is what is called a sample (Adekeye and Eleojo, 2019: 101). Having realised the cost of interviewing the entire population and challenges embedded, a sample size is always determined to represent the entire population on generalisation. This forms the unit of analysis during research studies. It is at this point that a sample survey is conducted using prepared tools to access various sampling methods such as random / probability sampling, non-random / probability sampling and mixed sampling.

Although determining an appropriate sample size is always a source of contention among researchers, the principal investigator found it straightforward and critical to determine the sample size for this study. Henceforth, it was perceived as the best approach that would be a solution to various questions that would arise in the minds of the reader in future. Based on the level of significance and non-significance, there are various approaches used based on the statistical power to determine the sample size. Under qualitative inquiry, Ajay and Micah (2014:1-2) recommended a sample size between 3 – 30 participants since the narratives from the sample size would be enough for the research objectives and questions. To Singh and Masuku (2014:1), a sample of 14 – 50 participants could be large enough; and a range of 35 – 133 could be the best for the medium survey range. Other researchers have insisted on using only 30 participants in order to get the results from the field.

For the purposes of this study, the sample size was determined using the formula by Israel (1992:3) at 95% confidence level and a precision of 0.05 given as:

$$n = \frac{N}{1 + N(e)^2}$$

Whereby; N = Total population; e = level of precision.

**Sampling Size**

Amongst the population of 111 registered building contractor companies in Uganda, a sample was drawn systematically from the various categories using proportional allocation procedure for the study. Etikan and Bala (2017: 2) discuss that proportional stratified random sampling technique is well utilised when the sample size from the different stratum is to be kept proportional to the strata size.

According to Jia and Zou (2018: 340) the following formulae for proportional stratified sampling was adopted during the study.

nh = fNh = n (Nh /N)

Where;

Sample fraction (f) = n/N.; nh = Sample size for hth stratum

Nh = Population size for hth stratum; N = Size of entire population; n = Size of entire sample

f = n/N = 56/111= 0.5

**Table 3.3: showing the sample calculation**

| Stratum | **A-1** | **A-1** | **A-2** | **A-3** | **A-4** | **A-5** | Total |
|---|---|---|---|---|---|---|---|
| | **(International)** | **(Local)** | | | | | |
| **Population Size (N*h*)** | 11 | 16 | 14 | 14 | 29 | 27 | **111** |
| **Sampling Fraction (*f*)** | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | |
| **Results (f *Nh)** | 6 | 8 | 7 | 7 | 15 | 13 | 56 |
| **Final Sampling Size** | 6 | 8 | 7 | 7 | 15 | 13 | **56** |

Out of the 56-sample size of the individual companies, six respondents will be purposely examined to represent each company. These included the projects manager, site engineers, supervisors, and three casual workers making a total of 336 respondents. The respondents were chosen on the basis of their leadership responsibilities in the company, their experience in the construction industry for more than ten years, the level of engagement in decision making on construction processes issues in the company, and their respective skills in construction controls.

Therefore, a sample size of 336 participants was used in this study. It is important to remark that by using a standard error which is not more than five percent, the level of confidence is almost 100%. The standard error is always a measure of expected dispersion of sample estimates around the true population parameter. The standard error is a standard deviation of sampling distribution of a statistic. The smaller the standard error, the more representative the sample will be of the overall population. The standard error is also inversely proportional to the sample size; the larger the sample size, the smaller the standard error because the statistic will approach the actual value.

The response rate of this study was also reached and it was found at 95%. This was because most of the participants could be interviewed and the investigator was obliged to continue getting new data at the point of saturation which was reached at 95%. A few (0.6%) of the responses were received through phone calls since participants feared to come out since it was COVID- 2021 lockdown. Under this survey, a total of 336 questionnaires were administered on the participants and the high responses were attributed to the interest of the participants to get involved in the study. This was one of the reasons that this study has a positive rate of responses from the field. The fact that most of the interviews were conducted on the administered forms, it became one of the reasons for the increasing rate of the participants. Besides, participants were briefed about the needs and the nature of this study. This also made them give quick responses in order to facilitate the finishing of this university study. On the other hand, it remained difficult to ascertain the reason for non-response participants from their respective companies while some of their workmates did. At the level of the company responses, the investigator was informed that there was a non-availability of time and non-interest in completing the questionnaire.

### 3.6.4 Research strategy and sampling techniques

The main strategy the investigator used was the quantitative survey which was applied in order to get quantitative data. This was applied in order to answer the research questions especially on awareness of the lean techniques and the extent to project delivery. Surveys have been worldwide known for collecting quantitative data in management and social sciences. This is normally on collecting data on the selected samples through a response technique that has been selected in research design. The survey used has been perceived as one of the best data collection approaches for descriptive studies. The surveys under such arrangement makes the work of data collection much faster than any other method of data collection.

Survey questionnaires can also explore various aspects of research such as collecting information to be discussed with literature. It can also be essential in building a narrative under the grounded theory research. Therefore, surveys are the most probable tools used in data collection that serve different purposes. From the research paradigm that underpinning this study, the data collected was analysed, interpreted and evaluated with meaning to the readers. The success of this study, even during COVID-19 was built on the premise of a skilful investigator, who undertook extra-effort to apply various research ethics and incorporate the then standard operative procedures (SOPs) in order to come up with results for this study. The investigator would arrange with one or two participants and meet at a designated area and they could start

interviewing using the questionnaires. This would however be a second step after visiting the company's office for authorisation.

Various methods have been identified as a prerequisite in carrying out surveys. Questionnaires are the widely used techniques and these go hand in hand with in-depth interviews, observation and content analysis. Taherdoost (2017: 20) shows that survey design provides quantitative or numerical description of phenomenological trends, attitude, perception or the opinion of the population. While interpretivism calls for different interpretation by different researchers, the use of survey questionnaires brings similar values that are essential in determining the rate, magnitude, values and strength of the event. In studying a sample of the population that has taken keen interest or have heard about concepts like lean; the attitudes, perception and opinions are taken seriously. It is important that surveys take a small part of the population to be investigated as a sample size. Apart from the use of surveys, researchers have also applied census to conduct studies that involve considering the entire population of the study under the research area. However, it has been found that such research through census is not realistic as well as the method applied against the population. This normally comes with a large number of the people a study is carried out and time spent or allocated for the research study. In most countries and various institutions of learning, time is limited and this calls for a manageable sample size. Therefore, large samples can be costly and time consuming and the accuracy is high if the entire population is selected. These among others barred the investigator from applying census in this study.

The commonly used surveys are emailed, use of telephones and interview surveys which were also applied in this research. The three were fundamentally recognised by this study and they could give participants a chance to read and understand the questions before meeting. Mailing was used as one of the techniques against COVID – 2019. Apart from mailing, participants like the use of WhatsApp as one of the common social media interactions during the survey. The application of the questionnaires which were taken to participants for the face-to-face interviews, use of telephone calls for arranging the meeting and schedule as well as the email and WhatsApp served the purpose for this study. Some participants would answer questions after receiving the tool through email and WhatsApp and could revert answered questions. These, in most cases, made the work simpler for the investigators. Whereas the people were under restriction to move, participants who could receive tools by emails and WhatsApp had enough time to answer the questions. In fact, mailed questionnaire surveys have a lower response rate, which distort and hence flaw a sample. Although telephone surveys are relatively efficient and inexpensive, they are more time consuming and correspondingly expensive than the personal interview that allows more details and complex data to be

collected. One of the main reasons for choosing a mailed questionnaire survey was to ensure anonymity of the respondents. Besides, it was an efficient solution at the time of COVID – 19.

### 3.6.4.1 Sampling techniques and selection

The investigator used various sampling procedure or techniques to reach the sample size for interrogation and these were selected from a broad of sampling procedure or techniques as presented in Figure 3.7

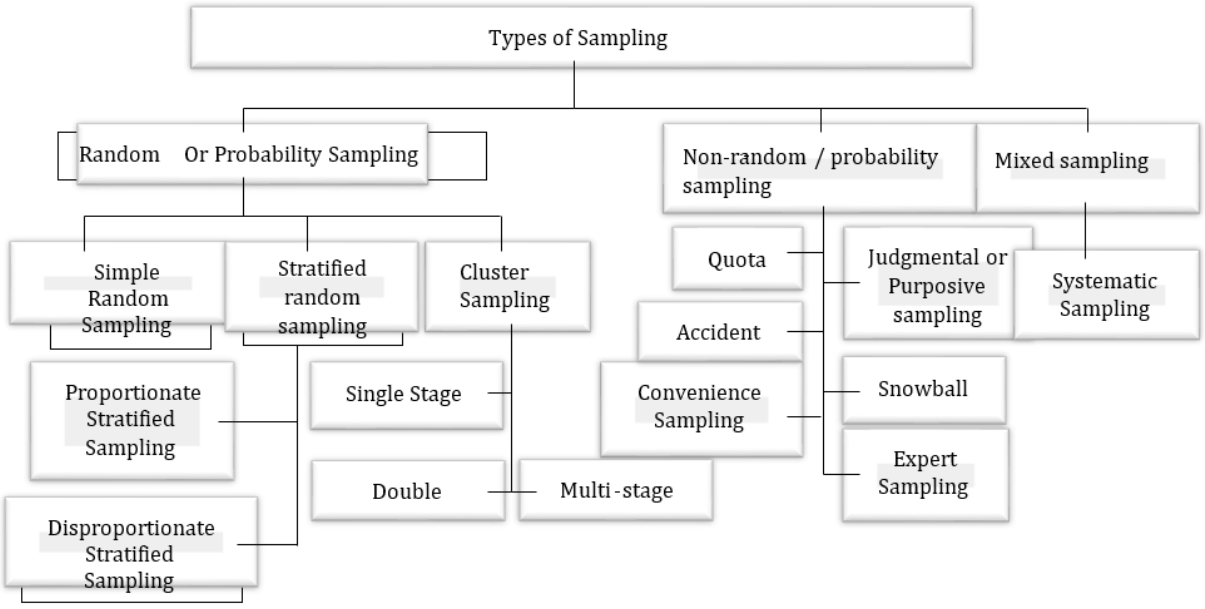



**Figure 3.7: Various sampling techniques**

Source: Ssali *et al.* (2022)

Research across the world always applies three types of sampling techniques during data collection: Simple random or probability sampling; non-random probability sampling; and mixed sampling techniques. Among these, investigators or researchers commonly apply simple random sampling in selecting samples for data collection. The rationale for using a simple random sampling is to give each person equal opportunities or chances to be selected. Stratified random sampling involves dividing the population into a number of groups or strata, where members of a group share a particular characteristic or characteristics. Stratified random sampling ensures that different groups of a population are adequately represented in the sample, so as to increase the level of accuracy when estimating parameters. On the other hand, cluster sampling involves dividing the sampling population into groups based on visible or easily identifiable characteristics, called clusters.

Based on the description herewith, a stratified sampling was considered for this study because it assumes that the members of the population have adequate representation in the sample proportionately. There has been a contention about stratified sampling technique over known and unknown samples. While many researchers assume that this sampling technique is not appropriate to studies since it assumes the samples are already known, it must be made clear that it was used in this study as the last option and after knowing the number of companies whose activities were more related to lean techniques. Stratified sampling was used after acknowledging that certain companies have been applying various technologies and planning that fall under lean principles. On the other hand, simple random and cluster sampling were exempted since the intention of research was not to ensure that numbers of groups selected for sample reflect the relative numbers in a population as a whole or to just randomly select. Moreover, stratified random sampling is an important strategy in order to have a proportionate sample that can be placed in the form of strata.

Non-random / probability methods of sampling as indicated in Figure 3.7 include quota sampling, experts sampling, judgmental sampling, accidental and convenience sampling. Quota sampling includes some of the features of a stratified sample and this means that it was never considered for this study. The main consideration guiding quota sampling is the researcher's ease of access to sample population. An investigator may be guided by some visible characteristics, such as gender or race of the study population that is of interest. These features were however never essential to this study since the matter of concern was about awareness of lean techniques and its discourse to project delivery or success. Accidental sampling is based upon convenience in accessing the sample population and it is common among market research and newspaper reporters. The fact that this study focused on the established companies and not markets, the sampling could not be applied.

Judgmental sampling which is commonly known as purposive is more common in qualitative research and generally associated with small in-depth studies. The main consideration in purposive sampling is the ability of an investigator to decide on who can provide the best information to achieve the objectives of the study. Besides, it cannot go wrong since it directs an investigator to knowledgeable participants from the samples. Purposive sampling is particularly useful to describe a phenomenon, construct a historical reality, or develop something about which only a little is known. In fact, the lean techniques were among the concepts which were conceptualised with limited information among the companies during planning and preparation of this study. The investigator sought that the completion of this study would be instrumental and a revelation among companies in Uganda. While lean techniques started in the 1950s among Asian countries,

over 70 years have elapsed when companies are silent about the technology whereas are just using some of its principles with no holistic application.

Expert sampling is similar to judgement sampling, but the main difference is that respondents must be known experts in the field of interest to the researcher. This therefore negates attempts to apply the sampling technique to be used. In fact, most of the participants have limited knowledge about lean techniques while others have been implementing unknown technology. Snowball sampling can be used when the populations are quite hard to find and there are no lists of such people or cases. A snowball sampling starts with a few known people who then help with contacts of other people in relevant cases. Sampling is the process of selecting a sample using networks. However, most of the companies were known based on the Ugandan directory and this became one of the possible means to reach the companies. Snowballing was also exempted since its application would not suit this study.

#### 3.6.4.2 Techniques selection

As indicated in the preceding paragraphs, this study applied stratified and purposive sampling techniques. Purposive sampling (rather than random sampling) of Uganda construction companies and organisations with expressed qualities of lean techniques was used through the database of 111 construction companies registered with UNABCEC. The process was conveniently done as a description of samples whose elements have been selected from the target population on the basis of their accessibility or convenience. In fact, none of the companies were aware about the intention of the investigator by selecting their companies accordingly. The fact that the companies are recorded in the directory, their access was convenient since no one would bar this access. Besides, all the registered companies in the directory had contact telephone numbers for particular persons who could answer some of the questions. From the same directory, a company's profile would purposely make the investigator infer its application of lean techniques features.

Convenient sampling also involves drawing samples that are both easily accessible and willing to participate in a study. The challenge to this study was about the willingness of the companies of the companies to participate in this study due to COVID – 19. But after a thorough telephone interactive discourse about the extent to which the study will be conducted, particularly with observing the SOPs, it became easier for the investigator to access the companies and their premises to get a list where a stratified sampling was carried out. It is a sampling technique that consists of participants who are readily available and easy to contact. The companies were therefore already available to the exposure

of the investigator from the directory to conveniently select them. In fact, purposive or convenience sampling was found appropriate for this study since there were special skills and knowledge needed to answer some of the questions appropriately. As a result, the number of companies started increasing through profile briefs. It was easy to select 56 companies where the population of the study was determined for the purpose of this study.

Aware of COVID-19, directories were regarded as the most suitable method of choosing the sample for the survey. Other reasons for the selection of the directory include: the updated nature of the directory in line with construction industry in Uganda; updated information about the profile and technology used in the construction; it was time saving and could lead an investigator to rightful information; through the directory, the entry – access to the company become much easier through a phone call.

Therefore, the sample frame included companies whose work relates lean techniques in implementation and successful delivery of the projects. The target sample respondent included contract managers, environmental managers, project managers, sustainability managers, training managers, quality managers, site managers and supervisors, ranging from strategic to operational level. The following procedure was adopted in choosing the sample from the directories and through personal contacts: initial review of the company profile; telephone calls of the contact person or an e-mail sent to enquiring about the company workers' participation in the study; sending first questionnaire to be filled the contact person or an engineer in this case. The criterion used in this study was that target participants must have knowledge of lean techniques and including its primacy to project delivery. Therefore, the role of the participants was one of the listed before contacting any person from the company. The chosen participants were included in the sample only after the investigator had verified through email or phone that the company has been implementing some of the principles of lean techniques.

### 3.7 Methods of data collection – questionnaire design and survey

A questionnaire was developed reflecting research questions developed in chapter one (ref. Appendix I) with the main section under awareness and project delivery. A Likert scale was used for all the questions. The Questionnaire used a four-point Likert scale of 1-4 where 1= Strongly disagree, 2= Disagree, 3= Agree and 4= Strongly agree. These questions were intended to capture the awareness, attitude, and perception among the participants of this study. Attitudinal measures in the form of Likert scale, can generate more

valid data than single measures. The scale was seen as the most appropriate to choose options that are far enough apart while at the same time, keeping them close enough to ensure that the investigator would not lose important points. Similarly, a Likert scale of 5 is also acceptable across the world as the main tools for the mind as opposed to observation. The use of a Likert scale of 5 was also considered but hardly applied to the scale beyond six. The scale of 6 was not considered since it was anticipated to cause more problems on the attitudes and causing confusion among participants and future readers.

In order maintain quality or adequacy of the issues therein in the questionnaires, a pilot study was conducted around Kampala, even before the selection of the companies. The questionnaire was evaluated and validated by the main investigator and a group of construction professionals who were attracted by the study. This was done to ensure clarity and unambiguity of the questions which were solved in the due preparation to the study. The questions were modified based on their understanding of research and in line to lean techniques.

### 3.7.1 Data collection - Semi-structured interviews

Apart from the administered questionnaires, an interview tool was used to get the data. Using an interview guide, the investigator conducted an in-depth interview with one director of the company as the key informants to this study. This was used in order to get the qualitative data that was essential in supporting the quantitative information. These were either met or phone calls could be used in order to reach the key informants. Whenever an interview would be finished, transcripts could be created while in an isolated area in order to avoid forgetting. Some of the information from the transcripts could be aligned with the quantitative data from the administered questionnaire and analysis would follow suit.

### 3.7.2 Scales of Measurement

Measurement is one of the central elements of enquiry in research study. It is one of the processes in research that is used in assigning labels or units of research in order to present their conceptual properties as used in research. Although the majority of the investigators in their studies do not involve visible easements, it is a tendency to show measurement of the variables as a critical approach to research. Therefore, the use of measurement shows the quality of data that is likely to be collected from the field and the extent towards the analysis.

Despite the users and non-users of the measurement, it is important for an investigator to resolve the measurement issue by using the nature and type of the data that is meant to be collected. This form of measurement is essential and various studies have used the numerical measurement that supports similar

forms of analysis. The scale of measurement is therefore critical since it relates the nature of statistics as indicated by the study results. Internationally, data has been classified into four scale measurements. These include nominal, ordinal, interval and ratio scale. It is also grouped into continuous and categorical data. Continuous data takes any value within a certain range, such as weight, height and opinion scores. Categorical data, in contrast, can take only one of a few values. The size of a family or number of the employees are essential examples to categorical data

### 3.7.2.1 The Nominal scales

Nominal entails assigning items to groups or categories. Normally, researchers use it to classify individuals into two or more groups. Members within the groups always differ based on characteristics that have been scaled without grading or differentiating members within the groups. In this way, it becomes classification rather than arrangement of variables in their order and there are no questions that are always attached to such classifications. There is no quantitative information that can be conveyed in the due course of classifying or naming items. By nature, they are qualitative rather than quantitative. The fact that some of the information was conducted using interview-guide which was intended to collect qualitative data, nominal scale was partly applied to lead towards the content analysis.

Nominal scale is one of the lowest levels of measurement and the fact that they use numbers as labels, there is no mathematical relationship or calculations that is needed in the due course of naming, transcribing and describing. There are scholars who have asserted that the non-parametric group of statics can only apply in this case. However, this study did not apply since the narrative from the key informants would be recorded well as per the objective of this study. The study also did not seek the discourse to cross – tabulation of the values / numerical values and the chi-square which most qualitative studies always embrace or one of the two. In accordance with this study, these were questions that were asked in an attempt to seek the extent to which company workers always have freedom to move from one place to another seeking food or resting in the due course at work to the key informants. The main emphasis was to highlight the ethics that have been followed among workers in the due course of executing works that share traits with the lean techniques. In fact, the key informants expressed optimism in applying lean techniques to the prevailing conditions in Kampala since there are still issues related to planning of the city. The fact that the city leads in various aspects of development, the interpretation cuts across the rest of the areas of Uganda.

### 3.7.2.2 The ordinal scales

These are normally presented right from the designing the questions in ranks as relates to the variables. They rank individuals and variables along continuum as applied in different questions, characteristics and variables. The order or ranking has been termed based on the Likert scale that have been either dissected into two while others have less meaning or scale positions. Ordinal scaling always measures systems that possess property of magnitude, but not the property of intervals. The property of rational zero is not important if the property of intervals is not satisfied. The use of the phrases ``more than" or "less than" is possible in ordinal scale and this does not apply in nominal or carry the same meaning as applied. The rank categories of people in accordance to height as found in group is a clear indication of ordinal since they are either short or tall which are according with 1 and 2 in cording. This one of the best examples of ordinal scale as used in the scaling. Ordinal scaling can also use non-parametric statistics like mean, median and mode. The rank order at this level correlates and the non-parametric analysis of the variance is required. Modelling of data is also part of ordinal data with the main purpose based on the observable times.

In general, researchers or investigators use ordinal scaling in most of the administered questionnaires. Ordinal scale has been used almost in this study since the main concern to this study is structural modelling equations. The questionnaires used in this study were administered in nature and clearly the discourse under this form of variance analysis. The strength of the Likert – type scale has been measured towards awareness of the lean techniques. Under this study, participants were requested to give their agreement or disagreement during the due course of answering the limited responses as needed in their responses.

### 3.7.2.3 Interval scales

Researchers using interval scale have realised similarities embedded with nominal and ordinal. Interval scale has got equal measurements to nominal and at the same time ordinal scales. The measurement units are equal, which makes it possible to interpret in order of the scores and the distance between the scale intervals. The main difference with ordinals is found in the order of arrangements rather than the degree of order. Parametric statistics of this nature and techniques are analysed under mean and standard deviation, correlation and regression, ANOVA and factor analysis. These are the best examples to illustrate interval scale data, in addition to a whole range of advanced multivariate and modelling techniques.

### 3.7.2.4 The Ration scales

The ratio scales differ from interval scales only in that they have a rational zero. The highest level of measurement is a ratio scale, which has properties of an interval scale together with a fixed origin or zero point. Weights, lengths and times are obvious examples of ration scale which were exempted by this study.

Ratio scales possess all the three properties that could be observed in questionnaires used in this study: magnitude, intervals and rational zero. However, it can be hardily noted that the ration scale was applied in this study. This was due to the parametric variables that this study was set to address. It could have been used in the due course of designing the period at work and age groups. However, these were none of the concerns of this study. Therefore, this study embraced the ordinal scale of analysis.

### 3.7.3 Quality control scale

Studies always analysed quality scale under two domains: Validity and Reliability scale. These can be carried out during the process of research depending on the nature of research one carries out. They are always carried out in order to establish the logical link between objectives of the study and tools or instruments. The ambiguity within questionnaires as per objective is revised by a group of professionals or trained researchers. A statistical analysis is always demonstrated to determine the level of established validity and reliability quantitatively. Research and various measurements are subjected to errors and therefore, it is imprudent to undertake a pilot study informing of a baseline survey in order to determine reliability and validity of instruments or tools to be used in the study. Reliability and validity are two main research items or qualities of surveys that require determination of scale in order to have accurate and reliable results.

Generally, reliability is the ability of instruments to yield consistent measurements and produce similar results each time when administered under the same or similar condition or population. In another way, it is the extent to which a test or an item produces similar results under constant conditions of the study. These are related to the occurrence of the phenomenon during the study as it relates to positivism and epistemology philosophy. On the other hand, validity is the extent to which the question, item or the score measure what is supposed to measure. Validity of measure depends on what is meant to be measured, how to be measured, when to be measured and for what purpose. Under the content validity, there are three types to be measured in the due course of research. These are face and content validity; concurrent and predictive validity; and constructive validity. Face and content validity is based on the judgement that instruments measure in terms of the basic link between the questions and objectives of the study. The link or what is normally called a relationship is valid. The assessment or analysis of the instrument is normally referred to as content. It is content in a sense that it contains the normative and subjective values of the instrument or the tool under assessment. These assessments normally take place under quantitative research as commanded by a positivistic way of doing things. Concurrent validity is examined or judged by the degree to which an

instrument or tool can easily foretell the outcome of the study. Concurrent validity is the extent to which an instrument to be used compares the second assessment that has been concurrently done. Lastly, construct validity comes in a sophisticated way or technique in an attempt to establish what researchers have referred to constructed validity. This includes statistical procedures in undertaking research studies and surveys in particular. Once the investigator or researcher ascertains the extent to which observable variance contributes to the occurrence of a phenomenon, it becomes statistically significant that the construct validity has been determined (Fellows and Liu, 2008: 152).

In quantitative research, investigators always consider external and internal procedures that could lead to reliability of instruments. Internally, validity seeks to establish what has been perceived or interpreted as the cause of the phenomenon necessary to lead to the effect or the outcomes. Thus, the main focus is the establishment of that relationship that is essential in linking the two sides. For example, does the application of the lean techniques necessarily lead to reduced wastage, effectiveness in time delivery and reduced costs? Such a relationship is significantly important to this study since it became the basis of recommendations. In fact, an internal validity is used to determine jurisdiction of theoretical territory that goes beyond defining the constituency and defining the borders.

The extent to which the findings can be generalised beyond the selected research sample is what is normally called external validity. Generalisation always takes place by considering the current results from the study on the general population of the study. In fact, it is the ability of replicating the findings of one study to various groups of the population or outside that population. Importantly, the population where the findings are meant to be replicated must possess similar qualities or characteristics with the population under the study. It is significant to recall that once populations have similar distinguished characters, the application of the findings becomes easier. For the purposes of this study, lean techniques were pioneered by the Japanese in the 1950s. The due course that has contributed its application to various countries across the globe has been due to similar needs of the population. To achieve external validity, it must be through theoretical relationships. For example, under external validity, the theoretical relationship affecting people is the same as long as they possess similar features and qualities. The main aim under which reliability is applied in research is to reduce errors that would accrue in due process and to maximise biases that could rise within research participants or future readers. In ascertaining and maintaining such aims, it becomes simple to collect findings and reach conclusions. Therefore, the difference between reliability and internal focus is on data collection. Reliability deals with data collection in order to ensure consistent results while internal validity focuses on the nature of conclusions from the findings of the study. Similarly, the two

constructs are governed by quantitative approach which is a traditional criterion leading to a positivistic paradigm.

There are two ways to carry out external consistency procedures in survey research. These include test / retest and parallel forms of the same test. Test / retest is always applied to establish reliability of research tools. In test / retest, an instrument is mistered once and repeated under the same conditions of study. The main disadvantage with this method is recalling the responses by participants once repeated. Being test/retest, it does not call for differentiations in conducting the experience. The same participants who the first test has been carried out, are the same groups under the study. The method is however advantageous since it allows comparison of the results and instruments in order to avoid some of the challenges that would have risen in assessing the instruments once. According to Ssali *et al.* (2022: 7) test / retest is a solution to itself and has been liked by many researchers since it is friendly and is not costly. It is carried in the initial stages of a survey, while the actual survey is a confirmation to the former baseline survey.

