Using Lean Operations to Reduce Wastes in the Medication Administration Process at the Gertrude's Childrens' Hospital, Nairobi, Kenya

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DECLARATION

Declaration by the candidate

I declare that this work is my original work and it has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

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DEDICATION

I dedicate this work to my family. To my husband Joshua, my children Clinton and Zuri and my loving parents who have given me encouragement, strength, emotional and social support in culminating this study.

LIST OF ABBREVIATIONS & ACRONYMS

GCH	Gertrude's Children Hospital
ISMP	Institute for Safe Medication Practices
IT	Information Technology
JCIA	Joint Commission International Accreditation
NPSA	National Patient Safety Agency
OPD	Out Patient Department
SEIPS	Systems Engineering Initiative for Patient Safety
WHO	World Health Organization
LSS	Lean Six Sigma
VSM	Value Stream Mapping
SPSS	Statistical Package for Social Sciences

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OPERATIONAL DEFINITION OF TERMS AND VARIABLES

Lean: means creating more value for customers with fewer resources. The core idea is to maximize customer value while minimizing waste (Liker, 2004).

Medication: A chemical compound recognized in an official formulary intended for the use in diagnosis, cure, treatment or prevention of disease (Online Oxford Dictionary, 2018).

Medication administration: The process of giving or applying a pharmacologic or therapeutic agent to a patient (Joint Commission, 2015).

Medication safety: Freedom from accidental injury during course of medication administration/use. Activities that prevent mortality and morbidity related to adverse drug events or delayed medication (Joint Commission, 2015).

Process: A process is a set of actions or steps, each of which must be accomplished properly in the proper sequence at the proper time to create value for a customer or patient (Spath, 2018).

***Muda*:** Means 'Waste'(Spath, 2018).

Outpatient Department- Part or wing of the hospital that is used for patients' diagnosis and treatment that do not require a bed or to be admitted for overnight care (Gertrude's Children Hospital, 2017).

Gertrude's Children Hospital- Private and not for profit hospital that deals with only pediatric Patients (0-18years old). Situated in Nairobi County, Kenya (Gertrude's Children Hospital, 2017).

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ABSTRACT

Lean operations can help to reduce waste and improve workflow, resulting in fewer medical errors, cost savings, reduced medication turnaround times, and reduced product verification and delivery time in healthcare industry. This study sought to describe the current medication processes at the Gertrude's Children Hospital, to identify wastes in the medication administration processes and, to develop and validate a novel medication process that minimizes identified wastes, improves safety and quality throughout the process. The study employed a descriptive cross-sectional design. The study employed a census approach in recruitment of study respondents. Both quantitative and qualitative data. Data was obtained using a self administered structured questionnaire from the frontline staff involved medication administration process and via indepth interview. Value Stream Mapping tool was used to analyze the medication administration process and process mapping was done to display the process flow. Data was analysed using descriptive and inferential statistics. Regression analysis was done to identify factors contributing to wastes in the medication process. Statistical Package for Social Sciences (SPSS) was used to analyze quantitative data. Qualitative data from the indepth interviews was analyzed thematically and framework approach was used in analysis.

Overall, targeted population was all employees involved in frontline of medication administration process (n=60). The study excluded two staff on leave schedule and together with a non response rate of 10.3% (6) a total of 52 staffs (18 pharmacists, 18 nurses and 16 doctors) were enrolled in the study. Among the respondents 63.5% (n=33) were females and 36.5% (n=19) were males. The results of the study established that there was a positive relationship between organizational, people (staffs and patients), technological, environmental and task related factors with timely medication administration but the relationship was insignificant. Thematic analysis revealed that a process engineering on the technology system by putting process alerts will help in reducing medication turnaround times. In conclusion, the factors leading to medication delays were, poor communication, lack of teamwork and inadequate staffing. The study therefore recommended there is need for the hospital management to look into outpatient staffing ratios to have adequate staff, to enhance a culture of teamwork among staff and put in place in the technology system , some process alerts in the system to give prompts for action on the computerized order system.

Keywords: **Lean Operations, Medication Process, Process Wastes, Medication Administration**

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

There is increased recognition that performance improvement strategies underlie successful operations across industries, including healthcare (Senna, Gomes, Monteiro, and Pinha, 2016). Health systems worldwide are undergoing significant reforms and change, motivated by changing technological and medical advancements coupled with an increased burden on services (World Health Organization, 2001). This necessitates re-examining existing work practices and improving efficiency. Quality improvement methods have been introduced to healthcare settings with a view to improving quality and effectiveness. While various approaches to quality improvement exist, Lean has demonstrated positive effects in healthcare settings (Moraros, Lemstra, and Nwankwo, 2016). The application of lean principles enables identification and removal of waste to add value to the patient (Nayar, Ojha, Fetrick, and Nguyen, 2016). Lean methodologies have been successfully employed to healthcare processes such as hand hygiene, emergency department triage and operating room workflow (Moraros et al., 2016).