Under the parallel approach of the same test, the two instruments intended to measure the same phenomenon are constructed and administered to two similar populations. Results obtained from both tests are compared. If similar, the instrument is assumed to be reliable. This method does not suffer from the recall problem found in the test/retest procedure. Also, there is no requirement of a time lapse between two tests. However, the need to construct two instruments instead of one and difficulty in constructing two instruments which are comparable in measurement of the occurrence of the phenomenon are some of the disadvantages to the method.

Researchers across the world always use Cronbach alpha to measure reliability. This is a measure of the internal consistency, which is the extent to which scores on the same item are correlated. Due to this correlation, the findings are always considered right since only true scores are measured while exempting some of them with errors. The approach put into consideration the extent to which participants responded to a question without escaping any of the questions as asked by an investigator.

#### 3.7.3.1 Reliability Analysis of Data

This allows the study properties measure the scale of the results under Cronbach's alpha. Essentially, reliability test is essential especially when derivative variables are intended to be used for subsequent predictive analyses. The nearer the result of alpha value to 1 - preferably 0.8 or above the more internally reliable the scale is. Reliability which is less than 0.6 as poor, and within the range of 0.6-0.7, it is acceptable

and over 0.8 to be good range. As shown in Table 4.7, the alpha coefficient of the data of this survey is 0.95. This indicates that the measures of scale used have been reliable and the data collected are interrelated, considering 0.7 as the limit value for being acceptable. Reliability to this study is presented in Table 3.4

**Table 3.4: Reliability statistics**

| Cronbach's Alpha | No. of items |
|---|---|
| .923 | 1002 |

### 3.8 Data analysis

Data collected from participants were arranged, coded and entered into Microsoft Excel before being imported into the Scientific Package for the Social Scientists (SPSS) version 25.0. Microsoft Excel was used in order to arrange the data well in accordance with variables and codes. It was also necessary to use SPSS in order to proofread the variables and remove some of the errors as well as making the work standardised. The investigator also used SPSS in order so as to arrange variables to be imported to AMOS for structural modelling analysis. SPSS was also used as a road to Severity Index Analysis, Kruskal Wallis test and Cronbach's Alpha for reliability.

The use of SPSS was also significant towards identification of types of four measurements like nominal, ordinal, interval or ratio as discussed in the preceding paragraphs. The data types were also grouped into categorical and continuous data. There are various studies which have presented nominal and ordinal scales as part of categorical data; internal and ratio scales as continuous data. As already noted, categorical scale data use non-parametric measures, such as logistic regression models and log linear models. Continuous scale data use parametric measures such as t-test, ANOVA, regression. Results of this study embraced linear regression and determined the level of significance of various variables that have been used in this study. Most of the data from the administered questionnaires were used categorically, ordinal and as nominal data. Nominal data was also contributed from the interview guide that was essential to add up the qualitative information. Importantly however, most of the qualitative data were tried to align it under quantitative presentation. This form of identification enabled the investigator to apply appropriate statistical analysis especially exploratory and confirmatory analysis as applied through AMOS. Suffice to say, this study also applied descriptive and inferential statistics in data analysis. In fact, descriptive statistics were used to reveal the nature or general characteristics of the participants which have been presented in a tabular form. Lastly, this study applied a significant level of analysis at 5% (0.05). The methods and tests through which this study was adopted have been presented as follows.

### 3.8.1 Severity Index Analysis

This is a non-parametric technique that is based on the aggregated weighing of the frequency scores of each variable or attribute. Its formula has been presented stemming from Elhag and Boussabaine (1999:18):

$$S.I. = \left\{ \sum_{i=1}^{i=n} W_i f_i \right\} \times \frac{100\%}{n} \qquad \text{.....(i)}$$

In this equation *(i), S.I.* is presented as severity index; $f_i$ as frequency of participants' response; $w_i$ is the weight for each rating as per scale (i.e. rating in scale/number of points in a scale), and *n* is the total number of responses. The value ($f_i$ x 100)/*n* is the valid percentage as computed by SPSS and AMOS as well. This study used Severity Index Analysis because it is known to provide a meaningful interpretation of ranks rather than analyses that use the mean score derived from non-parametric data. It has been used in ranking of the variables in effort to analyse quantitative data by various researchers due to its truth and accuracy.

### 3.8.2 Kruskal – Wallis Test

This is also a non-parametric statistical test that is commonly used in quantitative data analysis of three or more independent samples to assess a single, non-normally distributed or continuous variable. Ordinal scale or variance suite to be analysed under this test. In fact, it is a more generalised form of the Mann-Whitney U test and is the nonparametric version of the one-way ANOVA. It tests the null hypothesis with multiple independent samples that always come from the same population under the study.

### 3.8.3 Mann-Whitney U Test

The Mann-Whitney U Test is always equating it with Wilcoxon rank sum test and Kruskal Wallis test for grouped variables. It is among strong quantitative non-parametric tests in comparing two populations and always used to test the null hypothesis with an assumption that two populations have identical distributions and functions. Therefore, it is an essential test for differences that would be occurring in the discourse of comparing the two cases of the population.

### 3.8.4 Cronbach's alpha

This is most popularly used to test reliability statistics. Cronbach alpha is always used in its formula as $(\alpha)$;

$$\alpha = \frac{k}{k-1}\left(\frac{\sigma_{y-\sum\sigma_i^2}^2}{\sigma_y^2}\right) \qquad \text{.....(ii)}$$

As per equation *(ii);* k = number of items, $\sigma_y^2$ = variance of the sum of all items; and $\sigma_i^2$ = variance of the $i$ the item (Stangor, 1998:23). It is a coefficient that ranges within values 0 to 1. However, there has been no

consensus about this value which shapes or gives the factual discourse to reliability in the narrative of Cronbach's alpha. Research has found that the acceptance range depends on the situation under which measurements have been presented with reference to the objectives of the study. The reliability of 5 – points under the Likert – type scale, which was mainly for this study was selected. It therefore determined the internal consistency of the items that have been used in this study. It can be asserted that Cronbach 's alpha is not a statistical test but a coefficient of reliability or consistency. Alpha coefficient is used to describe reliability or internal consistency of factors extracted from dichotomous (questions with two possible answers) and/or multi-point formatted questionnaires or scales. The higher the score, the more reliable the generated scale is. Research does consider a reliability of less than 0.6 as poor, in the range of 0.6-0.7 as acceptable and over 0.8 to be good.

### 3.8.5 Pearson's Correlation Analysis

This is a statistical measure of strength of a linear relationship between two data. Its calculation and the subsequent significance testing require the interval or ratio level, linear relation, and bivariate normal distribution assumptions to hold. Under Pearson 's correlation coefficient, r is used to evaluate sample data as an indication that a linear association exists between two quantitative variables. It can also be used to test the null hypothesis that there is no association between the variables X and Y (Lemire, 2010). Pearson 's r is not represented in any unit of measurement, it ranges between -1 and +1. A correlation value of zero indicates that there is no association between the variables. The bivariate correlations procedure computes the pair-wise associations for a set of variables and displays the results in a matrix. Pearson 's correlation was used in this study to determine the strength and direction of the association between ordinal variables.

### 3.8.6 Content Analysis

Content analysis is a research method for making replicable and valid inferences from data to their context, with the purpose of providing knowledge, new insights, a representation of facts and a practical guide to action. It is also used for compressing many words of text into fewer content categories based on explicit rules of coding. Content analysis has been viewed as quantitative while other authors believe that it has the elements of both quantitative and qualitative approaches. It should be noted that content analysis is usually used to examine contents of communication such as written documents and transcripts of interviews. Normally, it is divided into three: conventional, directed and summative. These three approaches adhere to the naturalistic paradigm and are used to interpret meaning from the content of the text. In conventional content analysis, coding categories are derived directly from the text data. With a directed approach, analysis starts with a theory or relevant research findings as guidance for initial codes. A summative content

analysis involves counting and comparisons, usually of keywords or content, followed by the interpretation of the underlying context.

The choice of content analysis was made mainly because it allows testing theoretical issues to enhance understanding of the data. Through content analysis, it is possible to distil words into fewer content-related categories. The conceptual analysis was adopted for the data analysis in this study. Coding of data is another important aspect of content analysis.

### 3.9 Hypothesis Testing

Qualitative researchers always test the null hypothesis in different ways. Normally, the significance level is always at 0.05 and it goes beyond to determine whether it is either positively or negatively significant. Such statements are based on the hypothesis that is always set in chapter one in line with the set objective. By definition, hypothesis is a conjectural statement expressing the relationship between the variables. Other researchers have described a hypothesis as a tentative statement about something, and the validity which is always unknown. Mathematically, hypothesis serves as a function that provides a focus to the research study. In doing so, it becomes an approach that clarifies a stated problem to enhance the objectives. Despite being small or one statement, hypothesis and alternative have broad meaning to the study as they prove the end. There are various forms of hypothesis but this study dissects them into two broad categories as presented in Figure 3.8

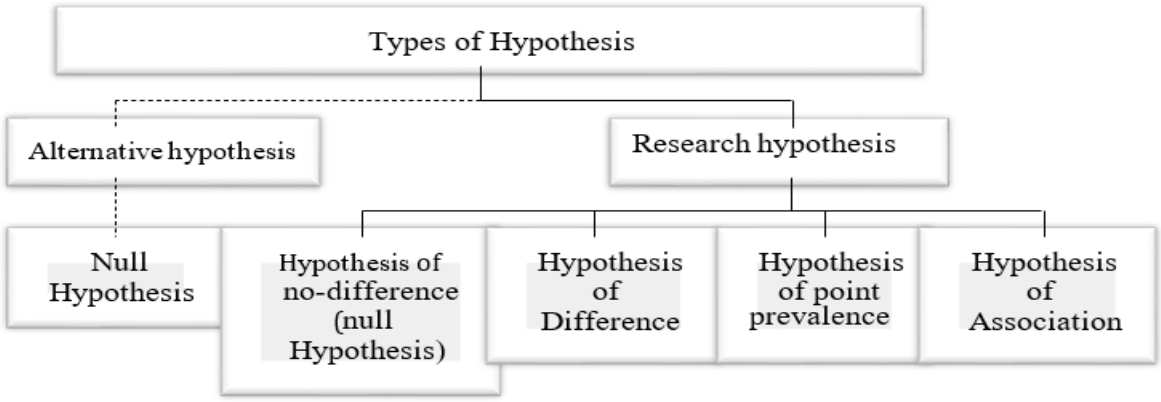



**Figure 3.8: Types of hypotheses**

Source: Ssali *et al.* (2022)

In research, the main function for stating an alternative hypothesis is to explicitly specify the relationship that is considered to be true or proven wrong. Thus, an alternative and opposite hypothesis of research study. The formulation of the null hypothesis is an intent or pre-emption of the upcoming alternative hypothesis. When a hypothesis is set reflecting that there is no difference or positively significant difference between two variables, situations, groups, outcomes, or the prevalence of a condition or phenomenon, it is referred to as

null hypothesis and is usually denoted as $H_o$. Hypothesis of difference is when a researcher stipulates that there will be difference but does not specify its magnitude. Hypothesis of point prevalence is when a researcher has enough knowledge about the study and its likely outcomes to speculate almost the exact prevalence of the situation or the outcome in quantitative units. For example, the level of infant mortality is 30/1000 and the proportion of female and male smokers is 60 and 30 percent respectively. According to Taherdoost (2017) hypothesis of association stipulates the extent of the relationship in terms of effect of different groups on the dependent variable. For example, using the aforementioned example of female and male smokers, a hypothesis of association will be stated as "twice as many females as male smokers." Null hypothesis testing is an optimal method for demonstrating sufficient evidence for an ordinal claim.

Null hypothesis testing is insufficient when size of effect is important, but is ideal for testing ordinal claims relating the order of conditions. Null hypothesis statistical testing (NHST) is widely used in research to test the viability of the null hypothesis in light of experimental data. There are two forms when hypotheses are used, null and alternative hypotheses. Null hypothesis makes a prediction that in the general population, no relationship or no significant difference exists between groups on a variable. For the purposes of this study, the null hypotheses were formed during research project writing and were tested during data analysis. This was after collection of the data and the invigilator continued with the writing of this synthesis.

### 3.10 Summary

The study henceforth under this chapter, adopted the descriptive cross-sectional research design. This is one of the approaches that this study embraced due to its nature and that it embodied the unique nature of the study. Both qualitative and quantitative approaches were as well adopted. A combination of interpretivism and positivism form the paradigm were used in this study. One would call them pragmatism in summary. However, there are some of the ideal aspects that pragmatism could not fix well as compared to positivism and interpretivism as well as post – positivism. What is clear is the fact that the combination of these paradigms was essential to the study design and tools that collected data that were later analysed. Ethical considerations were as well of great importance and were properly outlined and considered during the study. The contextual gap, population and study geographical scope was determined and underlined. A population of 111 was generated from the registered companies under UNABCEC and by the utilisation of purposive and proportional stratified random sampling techniques a sample of 56 companies was selected. 316 Structured questionnaires and an interview schedule were as well adopted for the study. Both the null and Alternative hypotheses ($H_0$) and ($H_1$) respectively were tested.

# CHAPTER FOUR:
# DATA PRESENTATION, ANALYSIS AND DISCUSSION OF FINDINGS

## 4.0 Introduction

The main focus of this chapter is to present the findings of the survey questionnaire which was carried out as part of this research. Under this chapter, the findings are related to implementation of lean construction techniques, general awareness and utilisation concepts. The issues which have been included in this section are based on the literature and the discussion which has been presented in a logical manner so as to generate meaning to the techniques.

## 4.1 Rate of reopens

This study had a sample size of 336 which was meant to be selected from the total of 56 companies from UNABCEC. All questionnaires were distributed and sent through emails as well as social media (WhatsApp). Only 315 were returned and analysed. This represented 94% of the total responses. Researchers have noted that a response rate that is about 30% in a survey is good enough to reach a generalisation of the findings (Idrus and Newman, 2002; 61). Illustration of the response rate is therefore presented in Table 4.1

**Table 4.1: Return from the survey**

| **Categories** | **Number** | **Percentage %** |
|---|---|---|
| Total number of questionnaires returned | 315 | 94 |
| Total number of questionnaires unreturned | 19 | 6 |
| Total number of questionnaires distributed | 336 | 100 |

One of the recognised disadvantages that has been associated with using emails and social media has been low response rate. These scholars asserted that the typical response rate that captures the reader is 95% that is higher than the responses by email survey that has been estimated between 20 – 40%. However, despite relying on email and social media during this study, the total percentage of response rate was 94%. This was achieved due to the following;

i. A mixture of research approaches such as emails, social media, face to face interviews were applied in the due course.
ii. The questionnaires used were straightforward without discourse and limited participants to certain responses.

iii. The questionnaires were covered by a cover letter from Durban University seeking cooperation for accomplishment of this study.

iv. The consent forms highlight the right of the participants to withdraw from the study in case of any challenge.

Apart from the survey questionnaire, 40 key informants were also interrogated in an in-depth interview for qualitative data so that voices could be captured directly. These were voices of the directors of the companies who could also express their commitment and ability to embrace lean techniques due to its advantages against other technologies in construction.

### 4.1.1 Nature of participants

The nature of participants under this study has been presented in Table 4.2

**Table 4.2: Illustrative nature of the participants**

| **Variables** | ***Fr = 315*** | |
|---|---|---|
| | **Categories** | **Percentage** |
| Sex | Male | 60.9% |
| | Female | 30.1% |
| Education | Diploma | 6.3% |
| | Undergraduate | 14.3% |
| | Post- graduate diploma | 32.4% |
| | Masters | 37.5% |
| | PhD | 9.5% |
| Duration of the company | Less than 6years | 17.5% |
| | 6- 10 years | 37.5% |
| | 11-20 years | 34.2% |
| | Over 20 years | 10.8% |
| Knowledge about lean techniques | Yes | 21.9% |
| | No | 32.1% |
| | Less Information | 46.0% |

Illustrative information in Table 4.2 indicates that majority participants were males (60.9%) while females were 30.1%. This distributive information is based on the attitude in Uganda that most construction

companies only employ men due to the nature of work they meet. In fact, the majority of females were found working under human resources and supervision but no women were involved in construction. Most of the participants had master's degree (37.5%); post-graduate diploma (32.4%); undergraduate degrees (14.3%), PhD (9.5%); and diploma (6.3%).

Participants came from companies that had existed in Uganda for various years of operation. As indicated from Table 4.2 companies that have existed for 6 – 10 years had 37.5%; those between 11 – 20 years were 34.2%; less than 6 years of existence were 17.5%; and over 20 years were 10.8 years. The Table 3.4 also indicates that 46.0% had less knowledge about lean techniques; 32.1% had no knowledge; and those with yes responses had 21.9%. All these variables were important in providing answers that this study sought to investigate on lean techniques.

## 4.2 Implementation, Awareness and Utilisation of Lean Construction Techniques

### 4.2.1 Implementation of lean techniques

Implementation is one of the critical parts in projects and concepts that are normally new to people as well as the society. It is normally done in order to obtain intended outcomes and therefore relevant to companies, organisations, researchers, policy makers, and government officers in practice. According to Durlak (2011:1), implementation is a set of activities designed to put into practice an activity or program. In the actual sense, an individual would perceive that the proposed program and what is delivered are the same. Therefore, there is no difference between the planned program and the subsequent implemented activities. In practice, when practitioners initiate evidence – based programs in an environment or any area, they rarely produce what has been evaluated or intended to be done. These officers always alter the setting or work in accordance to the needs of the people or clients rather than the standard requirements. This makes implementation a problem in most emerging companies. Strong companies on the other hand have nothing like copy and paste or changing the concept of the program into a different design or approach. Therefore, the lean techniques are within the ambits that are hardily to change rather implemented on the basis of originality.

Rudd and Mills (2015:1) stated that implementation is a process of putting plans into actions. Implementation is a process that is done after hundreds and thousands of decisions that are extraordinary in the career of a company, institution or organisation. It is normally done by managers who start with particular problems they intend to fulfil and develop plans to do it. Many decisions are simple, while others can become very complex. It is a fact that all companies make decisions on a day-to-day basis; but managerial decisions differ from personal ones in that they affect the entire organisation and possibly

thousands of people. Decision making for implementing new ideas involves defining problems and generating a variety of alternatives that are best to be implemented by the company or an organisation. An important decision making involves coming together of responsible persons to establish the goodness that can be received in effect to the final solution. Such solutions have identified opportunities, alternative plans, strengths, weaknesses and threats. Therefore, it is the obligation of the implementers to make clear decisions that would fulfil goals of the organisation that commits the use of resources towards a concept that has been implemented.

Sundar *et al*. (2014:2) perceived that among the concepts of the 19$^{th}$ century is the lean techniques that has been developed to and maximise waste during the implementation process. It rose within the periods of fluctuation and competitive business environment in manufacturing and construction processes. The lean construction as a concept was developed to minimise wastes in manufacturing or service-oriented business with systematic and product values. It is the value added that makes the lean techniques more appreciative, protective and sustaining. By minimising wastes, the lean techniques add an appreciative value to the implementers and clients to the services rendered. This study therefore agreed with what Ellingsen (2017:1-4) presented that the implementation of lean techniques contains Value Stream Mapping (VSM), Cellular Manufacturing (CM), Line Balancing, U-line system and Production Levelling among others. In a volatile environment, this study established that implementation of lean techniques is volatile (Batra *et al*. 2016: 1-2).

As noted by Antoss and Stadnicka (2017:1), this study found that lean techniques are implemented by different companies across the globe. It uses different methods, and on cost minimisation, avoidance of the poor-quality materials and effect the work plan in order to avoid the wastes. This study established that there are various managers and employees disturbed by unknowns and methods that do not add value in the process of implementing lean techniques. As noted by Sahraee *et al*. (2014: 3-4), companies with employees that feels such heatt need approaches and models that are essential in applying lean techniques in effect to time, and elimination of wastage. In the modern age, Bangi (2022:1-2) state that lean techniques have got an implementation framework that is beneficial and compels management to speed that revelation process with proper planning schemes. In a study by Tripathi *et al*. (2022), it has been indicated that the main gap with the lean techniques is systemic planning scheme which is essential for the combined lean techniques implementation framework. Although studies have been conducted on implementation framework and observation schedule, Bangi (2022:1) calls for proper systematic planning design that can make lean techniques more effective to construction and manufacturing companies. This framework must embrace

team section, distribution of work and access to tools for implementation of lean techniques. Therefore, lean becomes successful with planning a systemised approach.

Saxby *et al*. (2020:1) support the view that Lean Implementation Management methods need continuous improvement during industrial implementation. In their study, semi-structured interviews were conducted using five Quality Specialists to get information about the supportive role of lean elements. The study established that lean techniques have potential to support and allow continuous elements in the industry. The supportive elements in this case include Continual Improvement, engaging supply chain, Pull System and having Customer Focus. According to Assen (2021:6), lean techniques do not attract any customers, rather quality customers who are meant to access services from the company that applied it. In fact, the lean techniques framework considers clients or customers important since the services are made to their satisfaction (Tshuma and Bernal, 2015:11). As presented by Saxby *et al*. (2020:1), lean techniques have the ability to integrate new ideas and methods for continuous improvement in the industry. However, this study still revealed that lean techniques still face various challenges due to practical implementation and updating certain parts in technology. The practical implementation at the end becomes the main hindrance to managers and employees.

In a study by Filardi *et al*. (2015:1), it is indicated that the need for improvement during implementation is an important element of lean techniques. Whereas companies have improved the process, there is still a limitation in the literature regarding its effective application and results from applying companies. Industries and companies have applied Lean Sigma methodology in various industries like multinational oil companies in Brazil. However, there is still limited information about the adherence by most industries applying this methodology. The cost implication embedded in the whole exercise has led scholars like Saytsev *et al*. (2020:2) to call for the most efficient methodological improvement approach while implementing the lean techniques. It has also been found that modern trends support the intensive means of achieving business efficiency by maximising waste, time, capital and other resources. In doing so, lean techniques have become important to communities to apply it as an educative, economic and a social technology that once embraced can as well improve the lives of the community (Zaytsev, Dmitriev and Dmitry, 2020).

### 4.2.2 Awareness of lean technique design

Results from the survey questions presented in this section are all related to knowledge. The survey considered implementation as one of the best necessities for lean techniques. All the results are presented through regression analysis from AMOS in the proceeding illustrations starting with Table 4.3.

**Table 4.3: Regression weights for knowledge of lean techniques design**

| | | | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| Knowledge | <--- | Technological efficiency | .002 | .046 | .054 | .957 |
| Knowledge | <--- | Attracting clients in Uganda | -.074 | .052 | -1.413 | .158 |
| Knowledge | <--- | Solution to construction problems | -.006 | .044 | -.129 | .897 |
| Knowledge | <--- | Reduce product development time | .001 | .054 | .027 | .978 |
| Knowledge | <--- | Reduce product development cost | .085 | .047 | 1.815 | .070 |
| Knowledge | <--- | Assured quality supervised control | -.032 | .051 | -.623 | .533 |
| Knowledge | <--- | Aids effective communication | .054 | .052 | 1.047 | .295 |
| Knowledge | <--- | Eliminates wastes and non-values | -.037 | .053 | -.694 | .488 |
| Knowledge | <--- | Increase client satisfaction | .122 | .054 | 2.242 | .025 |

The regression estimates presented in Table 4.3 shows that the increment in clients' satisfaction was positively significant since its p-value 0.025<0.05. In such circumstances, the null hypothesis is rejected in favour of alternatives. The rest of the parameters run under EMOS were not significant as presented in the table.

### 4.2.3 Awareness to lean techniques in construction

AMOS was also used to run data on awareness of lean techniques in construction and results were also presented in Table 4.4

**Table 4.4: Regression weights for lean construction awareness**

| | | | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| Knowledge | <--- | LC improves safety and environment. Issues | -.017 | .053 | -.327 | .744 |
| Knowledge | <--- | LC improves time, costs and quality | -.031 | .048 | -.641 | .522 |
| Knowledge | <--- | LC helps to identify the constraints | .002 | .055 | .032 | .975 |
| Knowledge | <--- | LC focus on value than cost | .003 | .048 | .065 | .948 |
| Knowledge | <--- | Optimising resource delivery schedule | -.062 | .050 | -1.235 | .217 |
| Knowledge | <--- | Aids reduction in on-site transport | -.010 | .054 | -.176 | .860 |
| Knowledge | <--- | LC results into standardised work | .057 | .055 | 1.043 | .297 |

Regression estimates in Table 4.4 show no significant knowledge about lean construction awareness since the p-value > 0.05. In such circumstances, the null hypothesis is accepted against the alternative.

### 4.2.4 Actual Implementation in the company or waiting

This study presented implementation in four parts with specific identifiable variables. These variables include the actual implementation in the company (waiting) which is examined in line with time wasted or utilised; actual implementation in the company which the study found was done basing on the policy approach by the company; actual implementation in the company that was under the workers' management); and actual implementation in the company in terms of productivity and output.

Emphasis on actual implementation focused on time wasting during the implementation phase. The most variables this study interrogated included waiting for the materials by the workers before work resumes; workers waiting to finish previous work before the second resumes; workers waiting to sign off by the supervisors; walking around the construction site to relax since the load is not too much; and move away to seek for breakfast and lunch during the implementation schedules. The study considered these factors under time waste in implementation of lean techniques by companies. The computed level of significant variables in relation to awareness or knowledge as relating to p-value were presented in Table 4.5.

**Table 4.5: Regression weight for awareness to waiting during implementation**

| | | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|
| Knowledge | <--- Waiting for material before work | -.017 | .047 | -.359 | .720 |
| Knowledge | <--- Waiting to finish work before another | .110 | .052 | 2.112 | .035 |
| Knowledge | <--- Waiting to sign off by supervisor | -.062 | .051 | -1.201 | .230 |
| Knowledge | <--- Move around to relax when little load | -.053 | .054 | -.994 | .320 |
| Knowledge | <--- Move away for breakfast and lunch | .093 | .047 | 1.973 | .048 |

Results presented in Table 4.5 indicate that apart from workers waiting for finishing hands – on before starting another task, p-value = 0.035; and workers moving away from the site to seek for breakfast and lunch, p-value = 0.048, the rest of the variables in the question were negatively not significant. In cases where the p-value = 0.035 and p-value = 0.048, the null hypothesis is rejected in favour of the alternative.

### 4.2.5 Actual Implementation in the company (Policy)

This section focused on the policy approach that companies always use in executing their duties. The study established that it is from the policies that companies implement the lean techniques by policy and delivery

of the projects to the clients. Computed estimates and level of significant variables in relation to awareness or knowledge were presented in Table 4.6.

**Table 4.6: Actual Implementation of lean techniques in companies by policy**

| | | | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| Knowledge | <--- | Embrace systemic change by policy | -.005 | .056 | -.095 | .924 |
| Knowledge | <--- | Observes legal contracts | -.097 | .048 | -2.008 | .045 |
| Knowledge | <--- | Design is legally towards customers | .043 | .044 | .980 | .327 |
| Knowledge | <--- | Design is legally to requirements | -.049 | .049 | -.995 | .320 |
| Knowledge | <--- | Company has environmental policy | -.044 | .056 | -.773 | .440 |
| Knowledge | <--- | Policy based on time delivery | .054 | .052 | 1.030 | .303 |
| Knowledge | <--- | Policy based on resources utilisation | -.054 | .050 | -1.096 | .273 |
| Knowledge | <--- | Policy to reduce surplus deficit | -.043 | .049 | -.881 | .378 |
| Knowledge | <--- | Ensures development of workers | -.003 | .049 | -.053 | .958 |

As indicated in Table 4.6, participants' awareness or knowledge of legal contract was found significant, p-value = 0.045. The rest of the variables had p-value > 0.05, which is a standard value of alpha.

### 4.2.6 Actual implementation in the company (worker's management)

The study also assessed awareness of the actual implementation within the companies among the workers and management. The main aim was to establish the extent to which the managers embrace lean techniques in management approach. Variables which this study interrogated were nine (9) which included: whether the companies have change management process; whether the companies have managers who communicate visions, objectives and policies; whether the companies have adequate functioning team management system that enhance all responsibilities that are allocated by the management; whether training within the companies are tailored based on objectives; whether the companies ensure high quality outputs from workers; satisfaction of the workers with working conditions; ensuring that the work is assigned and accomplished within time schedule; and the extent of accountability within the management. Results from the run AMOS are presented in Table 4.7 relating the level of significant variables in relation to awareness or knowledge.

**Table 4.7: Actual implementation of lean techniques in companies by workers' management**

| | | | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| Knowledge | <-- | Effective change management process | -.078 | .049 | -1.568 | .117 |
| Knowledge | <-- | Communicate vision and objectives | -.041 | .047 | -.883 | .377 |
| Knowledge | <-- | Functioning team for all responsibilities | -.011 | .043 | -.261 | .794 |
| Knowledge | <-- | Training tailored to its objectives | .053 | .045 | 1.168 | .243 |
| Knowledge | <-- | Ensures quality output from workers | .086 | .046 | 1.859 | .063 |
| Knowledge | <-- | Ensures fast response to workers | .072 | .048 | 1.496 | .135 |
| Knowledge | <-- | Satisfied with working conditions | -.059 | .049 | -1.224 | .221 |
| Knowledge | <-- | Assigned work is accomplished in time | -.017 | .045 | -.378 | .706 |
| Knowledge | <-- | Accountable for everything | -.023 | .054 | -.436 | .663 |

Results run on the actual implementation of lean techniques in Table 4.7 to indicate all the variables interrogated from participants had p-value > = 0.05. Thus, the alternative hypothesis becomes a priority to this case.

### 4.2.7 Actual implementation in companies – output

This has been presented to include various variables whether companies produce quality work as well as standard. Other variables include: whether companies redo work after sub-standard works; whether there is high concentration in a given high quality output; faster service delivery, production at a low cost and minimise few errors. The computed level of significant variables in relation to awareness or knowledge were presented in Table 4.8.

**Table 4.8: Regression weights for actual implementation in companies – output**

| | | | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| Knowledge | <--- | Company produces quality work | -.050 | .048 | -1.043 | .297 |
| Knowledge | <--- | Reworking comes in case sub-standards | .012 | .047 | .252 | .801 |
| Knowledge | <--- | High concentration is given for quality output | .051 | .047 | 1.073 | .283 |
| Knowledge | <--- | Company ensures quality output | .094 | .047 | 2.015 | .044 |
| Knowledge | <--- | Fast responses for service delivery | .049 | .049 | .999 | .318 |
| Knowledge | <--- | Company seeks to produce at low costs | -.004 | .048 | -.076 | .940 |
| Knowledge | <--- | Company even minimises few errors | -.007 | .045 | -.147 | .883 |

In accordance with Table 4.8, it is indicated that apart from the statement that companies execute their duties to ensure quality output, with p-value = 0.044, the rest of the responses analysed had results above 0.05 which is a standard value of alpha. Such circumstances call for acceptance of the alternative hypothesis.

### 4.2.8 Utilisation of lean techniques concept at project level

This section presents the findings about utilisation of lean techniques by the companies. Results are presented under three themes: Utilisation of the lean technological concept at project level; utilisation of lean concept by employees; utilisation of lean concept by managers. Responses to this section were collected using a five Likert scale in an attempt to establish the agreement with their knowledge or awareness. It was assessed on the comparison if the lean techniques are similar to traditional practices of construction; extent it improves competitiveness and market share; ensuring sustainability in using resources; motivating and shaping employees' behaviours among others. The findings are presented in Table 4.9

**Table 4.9: Responses to utilisation of lean techniques at project level**

| | Fr = 315 | | | | |
|---|---|---|---|---|---|
| | Responses (%ag) = $R^1$ | | | | |
| Statement | 1 | 2 | 3 | 4 | 5 |
| lean techniques is similar to traditional practices | 42.5 | 26.7 | 14.0 | 7.9 | 8.9 |
| lean techniques has improved competitiveness and market share | 6.7 | 10.5 | 16.5 | 29.5 | 36.8 |
| lean techniques ensures sustainability in using resources | 3.5 | 8.3 | 47.0 | 24.4 | 16.8 |
| lean techniques motivates and shapes employees' behaviours | 4.1 | 13.0 | 48.6 | 26.0 | 8.3 |
| lean techniques innovates sustainable competitiveness of work | 6.3 | 14.9 | 46.3 | 22.3 | 10.2 |
| lean techniques promotes integration of supply chain | 6.0 | 15.6 | 50.8 | 21.3 | 6.3 |

$R^1$: 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

The disagreement responses were received from establishing or comparing the lean techniques with traditional practices, with 42.5% and 26.7% who strongly agreed and agreed respectively. There were many respondents who remained neutral in various responses. For the improved competitiveness and market share, it was 16.5%; sustainability in using resources was 4.0%; motivating and shaping employees' behaviours was 48.6%; innovating the sustainable competitiveness was 46.3%; and 50.8% for promoting integrative supply chain. The key informants to this study ascertained that;

> *"There are a number of employees in the construction industry who rarely; and have less information about the lean techniques. Being a 21st technique, which is not common in Uganda, there are various employees who are ignorant of it. This is because most of the employees are interested in constructing buildings or any civil work without taking extra miles to know which*

*form of technology has been used to accomplish the work. There are employees however who take extra time to establish the meaning of lean techniques, and some have taken studies about lean techniques in research. Therefore, you should find some employees with limited, or not knowledgeable about lean techniques contents*" (One of the key informants February, 2021).

The study also found that some companies have borrowed information or concepts from lean techniques which they integrate into their traditional approaches of construction. Companies have tried to include time schedules but they find it impossible to ascertain completion and delivery time of the projects. It was also found that wastes have been yet another main challenge which is highly controlled under the lean techniques. From the key informants, this study also established that;

*"..reduction or no wastes at all has been one of the major components to lean techniques which is not found among other types of construction concepts. Minimising wastes starts with procurement to actual time of implementation or onsite construction, where workers utilise materials effectively for the purpose of waste elimination. However, most construction companies in Uganda have tried to reduce or to minimise wastes but failed since it is not their main concern right from their strategic planning schedules"* (the key informant April, 2021).

### 4.2.9 Utilisation of lean construction tecniques by employees

The study also assessed various variables under the utilisation of lean techniques concept utilisation by employees. These include enabling employees to handle projects, increasing coordination at work and capacity building during the construction as presented in Table 4.10

**Table 4.10: Utilisation of lean technological concept by employees**

| | Fr = 315 | | | | |
|---|---|---|---|---|---|
| | Responses (%ag) = R[1] | | | | |
| Statement | 1 | 2 | 3 | 4 | 5 |
| lean techniques enables employees to handle projects | 6.7 | 8.9 | 21.0 | 28.3 | 35.1 |
| lean techniques increases managerial coordination at work | 7.9 | 11.1 | 28.3 | 23.5 | 29.2 |
| lean techniques increases capacity building during construction | 4.8 | 12.1 | 21.2 | 30.5 | 31.4 |
| lean techniques creates opportunities for further learning | 2.9 | 19.8 | 32.0 | 32.0 | 13.3 |

| | | | | | |
|---|---|---|---|---|---|
| lean techniques inspires contractual workers onsite | 7.6 | 8.6 | 30.2 | 26.6 | 27.0 |

R[1]: 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

Results presented in Table 4.10 indicate that there were many participants to this study who were neutral. It is indicated that 21.0% of the participants were neutral on the extent to which lean techniques enable employees to handle projects. The study also established that while some employees could handle projects during the construction process, it was not clear if such employees would do practices with knowledge of the applied technology. As already noted, participants noted with ease that the important narrative is construction of building rather than technological knowledge.

On whether the lean techniques have an effect on increasing coordination at work, quantitative results show that 28.5% were neutral. This was an indication that participants have limited information on such statements or questions and according to the key informants, "*weakness in managerial coordination has been one of the main effects that increases delays of finishing projects in Uganda*." The study established that due to the inability of company managers, it is difficult to engage in the competitive bidding advertised by the government and its institutions. At times, some of the bidders have poor managers with limited instruments to construct. Suffice to say, the key informants noted that "*most bidders in Uganda are foreign companies or companies and departments headed by foreigners*." Although such a form of engagement could be beneficial to the government and its institutions, it has been blamed for repatriating profits from the country to foreign nations. At this point, one of the key informants remarked that "*the extent to which the used technology can benefit the nation remains void.*"

There are various Ugandans who have limited knowledge in construction but managers have been engaging such groups of people and individuals to contribute their effort during projects. Some of the onsite builders do not have competent knowledge rather than studying by practice. The study also found that some companies do not advertise for jobs as they prepare to win projects. The narrative of who and whose child has been used to recruit the lower lever or onsite builders. This study also established that some supervisors in some of the government agencies are also employed with less emphasis on engineering or knowledge of construction. Such groups or individuals take a long time to learn on the job. In the due course, collapsing of some buildings became the norm in the construction industry.

lean techniques increase capacity building during the construction process and this was supported by 30.5% and 31.4% who agreed and strongly agreed, with 21.1% that remained neutral. This information was supplemented by the key informants who asserted that there are various individuals in the construction industry who increased their level of expertise during the process in construction activities. These include

the managers, onsite constructors and human resource individuals in procurement of materials to use in the due course. Essentially, companies that have incorporated some of the lean components into their process, have increased the understanding and construction skills of their employees as compared to those that have completely shunned it off. Workers learn to manage time and use materials such as sand, cement and stones averagely without or less wastes. Nonetheless, the study findings revealed that there is still a large number of employees or participants that remained neutral. This percentage together with participants who disagreed revealed the largest extent of limited understanding of lean techniques. Other variables where participants revealed limited knowledge included the technology's ability to create opportunities for further learning with 32.0% and 30.2% on inspiring contractual workers onsite.

### 4.2.10 Utilisation of lean technological concept by managers

Lastly, the study established the utilisation of lean techniques concept at managerial level in which results have been presented in percentages. The managers are the daily controllers and implementers of the lean techniques at the company level. They have a greater say towards decision making in the construction industry and they were among the highly educated of the companies. Their responses are presented in Table 4.11 of this dissertation.

**Table 4.11: Utilisation of lean techniques by managers**

| | Fr = 315 | | | | |
|---|---|---|---|---|---|
| | Responses (%ag) = R[1] | | | | |
| Statement | 1 | 2 | 3 | 4 | 5 |
| Managers use waste – walk sheet to identify non-value activities | 3.5 | 13.0 | 55.9 | 17.8 | 9.8 |
| Managers hire external experts to tackle non-value ambiguities | 28.3 | 32.0 | 19.4 | 12.7 | 7.6 |
| Managers always inspect the root causes of waste activities | 8.2 | 7.0 | 22.9 | 32.4 | 29.5 |
| Managers reduce costs by capturing defects in early stages | 7.0 | 7.3 | 12.7 | 28.9 | 44.1 |

R1: 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

Results presented in Table 4.11 indicate that 55.9% of the participants were neutral to the statement that managers use waste – walk sheets to identify non-values activities while implementing lean techniques. The study established that non-value would be removed in order to allow proper operation of valued activities. This is done focusing on determining productivity of the company. Like other remarks by the key informants, the study found that workers have less knowledge about the lean techniques. Against this background was the fact that managers hire external persons to tackle non-value ambiguities of the

companies in the due course of implementation of lean techniques. The findings show that 32.0% of the participants disagreed and 28.3% strongly disagreed with the statement.

Nonetheless, the findings show that managers inspect the root causes of waste activities and 32.4% agreed and 28.5% strongly agreed while 22.9% remained neutral. It is also presented that 44.1% and 28.9% strongly agreed and agreed respectively with the statement that managers reduce costs in the early phases of the projects. It was however noted by the key informants that the reasons why most employees were aware of these two was the similarity with the traditional or pre-existing approaches before knowledge of lean techniques.

### 4.2.11 Test of hypothesis on implementation of lean techniques

Based on Table 4.8 – Table 4.11, the research hypothesis $H_1$ states: There is a significant level of implementation of lean techniques by utilisation of concepts. This was also examined under the null hypothesis. Null hypothesis $H_0$ states that; there is no significant level of implementation of lean construction by utilisation of concepts.

In Table 4.12, the significant value of Cochran's test is 0.000 (p-value < 0.05). This result makes possible rejection of null hypothesis at 5% significance level. Therefore, the alternative hypothesis - there is a significant level of implementation of lean techniques by utilisation of concept is accepted.

**Table 4.12: ANOVA with Cochran's test of hypothesis on lean techniques implementation**

| | | Sum of Squares | Df | Mean Square | Cochran's Q | Sig |
|---|---|---|---|---|---|---|
| Between People | | 487.288 | 314 | 1.552 | | |
| Within People | Between Items | 1140.767 | 14 | 81.483 | 760.979 | .000 |
| | Residual | 5470.166 | 4396 | 1.244 | | |
| | Total | 6610.933 | 4410 | 1.499 | | |
| Total | | 7098.221 | 4724 | 1.503 | | |
| Grand Mean = 3.33 | | | | | | |

### 4.2.12 Discussion of findings

As indicated from the administrative theory in accordance with Fayol, the findings are in agreement to his theory. According to Nadrifar *et al*. (2016: 84), the management of any project must embrace planning, organisation, leading, coordination and control. These have been important in reference to the findings on the awareness and utilisation of the lean techniques as part of this study. As presented in Table 4.1, it is significant that participants were aware about reduction of costs by lean techniques. It is also indicated that

the use of lean techniques satisfies clients. This cannot be reached without initial planning as emphasised by the theory. The findings to this study are also in agreement with what Johansson and Sundin (2014:3) indicate about awareness within the institution or company. Within the seven prepositions presented from their study such as value creation, waste generation, implementation, education / training, tools or techniques are also presented in this study. For example, the value creation is presented as an attribute that managers always work upon in their exclusive behaviours.

This study shows that managers exclude non-value activities so as to reduce waste generation during the implementation of lean techniques which some construction companies have never embraced in totality. It is such awareness that Negrão *et al*. (2017:11) show importance towards the success of firms. In fact, the adoption of lean techniques is a road to success according to Negrão *et al*. (2017:11). This therefore leaves a gap to assess levels of success of projects among companies that adopted lean techniques, half-adopted and non-adopters in the construction industry in Uganda. Despite the importance of awareness, this study revealed a limited knowledge among employees that were interviewed. This is an indication that most Ugandan construction companies have not fully embraced lean techniques which could have been the main reason for collapsing buildings. It also puts the construction companies at the peripheral position from attaining the benefits of lean techniques.

### 4.3 The Degree of Success and Realisation of Projects

The main goal of this section is to present the level of success attained by the construction companies whose employees were interviewed. The findings are related to the delivery of the projects and satisfaction of the employees in the due course of implementation of the lean techniques. It starts with an overview of realising success of lean delivered projects and later gives survey results which were collected using a five point Likert scale. It then gives the testing hypothesis and discussion of the findings.

#### 4.3.1 Overview to success

Success has been the main target of man in life ever since the existence of the world. It is a state of achieving or accomplishing the targets in life or as planned (Dotson, 2016). This study used the term to refer to accomplished projects in accordance to plans without any regrets. In theory and education especially, success is related to the ability to get a good degree, getting employed at the right age at the right time, having good residence, promising cars and wealth in life (Dangara, 2016). For the purposes of this study, successful projects are evidenced whenever wastes are minimised or when a project is accomplished without wastes, within time and using competent constructors (Dotson, 2016). As indicated in the lean techniques literature, there must be goals set by the company to be achieved which could be

either short and long term goals. In order to be successful with such goals, a company needs to have hard working employees with a positive attitude to development and towards its goals. Such employees must be willing to adopt new innovations and inventions like lean techniques, and work to achieve its components.

### 4.3.2 The degree of success of project under lean techniques

This study established various information that has been researched in reference to the success of the lean techniques. The studies broadly accept the view that once lean techniques have been adopted, there are various elements that determine its success. The variables range from the context under which lean has been adopted, the government policy and employees themselves. The most important factor is evaluation that is carried to determine the success of certain projects based on the predetermined plan or goals. In fact, chapter two shows that contractors and planners engage in the planning process before any project. As long as the set goals and aims are achieved as they were framed, then the success is achieved. Herzog and Tonchia (2014:1) are of the view that despite lean techniques being broadly accepted as one of the technological approaches in construction and industrial sectors, there is still confusion of measuring its success since various companies embrace partial technology. Therefore, this makes it hard to define the partial technology as lean techniques, thinking or philosophy.

In their survey conducted within 72 medium and large-scale manufacturing companies of Slovenia, Herzog and Tonchia (2014:1) used qualitative and quantitative methods of research in order to ensure a generic framework for lean techniques research. Based on the synthesis of lean literature for assessing the success in implementation, eight crucial areas were identified. These include value concept and customers, Value Stream Mapping (VSM), pull/Kanban and flow, waste elimination, productive maintenance, just – in – time (JIT), employee involvement and development of excellent suppliers (lean suppliers). Under these, the variables were interrogated using the Likert scale of the questionnaire. It was found that interrogated variables would be important in understanding lean and measuring the degree of successful implemented projects. However, the study received mixed reactions about understanding lean thinking concepts and how they would be used in successful lean projects.

In yet another study by Perumal (2020:1) from Malaysia, Critical Success Factors (CSFs) for implementation of lean manufacturing in SMEs that produced machinery and equipment (MandE) were studied. Convergent parallel mixed methods of qualitative and quantitative were used to extract the data. Four CSFs were established which included leadership and commitment of top management, training to skills and expertise, employee involvement and empowerment, and development of the lean methodological

implementation framework. This study would assist the SMEs to improve its strategy in order to achieve highly sustainable results using its earlier successes. Secondly, the study would be used by other companies for reference in order to improve. While such variables were important, this study did not go extra – miles to ascertain their efficacy in such a narrative. It thus leaves a gap for the case of Uganda, where leadership claim to be corporately working.

Hương and Anh, (2021:1) is of the view that the success of lean techniques in the manufacturing industries is achieved through streamlined production, reduction of wastes, and increased efficiency. Success in these variables is inversely correlated to quality productivity at the local and national level of manufacturing. Despite the importance of these variables, there has been difficulty for most companies and businesses to convert to lean techniques and this has jeopardised the success. In a study from Vietnam, Hương and Anh, (2021:1) studied the characteristic factors affecting the success of lean techniques using an application model. From the sample of 10 typical industrial manufacturing enterprises, six characteristics as already indicated in the preceding paragraphs were mentioned. They therefore become key recommendations to other industries and companies in case they need to be successful. While embracing six characteristics would mean adopting lean techniques, most companies and industries could not manage the transition from the pre-existing paradigm to lean techniques.

In Morocco Houthi *et al*. (2019:1), found that the lean techniques had become a pillar to modernising the industry. It was found that companies in Morocco had utilised the Japanese approach for minimising costs and maximising profits. These were mostly SMEs that started with the support by the government to transform the economy. Since lean techniques was also a Japanese concept, the companies would apply lean techniques without prior studies or assessing secondary literature. The study which was conducted established that companies that adopted lean techniques without prior studies could hardly achieve their goals as compared to those that engaged in prior studies. In fact, most companies with prior studies had a high level of success as compared to companies which adopted certain components of lean techniques. Moreover, some companies could not differentiate some components of lean techniques used during implementation. This fulfilled the assertion by Achanga *et al*. (2006:24) that while companies have embraced lean techniques in improving productivity, SMEs are hardly sure about the costs of implementing it. Moreover, more companies have not yet explored tangible success that would accrue from implementing lean techniques in totality.

In developing nations, productivity has become one of the problems for the construction sector (Koohestani *et al*. 2020:1). While companies in nations like Iran have adopted the lean techniques, success from

implementation is either negative or positive. While carrying out a study from Iranian literature, Koohestani *et al*. (2020:1) identified 44 critical success factors at a global level which Iranian companies must embrace to attain success in lean techniques. The 44 factors were later summarised into four groups of the industry, its professional leadership, environment and adopting critical lean techniques components. Nonetheless, the study established a high level of lack of awareness and knowledge about lean techniques. The study recommended more focus to be put on factors creating the need for lean techniques adoption if the companies needed success in their businesses. As it was identified that management, leadership, human resources and training were most significant CSFs for the success of lean, the study found little knowledge and interpretation of such concepts. Knowledge or awareness of lean techniques concept has been illustrated from the context of this study as indicated in chapter four.

In a study by Sohal *et al*. (2022), CSFs under lean techniques were studied under management control and operations. The authors noted that despite the presence of literature, studies from healthcare related issues are scarce. In implementing the Lean Six Sigma (LSS), 62 LSS projects in Green and Black Belts were analysed using the Grounded theory approach with main intention to success factor. Through workshops, the scholars were able to brainstorm and revise CSFs as presented in the 62 projects to eight CSFs using the five points Likert scale. In this narrative, success was measured against the extent to which the project met its stated aims and achieved key performance parameters. Correlations were therefore made between success factors project success. The findings justified that eight CSFs were significantly correlated to project success in which the intended goals were realised at the end of the project. The main aspect that the study ought to have contributed included the management controls, operational management and called for the continuous improvement of the project through rigorous practical measures. It was therefore noted that other specified CSFs indicators that were identified would continue presenting themselves in the improvement of the healthcare projects where the lean techniques were implemented in the management process.

Using this literature, it is indicated that success in projects under lean have been measured differently with special focus on management, clients' satisfaction and the extent to which a project would achieve its set goals. Under this study, the narrative focused on success and timely delivery as expected by stakeholders, organisation commitment or management with other aspects of lean project success.

### 4.3.3 Lean techniques project success to stakeholders

Results for this section have been obtained using a five points Likert scale with the main focus on success in accordance to stakeholders, project organisation commitment success and success of lean techniques

projects. Stakeholders are the most important persons in the management process of the projects which starts from planning, implementation management and evaluation. In fact, it is an evaluation which is made based on the stated goals / plans that determines the success or need for revision. The Quantitative results have been presented in Table 4.13 of this section.

**Table 4.13: Illustration of lean techniques project success to stakeholders**

| | Fr = 315 | | | | |
|---|---|---|---|---|---|
| | Responses (%ag) = $R^1$ | | | | |
| Statement | 1 | 2 | 3 | 4 | 5 |
| lean techniques increases management commitment | 7.6 | 14.0 | 21.9 | 31.7 | 24.8 |
| lean techniques creates good working environment | 3.5 | 8.6 | 24.4 | 33.7 | 29.8 |
| lean techniques improves customers' focus and integration | 4.8 | 7.3 | 20.3 | 31.1 | 36.5 |
| lean techniques creates systems and change management | 4.1 | 11.1 | 54.0 | 20.6 | 10.2 |
| lean techniques enables regular training | 32.4 | 34.3 | 17.5 | 10.8 | 5.0 |

$R^1$: 1 = Very successful; 2 = Successful; 3 = Not sure; 4 = Not successful; 5 = Fail

The information presented in Table 4.13 indicates success of lean techniques at the management of the project. The management has been successful in commitment towards managing the lean techniques projects with 14.0% of the participants and 7.6% responding with successful and very successful to the statement. It is the duty of the management to create a good working environment for the rest of the workers. Under the lean techniques implementation, the managers have been successful as evidenced by 8.6% and 3.5% with very successful. The management within the companies have improved customers' focus and integration with success by 7.3% and very successfully by 4.8%. Change management is one of the common practices that has been supported by literature and managers whose companies have been implementing lean techniques have been successful as indicated by 11.1% and 4.1% with very successful. It was on regular training that this study found a greater percentage (34.3% with success and 32.4% with very successful) that management have been involved in such. This was highly supported by the key informants who asserted that;

> *"Most of the companies with better performance in Kampala District have engaged employees in training. This form of training starts from the workshops where employees are updated on their ability to serve and work during the project. Some companies have also selected their employees and financed them for further studies in order to be knowledgeable with the lean techniques. In doing so, companies add value to employees with the expectation they would train the rest of the employees".*

Despite such success in management, the findings in Table 4.13 indicate a large percentage of participants are not sure, not successful and failed. In some companies therefore, there has never been successful management regarding lean techniques, or companies that are still applying traditional approaches. While conducting interviews with the key informants, it has been due to poor and weak management that has been the source of collapsing buildings. This according to the key informants starts with procurement of essential materials in construction that cannot support strong constructions. The fast results have been developing cracks that make the construction unable to stand overtime.

**Analysis of lean techniques project success to stakeholder**

Analysis was done by running one –way ANOVA and the findings indicate that managers have been significant in certain variables as opposed to others. This is presented in Table 4.14

**Table 4.14: One-way ANOVA analysis for the success of lean techniques to stakeholders**

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| lean techniques increase management commitment | Between Groups | 3.881 | 3 | 1.294 | .870 | .457 |
| | Within Groups | 462.735 | 311 | 1.488 | | |
| | Total | 466.616 | 314 | | | |
| lean techniques create good working environment | Between Groups | 12.938 | 3 | 4.313 | 3.837 | .010 |
| | Within Groups | 349.507 | 311 | 1.124 | | |
| | Total | 362.444 | 314 | | | |
| lean techniques improve customer focus and integration | Between Groups | 8.614 | 3 | 2.871 | 2.276 | .080 |
| | Within Groups | 392.307 | 311 | 1.261 | | |
| | Total | 400.921 | 314 | | | |
| lean techniques create system and change management | Between Groups | 3.745 | 3 | 1.248 | 1.484 | .219 |
| | Within Groups | 261.575 | 311 | .841 | | |
| | Total | 265.321 | 314 | | | |
| lean techniques enable regular training of workforce | Between Groups | 24.392 | 3 | 8.131 | 6.362 | .000 |
| | Within Groups | 397.493 | 311 | 1.278 | | |
| | Total | 421.886 | 314 | | | |

Information presented in Table 4.14 shows that managers have been successful in creating a good environment at the significant level where p-value = 0.010 and enabling regular training of the workforce with p-value 0.000. In such circumstances, the $H_0$ which states that: there is no significant environment created by management under lean techniques; and there is no significant regular training of the workforce by management under lean techniques are rejected in favour of the alternatives. These alternatives are called $H_1$; there is a significant environment created by the management under the lean techniques; and there is significant regular training of the workforce by management under lean techniques.