As the world becomes more globalized and competitive, organizations with poor operations management principles are edged out, with more efficient ones thriving. As the prominence of operations management grows, more and more approaches are being presented as pathways to improved efficiency. Lean Operations is one such model, previously popular in manufacturing, but now increasingly used in the service industry. Central to the Lean model is the notion of providing the customer with more value sooner (Rother and Shook, 1999). They observed that the focus of Lean in healthcare, is concentrating effort towards reducing waste and improving workflow processes. Through this, services will improve and costs reduced. Lean can help to reduce medication errors, medication turnaround times, pharmacist verification time, product verification time, and medication delivery time (Critchley, 2015; Sullivan, Soefje, Reinhart, McGeary, and Cabie, 2014). Improved turnaround time is essential for provision of quality care (Berwick, 2002).

Use of medicines is the most widely used method for treating illness across health systems. However, increased medication use, coupled with increased number of molecules in the market, has created additional risks across health systems. There is overwhelming evidence of increased medication error leading to adverse events. As a result, there has been increased interest in tracing the sources of medication related incidences. Underlying factors reported include delayed medication administration turnaround times and medication process errors. Between September 2006 and June 2009, the United Kingdom National Patient Safety Agency (NPSA) received reports of 27 deaths, 68 severe episodes of harm and 21 383 other patient safety incidents from omitted or delayed medicines (National Patient Safety Agency, 2010).

Medication management and use is one of the key aspects highlighted in the Joint Commission International Accreditation Handbook (Joint Commission, 2015). Delays in antimicrobial administration, for instance, can contribute significantly to patient harm (Nagar & davey, 2015). Other studies have linked delayed antibiotic administration to higher mortality rates among patients with sepsis (Kumar et al., 2006). Delayed antibiotic administration is a common occurrence across hospitals (Gaieski et al., 2010). Similarly, for epileptic children, delayed administration of anti-epileptic drugs is linked to prolonged seizures (Chin et al., 2008). Hence, Ttmeliness is a critical lever for increasing value for patients, providers and health care systems in general. Delays in treatment and failure to provide the right care at the right place and time puts patients at risk. For instance, factors such as poor communication, unclear prescriptions and poor workflow design have been shown to contribute to wastes in the medication administration process. When these inconsistencies line up in a process, as in the Swiss cheese model, the holes allow problems to pass through each layer and can cause potential harm to the patient. Challenges that hinder organizational excellence in medication administration include excessive (low-value) procedures, staff working in silos, excessive targets, insufficient 'buy-in' by staff and a lack of understanding of the effect of variation, systems thinking and process flow.

1.1.1 Lean Operations in Healthcare

Overview on lean: Lean is a concept that was originally developed by Toyota to eliminate waste and inefficiency in its manufacturing processes. The concept became so successful that it has been embraced in manufacturing sectors around the world, and more recently, service industries, including healthcare organizations. The goal of Lean is to eliminate waste, defined as components in any process that do not add value to the user (Liker, 2004). Lean involves principles, methods, and tools to understand and improve the performance of a system. Key principles include the elimination of unnecessary waste, minimizing delays, just-in-time delivery of products and services, worker empowerment, and continuous improvement.

The introduction of these principles placed 'customer value' and 'removing waste' at the centre of Lean thinking. In this manner, the process is essentially driven by 'what customers want' and then organizational steps are taken to define which activities are considered to be 'value-adding' as opposed to 'non-value adding'. 'Value adding' activities are encouraged because they contribute to creating products or services that meet customer expectations. On the other hand, 'non-value adding' activities are considered a waste and need to be removed or avoided (Joosten, Bongers, and Janssen, 2009).

Lean Principles and its application in healthcare: Lean as a concept is based on the principles and working processes of the Toyota Production System and in its simplest terms can be described as the elimination of waste (Liker, 2004). According to Womack and Jones (1997) , the five lean principles include; (1) **Value:** entails defining value from a customer's perspective. Learn what a customer values, and how their experience could be improved to support the best outcome (Spath, 2018). (2) **Value stream:** involves evaluating how steps of a process or procedure should be organized to deliver a seamless customer experience; eliminate any steps that do not directly contribute to achieving that goal. Value-stream mapping is sometimes referred to as process re-engineering (Spath, 2018).(3) **Flow**: whenever possible, eliminate waste between steps of a process so that a product or service is delivered as efficiently as possible. This may require breaking down silo thinking and making the effort to become cross-functional across all departments (Spath, 2018). (4) **Pull**: allows the customer to receive or request products

or services if and when needed; do not push a product or service that a customer is not ready to receive (Spath, 2018).(v) **Perfection**: continuously adapt to an ever-changing environment and customer needs in order to deliver a product or service of the highest possible quality. This entails making lean thinking and process improvement part of the corporate culture (Spath, 2018). The application of lean principles depends on an organization's commitment to continuously improve the value provided to a customer. A lean improvement system uses science-based problem-solving methods to identify root cause of issues, and applies improvement tools to create new standard procedures that reduce waste and improve quality. The effectiveness of new process is monitored to assess results and changes are incorporated to further improve it.