**Testing hypothesis of success of lean techniques by stakeholders**

Two hypotheses that this section tested were $H_0$: there is no significant success by stakeholders / management under lean techniques; and $H_1$: there is significant success by stakeholders / management under lean techniques. Testing the hypothesis was done by running data from variables that led to results in Table 4.13. The hypothesis test was done using Cochran's Test and results have been presented in Table Table 4.15.

**Table 4.15: Hypothesis testing of success of lean techniques project by stakeholders**

| | | Sum of Squares | df | Mean Square | Cochran's Q | Sig |
|---|---|---|---|---|---|---|
| Between People | | 457.437 | 314 | 1.457 | | |
| Within People | Between Items | 560.250 | 4 | 140.063 | 349.463 | .000 |
| | Residual | 1459.750 | 1256 | 1.162 | | |
| | Total | 2020.000 | 1260 | 1.603 | | |
| Total | | 2477.437 | 1574 | 1.574 | | |
| Grand Mean = 3.32 | | | | | | |

Table 4.15 shows the significant result using Cochran's Q was 0.000< 0.05. Therefore, the null hypothesis is rejected in favour of the alternative.

### 4.3.4 Success of lean techniques project by organisation commitment

This section presents results within the commitment to the organisation or the companies by the stakeholders, especially the managers. The organisation ability by the managers during the lean techniques implementation has been presented as effective planning under which managers would be expected to involve other stakeholders in planning. It also focused on teamwork which this study perceived as the basis

of project success by company. The other variables have been presented in Table 4.16 with corresponding percentages. The success of lean techniques projects by organisation commitment was also found among participants to this study. The success was 14.9% and very successful with 12.7% on effective planning by managers or stakeholders under lean techniques. On integration of teams and end to end supply chain which was mainly in line with procurement procedures, the success was 9.5% and very successful was 6.1%. The success in benchmarking against each other was 9.3% and very successful being 6.0%. Managers also engage in communication and coordination as they embrace lean techniques with acknowledged success 9.5% and very successful of 3.5%.

**Table 4.16: Illustration of success of lean techniques project at organisation commitment**

| | Fr = 315 | | | | |
|---|---|---|---|---|---|
| | Responses (%ag) = R[1] | | | | |
| Statement | 1 | 2 | 3 | 4 | 5 |
| lean techniques enables successful and effective planning | 12.7 | 14.9 | 34.0 | 21.6 | 16.8 |
| lean techniques integrates teams and end – end supply chain | 5.1 | 9.5 | 21.0 | 34.6 | 29.8 |
| lean techniques benchmarks supply against each other | 6.0 | 9.3 | 10.8 | 35.2 | 38.7 |
| lean techniques enables communication and coordination | 3.5 | 9.5 | 17.1 | 34.3 | 35.6 |
| lean techniques improves reviews towards targets | 9.8 | 3.9 | 14.9 | 34.3 | 37.1 |
| lean techniques increase sustainable concepts | 4.8 | 12.7 | 20.0 | 30.5 | 32.0 |
| lean techniques increase its understanding of benefits | 5.4 | 9.5 | 22.2 | 30.8 | 32.1 |

R[1]: 1 = Very successful; 2 = Successful; 3 = Not sure; 4 = Not successful; 5 = Fail

The respective communication and coordination starts at initial planning for lean project construction, in case it has been embraced. During the process, reviews were acknowledged with a very successful percentage of 9.8% and 3.9% success.

The findings presented reveal that there is a high level attempt in the management to engage other stakeholders in the organisation commitment so as companies would be successful. However, the key informants noted that there is still a challenge with workers of the company with respect to turnover. Employees still seek for various opportunities where they could earn more money which makes them not to embrace the components of lean techniques. The incoming employees have similar and related challenges! Some have limited knowledge while others are ignorant about the information. Although it was

mentioned in the preceding paragraphs that company managers are involved in regular training during operations of companies, such training has been expensive as they take funds. These challenges have made some construction companies to include parts of components in management and leave others. The key informants noted that there are companies which have attempted to reduce wastes but this failed since little has been turned into lean perspective. Moreover, some onsite employees are less or not knowledgeable about lean techniques.

While the challenges have affected the companies' employees to believe that management do not engage other stakeholders in planning as acknowledged by 21.6% with never successful and 16.8% with failed; the image was also mentioned to have affected the general public or clients. Aware that some companies have got shortfalls, there has been a tendency by the government to award contracts to foreign contractors and its agencies like Uganda National Road Authority (UNRA). Yet, it has a number of construction jobs pending known efficient contractors. The key informants cited the Karuma Dam project as one of the projects where the government trusted foreign contractors but due to dependence on the domestic workers, the project had tremendous critics since it could not meet expectations. Participants also noted that the increased collapse of buildings in Kampala District, has been due to the failure to embrace lean techniques by companies' management.

**Analysis for success of lean techniques project at organisation level**

Analysis of the results under this section was done using one way - ANOVA and the findings have been presented in Table 4.17.

**Table 4.17: ANOVA analysis for success of lean techniques project at organisation commitment**

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| lean techniques creates effective planning | Between Groups | 5.171 | 3 | 1.724 | 1.129 | .337 |
| | Within Groups | 474.816 | 311 | 1.527 | | |
| | Total | 479.987 | 314 | | | |
| lean techniques integrates team and end to end supply chain | Between Groups | 2.951 | 3 | .984 | .763 | .515 |
| | Within Groups | 400.731 | 311 | 1.289 | | |
| | Total | 403.683 | 314 | | | |
| lean techniques benchmarks suppliers against each other | Between Groups | 8.432 | 3 | 2.811 | 2.022 | .111 |
| | Within Groups | 432.254 | 311 | 1.390 | | |
| | Total | 440.686 | 314 | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| lean techniques enables communication and coordination | Between Groups | 4.117 | 3 | 1.372 | 1.132 | .336 |
| | Within Groups | 376.994 | 311 | 1.212 | | |
| | Total | 381.111 | 314 | | | |
| lean techniques improves reviews towards targets | Between Groups | 5.932 | 3 | 1.977 | 1.286 | .279 |
| | Within Groups | 478.055 | 311 | 1.537 | | |
| | Total | 483.987 | 314 | | | |
| lean techniques increases adoption of sustainable concepts | Between Groups | 20.352 | 3 | 6.784 | 5.088 | .002 |
| | Within Groups | 414.620 | 311 | 1.333 | | |
| | Total | 434.971 | 314 | | | |
| lean techniques increases understanding of its benefits | Between Groups | 24.335 | 3 | 8.112 | 6.317 | .000 |
| | Within Groups | 399.347 | 311 | 1.284 | | |
| | Total | 423.683 | 314 | | | |

Only increasing the adoption of lean sustainable concepts (p-value= 0.002) and increasing understanding of the benefits (p-value = 0.000) of lean techniques were presented significantly. In such circumstances, the null hypothesis $H_0$ is rejected for the case of alternative $H_1$. The rejected hypothesis included: the extent to which lean techniques increase adoption of sustainable projects is not significant; and lean techniques do not significantly increase understanding of its benefits.

**Testing the general hypothesis**

The general hypothesis to this section tested was $H_0$; there is no significant success of lean techniques project by organisation commitment. This was tested using Cochran's Q and results are presented in Table 4.18.

**Table 4.18: ANOVA with Cochran's Q Test of success for lean techniques project by organisational commitment**

| | | Sum of Squares | df | Mean Square | Cochran's Q | Sig |
|---|---|---|---|---|---|---|
| Between People | | 398.841 | 314 | 1.270 | | |
| Within People | Between Items | 129.304 | 6 | 21.551 | 87.954 | .000 |
| | Residual | 2649.267 | 1884 | 1.406 | | |
| | Total | 2778.571 | 1890 | 1.470 | | |
| Total | | 3177.412 | 2204 | 1.442 | | |
| Grand Mean = 3.72 | | | | | | |

The p-value = 0.000 < 0.05, and therefore the null hypothesis was rejected for the alternative $H_1$ which states that there is a significant success of lean techniques project by organisation commitment.

### 4.3.5 Success in lean techniques project

This section presents the success that would be attained while constructing projects under lean techniques. The main concern is reduction of wastes, time of delivery to the project, reduction in costs, quality improvements and manageable environment. The success responses from respondents is presented in Table 4.19.

**Table 4.19: Success of lean techniques project**

| | Fr = 315 | | | | |
|---|---|---|---|---|---|
| | Responses (%ag) = $R^1$ | | | | |
| Statement | 1 | 2 | 3 | 4 | 5 |
| lean techniques reduces wastes | 6.0 | 10.8 | 15.2 | 27.0 | 41.0 |
| lean techniques enables environmental management | 6.3 | 11.2 | 20.3 | 26.0 | 36.2 |
| lean techniques ever success on value maximisation | 6.7 | 10.8 | 28.3 | 23.8 | 30.4 |
| lean techniques reduces costs | 6.3 | 14.3 | 19.7 | 32.7 | 27.0 |
| lean techniques maximises energy | 6.3 | 7.6 | 15.9 | 29.2 | 41.0 |
| lean techniques improves quality | 8.3 | 7.3 | 20.6 | 34.9 | 28.9 |
| lean techniques calls for continuous evaluation of project | 6.0 | 6.7 | 23.5 | 34.3 | 29.5 |
| lean techniques leads to proper management of resources | 4.8 | 6.4 | 23.8 | 37.1 | 27.9 |
| lean techniques maximises performance of project | 4.4 | 8.9 | 17.5 | 30.8 | 38.4 |
| lean techniques eliminates unnecessary processes | 5.4 | 13.0 | 24.1 | 31.2 | 26.3 |

$R^1$: 1 = Very successful; 2 = Successful; 3 = Not sure; 4 = Not successful; 5 = Fail

The findings on success of lean projects indicated there was less success as compared to not successful, neutral and failure. The success in reduction of project waste shows that only 10.2% responded with successfully and 6.0% very successful. On the success of the environment management indicated 11.2% supported successful while 6.3% very successful. Less successful responses were also received in terms of reducing the costs during the lean techniques project as 14.3% responded with successful whilst 6.3% with very successful. These findings indicated that although lean techniques have not been fully embraced by all companies in Uganda, there has been some form of success with a few that have adopted the technology. While there could be some of the factors for the limited success, this study did not go extra-mile to capture

such factors due to scope. This therefore calls for further studies on limited success of lean techniques in Uganda despite its benefits.

The study established that less success of lean techniques projects among companies can be traced from strategic planning and culture organisations which is a base for activities. As indicated in the preceding sections, the key informants emphasised that;

> *"Companies do not engage all stakeholders in strategic planning. Even some companies that claim to have partly or wholly embraced lean techniques do not involve all stakeholders into strategic planning. In one instance stakeholders are not informed, while some stakeholders do not have time due to logistic and personal reasons. Secondly, some stakeholders have limited knowledge to contribute to strategic planning in the due course. Therefore, there is a gap created within the cultural organisation starting with planning up to completion of the project."*

This study established that participants who remained neutral were taken by the claim that they did not have or have never received evaluation reports about the success of the lean techniques projects or any other project evaluation outside the lean techniques. Companies carry out various projects that become successful at the end, but the results of success could not be shared to employees since most of them have less interest in such rather than protecting their employment opportunities. *Some employees are technical who are more interested in practical work than reading such information*, while some do not mind which level of success as long as a project has been completed.

The study also indicated many responses for not successful and failed. This did not infer that projects were not successful or failed. The findings isolate one variable as interrogated despite the successfulness of the project. The study established that lean techniques projects or any other project can be successful with a lot of wastes. Or, a project could be completed beyond scheduled time or with heavy costs. The heavy costs, accumulated wastes and beyond time schedule do not affect the success of the project, rather the company managers failed to control such variables to the expected level. In fact, this study established that whether lean techniques projects or projects under any other approach, it is imperative to reduce wastes, to enable a good environment for the project planning and implementation, minimising non-value activities, reduce costs, improve quality and many other positive variables in construction. However, the failure or weak adoption of lean techniques was mentioned as the main reasons for the failure.

**Variable analysis for the success of lean techniques project**

Analysis of each variable was done using ANOVA in order to establish the level of successful significance. Table 4.20 shows sum of squares, degree of freedom (df), mean square, factor (F) analysis and significance (sig).

**Table 4.20: ANOVA analysis for the success of lean techniques project**

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| lean techniques reduces wastes | Between Groups | 20.487 | 3 | 6.829 | 4.644 | .003 |
| | Within Groups | 457.367 | 311 | 1.471 | | |
| | Total | 477.854 | 314 | | | |
| lean techniques manages environmental | Between Groups | 2.557 | 3 | .852 | .558 | .643 |
| | Within Groups | 475.126 | 311 | 1.528 | | |
| | Total | 477.683 | 314 | | | |
| lean techniques maximises value | Between Groups | 4.292 | 3 | 1.431 | .974 | .405 |
| | Within Groups | 456.895 | 311 | 1.469 | | |
| | Total | 461.187 | 314 | | | |
| lean techniques reduces costs | Between Groups | 12.488 | 3 | 4.163 | 2.920 | .034 |
| | Within Groups | 443.309 | 311 | 1.425 | | |
| | Total | 455.797 | 314 | | | |
| lean techniques maximises energy | Between Groups | 1.928 | 3 | .643 | .444 | .722 |
| | Within Groups | 450.402 | 311 | 1.448 | | |
| | Total | 452.330 | 314 | | | |
| lean techniques improves quality | Between Groups | 3.719 | 3 | 1.240 | .861 | .462 |
| | Within Groups | 447.792 | 311 | 1.440 | | |
| | Total | 451.511 | 314 | | | |
| lean techniques calls for continuous evaluation | Between Groups | 3.392 | 3 | 1.131 | .883 | .450 |
| | Within Groups | 398.290 | 311 | 1.281 | | |
| | Total | 401.683 | 314 | | | |
| | Between Groups | 8.545 | 3 | 2.848 | 2.509 | .059 |

| | | | | | | |
|---|---|---|---|---|---|---|
| lean techniques manages resources | Within Groups | 352.998 | 311 | 1.135 | | |
| | Total | 361.543 | 314 | | | |
| lean techniques maximises performance | Between Groups | 8.795 | 3 | 2.932 | 2.268 | .081 |
| | Within Groups | 401.954 | 311 | 1.292 | | |
| | Total | 410.749 | 314 | | | |
| lean techniques eliminates unnecessary process | Between Groups | 1.356 | 3 | .452 | .331 | .803 |
| | Within Groups | 424.244 | 311 | 1.364 | | |
| | Total | 425.600 | 314 | | | |

As indicated in Table 4.20, only two individual variables were found significant in the one-way ANOVA run. These were lean techniques reducing wastes with the p-value = 0.003; and lean techniques reducing costs, with p-value = 0.034.

**Testing hypothesis on success of lean techniques project**

Under this section, two hypotheses for the general section were tested. $H_0$ stated that there is no significant success of lean techniques projects in Uganda. $H_1$ stated that there is a significant success of lean techniques project in Uganda. Results from the run variables are presented in Table 4.21.

**Table 4.21: Cochran's Test for hypothesis about the success of lean techniques project**

| | | Sum of Squares | df | Mean Square | Cochran's Q | Sig |
|---|---|---|---|---|---|---|
| Between People | | 483.484 | 314 | 1.540 | | |
| Within People | Between Items | 40.748 | 9 | 4.528 | 29.371 | .001 |
| | Residual | 3892.452 | 2826 | 1.377 | | |
| | Total | 3933.200 | 2835 | 1.387 | | |
| Total | | 4416.684 | 3149 | 1.403 | | |
| Grand Mean = 3.74 | | | | | | |

Results presented in Table 4.21 indicate the significant p-value = 0.001 < 0.05. Therefore, the null hypothesis is rejected in favour of the alternative.

### 4.3.5 Realising general success in Uganda

This was examined under two sub-sections: realising the success of lean projects in Uganda and realising the success at the project level. This was intended to establish where participants find the success of lean techniques, whether national or project success. The findings from the study have been presented in Table 4.22 of this section. Variables which this study assessed at national success include creation of sustainable innovation, increased competitive advantage, reduction in cost of the project, saving time, improvement of the process flow among workers, compliance and environmental quality.

**Table 4.22: Realising general success in Uganda**

| | Fr = 315 | | | | |
|---|---|---|---|---|---|
| | Responses (%ag) = $R^1$ | | | | |
| Statement | 1 | 2 | 3 | 4 | 5 |
| Creation of sustainable innovation | 7.6 | 6.4 | 19.0 | 36.5 | 30.5 |
| Increases sustainable competitive advantage | 1.9 | 7.6 | 21.9 | 36.8 | 31.8 |
| Reduction in cost of project | 4.8 | 10.2 | 19.7 | 36.2 | 29.1 |
| Saves time | 5.1 | 7.6 | 17.1 | 32.7 | 37.5 |
| Improvement in process flow among workers | 7.9 | 12.7 | 18.1 | 32.4 | 28.9 |
| Increase compliance to customers‘ expectations | 2.2 | 5.7 | 17.1 | 39.4 | 35.6 |
| Improves environmental quality | 4.4 | 10.8 | 21.9 | 35.6 | 27.3 |

$R^1$: 1 = Very successful; 2 = Successful; 3 = Not sure; 4 = Not successful; 5 = Fail

Results from Table 4.22 indicate that at national level, there was realisation of success at national level despite less rating in percentages. None of the percentages per variable under very successful that is above 10% and under successful, all were below 15%. The interpretation to such findings is less realisation of successful lean techniques projects in Uganda at a national level. It is also an indication of low adoption of lean techniques despite its essential benefits to conditions in Uganda.

The study shows that most participants indicated not being successful in accordance with Table 4.22. This was attributed to the fact that lean techniques have not yet been embraced by most construction companies in Uganda. It has not even been embraced by other SMEs in business and management sectors. The key informants were of the view that there is a need for a critical policy that would compel companies to fulfil certain levels of standards that would embrace certain technology. The yearly increase of engineers and registration of construction companies need to be revised if such industries are to reach a certain standard.

At an individual variable which has been interrogated in this research, high responses in percentage were neutral, not successful and failed. This indicates that there are still weak responses towards implementing lean techniques.

**Analysis of general success realised in Uganda**

Analysis of the findings was done using one-way ANOVA in order to establish the significance of individual variables that this study interrogated during the field study. The analytical results presented in Table 4.23 indicate no significant successful variable that has been realised in general by Ugandans.

**Table 4.23: Analysis of realised general success realised in lean techniques in Uganda**

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Creation of sustainable innovation | Between Groups | 9.746 | 3 | 3.249 | 2.383 | .069 |
| | Within Groups | 423.917 | 311 | 1.363 | | |
| | Total | 433.663 | 314 | | | |
| Increases sustainable competitive advantage | Between Groups | 1.496 | 3 | .499 | .495 | .686 |
| | Within Groups | 313.615 | 311 | 1.008 | | |
| | Total | 315.111 | 314 | | | |
| Reduces costs | Between Groups | 2.105 | 3 | .702 | .552 | .647 |
| | Within Groups | 395.082 | 311 | 1.270 | | |
| | Total | 397.187 | 314 | | | |
| Saves time | Between Groups | 3.695 | 3 | 1.232 | .946 | .419 |
| | Within Groups | 405.054 | 311 | 1.302 | | |
| | Total | 408.749 | 314 | | | |
| Improvement in process flow among workers | Between Groups | 16.885 | 3 | 5.628 | 3.727 | .012 |
| | Within Groups | 469.636 | 311 | 1.510 | | |
| | Total | 486.521 | 314 | | | |
| Increase compliance to customers‘ expectations | Between Groups | 3.404 | 3 | 1.135 | 1.186 | .315 |
| | Within Groups | 297.593 | 311 | .957 | | |
| | Total | 300.997 | 314 | | | |
| Improves environmental quality | Between Groups | 7.493 | 3 | 2.498 | 2.033 | .109 |
| | Within Groups | 382.050 | 311 | 1.228 | | |
| | Total | 389.543 | 314 | | | |

### 4.3.5 Realised success at project level

Under this section, the main variables which were assessed included realising the success with employee morale and increased commitment to their jobs; reduction in materials used at work; reduction in energy consumption at or during onsite work (ref. appendix III and IV), reduced wastage, increased productivity, health and safety lives. Responses have been presented in percentage in Table 4.24

**Table 4.24: Realised success at project level**

| | Fr = 315 | | | | |
|---|---|---|---|---|---|
| | Responses (%ag) = $R^1$ | | | | |
| Statement | 1 | 2 | 3 | 4 | 5 |
| Increase employee morale, and commitment | 7.6 | 11.7 | 18.2 | 29.8 | 32.7 |
| Reduced material usage | 9.2 | 7.3 | 12.7 | 35.2 | 35.6 |
| Reduced energy consumption | 3.8 | 6.7 | 16.5 | 31.4 | 41.6 |
| Reduced waste | 6.7 | 11.4 | 22.2 | 34.0 | 25.7 |
| Reduced water usage | 5.4 | 9.1 | 17.5 | 33.7 | 34.3 |
| Increased productivity | 5.4 | 13.3 | 14.9 | 32.1 | 34.3 |
| Improved Health and Safety | 11.1 | 10.5 | 22.2 | 33.3 | 22.9 |

$R^1$: 1 = Very successful; 2 = Successful; 3 = Not sure; 4 = Not successful; 5 = Fail

Realising success at project level would take place at the company in which participants workers have been participating in the project implementation. It shows that responses for successful and very successful per variable interrogated never exceed 15%. The highest response was from increased productivity with 13.3%, where respondents asserted that this variable was successful. According to the key informants;

> *"...the success of such variables at the project level rotates from the management of the companies. Once the managers involve all the stakeholders into the project, there is a high chance of realising the success. Indicated in appendix III – V, wastes cannot increase to that level if the management and employees work together in coordination, plan together and employees satisfied with both intrinsic and extrinsic motivators. Uganda has many companies that aim at maximising profits against productivity. This has rendered the human resource to be marginalised by the managers and company or institution workers. Such an attitude has led to weak or poor realisation of successes in various institutions or companies."*

Based on Table 4.24, shows that the highest responses were not successful and failed. This means that their companies witness less morale and commitment from employees and wastes as indicated in appendix III – V have been at an increasing rate. Secondly, neutral responses were also high which has been interpreted that participants had limited knowledge about the success of the company's success.

**Analysis of realised success at project level**

Analysis was done using a one – way ANOVA which presents results in terms of sum of squares, degree of freedom (df), mean square, factor analysis (F) and significance (sig) as presented in Table 4.25.

**Table 4.25: Analysis of realised success at project level**

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Increase employee morale and commitment | Between Groups | 27.210 | 3 | 9.070 | 6.066 | .001 |
| | Within Groups | 465.044 | 311 | 1.495 | | |
| | Total | 492.254 | 314 | | | |
| Reduced material usage | Between Groups | 3.908 | 3 | 1.303 | .828 | .479 |
| | Within Groups | 489.279 | 311 | 1.573 | | |
| | Total | 493.187 | 314 | | | |
| Reduced energy consumption | Between Groups | 7.726 | 3 | 2.575 | 2.181 | .090 |
| | Within Groups | 367.271 | 311 | 1.181 | | |
| | Total | 374.997 | 314 | | | |
| Reduced waste | Between Groups | 2.725 | 3 | .908 | .653 | .582 |
| | Within Groups | 432.463 | 311 | 1.391 | | |
| | Total | 435.187 | 314 | | | |
| Reduced water usage | Between Groups | 4.257 | 3 | 1.419 | 1.056 | .368 |
| | Within Groups | 417.788 | 311 | 1.343 | | |
| | Total | 422.044 | 314 | | | |
| Increased productivity | Between Groups | 3.271 | 3 | 1.090 | .745 | .526 |
| | Within Groups | 455.345 | 311 | 1.464 | | |
| | Total | 458.616 | 314 | | | |
| Improved Health and Safety | Between Groups | 2.554 | 3 | .851 | .534 | .659 |
| | Within Groups | 495.776 | 311 | 1.594 | | |
| | Total | 498.330 | 314 | | | |

Results of individual variable analysis in Table 4.25 shows that only increasing employee morale and commitment was significant with p-value = 0.001 < 0.05.

**Testing hypothesis on realised success at project level using Cochran's Q**

The hypothesis tested was inclusive for all results under realised success at project level. $H_0$ stated; there is no significant realised success at the project level. $H_1$ states that; there is significant realised success at the project level. Results of ANOVA and Cochran's Test were presented in Table 4.26

**Table 4.26: ANOVA with Cochran's Test of realised success at project level**

| | | Sum of Squares | df | Mean Square | Cochran's Q | Sig |
|---|---|---|---|---|---|---|
| Between People | | 584.855 | 314 | 1.863 | | |
| Within People | Between Items | 56.239 | 6 | 9.373 | 40.171 | .000 |
| | Residual | 2589.761 | 1884 | 1.375 | | |
| | Total | 2646.000 | 1890 | 1.400 | | |
| Total | | 3230.855 | 2204 | 1.466 | | |
| Grand Mean = 3.74 | | | | | | |

Results presented in Table 4.26 shows the significance of p-value = 0.000 < 0.05. This makes it easier to reject the null hypothesis in favour of the alternative.

### 4.3.6 Discussion of findings

The findings under this section embrace the theoretical perspective as discussed in section two. In the first instance, it re-echoes the need for a system as emphasised by Mele *et al*. (2010:2), where different departments and individuals work together for efficient work of the system. In fact, the management as emphasised in realising the success of the project cannot be efficient in isolation starting with planning, implementation and evaluation. This calls for various departments and individuals if wastes are to be eliminated, projects delivered in time and reduction of costs in the company. For effectiveness of systemic organisation, literature has indicated that the managers of the system must plan, organise, lead, coordinate, control and exhibit staffing qualities (Mcnamara, 2009: 63). These parameters are associated with what this study has examined in this section. Table 4.26 emphasises effective planning, teamwork, communication and coordination which are the main parameters underpinned by the administrative theory by Fayal. In reducing wastes and costs, controls must be put in place in a specialised manner by the management that has adopted lean techniques. Fayol wants managers of such companies to use their authority and exercise

it in accordance with organisation principles (Poperwi, 2018: 809). In fact, it is due to the failure to abide by the theoretical underpinning that companies have not been successful and realised the success in lean projects. Therefore, the need to implement the lean techniques as guided systems and administrative theories are the core emphasis of this study.

The study findings indicate that lean techniques increase management commitment, create a good environment, improves customers' focus and integration; creates systems and change management that are all important to stakeholders or managers of companies. In fact, the findings show that lean techniques enable regular training of the workforce with the p-value = 0.00, while the hypothesised statement $H_0$, which states that there is no significant success by stakeholders / management under lean techniques is dismissed in favour of the alternative since p-value = 0.000. These are among other CSFs which Perumal (2020:1) emphasises in his study from Malaysia, which was conducted from SMEs in the manufacturing sector. However, this section indicates that despite the importance of such variables, there is still a big gap in implementing critical factors which are essential for the success of lean techniques in Uganda. The findings in this section are therefore similar to what literature presents: that for a project to be considered as successful, it must be completed in time, within budget and with quality output that satisfies clients (Ramlee *et al*. 2016:13). The failures and no success that this study presents are similar to what has been discussed in literature. To Alsahrani and Emsley (2013:1), project success is attained when results are much better with what has been planned or expected in terms of cost, schedule, quality, safety and participant satisfaction. The non – successful and failures in certain project success as indicated in this section calls for revision of lean techniques project revision in Uganda.

Losonci *et al*. (2011:78) present the degree, and realisation that success under lean has four main factors during the implementation programme. These include commitment, belief, work method and communication. Radnor and Boaden (2008:1) go one to state factors responsible for the success of lean projects like organisational readiness, a culture of continuous improvement, effective leadership, the availability of resources and communication strategy. These are among other factors this study interrogated, yet the application to companies is still low. In fact, it is from the low level of application that this study shows less success of lean techniques. The findings of this study are similar to various literature which this study has reviewed. Kollberg *et al*. (2006:19) are of the view that there is a need for clear communication between stakeholders of the organisation if the organisation project is to be successful. Such communication and coordination of stakeholders is presented as a major component for the success of lean techniques in Uganda. Kollberg *et al*. (2006:67) suggests four critical factors that need to be considered in executing lean techniques and such factors are cardinal to project success. Critical factors are careful planning to keep

competition among members of the implementation team; reviewing and analyse dimensions of lean techniques carefully; and acceptance of the managers to encourage cooperation within lean projects. Nonetheless, there is limited information from the findings that such factors have been successful where they have been implemented. The lean techniques are therefore a need concern in Uganda in case visible and tangible success are to be achieved.

### 4.4 Lean techniques and project success by testing null hypothesis

The main emphasis is to test the hypothesis between lean techniques and project success with the main bias to the null hypothesis. AMOS was used for the regression correlation, ANOVA analysis and Cochran's Test for the general hypothesis.

#### 4.4.1 Overview to null hypothesis testing

This study established that testing hypotheses is an important activity that is supported by theoretical underpinning in relation to evidence-based research. In analysis by Mourougan and Sethuraman (2017:34), it is presented that a well set hypothesis is an approach to answer research questions which would not have been answered if not using and testing it. In their paper presented after a critical review of documents and using statistical concepts, Mourougan and Sethuraman (2017:34) presents a working method that would make a good hypothesis and statistical approach to testing. The scholars first defined a research hypothesis as a statement that is created by researchers while speculating the outcome of a research experiment or study. They recognised that each study or experiment has got a design and core statement that underpins its ultimate discussion. Upon this statement, a gist narrative of write-up is formed. In this context, Mourougan and Sethuraman found that a hypothesis is generated through inductive reasoning where observations can be used to build a theory. They stated that all scientific research must have testable hypotheses, as well as deductive methods to arrive at falsifiability and reality. The two concepts – falsifiable and realistic are most two concepts that shape a hypothesis (Genin, 2022:1).

Persson (2016:462) is of the view that scientists use a variety of deductive approaches in order to test, falsify and prove realistic hypotheses. In the due course, the first action is to state a hypothesis to be tested through observation and experiment or survey studies. Under this narrative of arriving at a hypothesis, the main goal is not to verify stated hypotheses, rather to falsify initial hypotheses. The two actions were mainly applied in this study wherein, the first hypothesis remained null hypothesis ($H_0$) and alternative ($H_1$). The analysis based on hypotheses were important as presented in this and proceeding chapters.

Tofighi and Kelley (2020: 189) had noted that hypotheses can be reached with data collection from the survey research. This therefore calls for determining the sample under which tools could be administered and responses collected for testing what relates to hypothesis and research questions. The scholars recognised there are different sampling procedures that differ from one another as applied to different researches. Whereas there are different methods of research and need to select proper samples and use sampling methods, testing hypotheses is an integral part of research, intended to inform readers. In order to reach hypothesis testing, research methods must be followed right from introduction to specific parts of the study for hypotheses. In hypothesis testing, falsification comes before verification. A verified statement or hypothesis is testable and has truth from what has been taking place on the ground in relation to the answered question. The main emphasis has been presented on rejecting the null and accepting alternative. These are two opposing probabilities that do not meet since one must be accepted or jested.

Early, Hartwick and Barki (1994: 447) have statistically stated that in hypothesis testing, the null hypothesis and alternative hypothesis are good for probability distribution of data rather than any other purpose. In circumstances where the sample obtained has a probability for the occurrence that is less as compared to what has been pre-specified for the threshold probability, the significance level, a given null hypothesis becomes true. In fact, the difference that researchers find is only the statistical significance. In such practices, testing hypotheses leads to rejection of null hypothesis or accepting the alternative. Or, confirming the primacy of null hypothesis altogether (Yergens et al. 2014: 3). Im and Yin (2020:164) indicated that statistical hypothesis test is a method of statistical inference to determine possible inclusion of two and likely conflicting hypotheses. The null and alternative hypothesis are used statistically to determine the probability distribution of data that has been collected and entered into a chosen software for analysis. In order to differentiate between null hypothesis and alternative hypothesis, it is important to consider type I and type II errors which are controlled by the pre-specified significance.

Imai and Tingley (2012: 218) testified by giving the significance of null hypothesis testing as a basis towards formulation of theories and models in social science studies. Through statistical models called finite mixture models, effective testing was run in the assumed framework through which observations were used. It was found that probability forms a foundation to any form of modelling and theories relating to particular events. By modelling probability with a covariate, researchers can determine the extent to which particular theories or models would be used differently. Dongen and Van (2019:2) presents an ongoing debate over values and problems of the universally used null hypothesis significance test (NHST). This was done after a crisis in knowledge about its primacy over the world researchers. From various studies and literature, the scholar showed that NHST takes place in essays and opinions of researchers that cover some,

but not qualities and problems of the methods. It also stated that the landscape of NHST is vast but it lacks an overview through which an individual person could talk to another or illustrate the past in present. The use of a five questionnaire scale was used which provided limited solutions that hardly captured and analysed qualitative information. Despite this, there was a contribution of knowledge about NHST which needs another approach for apprehension. It was also noted that the Null Hypothesis Significance Test has become one of the universally accepted procedures that are used in many forms of social sciences for analysis of quantitative data. The summarised NHST produced by a study are compared to a null hypothesis of no-effect (e.g., no difference between two groups on the investigated measure). The null hypothesis is rejected if the observed data are sufficiently improbable according to this null hypothesis. Specifically, the null hypothesis is rejected if, under the assumption that the null hypothesis is true, the probability of observing the obtained data or data more extremely deviating from the null hypothesis is below a certain threshold of either 5% probability; or p-value < 0.05. In such a case, the null hypothesis is generally rejected in favour of an unspecified alternative hypothesis (there is a difference between the two groups). Otherwise, the null hypothesis is retained, though one is not supposed to consider this as evidence in its favour.

### 4.4.2 Lean techniques and project success

Under this section, the main lean techniques components used for the null hypothesis were time, waste elimination, sustainability, streamlining the construction process, cost and project improvement. The computed variables were correlated regressively and results presented in Table 4.27.

**Table 4.27: Regression analysis for variables under lean techniques and project success**

| | | | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| Project success | <--- | Timely completion | .005 | .018 | .262 | .793 |
| Project success | <--- | Eliminate of waste | .022 | .019 | 1.117 | .264 |
| Project success | <--- | Sustainability | .053 | .022 | 2.393 | .017 |
| Project success | <--- | Streamlined plans | .018 | .020 | .894 | .371 |
| Project success | <--- | Reduce costs | .033 | .024 | 1.388 | .165 |
| Project success | <--- | Project improvement | .012 | .023 | .523 | .601 |

Regression estimates per AMOS indicated that project success was significantly positively related to enhanced sustainability in construction as evidenced by p-value = 0.017 < 0.05. The null hypothesis against the would be relation was therefore rejected in favour of the alternative. The rest of the variables as per Table 4.27, were positively not significantly related.

**Test of Hypothesis of lean techniques and project success**

Based on the analytical process in Table 6.1, the main investigator was compelled to run all the six (6) variables to establish the hypothesis against and in favour of the relation between lean techniques and project success. The null hypothesis – $H_0$: There is no relationship between lean techniques variables and project success. Alternatively, $H_1$ stated that: there is a relationship between lean techniques variables and project success were tested and results have been presented in Table 4.28.

**Table 4.28: Kendall's Coefficient of Concordance Test Agreement for lean techniques and project success**

| N | W[a] | $X^2$ | df | Asymp. Sig | Monte Carlo. Sig | | |
|---|---|---|---|---|---|---|---|
| 315 | .048 | 74.952 | 5 | .000 | Sig. | 95% Confidence Interval | |
| | | | | | .000[b] | Lower Bound | Upper Bound |
| | | | | | | .000 | .393 |

a. Kendall's Coefficient of Concordance b. Based on 6 sampled tables

Results in Table 4.28 show a significant value of Kendall's coefficient of concordance at 0.000 < 0.05. This made it possible to reject the null hypothesis at 5% significance relationship level. Therefore, the alternative hypothesis - there is a relationship between lean techniques variables and project success was accepted.

### 4.4.3 Lean techniques and workers' related project success

The study also considered the success of any project to be related to workers or the employees. As presented in Table 4.29, variables that were regressively correlated were empowerment of workers, increasing ability of managers in projects, skilling of personnel, unity among workers, teamwork, discrimination and leadership skills.

**Table 4.29: Regression analysis for variables under lean techniques and workers' related project success**

| | | | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| Workers' success | <--- | It does not empower workers | .005 | .022 | .239 | .811 |
| Workers' success | <--- | It does not develop managers' abilities | .012 | .022 | .550 | .582 |
| Workers' success | <--- | It does not encourage on job skilling | .024 | .019 | 1.272 | .204 |
| Workers' success | <--- | It does not encourage team work | -.024 | .021 | -1.124 | .261 |
| Workers' success | <--- | It is discriminative in nature | -.023 | .023 | -.981 | .327 |
| Workers' success | <--- | It does not build leadership skills | .022 | .023 | .970 | .332 |

Results presented in Table 4.29 show two forms of results. In the first instance, there was no significant relationship between lean techniques and workers' related project success. Within the non-relationship, teamwork and being discriminative in nature were negative while others were positive.

**Test of hypothesis of lean techniques and workers' related success**

Based on the analytical process in Table 4.30, the main investigator was compelled to run the six (6) variables to establish the hypothesis against and in favour of the relation between lean techniques and workers related project success. The null hypothesis – $H_0$: There is no relationship between lean techniques variables and workers' related project success. Alternatively, $H_1$ states: there is a relationship between lean techniques variables and workers' related project success were tested and results have been presented in Table 4.30.

**Table 4.30: Kendall's Coefficient of Concordance Test Agreement for lean techniques and workers' related project success**

| N | W[a] | $X^2$ | df | Asymp. Sig | Monte Carlo. Sig | | |
|---|---|---|---|---|---|---|---|
| 315 | .003 | 5.030 | 5 | .540 | Sig. | 95% Confidence Interval | |
| | | | | | .714[b] | Lower Bound | Upper Bound |
| | | | | | | .380 | 1.000 |

a. Kendall's Coefficient of Concordance

b. Based on 6 sampled tables

Results in Table 4.30 show a non-significant value of Kendall's coefficient of concordance at 0.540 > 0.05. This made it possible to accept the null hypothesis at 5% non significance level. Therefore, there was no relationship between lean techniques variables and workers' related project success.

### 4.4.4 Lean techniques and environmental success

The study also assessed the link between lean techniques and successes on the environment. The main issues assessed include its ability to save the environment, consideration of the surrounding persons, improvement in the general working environment, embracing the use of local materials and elimination of wastes to the general environment. Results from the run regression analysis by AMOS were presented in Table 4.31.

**Table 4.31: Regression analysis for lean techniques variables and environmental success**

| | | | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| Environmental success | <--- | It does not save environment | -.022 | .023 | -.979 | .328 |
| Environmental success | <--- | It does not consider nearby persons | -.006 | .023 | -.288 | .773 |
| Environmental success | <--- | It does not improve working place | .000 | .025 | -.020 | .984 |
| Environmental success | <--- | It does not use local materials | .047 | .021 | 2.208 | .027 |
| Environmental success | <--- | It does not remove waste from environment | .034 | .024 | 1.431 | .152 |

Results presented in Table 4.31 illustrate a significantly positive relationship between lean techniques and environmental success. In such circumstances, the null hypothesis – $H_0$ which states that: There is no significant relationship between environmental success under technology and use of local materials was rejected. For the other two first variables run, the relationship was negative while the rest of the variables had positive relationships.

**Test of hypothesis of lean techniques variables and environmental success**

Based on the analytical process in Table 4.32, six (6) variables were run together in order to establish the hypothesis against and in favour of the relation between lean techniques variables and environmental protection success. The null hypothesis – $H_0$ stated: There is no relationship between lean techniques variables and environmental protection success. $H_1$ states: there is a relationship between lean techniques variables and environmental protection success. Results run under Kendall's Coefficient of Concordance Test Agreement have been presented in Table 4.32.

**Table 4.32: Kendall's Coefficient of Concordance Test Agreement for lean techniques variables and environmental protection success**

| N | W[a] | $X^2$ | df | Asymp. Sig | Monte Carlo. Sig | | |
|---|---|---|---|---|---|---|---|
| 315 | .011 | 13.607 | 4 | .009 | Sig. | 95% Confidence Interval | |
| | | | | | .000[b] | Lower Bound | Upper Bound |
| | | | | | | .000 | .393 |

a. Kendall's Coefficient of Concordance

b. Based on 5 sampled tables

Results in Table 4.32 show a significant relations value of Kendall's coefficient of concordance at 0.009 < 0.05. This made it possible to reject the null hypothesis at 5% significance level. Therefore, there was a relationship between lean techniques variables and environmental success.

### 4.4.5 Discussion of findings

The findings to this study reveal a relationship or link between variables under lean techniques and project success. This success is captured with the sustainability (which was significant), west elimination, time delivery, cost reduction and project improvements. The findings to this nature relate to what Kundu and Manohar (2012: 302-305) find in their study where waste elimination and efficient improvements of the project are among other parameters to determine the application of lean technology. In accordance with Fernandes (2022:735), the lean technique is adopted as a means to improve the supply chain in order to achieve the end use projects. As the findings indicate, once the project is delivered in time with elimination of waste and waste control, it is important to assert that a project has been successful. Similarly, this study identifies various aspects which are also found in literature as presented by Pace (2019:56-57). Both literature and this study show that lean techniques make the project successful when adverse wastes are reduced or removed in the due course to construction within the supply chain. Pace (2010:56 - 57) identifies various stages of lean techniques with various success in projects. Elimination of wastes from technical and operational perspective is the first stage that essentially contributes to success. In accordance with this study and especially with the key informants, this starts with planning in which managers involve the rest of the stakeholders so that procurements and other lean activities are aligned to lean techniques. Pace (2010:56 - 57) also talks of eliminating the confrontational relationship and enhancing cooperative relationships and team work within the supply and operational chains. At this point, it is imperative to observe that this study puts an emphasis to managers in order to achieve these parameters. Therefore, the findings to this study are similar to what is in literature. However, the rate at which Ugandan companies are adopting lean techniques and applying its components is wanting. In relation to knowledge which is examined in chapter four, this study seeks possible approaches that would increase knowledge or awareness about benefits of lean techniques so that there is faster adoption and benefits throughout constructions.

One of the challenges facing the construction industry in Uganda is cost related to finance and project improvements so as to reduce the rate at which buildings collapse at any time of construction. Yet, the lean techniques according to this study are related to two parameters if success is achieved. In addition, Hughes *et al*. (2020: 38) is of the view that in addition, the success of lean techniques is related with JIT and continuous improvement which this study shows that some of the participants are aware too. This study

however did not go extra miles to assess difficulties faced by companies in Uganda towards the adoption of lean techniques, which seems to be a solution to their problem in construction. This remains the need for further study in effort to seek for a solution that would curb the challenge. Both Knol *et al*. (2018: 3956) and Hughes *et al*. (2020: 38) acknowledge a significant relationship between lean techniques in construction and successful projects. This is similar to what most of the study hypotheses conclude with.

In project success, Dave *et al*. (2013: 2) show five lean principles that relates to project success: value from a perspective of a customer; identifying the value stream to the project; create flow of resources to the successful project; allowing customer demand to the pace and pull production; and manage continuous improvement and purse perfection of the project. These are essential to elimination of waste according to Dave *et al*. (2013: 2). These parameters were also discussed in chapter four, five and six as main lean techniques parameters that determine the success of the project.

Literature also reveals that successful projects under lean have been linked to sustainability, environmental quality, waste reduction, health and safety. These parameters according to Vrchota *et al*. (2021: 2-3) are related to efficiency, safety, productivity and waste minimisation. Barnes (2017:42) show that relationships between successful sustainable projects and lean concepts have frameworks that integrate lean techniques. In accordance with this study, the lean parameters are essential towards successful projects. Like in literature to this study, the need is essential to incorporate various aspects during adoption in Uganda so that the major challenges confronting the country's construction industry are addressed.

### 4.5 Proposing LPS for Project Delivery

This section presents the narrative to the proposed lean construction project delivery strategy in the construction industry that is essential and according to this study, this is the last planner for the project delivery success. The section starts with illustrations about the last planner and how it has been essential in delivering successful projects. It then gives results from the survey, and discussion of the findings.

#### 4.5.1 The choice of last plan system overview

Last Planner System (LPS) is a high-level planning before and during the construction process under lean techniques (Hamzeh et al., 2020:1-2). According to Krishna (2021: 32-34), planning has been given seven stages which a construction company needs to embrace in the process of implementing the lean techniques (Venkatesan, 2021:139). In the first phase / stage, it is imperative to review the designs as one develops the first schedule. These schedules are essential and used by the site managers in reference to other stakeholders. The second stage is the last planner meeting which is normally known as a pull session. The

main activity in the meeting is to approve a master plan, confirm commitment of all employees and stakeholders. Thirdly, within the master plan, the look – ahead plan is produced by the construction manager and this can be assisted by the last planners. The fourth stage is a weekly plan, which is produced to monitor and provide checks during lean techniques implementation. Tasks are assigned to various employees and issues concerning who is responsible for whom and what during the upcoming week are assessed. Checking the compliance is the fifth stage. In case there are non-compliant groups and individuals, the managers must go extra-miles to establish reasons. The weekly meetings and results are published at the construction site (sixth stage). The publication of results is always intended to energise the workers and seek an approach to improve the weak ones (Pellicer and Lozano, 2015:4879). Lastly, the seventh stage looks at the provision of feedback at every stage at work. In order to establish the reliability of the plan, the Percent Plan Complete (PPC) indicator is always used (More and Fulse, 2021: 503 - 505).

According to Power *et al*. (2021:142), LPS has been used by various companies to positively influence economic and environmental sustainability. It has been extolled as a value – added process in the construction industry since it addresses workflow variability and eliminates wastes. The wastes are eliminated in the due course since it has been incorporated within planning. The application of LPS enables complete implementation, coordination, efficiency and productivity. Power *et al*. (2021:142) adopted a mixed approach to review the literature in order to establish the primacy of LPS in reference to lean techniques. The findings show that once LPS has been applied, there must be an increased productivity that is more reliable, predictable, and stable; enhanced team collaboration is also achieved, as well as safety, quality work, reduced costs and schedule benefits. Knowledgeable planners with competency are essential for successful implementation of LPS. However, this study remained limited since there was use of small sample size, which exposed the work to lack of wider coverage for generalisability. Potential and academic researchers of LPS have however expressed the importance of this strategy in construction waste reduction. Thus, such values found in LPS in such studies pertinently form the choice for the case of Ugandan construction companies.

In Ethiopian capital Addis Ababa, Limenih *et al*. (2022:1) show that road construction had failed to be executed within the needed time, allocated budget and quality. The new management had to come with a term known as lean construction which was borrowed from lean techniques, with main intention to increase productivity and reduce wastes. The managers had to apply the Last Planner System as a strategy. As studied by Limenih *et al*. (2022:1), the specific objectives were to examine the current construction process management practices in the City of Addis Ababa – road construction projects. Secondly, it aimed at identifying and assessing the barriers of LPS as being implemented in Addis Ababa using a super decision

model. Lastly, to develop the conceptual framework for the last planner system which was implemented in Addis Ababa to overcome the challenges of road construction. The study applied the use of questionnaires, observation, interview and Focused Group Discussions (FGDs) under a mixed approach (qualitative and quantitative). Under LPS, a push planning system for materials and a critical method to master schedule were adopted. However, there were no weekly plans and I was looking ahead for the upcoming operations. The study established the barriers of implementing LPS in Addis Ababa and categorised them into five: labour related challenges; internal working environment; stakeholders' related problems; and material-based problems. These challenges according to the study were due to the conditions within the Ethiopian capital rather than conceptual problems (Limenih *et al*. 2022:1). Despite the nature of Addis Ababa and some of the challenges within the implementers, the study identified the primacy of LPS as opposed to preceded systems. These benefits include time related commitment in accomplishing the project; there were also quality related benefits which were witnessed on road by clients and public. The scholars and implementers concluded that LPS is one of the best approaches that are appropriate for road constructions despite some of the barriers encountered. This study was also able to develop the road conceptual framework for Addis Ababa based on the LPS, which is an indication that there is value in using LPS.

Suresh and Sivakumar (2019:3350) found LPS as one of the effective approaches to project management in the manufacturing sector. It is effective towards planning and completion of the projects under the manufacturing and services sectors. Suresh and Sivakumar (2019:3350), organisations which have embraced LPS have been able to achieve their goals and manage the projects well. Under LPS, these companies have been able to control, schedule and monitor the entire organisation and project implementation. Therefore, an efficient schedule management plan is one of the effective approaches to organisations. In their study from India, schedule management plans were essential to effectiveness. Using quantitative design, close – ended questionnaires were used to collect primary data from 208 participants in order to test the relevance of schedule planning in project management of a manufacturing firm. This was carried out after a long period of discourse in which the management problems have remained challenging the daily operation and workers would face turnover and its effects. The production capacity of the manufacturing industries had started to decline which threatened profits and possible turnovers ahead. The study established a positive relationship between schedule management plan and project management. It was also found that factors affecting schedule management plan have a significant and positive impact on the effectiveness of project management. To the main investigators, the findings of this study would be used by organisations and companies, particularly in the manufacturing sector, to correctly identify the project management parameters that require more attention and utilise schedule management planning to

enhance effectiveness of operational processes. Managers can also use results of this study to determine the accrued benefits in case LPS is whole embraced by an organisation or a company rather than partial adoption.

In Denmark, Ballard (2020:1) established that it was not only schedule planning that called for implementation of LPS, rather a realisation that weekly planning was equally an enabling factor for a company or organisation to achieve 70% productivity. The scholar recognised that LPS was introduced in 1991 as a response to discovery of what the companies would lose due to failure to engage in weekly planning and scheduling. Thinking of what weekly planning would do to companies, design and operational planning began to include weekly planning as one of the components of LPS. In their study, it was established that some employees were willing to engage in the weekly planning which was estimated to encourage more investments to increase productivity. The study also established that once weekly planning and forecasting would be implemented, frontline supervisors would give up general planning and rely on flexibility and forecasting as a norm to business. Besides, frontline supervisors would prepare to do whatever that could work in order to deploy workers happily. This later explained why excellent companies and industries focus on improving labour utilisation in order to improve productivity. It was therefore concluded that once performance varies with planning and preparation, effects would be below work-flow reliability which would degrade performance, with resultant increase in injuries, rework, cost and project duration. LPS was therefore recommended as the system that would provide 99% solution to companies in their daily operation by management, practice and theory. Therefore, the choice of LPS to this study is not by oversight rather by a variety of comparative analyses of companies and industries that had used the same towards their success story.

In India, Venkatesan (2021:125) is of the view that industries or companies applying LPS should be aware about the potential to reduce environmental, economic and social impacts during the construction. Such companies also need to know that there is a high ability for sustainability in their programs. This study has limited information about such a narrative to sustainability and environmental perspective since it has been found that some of the constructions have been the source of death of human beings and destruction of nearby houses. Nonetheless, there are lots of benefits which have been studied in relation to LPS. These among others include ability to increase possible time for delivering the constructed structure, increasing confidence to workers, supervisors and managers. In an intensive review of literature, it is indicated that LPS adds improvements in reliable planning, visualisation of future and planning transparently, reduction in project time as a major benefit, commitment from top management, training of the participants as the critical success factors, resistance to implement LPS, involvement of many parties in the project as most

significant barriers. The study also presented difficulties faced during LPS implementation which if addressed would enable to improve the process, translate to project success, and instil confidence in industry practitioners to implement the system widely. Therefore, LPS is advantageous and these support the choice to be recommended.

In yet another study by (Lerche et al., 2020:2835), LPS was evaluated as the best construction practice to enhance site construction. In this study, LPS was implemented in residential building construction. In order to collect the data, a questionnaire survey, direct and indirect observations and interviews were among study tools that were applied. The study found that the construction of residential buildings was associated with a number of challenges which were grouped and classified into six major barriers: supervision and quality control, fluctuation and variations, sub-contractor involvement, resistance to change, cultural issues, and lengthy approvals. Despite such challenges, the advantages of applying LPS would improve construction planning; intensify site management, good communication and coordination between the parties involved.

Construction projects generally face delays and other time-related uncertainties. They involve various risk factors that impact time objectives and may lead to time-overrun. Delays usually trigger due to weak communication, unclear project requirements, and regular misunderstandings in the construction industry. Collaboration problems are one of the significant factors influencing the low-productivity and efficiency in the construction industry. The continuous deterioration of profit margins because of project delays and increased competition, construction contractors have to minimise waste for maximise profit. Due to the triumph of the lean production system in the manufacturing sector, the construction industry has adapted lean procedures to minimise waste and increase profitability.

In New Zealand, Kumar *et al*. (2020:6035) found that productivity has been one of the initiatives for the construction industry. By 2020, construction industries were struggling for a 20% productivity increase, a move that had started in 2009 when most companies started implementing lean techniques in construction. Along with implementation of lean techniques, emphasis was put on the application of LPS in the production planning and controls. In their study, Kumar *et al*. (2020:6035) found that companies which embraced LPS have got satisfactory results with or without claims. In their study to determine the level of application of LPS as the only approach to provide empirical study, survey online questionnaires were conducted and data analysed using descriptive yet quantitative approaches. The benefits of the LPS were found cross-cutting SMEs and major processing industries. Participants mentioned not only benefits to the companies but also advantages to individual employees at home.

### 4.5.2 Motivation by LPS to project delivery

This section presents responses on LPS from the survey. It starts with responses about LPS implementation at the company level, motivations accruing from LPS delivery, attitude to LPS, its timely delivery, budgeting and quality. Participants were asked if LPS has ever been implemented in Uganda at the company level. Results indicated that 89% responded with a "Yes" response whilst 11% with a "no" response.

Motivation is a form of an enticement to an individual or a group so that the once observed behaviour is repeated positively. This section therefore supports the view that the adoption or application of LPS in a company is introduced as a motivator to the company employees. Results from the Likert scale have been presented in Table 4.33.

**Table 4.33: Response towards motivation by LPS to project delivery**

| | Fr = 315 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Responses (%ag) = $R^1$ | | | | | | |
| Statement | 1 | 2 | 3 | 4 | 5 | $X^2$ | Sig. |
| Enables planning departments identify problems | 6.0 | 12.7 | 16.5 | 30.2 | 34.6 | 90.889[a] | .000 |
| Enables to streamline sub-contractors | 8.6 | 1.9 | 19.7 | 32.7 | 37.1 | 143.841[a] | .000 |
| Energise teams to resolve constraints | 10.1 | 8.3 | 14.0 | 31.7 | 35.9 | 104.127[a] | .000 |
| Energise teams to streamlines client requirements | 2.9 | 10.1 | 18.7 | 32.7 | 35.6 | 125.302[a] | .000 |
| Weekly plans lead to client satisfaction | 4.1 | 7.9 | 15.9 | 30.2 | 41.9 | 157.111[a] | .000 |
| Enables teams to brainstorm on issues | 5.7 | 8.6 | 19.0 | 30.5 | 36.2 | 190.286[a] | .000 |

$R^1$: 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

From the literature, it has been observed that LPS works on planning and departments in planning. Therefore, its application was found important as one of the lean techniques recommended to be adopted by the construction industries. Results in Table 4.33 show that 34.6% and 30.2% strongly agreed and agreed that LPS enables planning departments to identify problems in construction and thus, provide solutions. In fact, this study was informed that most of the buildings which have been collapsing around Kampala District have been due to lack of competent general planning.

> *"Planning identifies resources needed to start and finish a project, who is to do what and when? Who is to procure what and use what? Planning comes with actual estimation of the number of*

*resources and funds for the project. This therefore energises planners and shapes their focus towards the end of the project. Some projects lack technical supervision and onsite workers end up stealing materials and underutilisation of some materials. Some can easily turn into waste so facts despite the ongoing project"* (Key informant, February 2022).

The study also established that planners must be inclusive and engage in determining sources of resources and funds as well. Companies get funding from their investments, government sources and commercial banks. There are companies who base on the solicited proposals/ calls and bidding. Such a form of bidding does not need more funds at first rather the amount of funds a company would invest in construction before the first releases of the negotiated percentage.

The study also established that LPS could enable in streamlining sub-contractors as justified by 31.1% and 32.7% who strongly agreed and disagreed. While interviewing the key informants, it was found that all human capital is important in the construction sector. *Although the importance differs from technical to casual workers, and managers to onsite constructors, with some subcontractors being inexperienced, it is important to observe that different groups perform differently to make a company. Streamlining was found to be one of the activities for the managers in the company so that the performance of the company cannot be jeopardised on a given project.* Most of the sub-contractors would be new companies with no or limited experience in the construction. Usually, some misrepresent themselves as experienced in search of work. Proper engagement by the main contractor management needs to be triggered in order to achieve good project success. Some sub-contractors would be just sourcing for a way of surviving financially rather than ensuring project performance and client satisfaction.

LPS was found as an energising tool for teams to resolve company's problems (35.9% and 31.7% as indicated in Table 4.33). Construction companies have challenges which range from human, to capital and machinery that are important in daily operations. Teams would liaise with the human resources department to identify gaps that are needed to be supported through meeting sessions. The key informants remarked that some of these constraints have been identified during planning for the overall companies. However, it is the duty of the department to provide a solution to be adopted by the general planning. Streamlining clients' requirements (35.6% and 32.7% that strongly agreed and agreed respectively) and planning towards clients' satisfaction (41.9% and 30.2% that strongly agreed and agreed respectively) were also among motivations that LPS offers to clients. The primary method used to as well address concerns is brainstorming, which was strongly agreed upon by 36.2% and agreed upon by 30.5%. Individual variables' analysis was done and it was found significant with p-value = 0.000 as indicated in Table 4.33.

**Testing hypothesis for LPS motivation towards project delivery**

Based on Table 4.34 variables, a set hypothesis was tested. The null hypothesis – $H_0$ stated: there is no significant LPS motivation upon project delivery. $H_1$ states that: there is a significant LPS motivation upon project delivery. Data were run and results presented under Kendall's Coefficient of Concordance Test Agreement have been presented in Table 4.34.

**Table 4.34: Kendall's Coefficient of Concordance Test Agreement for LPS motivation and project delivery**

| N | W[a] | $X^2$ | df | Asymp. Sig | Monte Carlo. Sig | | |
|---|---|---|---|---|---|---|---|
| 315 | .008 | 18.298 | 7 | .011 | Sig. | 95% Confidence Interval | |
| | | | | | .125[b] | Lower Bound | Upper Bound |
| | | | | | | .000 | .354 |

a. Kendall's Coefficient of Concordance
b. Based on 8 sampled tables

Results in Table 4.34 show a significant value of Kendall's coefficient of concordance at $0.011 < 0.05$. This made it possible to reject the null hypothesis at 5% significance level. Therefore, LPS motivation was significant to project delivery.

### 4.5.3 Attitudes towards Last Planner System of delivery

The study also interrogated participants' attitudes towards LPS delivery with the main reason to determine if the companies feel lean techniques have importance to their careers. The statement constructs were focused on individuals since they were perceived as the mainstream for the existence of their companies. The statements were set borrowing a leaf from the main components of LPS, and quantitative results have been presented in Table 4.35.

**Table 4.35: Attitudes towards LPS of delivery**

| | Fr = 315 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Responses (%ag) = $R^1$ | | | | | | |
| Statement | 1 | 2 | 3 | 4 | 5 | $X^2$ | Sig. |
| I support individuals to collaborate in planning | 8.2 | 4.8 | 15.6 | 37.1 | 34.3 | 139.841[a] | .000 |
| I support readiness to work with schedules | 4.4 | 12.7 | 19.0 | 33.1 | 30.8 | 91.683[a] | .000 |
| I like LPS to identify constraints | 5.4 | 8.3 | 17.1 | 29.5 | 39.7 | 131.905[a] | .000 |
| I like LPS to enable contractors' commitment | 7.6 | 12.8 | 17.1 | 27.9 | 34.6 | 77.333[a] | .000 |
| I like LPS to breakdown schedules | 1.3 | 6.0 | 14.3 | 34.9 | 43.5 | 213.111[a] | .000 |
| I like LPS in designing end – work | 5.7 | 15.9 | 17.8 | 31.7 | 28.9 | 69.778[a] | .000 |
| I like LPS because it controls flows | 7.9 | 9.5 | 21.9 | 32.4 | 28.3 | 75.651[a] | .000 |
| I like LPS to identify the problem | 13.0 | 6.3 | 16.8 | 37.2 | 26.7 | 91.905[a] | .000 |

$R^1$: 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

Table 4.35 shows the agreement from participants that they agreed (37.1%) and strongly agreed (34.3%) in support of collaborative planning by individual persons in setting patterns towards successful work. The study also found readiness towards work schedules with 33.1% who agreed and 30.8% that strongly agreed. The key informants however noted that while there are some participants supporting planning and wish to observe companies' schedule, there are a few participants who have studied the application of lean techniques and its effectiveness at work. Besides, employees in Uganda do not settle for once due to various factors like working conditions, culture and salaries. The attitude today is different from the next day due to various factors which this study could not establish at length due to its content scope.

The study established that participants like the proposed LPS since it could identify the constraints of construction in management. Some of the constraints would be current like human capital needs or finance to implement the program. Its use can also identify onsite constraints since the strategy encourages weekly meetings by managers, onsite supervisors and the workers. In the due course of planning and meetings, some of the anticipated challenges could be thought through as they could affect the success of the project during the processes. The ability to identify the challenges by the LPS is essential since it enables managers to seek a solution either through the human resources department or workers themselves since they are as well part of the stakeholders of the company.

The success and efficient operation of any organisation are based on commitment of the employees towards work. This study established that most committed workers have been interested in getting salaries rather than the services. It was found the managers always engage workers towards work through ethical standards of probity. This has not been taken as the first priority. The cash economy is always the first agenda rather than services. The key informants noted that there is a need for the company's management to seek new styles of administering employees so that ethical standards become the top priority in employment rather than thinking about the money. The management should also think of occupying its personnel (professional and casual) with work rather than allowing workers to engage in other activities and unnecessary obligations that do not contribute anything to companies.

The study established that participants like breakdown schedules as justified by 43.5% who strongly agreed and 34.9% that agreed. The schedules were forms of management styles in which the managers divide workers according to their specialised tasks and time to accomplish works. The managers must draw schedules for accomplishing tasks based on programs of the companies. The end-work programs were also supported and liked by participants since it could give the overview of what has been accomplished, refreshment and ability towards the new task. Above all, managers have the main task of controlling the

flow of various things within the company. The control methods are especially direct to human capital, resource use, communication and finance. All the variables under attitude towards LPS were found significant and this made it one of the strategies that would apply and help construction companies towards the application of lean techniques.

**Testing the attitudinal hypothesis towards LPS of project delivery**

Table 4.36 indicates significant attitude of LPS as supported by p-value = 0.000. The null hypothesis – $H_0$ which was tested stated: there is no significant attitude towards LPS of delivering the projects. $H_1$ also stated that: there is a significant attitude towards LPS motivation of delivering projects. Data were analysed by SPSS and results presented under Kendall's Coefficient of Concordance Test Agreement have been presented in Table 4.36.

**Table 4.36: Kendall's Coefficient of Concordance Test Agreement for attitude towards LPS of project delivery**

| N | W[a] | $X^2$ | df | Asymp. Sig | Monte Carlo. Sig | | |
|---|---|---|---|---|---|---|---|
| 315 | .027 | 59.099 | 7 | .000 | Sig. | 95% Confidence Interval | |
| | | | | | .000[b] | Lower Bound | Upper Bound |
| | | | | | | .000 | .312 |

a. Kendall's Coefficient of Concordance

b. Based on 8 sampled tables

Table 4.36 shows the number of cases (315) for the study, Kendall's Coefficient of Concordance Test Agreement for the LPS of project delivery (W[a], 0.027), Chi-square (59.099), degree of freedom (df) and significance, p-value = 0.000. Results in Table 7.4 show a significant value of Kendall's coefficient of concordance at $0.000 < 0.05$. This significant value made it possible to reject the null hypothesis at 5% significance level. Therefore, there was a significant attitude towards the LPS of project delivery.

### 4.5.4 Last Planner System and timely delivery

This study also considers timely delivery as yet another important aspect of LPS. Time is important since it is found within parameters for determining the lean techniques. In fact, in meeting the goals and objectives as described in the project plan, there must be technical performance based on the scheduled time specific and within the budgetary framework. While there are various changes managers always implement in construction industries, they have maintained normal delivery of the projects in time. As a planning strategy, working and delivering project outcomes in time is a management tool that successful companies have always attempted to achieve. Responses in percentages, chi-square and significance are presented in Table 4.37.

**Table 4.37: Responses to Last Planner System and timely delivery**

| | Fr = 315 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Responses (%ag) = $R^1$ | | | | | | |
| Statement | 1 | 2 | 3 | 4 | 5 | $X^2$ | Sig. |
| LPS encourages on – work training | 9.2 | 3.8 | 7.0 | 14.6 | 65.4 | 415.492[a] | .000 |
| LPS supports voluntary working beyond hours | 7.9 | 7.0 | 61.3 | 13.7 | 10.2 | 339.460[a] | .000 |
| LPS encourages accurate delivery of equipment | 7.0 | 6.7 | 52.3 | 23.8 | 10.2 | 237.365[a] | .000 |
| LPS supports a consultant to remove ambiguities | 7.0 | 7.0 | 60.0 | 18.1 | 7.9 | 328.857[a] | .000 |
| LPS ensures Gantt Chart | 6.0 | 4.4 | 63.8 | 17.1 | 8.6 | 392.984[a] | .000 |
| LPS ensures use of loops to unforeseen things | 7.6 | 6.3 | 63.2 | 12.1 | 10.8 | 370.349[a] | .000 |
| LPS prepares for the unforeseen circumstances | 8.6 | 5.4 | 62.5 | 13.0 | 10.5 | 361.143[a] | .000 |
| LPS allows clients to fulfil their obligations | 6.0 | 6.7 | 60.3 | 15.2 | 11.7 | 329.048[a] | .000 |

$R^1$: 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

Table 4.37 shows that LPS encourages training of employees while at work. This study established that there are some workers who could be lacking in skills and practice yet such persons have been already employed by the companies. Secondly, a company may adopt new technology in the due course of project implementation. Rather than recruiting other personnel with expertise into the new technology or relinquishing the already employed personnel, it is imperative to train them with skills and knowledge. Supporters of LPS have found it an imperative attribute and this study shows that 65.4% of the participants strongly agreed with the statement, and 14.6% agreed. The key informants noted that on-job training is yet another management technique that is applied by managers in order to express their care and need of certain employees into the ongoing project rather than deploying new staff. Moreover, the process of recruitment and induction to such a project would be costly as well as unplanned for. On-job training therefore motivates employees or workers to invest more time, knowledge and expertise into the job so that better results could be obtained within a time limit.

LPS has a provision of encouraging workers to add extra-time beyond the normal routine so as a project is delivered within time schedule. In accordance with Table 4.35, it is indicated that 61.3% remained neutral to the statement, 13.7% agreed and 10.2% strongly agreed. This voluntary work is normally an initiative of the workers before the normal time and after the normal time. This study established that some workers voluntarily add time to work during weekends. These were workers with private laptops or other appliances

that are essential towards soft-copy works. It was also found that LPS encourages accurate delivery of equipment by the procurement and transportation officers. The procurement officers have been associated with shipping equipment or commodities abroad while transporters carry such equipment from the stores to onsite construction points. In fact, one of the key informants noted that where LPS has been applied, some of the equipment is automated so that illicit activities like stealing, corruption and embezzlement of the company's funds hardly take place. The administrative and management structures are well instituted for proper coordination and communication of daily activities. Specialised engineers and managers are employed in relation to the needs and those in transport know their duties and are ethically approved.

Consultants are also employed in line to the needs of their duties in order to identify and provide approaches to solve or harness ambiguities. These are construction challenges ranging from human errors, technical and organisation perspectives. This study established that consultants intervene for evaluating the improvement, the rate of performance and productivity. However, this study found that 60.0% of the respondents remained neutral on the statement about consultants' interventions. It was mentioned that some of the employees do not know when a consultant has been hired and at what level since this has always been managerial duties.

The Gantt Chart, loops to unforeseen future things, circumstances and the extent of allowing clients to fulfil their obligations were among others that had a high percentage of participants with neutral responses. This study established that most of participants interviewed did not have wider knowledge of such variables which justified their neutrality. Despite such neutrality and participants who disagreed, LPS is an instrument strategy towards the practice of learning techniques.

**Testing hypothesis about Last Planner System and timely delivery**

The hypothesis was stated from the heading of Table 4.38 about last planners and timely delivery and the p-value = 0.014 was received from run results. The null hypothesis – $H_0$ which was tested stated: there is no significant relationship between LPS and timely delivery of projects. $H_1$ stated that: there is a significant relationship between LPS and timely delivery of projects. Data were analysed by the SPSS and results presented under Kendall's Coefficient of Concordance Test Agreement have been presented in Table 4.38.

**Table 4.38: Kendall's Coefficient of Concordance Test Agreement for significant relationship between LPS and timely delivery of projects**

| N | W[a] | $X^2$ | df | Asymp. Sig | Monte Carlo. Sig | | |
|---|---|---|---|---|---|---|---|
| 315 | .008 | 17.654 | 7 | .014 | Sig. | 95% Confidence Interval | |
| | | | | | .000[b] | Lower Bound | Upper Bound |
| | | | | | | .000 | .312 |

a. Kendall's Coefficient of Concordance

b. Based on 8 sampled tables

Table 4.38 shows a significant relationship between LPS and timely delivery of projects, with the p-value = 0.000. Even, the significant value of Kendall's coefficient of concordance at 0.008 < 0.05. This significant value made it possible to reject the null hypothesis at 5% significance level. Therefore, there was a significant relationship between LPS and timely delivery of the projects.

### 4.5.5 Last Planner System and budgets

Budget is a quantitative expression of the planned activities or actions for a defined period of time. The budget framed can also include planned sale volumes and revenues, resources quantities, costs and expenses, assets, liabilities and the cash flows within an organisation or a company. It must contain quantities of the economic resources that have been planned and allocated for a particular purpose within a certain period of time. In fact, the quantitative expression of actions or activities into monetary terms is what is called a budget. Budget is important in planning of actual operations by forcing managers to consider how conditions might change and what steps should be taken now and by encouraging managers to consider problems before they arise. It also helps coordinate the activities of the organisation by compelling managers to examine relationships between their own operation and those of other departments as well as employees that mostly earn a living from their work. A budget controls resources, communicates plans to responsible managers who seek to work within a period of time and express their work in terms of budget, motivates managers to work at maximum in order to achieve their goals which is reached by evaluating performance, and above all, to limit and control the use of money.

This study established that there are different types of budgets which include sales budget, production budget, capital budget, cash flow / cash budget, marketing budget, project budget, revenue budget and expenditure budget. The fact that this study was carried among the construction companies, a project budget is the most core of the discussion. This study therefore expressed the extent to which LPS leads to budgeting during the company projects and the findings are presented in Table 4.39

**Table 4.39 Illustration of responses to LPS and budgets**

| | Fr = 315 | | | | | | |
|---|---|---|---|---|---|---|---|
| | Responses (%ag) = $R^1$ | | | | | | |
| Statement | 1 | 2 | 3 | 4 | 5 | $X^2$ | Sig. |
| LPS has cost planning before any projects | 2.5 | 6.7 | 63.5 | 17.5 | 9.8 | 391.206[a] | .000 |
| LPS avoids getting items on debts from suppliers | 9.2 | 5.4 | 61.9 | 15.6 | 7.9 | 354.540[a] | .000 |
| LPS calls managers to budget their activities | 9.5 | 11.1 | 51.7 | 17.2 | 10.5 | 204.032[a] | .000 |
| LPS calls for alternative approaches | 9.2 | 7.3 | 51.1 | 20.0 | 12.4 | 205.333[a] | .000 |
| LPS encourages projects in relation to costs | 8.3 | 10.2 | 57.1 | 14.2 | 10.2 | 274.667[a] | .000 |
| LPS has penalties in due course of projects | 4.8 | 10.2 | 52.7 | 21.9 | 10.4 | 235.079[a] | .000 |
| LPS projects are completed in relevant budgets | 5.1 | 7.6 | 61.0 | 14.3 | 12.0 | 338.413[a] | .000 |

$R^1$: 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

Table 4.39 illustrates what LPS can influence before and during the project budget. Most of the responses were however neutral which was attributed by limited time to participate in the budgeting process and use. The study established that budgets in companies are tools used by managers and company owners. The budget drives managers in what is to do in a specified period of time. The study established that the fact that companies were mainly for construction, there are few departments like the human resource and accounting / finance departments. The rest of the employees fall under construction which is the main reason for the founding of the companies. Nonetheless, results run indicated significant value since the p-value = 0.000 as indicated in the last column of the table. This confirms the significant aspect of LPS in the company's budgeting.

**Testing hypothesis about Last Planner System and budgeting**

The study also tested the underlying hypothesis which was stated relating Last Planners System and budgeting. The null hypothesis stated that – $H_0$: there is no significant relationship between Last Planner System and budgeting of projects at the company level. $H_1$ stated that: there is a significant relationship between Last Planner System and budgeting of the projects at the company level. Data which were run in Table 4.40 was run at once under Kendall's Coefficient of Concordance Test Agreement and the results have been presented in Table 4.38.

**Table 4.40: Kendall's Coefficient of Concordance Test Agreement for Last Planner System and budgeting for projects at company level**

| N | W[a] | $X^2$ | df | Asymp. Sig | Monte Carlo. Sig | | |
|---|---|---|---|---|---|---|---|
| 315 | .012 | 23.216 | 6 | .001 | Sig. | 95% Confidence Interval | |
| | | | | | .000[b] | Lower Bound | Upper Bound |
| | | | | | | .000 | .312 |

a. Kendall's Coefficient of Concordance

b. Based on 8 sampled tables

Table 4.40 shows a significant relationship between LPS and budgeting of projects at the company level, with the p-value = 0.001. Kendall's coefficient of concordance was 0.012 < 0.05. This significant value also made it possible to reject the null hypothesis at 5% significance level. Therefore, there was a significant relationship between LPS and timely delivery of the projects.

## 4.6 Perception of Last Planner Strategy

### 4.6.1 Overview to perception to LPS

Perception is a cognitive state that stems from contextual environment or heresies and later forms a construct within the mind (Manik and Sidharta, 2017: 65-66). These constructs are later translated into action in the form of work behaviours which are essential to the success of an institution or organisation. In Indonesia, Kastanja and Amin (2021:50) show that due to awareness that building construction is made of planning before the start of the project, employees have a positive attitude since planning has been incorporated into the daily activities as they focus towards the benefits. In implementing any project, the duration / time taken by the project was considered essential since delivery always goes together with the needs to use the facility. It is also indicated that some workers developed perceptions based on the project owner. An owner would need the facility to be constructed before real plan or planning. This shapes the perception of non-professionals, and even professional builders would go the extra mile to explain the consequences of such a facility to time, the environment, and humans. According to Kastanja and Amin (2021:50), constructions across Indonesia were facing short periods of planning and this would have dire consequences on facilities and the surrounding environment. The application of LPS by the constructors enabled clear schedules of time for planning, reduction of costs; yet with high – quality goods to clients. It also enabled contractors to attain efficiency and effectiveness in such a competitive economy. In their study, the underlying questions include how to understand project workers, the nature of implementing LPS, Least Cost Analysis (LCA), and use of process control of high residential projects. The understanding of project

workers was also due to Least Cost Analysis (LCA) in accordance with completion schedule, and cost per budget. The analysis of LPS and LCA were perceived as obstacles to workers towards completion. The study found a relationship between understanding of project workers as they implemented the methods of LPS and LCA. It was found that implementing the LCA to high-rise residential building projects would result in project completion time. It was therefore concluded that use of LPS and LCA had a significantly positive effect on the control process of workers' jobs in the project. The study also found that there is a synergistic effect of project workers' understanding of LPS and LCA which can increase understanding of their ability and importance to control each job of the project. Such results remained important to underscore limited application of Lean Technology in Uganda, especially in Kampala.

In Gaza Strip and Palestine in particular, Abusalem (2020:368) states that the construction industry had a challenge of the unreliable production plans with variability. One of the solutions which companies have found viable was the adoption of the LPS. In his study, Abusalem (2020:369) indicated the importance of eliminating variations in planning and control which were brought by the adoption of LPS. Using a survey questionnaire and in-depth interview, the study established that some of the elements of LPS were already in existence in the Gaza Strip but the application of the elements would never constitute LPS. The main challenge was the involvement of sub-contractors who would perceive the process as faster and compacting their rights. Some of the companies that applied LPS would at the end face unavailability of materials since their suppliers would not be part of LPS. Despite such challenges, companies had positive perceptions for faster completion of programs and success. They were also positive with the view that once CSF are applied, waste would be eliminated, and materials or inputs would be accessed at a low cost.

Utomo *et al*. (2018:1) show that LPS has been perceived positively as one of the Lean Construction tools for scheduling which enhances reliability, productivity and performance of the companies. The scholars observe that if LPS has been poorly perceived, nations across the world would not have adopted it. Its benefits like shorter duration of delivery of the facility, less rework and better communication channels before and during project implementation have been among other indicators attracting practitioners to it. Nonetheless, the Indonesian companies had not yet received and documented benefits accruing from LPS. In their study, five factors were interrogated in order to ascertain if companies had realised some benefits or their readiness to do so. These included Master Schedule, Pull Planning, Making Work Ready, Weekly Work Plan, and Learning, using four categories of assessment, i.e. not aware, aware, willing, and implemented. The study went ahead to categorise readiness in terms of none, poor, moderate, high and excellent towards the success. The data were collected from interviews and questionnaire surveys as primary tools for primary data from participants. Main participants to this study were mainly managers and

the deputies; supervisors and onsite workers. Average results were mainly moderate, particularly under the Pull Planning and Look – ahead Plan which were essential to inform the study and companies interested in results. At first, the study provided an initial understanding of LPS as perceived by the contractors and managers, and was later applied to construct a framework for wider adoption of lean in Indonesia so as to improve performance in the construction industries. In this study, the perception and understanding of lean technology, especially LPS, has limits since most industries do not apply the technology appropriately.

Kassab *et al* (2020: II) stated that since the establishment of the Last Planner System by Ballard and Howell, there has been increased studies to assess understanding of LPS, implementation and perceptions to successful projects. However, there have been limited studies which have been conducted among the companies in infrastructure. This therefore compelled his study in the same field to assess the challenges arising during implementing the LPS and to suggest approaches that would be used to harmonise such challenges. The findings of the study revealed that companies which followed LPS implementation rightful principles as found in the literature were able to have various successful projects. Although managers, contractors and other employees in the companies had positive perception towards the successful projects, they were not aware that application of LPS was the main cause of the results. The study indicated that some of the challenges met were similar to what was found in literature, which indicated that such companies would be on a rightful path of implementation. The study had to conclude suggesting measures to overcome some of the challenges which could relate to sufficient training of the workers to uncover ignorance about the LPS and lean techniques in general; openness towards the use of LPS and its importance as applied; a call to apply an incremental strategy when using Key Performance Indicators (KPIs). The study also calls upon the managers, contractors and company owners to engage workers into different training in order to solve the main problem of fearing to take responsibilities by workers. The Trust – Doubt Indicator was also suggested which is utilised by various managers while trapping doubt and trust attitudes towards LPS and other scientific strategies applied in the construction sector.

This has got a lot in terms of management approaches and satisfying human needs which the only approach has been modernised to lean techniques. The application of the technology has been presented outstanding to the cause of human existence. Therefore, supporters of management within the lean techniques like Hallman (2013: II) have observed that the management is a continuous improvement to implementers. Like any theory of change as presented by Kurt Lewin, LPS as a component to lean techniques cannot be welcomed without adapters, resisters and individuals (Ting, 2021: 2-3: Akram et al 2020: 119). Such divisions in human groups are the sources of varied perception as investigated by this study. In a study conducted by Hallman (2013: II), it was found that LPS needs to be implemented in an effective and smooth

approach if results are to be desired for all future days. The success of lean techniques is not for today only, rather for various years to come. In his study, five construction superintendents and a foreman from different companies were interviewed in Chicago. Each of these persons have implemented LPS in their construction as an approach to change in systematic approach to construction. The study confirmed that LPS is a product of a planned system that is intended to produce better flow, production and continuous improvement during and after implementation. Despite such planning, the study confirmed that there existed resistance to LPS as part of lean management came from the subcontractors and foremen. While companies would perceive such individuals as barriers to LPS, it was also essential to understand their needs in the process of making LPS adopted. Through various processes and training within various theories like change theory by Lewin Kurt (Akram et al 2020: 119), the adoption of LPS was successful. Therefore, perceptions come within and outside the implementers. It is important to study such perceptions so that a clear approach is taken with relevance to seek for the solution to the impending challenge.

### 4.6.2 General Last Planner System delivery perceptions

A questionnaire survey was used to capture perceptions of participants towards LPS as a strategy proposed under lean techniques. A five Likert scale was used to get responses under various headings like perceptions on delivery under LPS, planning, teamwork, the control of wastes and environment. These were thought essential towards a smooth system that would bring results at the end.

Under this section, four variables were interrogated. They include perceptions on faster delivery of tasks, quality work, reduction of wastes to zero level during delivery process, and satisfaction of the employees. The quantitative responses have been presented in Table 4.41.

**Table 4.41: Perceptions of last planner system on delivery**

| | Fr = 315 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Responses (%ag) = R[1]** | | | | | | | |
| **Statement** | 1 | 2 | 3 | 4 | 5 | $X^2$ | Mean | Sig. |
| LPS enables faster delivery of tasks in time | 5.7 | 6.3 | 12.4 | 61.6 | 14.0 | 348.762[a] | 3.06 | .000 |
| LPS leads to quality work | 8.6 | 8.6 | 8.6 | 54.6 | 19.6 | 250.317[a] | 2.89 | .000 |
| LPS reduces wastes to sero level | 10.2 | 10.8 | 11.3 | 50.2 | 17.5 | 184.444[a] | 3.15 | .000 |
| LPS satisfies clients | 8.6 | 12.4 | 19.0 | 38.4 | 21.6 | 83.651[a] | 3.33 | .000 |

R[1]: 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

This study established a positive response about LPS as a strategy for faster delivery of tasks within speculated time. According to Table 4.41, it is indicated that 61.6% of the participants agreed with the statement while 14.0% strongly agreed.; with a ±3.06 and significance level of 0.000. It was also found that LPS leads to quality work as justified by 54.6% who agreed and 19.6% with ±2.89. Although it was found that LPS reduces wastes to zero level by 50.2% of the participants who agreed and 17.5% that strongly agreed, the key informants asserted that some of the wastes are inevitable but companies can keep them safely for the purposes of re-use. These included timbers and dry wood that are always used in the due course of building construction. It was therefore concluded that there is a positive perception of the last planner as a system of delivery.

**Testing hypothesis for the perceptions of last planner system of delivery**

Testing the hypothesis was done on perceptions of the Last Planner System on delivery. The null hypothesis stated that – $H_0$: there is no a positive significant perception of the last planner system of delivery. $H_1$ stated that: there is a positive significant perception of the last planner system of delivery. Data which were run led to results as presented in Table 4.40 under Kendall's Coefficient of Concordance Test Agreement**.**

**Table 4.42: Kendall's Coefficient of Concordance Test Agreement for Perceptions of last planner system of delivery**

| N | W[a] | $X^2$ | df | Significance |
|---|---|---|---|---|
| 315 | .037 | 34.539 | 3 | .000 |
| a. Kendall's Coefficient of Concordance | | | | |

Table 4.42 shows a positively significant result of perception towards the last planner system of delivery with a p-value = 0.000. Kendall's coefficient of concordance was 0.037 < 0.05. The positively significant value made it possible to reject the null hypothesis at 5% significance level. Therefore, a positive significant perception of the last planner system of delivery of projects was accepted.

### 4.6.3 Perceptions to Last Planner System towards planning

Responses to perceptions were also received on planning with the major emphasis on budgeting, inclusiveness, stakeholders' involvement, and being done at the company level. Descriptive statistics are presented in Table 4.43 in percentages.

**Table 4.43: Illustration of last planner system towards planning**

| | Fr = 315 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Responses (%ag) = R[1] | | | | | | | |
| Statement | 1 | 2 | 3 | 4 | 5 | $X^2$ | Mean | Sig. |
| LPS emphasises budgeting | 14.9 | 12.7 | 11.7 | 45.7 | 14.9 | 131.397[a] | 3.01 | .000 |
| LPS planning is inclusive | 5.6 | 10.2 | 20.0 | 41.0 | 23.2 | 118.127[a] | 3.45 | .000 |
| All stakeholders are involved in LPS | 7.6 | 3.2 | 6.0 | 71.1 | 12.1 | 520.825[a] | 2.88 | .000 |
| LPS is done at company level | 8.9 | 12.4 | 32.4 | 23.8 | 22.5 | 56.032[a] | 3.39 | .000 |

R[1]: 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

Results run as presented in Table 4.43 show significant variables as emphasised by the last planner system, p-value = 0.000. The ± were also significant, resulting from highly percentage figures. Results show that there was a positive perception towards the emphasis on budgeting with 45.7% of the participants in agreement while 14.9% strongly agreed. It also indicates that 41.0% of the participants agreed towards inclusiveness of the planning nature of LPS while 23.2% strongly agreed with the ± 3.45. Over 71.1% of the participants agreed with stakeholders' involvement in LPS and 12.1% strongly agreed. The study established that once there is a need for bidding, a few employees can participate in developing plans rather than including all. In some companies, such plans and bidding proposals call for verifications by different persons. These actions are all done at the company level by certain employees and this was justified by 23.8% who agreed and 22.5% that strongly agreed.

**Testing hypothesis for perceptions of last planner system towards planning**

Testing the hypothesis on perceptions of the last planner system towards planning was reached by analysing results in Table 4.44. The null hypothesis stated that – $H_0$: there is no significant perception of the last planner system towards planning. $H_1$ stated that: there is a significant perception of the last planner system towards planning. Data which were run led to results as presented in Table 8.4 under Kendall's Coefficient of Concordance Test Agreement**.**

**Table 4.44: Kendall's Coefficient of Concordance Test Agreement for perceptions of last planner system towards planning**

| N | W[a] | $X^2$ | Df | Significance |
|---|---|---|---|---|
| 315 | .065 | 61.574 | 3 | .000 |
| a. Kendall's Coefficient of Concordance | | | | |

Table 4.44 shows significant results of perception of the last planner system towards planning with a p-value = 0.000. This significant value made it possible to reject the null hypothesis at 5% significance level. Therefore, a significant perception of the last planner system towards planning was accepted.

### 4.6.4 Perceptions to Last Planner System towards controlling wastes

This study also assessed the attitude towards the last planner system in reducing waste since it is a major component to lean techniques, besides costs and timely delivery. The wastes were examined towards general construction works, effectiveness, in terms of input and waste with loops. Some of the examples of wastes generated by a company during construction have been presented in appendices, and responses to this concern are presented in Table 4.45

**Table 4.45: Perception to last planner towards waste control**

| | Fr = 315 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Responses (%ag) = $R^1$ | | | | | | | |
| Statement | 1 | 2 | 3 | 4 | 5 | $X^2$ | Mean | Sig. |
| LPS effectively reduces in wastes | 6.7 | 10.5 | 15.9 | 45.7 | 21.2 | 149.365[a] | 3.29 | .000 |
| LPS reduces wastes at construction | 7.9 | 8.3 | 12.1 | 58.7 | 13.0 | 298.508[a] | 2.86 | .000 |
| LPS reduces waste in terms of inputs | 8.6 | 5.4 | 16.8 | 60.0 | 9.2 | 326.095[a] | 2.86 | .000 |
| LPS reduces wastes with loops | 7.3 | 11.7 | 13.0 | 47.0 | 21.0 | 158.635[a] | 2.83 | .000 |

$R^1$: 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

Variables of Last Planner System which were interrogated among participants were found significant, p-value = 0.000 as presented in Table 4.45. The ± were also significant. Therefore, LPS is effective in reducing wastes as supported by 45.7% of the participants who agreed and 21.2% that strongly agreed. It was also found important in reducing wastes during the construction as justified by 58.7% of the participants that agreed and 13.0% that strongly agreed. The highest percentage was also observed as 60.0% in agreement and 9.2% strongly agreed with the statement. The study further established that LPS is important in enabling managers, supervisors and onsite workers to do their duties carefully so that wastes are controlled. The work of construction was however mentioned with a lot of waste right from the period of procurement to the end point or project delivery. Company owners and managers have been observant on a number of wastes that are generated in the due course of construction. The key important had to appreciate with LPS in case it is embraced in totality rather than partially.

The study established that there are company workers that serve on the constructed facilities without technical knowledge about reducing wastes. These are among other individuals that need training workshops and further studies about the lean techniques and its operations. It was also mentioned that elimination of wastes by other systems like traditional has remained difficult due to the nature of workers that are always deployed in the construction of various facilities. *Some of the facilities are constructed without plans and at night*. In such circumstances, it is hard to control wastes accruing from the construction.

**Hypothesis testing about perception to last planner towards waste control**

Results were run from Kendall's Coefficient Concordance Test Agreement in order to test the set hypothesis on waste control as presented in Table 4.46. The null hypothesis stated that – $H_0$: there is no significant perception for the last planner system in controlling waste during construction. $H_1$ stated that: there is a significant perception for the last planner system in controlling waste during construction.

**Table 4.46: Kendall's Coefficient of Concordance Test Agreement for Perception to last planner waste control**

| N | W[a] | $X^2$ | df | Significance |
|---|---|---|---|---|
| 315 | .038 | 48.227 | 4 | .000 |

a. Kendall's Coefficient of Concordance

There is a significant perception for the last planner system in controlling waste during construction as justified by p-value = 0.000, as indicated by Table 4.46. Kendall's coefficient of concordance was 0.038 < 0.05. This significant value became a basis to all the possible rejection for the null hypothesis at 5% significance level. Therefore, the null hypothesis was rejected and alternative accepted.

### 4.6.5 Perceptions to Last Planner System towards environmental management

The study also interrogated the perception of the Last Planner System and environmental management. As the concept used in construction, environmental management includes the extent to which construction under lean techniques – Last Planner System would not interfere with the environment around the constructed facilities. Secondly, does the construction under the Last Planner System attract the neighbourhood into a clean and protected environment. Do the construction commands to relocate people adjacent a constructed facility, or is it friends and calls for co-existence? Responses to the variables interrogated on environmental management are presented in Table 4.47.

**Table 4. 47: Last planner system towards environmental management**

| | Fr = 315 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Responses (%ag) = $R^1$ | | | | | | | |
| Statement | 1 | 2 | 3 | 4 | 5 | $X^2$ | Mean | Sig. |
| LPS is environmental friendly | .6 | 2.2 | 14.3 | 66.3 | 16.5 | 454.254[a] | 2.58 | .000 |
| Leads to quality environment | 8.6 | 10.1 | 12.1 | 54.3 | 14.9 | 257.810[a] | 3.00 | .000 |
| Protects environment by loops | 7.3 | 11.7 | 13.0 | 47.0 | 21.0 | 412.635[a] | 2.83 | .000 |
| Construction cannot affect neighbours | 4.8 | 12.4 | 12.7 | 55.6 | 14.6 | 136.730[a] | 3.20 | .000 |

$R^1$: 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

The study findings show that Last Planners System is friendly to the environment since 66.3% of the participants agreed and 16.7% strongly agreed with the statement. participants noted that apart from road construction and bridges as well, most constructions have remained environmentally friendly although some collapsing constructions cost lives. The LPS strategy however was mentioned as an approach that would consider such eventualities so that lives are protected and saved from dangers. It also leads to a quality environment as supported by 54.3% that agreed and 14.9% that strongly agreed. Under the Last Planner System, the study established that the construction cannot affect neighbours. This was supported by 55.6% in agreement and 14.6% that strongly agreed.

**Test Hypothesis for Last planner system and environmental management**

Like the preceding analysis, the Kendall's Coefficient Concordance Test Agreement was used to test the set hypothesis on environmental management and results presented in Table 4.48. The null hypothesis stated that – $H_0$: there is no significant perception for the last planner system as a strategy for environmental management. $H_1$ stated that: there is a significant perception towards the last planner system as a strategy for environmental management.

**Table 4.48: Kendall's Coefficient of Concordance Test Agreement for lean techniques variables and environmental protection success**

| N | W[a] | $X^2$ | df | Significance |
|---|---|---|---|---|
| 315 | .057 | 54.010 | 3 | .000 |
| a. Kendall's Coefficient of Concordance | | | | |

Results presented in Table 4.48 presents Kendall's Coefficient of Concordance Test Agreement test, with the p-value = 0.000, which is highly significant. The significant value became a basis to possible rejection for the null hypothesis at 5% significance level. Therefore, the null hypothesis was rejected and alternative

accepted. Indeed, there is a significant perception towards the last planner system as a strategy for environmental management.

### 4.6.6 Perceptions to Last Planner System towards teamwork

Lastly, investigations were also made on teamwork. The motivation to do this on teamwork was based on the ground that teams perform better in an organisation and have a special position towards the success of any introduced or improved technology. A proposed LPS would therefore need competent workers in a team to make it successful to any company that applies it. Responses to the variables interrogated have been presented in Table 4.49

**Table 4.49: Responses on perceptions towards Last Planners System towards teamwork**

| | Fr = 315 | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Responses (%ag) = R[1] | | | | | | | |
| Statement | 1 | 2 | 3 | 4 | 5 | $X^2$ | Mean | Sig. |
| LPS encourages a team work | 2.5 | 12.1 | 12.7 | 47.9 | 24.8 | 192.825[a] | 2.69 | .000 |
| Teams work in shifts under LPS | 6.7 | 6.3 | 11.4 | 55.6 | 20.0 | 268.032[a] | 2.92 | .000 |
| Teams come together for a problem | 8.6 | 16.2 | 7.3 | 49.8 | 18.1 | 189.079[a] | 3.04 | .000 |
| Teams are formed with leaders | 10.2 | 10.5 | 10.8 | 51.4 | 17.1 | 199.746[a] | 2.94 | .000 |

R[1]: 1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree

The study established that Last Planner Encourages teamwork. This was supported by 47.9% in agreement and 24.8% who strongly agreed at a ± 2.69, p-value = 0.000. The key informants remarked that workers' performance can be due to specialised effort applied, but the impetus for the success of the organisation is a team spirit which starts with the managers. One of the key informants remarked that;

> "*A manager is a key figure to all operations and activities of any company. A good manager can easily sell the company to the outside world yet a weak manager makes the company small.*"

The study established that the Last Planners System encourages teams to work in shifts. There was positive perception on this variable since 55.6% of respondents agreed and 20.0% strongly agreed at ± 2.92 and p-value 0.000. Last Planner Teams come together in case there is a problem or a challenge within the company or at work. This was supported by 49.8% of the participants who agreed; and 18.1% that strongly agreed, with ± 3.04 value.

**Testing hypothesis about perceptions towards Last Planners System towards teamwork**

The test analysis was run under the Kendall's Coefficient Concordance Test Agreement and results presented in Table 4.50. The null hypothesis stated that – $H_0$: there is no significant perception of a relationship between Last Planner System and creation of teamwork in the construction companies implementing lean techniques. $H_1$ stated that: there is significant perception of the relationship between Last Planner System and creation of teamwork in the construction companies implementing lean techniques.

**Table 4.50: Kendall's Coefficient of Concordance Test Agreement for perceptions towards Last Planners System towards teamwork**

| N | W[a] | $X^2$ | df | Significance |
|---|---|---|---|---|
| 315 | .014 | 17.306 | 4 | .000 |

a. Kendall's Coefficient of Concordance

From results presented in Table 4.50, the null hypothesis is rejected for the alternative. Therefore, there is a significant perception of the relationship between Last Planner System and creation of teamwork in the construction companies implementing lean techniques. This has been reached with a justifiable p-value = 0.000, with Kendall's coefficient of concordance was 0.014 < 0.05.

316 participants from 56 construction companies. Survey questionnaire and interview guide were used to collect data from the field which were analysed using multiple methods that included AMOS, Chi-square, ANOVA, multiple regression, Cochran's Q test, Kendall's Coefficient of Concordance Test Agreement for quantitative data and content analysis for the qualitative data. The study established that there is limited form of knowledge of lean construction techniques and its design. This makes the implementation fall short among the companies. Despite the constraint in the knowledge and awareness of design, utilisation and awareness, the null hypothesis $H_0$ which stated that there was no significant level of implementation of lean construction by utilisation of lean technological concept was dismissed at a significant value of Cochran's test of 0.000 (p-value < 0.05).

**4.7 Summary**

According to the chapter, the study found that lean techniques have the ability to determine an improved degree of success despite the constraints in the construction industry. At a significant value of 0.000 (p-value < 0.05), the techniques were found with the ability to enable regular training of the employees and

creation of a good working environment at a significant p-value = .010. In fact, $H_0$ was rejected at the significant Cochran's Q value 0.000 < 0.05. With organisational commitment, lean techniques can increase sustainability at p-value = 0.002 and understanding of benefits at p-value = 0.000. The general test of hypothesis through Cochran's Q value indicated 0.001< 0.05. Positive results were also obtained from perceptions towards the last planner system as an important approach in the construction industry. Furthermore, it should be noted that, despite the constraints in applying or implementing lean construction techniques by the Uganda's construction industry, it is of great value in terms of values needed in the construction industry, such as waste reduction and cost decrease.

# CHAPTER FIVE:

# CONCLUSIONS AND RECOMMENDATIONS

## 5.1 Summary

In the theoretical review of this study, it has been observed that companies act as open systems that welcome the exchange of skills, human capital, and information. The theory also supports the study that skills are required for construction industries seeking to apply advanced techniques in order to reduce construction wastes for a successful construction process. The study determined that techniques such as lean construction in the production of buildings were the most appropriate in the evolving modern day time.

Management, as observed from historical and philosophical perspectives, is an important tool or discourse that an institution must strengthen in order to achieve desired outcomes. If management is carried out properly, it may lead to a high level of confidence in the industry in terms of profit generation for construction companies. This also improves the business sense of projects and yields value for money for the parties involved.

This according to the management theory by Fayol is hinged on 14 principles which the managers must address in the organisation and as a result, there is a need for human behaviour management within the systems. Maslow considers these to be five: physiological management, safety, love/sense of belonging, self-esteem, and self-actualisation or self-fulfilment. To achieve the five, lean techniques were used, despite this, the situation in Uganda, according to this study, demonstrates a lack of adequate knowledge and concern regarding lean construction, as well as a gap in what system, specifically, should be used if an attempt is made to adopt lean construction.

According to the research, the Last Planner System technique used in lean construction is the most adequate solution. Thus, the conclusion as presented hereunder.

## 5.2 Conclusions

### 5.2.1 Implementation of lean construction techniques in Uganda's construction industry

According to this study, one of the best practices that some companies have attempted to implement in the fight to reduce waste on construction sites is the application of some features of lean construction techniques. According to the findings of the study, the majority of the companies have yet to embrace the most pertinent components of lean techniques in the Ugandan context. To some extent workers or employees were found to have some knowledge about the lean techniques but the management has not yet opted for any specific forms of engagement.

Implementation sounds best in a context where workers or persons know what is being done. Such knowledge would have informed the implementation process, as well as various groups at different levels of implementation, and realising the outcome. Moreover, in Uganda this study has identified gaps in the knowledge or awareness of lean construction techniques and this would have been one of the causes for the partial implementation, and the limitation in utilisation and realising of the outcomes. Limitation in knowledge was observed in design, construction, actual implementation/ waiting, company policy, management of workers and output per input.

The utilisation of lean techniques is also limited and this has been observed in the various aspects like application of lean at project level, utilisation by employees and managers. Despite such lapses, the technology is still significant to the nation, more so to the construction industry. The analysis of this kind is therefore important to companies that would need progress and apply the techniques to their work so that they could minimise waste, reduce costs, and deliver within time for successful projects.

### 5.2.2 Degree of success and realisation of projects in Uganda's Construction Industry

The study also discovered that there is limited success and realisation of projects in Uganda's construction industry generally. According to the study, most of construction projects in Uganda are not completed within the specified project durations, the quality is as well still underwhelming, the projects are as well culminated with cost overruns. The limited success has been attributed to the lack of concerns about how work is being carried out on construction sites, a general lack of duty of care about wastages on sites, and the lack of appropriate pre and post planning procedures during the construction processes. Furthermore, based on the various perspectives discussed previously in the study, most clients and other stakeholders are left dissatisfied in one way or another.

Additionally, there are few management techniques that have been appropriately explored for adoption in order to reduce the escalating construction wastes while improving project success. According to the findings of this study, the narrative to success remains limited among stakeholders, and organisational commitment remains low. As a result, because it is the culmination of all technological implementation and conception processes, it necessitates a significant increase in the awareness for improvement in projects success and realisation.

### 5.2.3 Relationship between lean construction techniques and general project success in Uganda and the challenges involved

According to the findings of this study, and after testing the hypotheses, the p-values were found to be = $0.000 < 0.05$, and therefore the null hypotheses ($H_0$) were rejected for the alternatives ($H_1$) which stated that

there was significant project success with the utilisation of the lean techniques in the perspectives of stakeholder and management engagements, project performance, training, and general organisation commitment.

Furthermore, according to the findings, it was discovered that lean construction techniques significantly reduce wastes, reduce costs during construction, and yield good results when it comes to management of resources all with p-values $< 0.05$. According to the study, these are some of the crucial factors in determining project success. Consequently, it is concluded that there is a significant relationship between lean construction techniques and project success in terms of waste reduction, timely completion and significant reduction of costs. However, according to the study, the relationship between construction quality aspects and lean construction techniques was demonstrated not to be significant. Moreover, from the results of this study and the literature review chapter, it was revealed that companies that have utilised the lean construction techniques have had significant improvements in project delivery and success.

Henceforth, there is a significant relationship between lean construction techniques and the overall project success. Meaning, if lean construction is adopted efficiently, there is a strong possibility that the project duration will be kept or even shortened, resources will be managed well, and cost overruns will be worked on expressively.

### 5.2.4 Appropriate lean construction project delivery strategy for Uganda’s Construction Industry

According to the study, based on the Ugandan construction industry context, the Last Planner System was recommended for adoption as one of the major lean construction techniques. LPS was discovered to be an adequate technique for quickly blending in with the industry. According to the findings of this study, LPS was discovered to be an easy-to-understand technique that does not necessitate specialised training, it was discovered to be used haphazardly to a small extent, it requires fewer people, and it is not expensive to implement. And it can be used throughout the project's entire lifecycle, for example, from start to finish, making it essential at all the stages of construction.

### 5.2.5 The perception of the proposed strategy in Uganda's Construction Industry

During perceptions testing, various industry professionals were positive to LPS in terms of enactment. This provided a strong indication of readiness and willingness by the various stakeholders to embrace the technique in the respective construction processes in order to reduce wastes to achieve project success. According to the findings, this was found to be significant at the project level, organisation commitment, environment, and creating teamwork. It is a system that can easily be conveyed to the company and the workers instinctively.

On the other hand, as an output of the study a journal paper has been published in a scopus indexed journal. The title of the paper is “Implementation of lean construction principles for a collective enhancement of project success in Uganda”. The paper was published on 9th September 2022. (See attached in Appendices).

### 5.3 Recommendations

The study focused on awareness, implementation and success about the lean techniques in Uganda which started in the 1950s in Japan. Since then, according to the study, the lean construction has circulated across borders to Europe – United Kingdom, USA and some parts of Africa like Egypt and Morocco. Despite the circulation of knowledge across other nations, there is still limited knowledge in Uganda. There is a need for the owners of industries and most stakeholders to embrace such technology in building and construction so that the sector gets a well-recognized approach. Lean construction techniques should also be imposed in the various construction offices so that workers would identify which principles have been fulfilled by the company in the due course of construction.

The study established that management in the construction sector is not a new phenomenon, but has existed for a long time. The construction sector needs to consider such management approaches with the main focus of reduction of waste and completing projects on time. There is a need for the managers to seek all possible approaches that would enable them to achieve the main narrative of their objectives and success of lean techniques in construction. One of the reasons that has been found common in the construction sector in this study has been lack of an outlined system, and inadequate management support in the implementation or construction processes. This has been one of the reasons for collapsing buildings in Kampala, increasing incomplete buildings, and the escalating costs of investment. The implementation of lean construction must address the effects that have a significant impact on stakeholders. As a result, this study recommends a comprehensive adoption of lean techniques to eliminate such risks and wastes in Uganda's construction sector.

Lean techniques have been implemented and used among developed nations. Their success has been witnessed through reduction of wastes, delivering within the time scheduled and reduced costs to the construction. The fact that it has advantages in the construction industry, it serves the best options that would be applied in the Ugandan sector.

According to the study, further research is recommended about the relationship and the impact of the adoption of lean construction techniques with project performance and quality in the Ugandan construction industry.

Future work is recommended to focus on looking at creating sustainable futures and communities as aligned to the sustainable development goal 11, of the United Nations Sustainable Development Goals, aimed at "making cities and human settlements inclusive, safe, resilient and sustainable" (United Nations, 2015).

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# APPENDICES

## APPENDIX A: Letter of Information and Consent

### LETTER OF INFORMATION

**Title of the Research Study:** Lean Project Delivery System as a Strategy for Project Success in Africa. A Case of Uganda's Construction Industry.

**Principal Investigator/s/researcher:** Ssali Francis
**Co-Investigator/s/supervisor/s:** Prof N. S. Matsiliza (PhD), Prof S Moyo (PhD)

**Brief Introduction and Purpose of the Study:** This study investigates Lean construction techniques in Ugandan's construction industry. The techniques aim at eliminating non value adding activities in the construction industry. The effects of this will be assessed using the construction projects success in terms of cost, time and quality as an indicator. A lean construction project delivery Model/ Strategy for Uganda's Construction Industry will be proposed and how this could be applied to the Construction industry in Africa and South Africa, in particular.
**Outline of the Procedures:** You will be responsible for filling in the questionnaires with the guidance of the research assistant/researcher at their respective offices or work stations. It will take you a maximum of 15 minutes. **Inclusion and exclusion criteria:** This will be based on the experience, skills and knowledge of an individual in a given company about construction in Uganda.
**Risks or Discomforts to you:** The researcher has not identified any risks or discomfort anticipated during the study.

**Benefits:** The research aims at helping the construction industry to adopt lean construction in the attempt to improve project success in terms cost, time and quality. However, there will be no prompt benefits to the participant during the survey. Nevertheless, the results from the study will be beneficial to the industry in Uganda and other African countries, and in particular, South Africa.
**Reason/s why you may be withdrawn from the study:** You may be withdrawn from the study for reasons such as non-compliance, illness, adverse reactions, etc. Nonetheless, there will be no adverse consequences for you should you choose to withdraw.
**Remuneration:** You will not receive any monetary or any other type of remuneration as a result of your participation in this survey.

**Costs of the Study:** You will not be expected to cover any costs towards the study.
**Confidentiality:** The survey will not collect any of the identifying information from you. Information will be collected anonymously to ensure concealment.
**Research-related Injury:** The survey will not expose you to injury. Your personal information will be protected from any other individuals use.

**Persons to Contact in the Event of Any Problems or Queries:**
Please you may contact any of the following: The researcher: Ssali Francis, mobile Number +256706904304. The Supervisor: Prof. N. S. Matsiliza, Tel: +27 338458852 and Co-Supervisor: Prof Sibusiso Moyo, Tel: +27837899465. The Institutional Research Ethics Administrator, Tel +27 313732900. Complaints can be reported to the Acting Director, Research and Postgraduate Support, on +27 313732828 or email: researchdirector@dut.ac.za.

6 August 2020

**CONSENT**

**Full Title of the Study:** Lean Project Delivery System as a Strategy for Project Success in Africa. A Case of Uganda's Construction Industry.

**Names of Researcher/s:** Ssali Francis

**Statement of Agreement to Participate in the Research Study:**

I hereby confirm that I have been informed by the researcher, Ssali Francis about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____

- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

| **Full Name of Participant** | **Date** | **Time** | **Signature** | **/Right Thumbprint** |
|---|---|---|---|---|

I, Ssali Francis herewith confirm that the above participant has b en fully informed about the nature, conduct and risks of the above study.

| Ssali Francis | 21-06-2021 | |
|---|---|---|
| **Full Name of Researcher** | **Date** | **Signature** |
| **Full Name of Witness (If applicable)** | **Date** | **Signature** |
| **Full Name of Legal Guardian (If applicable)** | **Date** | **Date Signature** |

6 August 2020

## APPENDIX B: Questionnaire


**QUESTIONNAIRE**

**Topic:**

**LEAN PROJECT DELIVERY SYSTEM AS A STRATEGY FOR PROJECT SUCCESS IN AFRICA. A CASE OF UGANDA'S CONSTRUCTION INDUSTRY**

Dear respondent,

This research is solely meant for academic purpose. You are kindly requested to provide answers to the subsequent questions as honestly and precisely as possible. Responses to these questions will be treated with utmost confidentiality and any information will not be disclosed. Please tick where appropriate or fill in the required information in the spaces provided. Your assistance will enable this study to come up with accurate results.

*Please fill in the blank or place a tick (√) in the box provided.*

**SECTION A: COMPANY AND RESPONDENTS' PROFILE**

1. Company Classification according to UNABCEC: ……..……..
2. Type of Job / Position: ……...
3. Age (Years):

| | |
|---|---|
| 20 –29 | ☐ |
| 30 –39 | ☐ |
| 40 –49 Above 50 | ☐ |
| | ☐ |

4. Your Experience in the Construction Field:

| | |
|---|---|
| Less than 2 years | ☐ |
| 2- 6 years | ☐ |
| 7-11 years | ☐ |
| 12-16 years | ☐ |
| 16 years and above | ☐ |

5. Company Experiences in Building and Construction Business:

| | |
|---|---|
| Less than 5 years | ☐ |
| 5- 10 years | ☐ |
| 15 years and above | ☐ |

6. Types of Projects Undertaken by Your Company:

| | |
|---|---|
| Housing | ☐ |
| Roads | ☐ |
| Mega Projects | ☐ |
| Others | ☐ |

(Please Specify) ……...

7. On a scale of (0 – 100%), how do you understand Lean Construction? .....

**SECTION B: LEAN IMPLEMENTATION IN THE CONSTRUCTION COMPANY**

Please fill in the blank space or tick (√) the number that applies.

**Rating Scale: Five-point Linker Scale**

| Strongly Disagree | Disagree | Average | Agree | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**a) In your opinion and experience, please rate the appropriate option basing on the question:**

| Qn No. | Question Construct | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Q1 | In this company;<br>▪ Materials or tools are normally waited for before a given piece of job could start. | | | | | |
| | ▪ There is normally waiting for others to finish their part of the job before another part could be started. | | | | | |
| | ▪ Workers normally wait for sign off by the supervisors before moving on | | | | | |
| Q2 | The company normally produces quality works and, in most cases, even produce beyond the expected requirements. | | | | | |
| Q3 | Any work which has not been done up to the required specification or quality is always reworked upon. | | | | | |
| Q4 | Many of the employees in this company normally move around the construction site to relax a bit when the work load is not much. | | | | | |
| Q4 (b) | Many of the employees in this company normally move away from the construction site to look for what to eat during lunch time and break time. | | | | | |
| Q5 | The company normally concentrates too much on a given activity in order to produce very good quality just to satisfy clients even if those kinds of activities are not all that necessary. | | | | | |
| Q6 | The company reserves too much and at times too little materials in the stores depending on the contract deals with suppliers. | | | | | |
| Q7 | In this company we always transport/move all the equipment, tools or materials to the construction site when working on a given project so that no one wastes time to go back to collect them. | | | | | |
| Q8 | The company has a system in place which emphasizes that everyone accepts and embraces change. | | | | | |
| Q9 | The company has an effective change management process to ensure that its vision and policy are effectively communicated towards achieving the project set objectives. | | | | | |
| Q10 | The company has a functioning team with the overall responsibility for training workers to ensure they understand the project objective. | | | | | |
| Q11 | The company provides an environment of team work and blame-free atmosphere to everyone. | | | | | |
| Q12 | The company has a system in place for managing and updating future legal, regulatory and contractual agreements. | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Q13 | The company's processing design is strictly always based on actual customers and stakeholder's demand, needs and requirements. | | | | | |
| Q14 | Operations in the company are systematically identified and well designed to ensure that services and resources are well delivered on time, in the right location and when they are needed in the right quantity with no surplus or deficit. | | | | | |
| Q15 | The company has an effective policy deployment strategy that ensures effectiveness of the operation in order to ensure that there is quality output, fast response, lower cost and fewer errors. | | | | | |
| Q16 | The workers are satisfied with the working conditions in the company. | | | | | |
| Q17 | The supervisors always ensure that all tasks assigned are accomplished on time and correctly | | | | | |
| Q18 | Management in our company is accountable for anything that occurs during operation including all facilitations needed. | | | | | |

| **Strongly Disagree** | **Disagree** | **Average** | **Agree** | **Strongly Agree** |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

| **Qn No.** | **Question Construct** | **1** | **2** | **3** | **4** | **5** |
|---|---|---|---|---|---|---|
| Q19 | The workers have sensitisation programmes about the negative impacts of non-value adding activities for all employees working in our company to ensure steady progress. | | | | | |
| Q20 | The management uses Waste Walk sheet in which non-value adding activities are always identified and noted down. | | | | | |
| Q21 | The management at times hires external experts in tackling ambiguous non-value adding activities if any. | | | | | |
| Q22 | The management always does inspection on the root causes of the waste/non-value activities if any (using Go and See approach) in order to come up with countermeasures. | | | | | |
| Q23 | The management always implements the easy and effective non-value adding activity countermeasures. i.e. Workers are always shown how they can tackle some for themselves. | | | | | |
| Q24 | The company always reduces cost by capturing defects early (it is expensive and unreliable to find defects through inspection). | | | | | |

**b)** If you have any comments/additions on any of the above questions you have just answered, please explain in the spaceprovidedbelow(Optional):……
……..……..……

**SECTION C: 2. PROJECT SUCCESS AND REALIZATION IN TERMS OF TIME, COST AND QUALITY.**

Please fill in the blank or tick (√) the number that applies.

**1. TIME**

**Rating Scale: Five-point Linker Scale**

| **Strongly Disagree** | **Disagree** | **Average** | **Agree** | **Strongly Agree** |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**a) In your opinion and experience, please rate the appropriate option basing on the question:**

| Qn No. | Question construct | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Q25 | Where necessary during execution, the company takes off some time to train the workers to ensure that wastage is minimised. | | | | | |
| Q26 | In the company workers at times work overtime in order to ensure timely hand over. | | | | | |
| Q27 | In the company workers deliver materials, tools and equipment needed after they have been asked for to avoid wastage on site. | | | | | |
| Q28 | In case of ambiguities in the designs, the consultants act immediately once contacted, normally within a maximum of a day, to officially clarify. | | | | | |
| Q29 | The company management always ensures that there is a Gantt chart on site and its normally properly well communicated to the entire team including the lowest labourers. | | | | | |
| Q30 | The critical path activities some times are delayed due to unforeseen circumstances. | | | | | |
| Q31 | At times it is found necessary to ask for extension of time due to; | | | | | |
| | i. Un avoidable natural calamities | | | | | |
| | ii. Clients' failure to fulfil their obligations | | | | | |
| | iii. Too much work for the company to finish on time | | | | | |
| | iv. Too many variations on the project | | | | | |
| Q32 | Projects are normally completed on the initially planned date of handover. | | | | | |

**2. COST**

**Rating Scale: Five-point Linker Scale**

| Strongly Disagree | Disagree | Average | Agree | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**a) In your opinion and experience, please rate the appropriate option basing on the question:**

| Qn No. | Question construct | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Q33 | The company carries out a cost plan before the implementation of any project. | | | | | |
| Q34 | The company normally avoids getting items from suppliers on debt given the complications involved in this. | | | | | |
| Q35 | During the execution of the projects the management keeps on referring to budgets to ensure a balance in accordance with the planned. | | | | | |
| Q36 | The company normally ensures to pay for the variations brought about as the contracts demonstrate. | | | | | |
| Q37 | Research is carried out to determine alternative cost saving methods of executing the company projects. | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Q38 | On most of the projects, corrective actions are normally carried out in case costs are detected to be escalating as compared to the budgeted. | | | | | |
| Q39 | At times penalties arise during execution of the construction contracts (i.e interests on delayed debt payments, among others) | | | | | |
| Q40 | Projects are normally completed within their initial budgets. | | | | | |

**3. QUALITY**

**Rating Scale: Five-point Linker Scale**

| Strongly Disagree | Disagree | Average | Agree | Strongly Agree |
|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 |

**a) In your opinion and experience, please rate the appropriate option basing on the question:**

| quiz no | Question construct | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| Q41 | The new employees are normally skilled enough and therefore there is less need for initial training for most of the operations on site. | | | | | |
| Q42 | The quality of the materials is always pre-tested or checked well before any proceedings on site. | | | | | |
| Q43 | The results of materials testing are always displayed and can easily be accessed by anyone on site in case required for review. | | | | | |
| Q44 | In the company, systems are in place to check and react to any defect i.e. feedback and actions take place at the error stage, to ensure that quality on site comes progressively under control. | | | | | |
| Q45 | Supervisors frequently inspect the project sites i.e. weekly or monthly, and quality issues compromised are normally addressed. | | | | | |
| Q46 | There are normally site visits and site meetings i.e., monthly to evaluate the project progress and quality issues. | | | | | |
| Q47 | Time is always set aside on a weekly or monthly basis for Problem Solving on Quality issues and Error Proofing for issues identified. This is done weekly or monthly | | | | | |
| Q48 | The client determines quality of works for the respective projects | | | | | |
| Q49 | The company prefers working as per the specifications compared to the bills of quantities. | | | | | |

**Thank You for Your Time and cooperation**

**APPENDIX C: Observation Schedule**

DUT
DURBAN UNIVERSITY OF TECHNOLOGY
INYUVESI YASETHEKWINI YEZOBUCHWEPHESHE

## OBSERVATION SCHEDULE

*All data and information to be kept strictly confidential only for academic study purposes*

**Interview guide for the Key Informants**

1. Do you know about the Lean Technology or Principles? If yes, state what you actually know about it.

2. In your opinion, has the construction industry in Uganda embraced Lean Construction Principles? Give reasons to support your response.

3. Are the construction industries in Uganda aware about lean principles? If yes, state the advantages of the technology.

4. State conceptual cases where companies have embraced lean principles. In your opinion, do you feel that the implementation has gone smoothly? Give reasons to support your answer.

5. How have some of the companies utilized the principles of Lean Technology at the project level? State the level and the extent of success to such projects by the various companies.

6. In your opinion, is there any realization of project success in the various companies implementing lean principles? Give reasons to support your answers?

7. State and explain the level of project realization and success by companies in Uganda. Show different levels of increases per project success under lean technology principles.

8. Mention and explain the relationship between lean construction technology and general project construction success.

9. Basing on your experience as well as knowledge of lean technology, which lean construction strategies would you propose to better project delivery. Give reasons for your choice.

10. In your opinion, what is the general perception of the companies towards the proposed construction delivery strategy? Give reasons to support your answer.

**END**

DURBAN UNIVERSITY OF TECHNOLOGY
INYUVESI YASETHEKWINI YEZOBUCHWEPHESHE

## APPENDIX D: Introductory Letter

**INTRODUCTORY LETTER**

Faculty of Management Sciences
Department of Business Administration
Date:

Dear Sir/Madam

I Ssali Francis a PhD student at the Faculty of Management Sciences, Durban University of Technology alongside my research committee here by request for authorisation to conduct research at your organisation. The research seeks to conduct interviews with two respondents from your organisation that will include the projects manager and a site engineer/ supervisor.

The research title is 'Lean Project Delivery System as a Strategy for Project Success in Africa: A Case of Uganda's Construction Industry'. The survey will take only 15 minutes to complete and the participation in this study will be voluntary and participants will be free to withdraw their participation from this study at any time. During the study, the participants will be requested to complete a questionnaire with the aid of the research assistant/researcher whilst observing the Covid-19 standard operating procedures.

This survey has been approved by the Institutional Review Board of Durban University of Technology. There are no risks associated with participating in this study. The survey collects no identifying information of any respondent. All of the responses in the survey will be recorded anonymously.
The information provided will benefit the construction industry generally as improvements in project success will be triggered through lean construction.

If you have any questions regarding the survey, please contact the under signed. By completing and submitting this survey, you are indicating your consent for the study to be conducted at your organisation. Your deliberate consideration is appreciated.

Francis Ssali

Student
Contact Details

Professor N.S. Matsiliza
Supervisor / Promoter

Contact Details

Professor S. Moyo
Co-Supervisor/Co-Promoter
Contact Details

## Appendix E: Gate Keeper's Letter

UGANDA NATIONAL ASSOCIATION OF BUILDING & CIVIL ENGINEERING CONTRACTORS
Lugogo UMA Show Grounds, Plot M764, Coronation Avenue P.O Box 34046, Kampala Uganda
Tel: +256 (0) 392 795036 | unabcec@unabcec.co.ug/ unabcec@yahoo.com | www.unabcec.co.ug

UNABCEC

Our Ref: UNAB/GEN/DUT/06/2022/292

3rd March 2022

Chair of Research Ethics Review Committee,
Faculty of Management Sciences,
Department of Business Administration,
Durban University of Technology,
Durban, South Africa.

Dear Sir/Madam,

**RE: LETTER OF SUPPORT FOR MR. FRANCIS SSALI'S REQUEST TO USE OUR DATABASE TO CARRY OUT HIS RESEARCH STUDY**

Uganda National Association of Building and Civil Engineering Contractors (UNABCEC) is a non-profit, non-political, member-driven Association that brings together **Genuine** Contractors, and other Companies and Organizations engaged in construction contracting in Uganda. Since 1993, UNABCEC has made great strides in improving performance in the Construction Contracting Sector by championing better regulation and enhancing operational integrity.

Reference is made to a letter from your institution dated 1st March 2022, introducing Mr. Francis Ssali and requesting for approval to use our data base of the registered Civil Engineering Contractors in Uganda. This is only to aid his research study titled: **"Lean Project Delivery System as a Strategy for Project Success in Africa. A Case of Uganda's Construction Industry"** in fulfilment for his PhD studies.

We wish to inform you of our acceptance of this request and hereby assure the student of our utmost cooperation towards achieving his research goals, of which the outcome we believe will help in helping the contractors in improving their construction project success in terms of time, cost and quality delivery. A database of our active members in the categories of A-1 Local, A2, A3, A4 and A5 has been availed to Mr. Francis Ssali as per the request. The student has as well been cautioned to observe the COVID-19 SOPs as guided by ministry of Health as he conducts the research.

We look forward to receiving a copy of the research report for the benefit of our members and the industry at large.

Yours faithfully.

UNABCEC
MAR 2022
P.O. BOX 34046, KAMPALA
TEL: 0392 795036

Elizabeth Muhebwa
Executive Director

To be the Lead Engine for the Growth and Development of the Construction Industry in the Region

## APPENDIX F: Costs, energy used and waste

a) A concrete mixer in action

b) A mason ready to transport concrete with a wheelbarrow

c) Transportation of concrete to destination

d) Transported concrete ready to be cast

## APPENDIX G: Waste, improper management, and wastes

a) Bags of cement left unused

b) Improper way of handling cement

c) Quantity of cement left unused


d) Mortar wasted as a result of plastering

## APPENDIX H: Wastes

a) A bag of cement left unused on site

b) Abandoned bags of cement

c) Abandoned bags of cement on site

d) Abandoned bags of cement on site

e) Mortar mixed with water

a) Dismantled formwork boards

b) Dismantled formwork left on site

c) Timber pieces left to decay on site

d) Pieces on timber left on site to decay

a) Broken pieces of blocks due to handling

b) Loss of physical appearance of blocks

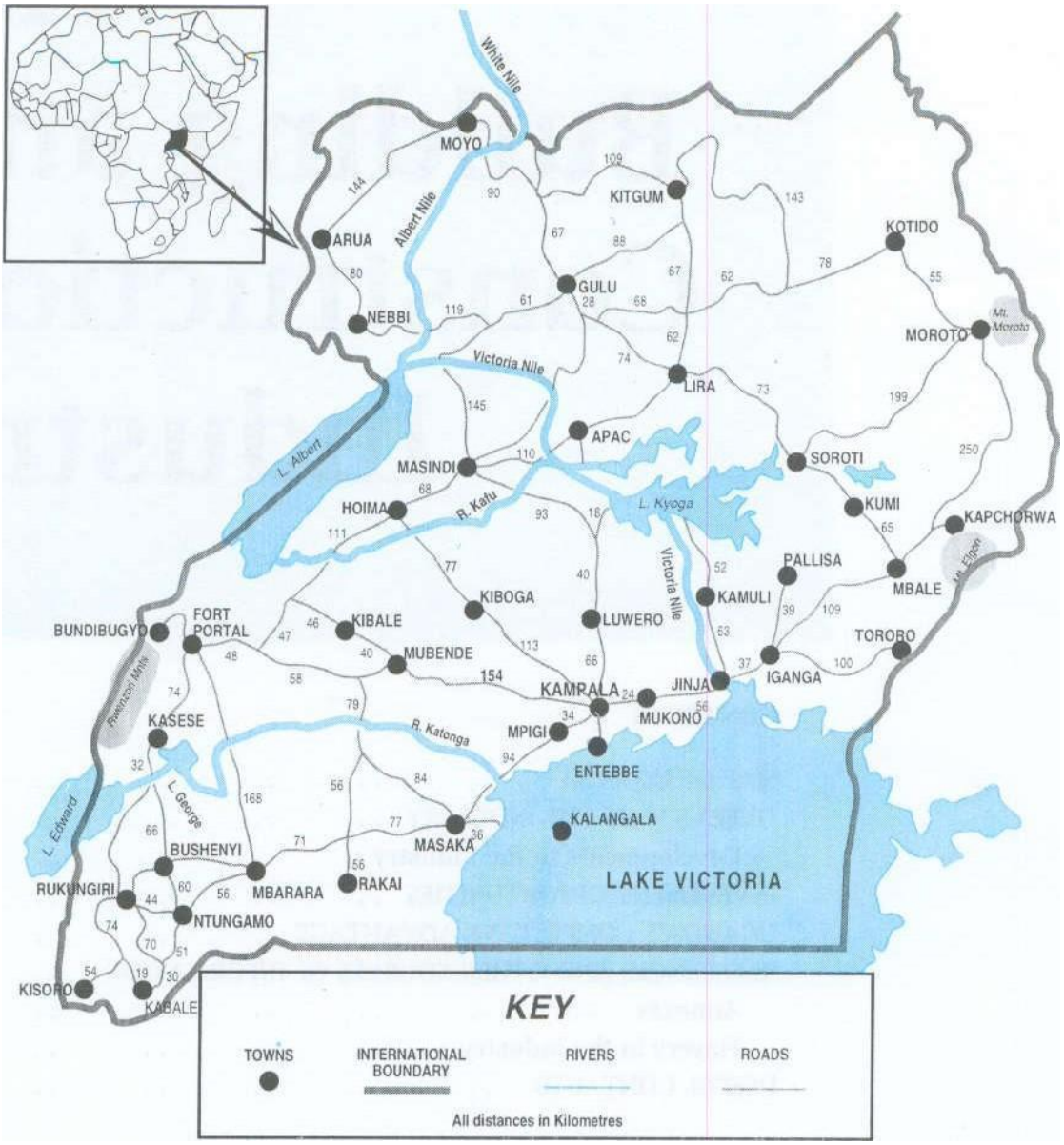
c) Loss of physical appearance due to poor storage

d) Poor storage of blocks

e) Broken pieces of blocks due to transportation

f) Wrong arrangement of blocks

**APPENDIX I: Locating Landlocked Uganda on Map of Africa**



**APPENDIX J: Signed Turn it in Report**

Thesis 1 Francis

ORIGINALITY REPORT

| 18% | 18% | 7% | 10% |
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| Exclude bibliography | On | | |

**Supervisor:** Prof. NS Matsiliza **Date:** 31ST NOV 2022

## APPENDIX K: Publication out of this Study (Accredited Journal Paper)

The Seybold Report

ISSN 1533-9211

**ACCEPTANCE LETTER**

09/09/2022

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| **Author Name/s** | **F. Ssali, N.S. Matsiliza, S. Moyo, H. Alinaitwe, D.N. Nshekanbo and S.H.P. Chikafalimani** |
| **Paper Title** | **IMPLEMENTATION OF LEAN CONSTRUCTION PRINCIPLES FOR A COLLECTIVE ENHANCEMENT OF PROJECT SUCCESS IN UGANDA** |
| **Paper Status** | **ACCEPTED** |

Dear Author/s,

We are pleased to inform you that your paper, submitted for publishing in Seybold Report (ISSN 1533-9211) (TSRJ ) has been accepted based on the recommendations from the Editorial Review Committee. TSRJ would like to request you to go through the Email to complete the necessary formalities for the smooth publication of the Research Paper.

Thank you for submitting your academic research work with Seybold Report. I believe that your collaboration with us will help to accelerate the global knowledge creation and sharing one step further. For any further Queries and support mail us to editor@seyboldreport.org

Looking forward to a good collaboration

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# IMPLEMENTATION OF LEAN CONSTRUCTION PRINCIPLES FOR A COLLECTIVE ENHANCEMENT OF PROJECT SUCCESS IN UGANDA

**F. SSALI[1], N.S. MATSILIZA[2], S. MOYO[3], H. ALINAITWE[4], D.N. NSHEKANBO[5] and S.H.P. CHIKAFALIMANI[6]**

[1,2,3,6] Department of Entrepreneurial Studies and Management, Durban University of Technology, Durban, South Africa.
[4,5]College of Engineering, Design, Arts and Technology, Makerere University, Kampala, Uganda.
Email: [1]ssalifrankie@gmail.com, [2]shirleymats2@gmail.com, [3]dvcrie@dut.ac.za, [3]smoyo962@gmail.com, [4]alinaitwe_h@cedat.mak.ac.ug, [5]dnaturinda@cedat.mak.ac.ug [6]samuelc@dut.ac.za

**Abstract:**

Globally, the cost of construction is escalating and the related industry practices are still regarded as wasteful. Despite the benefits that come along with lean construction concepts and practices worldwide, its adoption generally is still at the incipient stage, particularly in developing countries like Uganda. Moreover, many projects have experienced several problems like; time delays, cost overruns and the generation of massive amounts of waste. Many construction companies in the country are being faced with challenges of non-value adding activities that need to be addressed for the industry to gain substantial benefits from the processes. This research investigates the implementation of lean construction principles for a collective enhancement of project success for Uganda as a developing country. A systematic review methodology was adopted to critically identify the diverse lean construction concepts, and a contextual rationalization of the lean construction benefits appropriate for Uganda was developed. Secondary data was used for the study. Data was collected from published journal papers, conference papers, text books and was analysed. From the study it is evident that Uganda's construction industry

has not yet substantially embraced the lean construction principles.

**Keywords**: Lean Construction, Project Success, Waste Reduction, Uganda

## 1. INTRODUCTION

### 1.1 Background

The construction industry is an important sector that generally produces small and mega projects globally (Jiang and Wong, 2016). The construction industry is faced with several challenges, in Africa and globally, which are certainly of great concern to solve (Sawhney, Agnihotri, and Virendra, 2014). Over time, the construction industry has been criticized for being wasteful, unsafe, fragmented, inefficient, and ineffective (Tezel and Nielsen, 2013). Additionally, Muhwezi et al., (2013) observed that wastage of resources in construction extends to labour, time, materials, capital and machinery. The underlying problems as a result drastically affect the overall project deliverables such as time, cost, and quality in the long run. Tabish and Jha (2012) assert that the specific project deliverables of schedule, cost and quality were considered to be the "iron triangle" which is a criteria for determining the success of a project. According to Ramlee et al., (2016) a project is considered as successful in the construction industry when it is completed on time, within budget and the quality is satisfied.

## APPENDIX M: Ethics Clearance

**Institutional Research Ethics Committee**
Research and Postgraduate Support Directorate
2nd Floor, Berwyn Court Gate 1, Steve Biko
Campus Durban University of Technology

P O Box 1334, Durban, South Africa, 4001

Tel: 031 373 2375
Email: lavishad@dut.ac.za
http://www.dut.ac.za/research/institutional_research_ethics

**www.dut.ac.za**

19 July 2022

Mr F Ssali
Department of Construction Economics and Management
College of Engineering, Design, Art and Technology
Makerere University
P.O. Box 7062
Kampala
Uganda

Dear Mr Ssali

**Lean Project Delivery System as a Strategy for Project Success in Africa: A Case of Uganda's Construction Industry**
**Ethics Clearance Number: 227/21**

The Institutional Research Ethics Committee acknowledges receipt of your final data collection tool for review.

We are pleased to inform you that the data collection tool has been approved. Kindly ensure that participants used for the pilot study are not part of the main study.

In addition, the IREC acknowledges receipt of your gatekeeper permission letter.

Please note that FULL APPROVAL is granted to your research proposal. You may proceed with data collection.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the IREC according to the IREC Standard Operating Procedures (SOP's).

Please note that any deviations from the approved proposal require the approval of the IREC as outlined in the IREC SOP's.

Yours Sincerely,

Prof J K Adam
Chairperson: DUT-IREC

## APPENDIX N: Statistician Certificate

### STATISTICIAN CERTIFICATION

I hereby declare that I served as consultant Statistician for the PhD dissertation titled, "LEAN PROJECT DELIVERY SYSTEM AS A STRATEGY FOR PROJECT SUCCESS IN AFRICA. A CASE OF UGANDA'S CONSTRUCTION INDUSTRY" by Francis Ssali.

I provided services including data management and statistical support for the period 20th August to 28th October, 2022.

The certification is issued to confirm that the university received quality research work.

Signed by:

Sande Muzamiru
Statistician
Email: sande@gmail.com
TEL: +256 705173410

29st October, 2022
Date

## Appendix O: Editor's Certificate

EDITORIAL CERTIFICATE

Email: kaakabrenda18@gmail.com Tel: +256 786221953

31st October, 2022

FACULTY OF MANAGEMENT SCIENCES
DURBAN UNIVERSITY OF TECHNOLOGY

To whom it may concern

DECLARATION BY LANGUAGE EDITOR

I hereby declare that the research report **'LEAN PROJECT DELIVERY SYSTEM AS A STRATEGY FOR PROJECT SUCCESS IN AFRICA. A CASE OF UGANDA'S CONSTRUCTION INDUSTRY"** was edited by an English-speaking professional.

We guarantee 100% language accuracy in the text, as edited and delivered to the student on the date above. We make no claim as to the substantive matter covered by the report and have not altered the intent or research content drafted by the student. The issues corrected were grammar, spelling, punctuation, sentence structure and phrasing.

Should you have any questions or concerns, my details may be found above.

Sincerely,

Kaaka Brenda