Types of Lean wastes: These include (i) Waiting: This waste occurs any time patients or employees are required to stand by, waste happens. Patients sitting in waiting areas, meetings stalled for latecomers, appointment waiting lists, and idle high-tech equipment are all areas that represent opportunities for healthcare organizations to tap the creativity and imagination of their teams to reduce waste (Spath, 2018). (ii) Inventory: This represents tied-up capital and storage cost. Inventory includes; surplus supplies and medications, superfluous equipment, extraneous data and stockpiles of pre-printed forms. Excessive inventory increases the risk of loss from being stolen or becoming obsolete (Spath, 2018). (iii) Defects: Process or system failures, medical mistakes, and misdiagnosis are examples of defect waste in healthcare. These wastes include preventable allergic reactions and incomplete or erroneous medical records. Organizations can leverage lean principles to mobilize every employee to eradicate defect waste and improve quality to positively impact the bottom line and, most importantly, to avoid mistakes (Grabans, 2016). (iv) Transportation: This waste involves moving people, supplies, and medical equipment unnecessarily. Transporting patients to different departments and running around to gather supplies also increase the risk of patient or caregiver injury (defect waste) and create delays in care (Grabans, 2016). (v) Motion: Waste in motion occurs whenever hospital workers perform movement within their workspace that does not add value for patients. Reaching or stooping for frequently used supplies and equipment, increased walking due to poor building design, or non-ergonomic patient transfers between beds or operating tables are

potential instances of motion waste (Grabans, 2016). (vi) Overproduction: The waste entails redundancies, creating too much of something, or creating it at inappropriate times. Preparing medications for a discharged patient, duplication of tests, or extending hospital stays beyond medical necessity are all examples of overproduction that healthcare organizations can tackle (Grabans, 2016). (vii) Over-Processing: Over-processing occurs when unnecessary work goes into treating patients. Needless tests, filling out different forms with the same information, and performing data entry in more than one system are examples. When time, effort, and resources do not add to the quality of care or improve patient outcomes, it has the potential to be changed or eliminated through lean analysis. The lens of lean healthcare, staff can help identify repetitive, redundant, or less than valuable processes to save time and money (Grabans, 2016). (viii) Untapped Human Potential (non utilization): This waste is brought about by not recognizing and strategically applying the skills, competencies, and initiative of staff members. Waste in healthcare detracts from time that employees could use for building relationships with patients or implementing systems-based improvements. Adopting a lean culture leads to improvements in care quality, decreased cost and improved employee morale and commitment (Grabans, 2016).

Lean tools in healthcare: Lean methodology uses various types of tool. These include;

(a) Value Stream Mapping (VSM): VSM has its roots in early car manufacturers who wanted a way to visualize and evaluate their entire process. The method largely consists of drawing two maps of your workplace. The first represents the current state of production, and should include current delay points, bottlenecks, and more (Belter et al., 2012). The second version is a "future" VSM, which represents where you want to be, and generally has eliminated the issues found in the first iteration. Next task involves working to close the gap between the two images, moving towards the latter (Belter et al., 2012). The focus of this tool is on identifying and eliminating the non-value added activities in each process step and reducing the wait time between consecutive steps wherever possible. Value enabling activities, can be sub-classified into value adding and non-value adding activities, allowing those value enabling activities that are non-valued added to be eliminated (Belter et al., 2012).

(b) Ishikawa (Cause-and-Effect) Diagram and 5 Whys: This method is used wher it is difficult to identify the root cause. In those scenarios, the 5 WHY'S– asking "Why?" five times –

along with a cause-and-effect diagram, can make the task more manageable. The 5 Why's tool helps uncover the process dynamics and the areas that can be addressed easily (Spath, 2018).

(c) The 5'S: The 5S system stands for sort, set in order, shine, standardize, and sustain (Mazzocato et al., 2012). These five steps make up an organizational blueprint for taking any cluttered, hard to navigate or inefficient space and bringing it up to par. It involves removal of items from a space and placing it into piles based upon how frequently they are used and needed. Items that are used are then replaced into new, sensible locations in the room, while unused items are discarded and rarely used ones are stored elsewhere. The room is then cleaned (shined) until it looks like new, at which point the final two steps focus on maintaining this condition indefinitely (Mazzocato et al., 2012).

(d) Mistake Proofing: This is a Japanese phrase meaning denoted as poka yoke. This can be used to tune process steps and also when designing a new system. A combination of an Ishikawa chart and Pareto analysis can be useful in listing the major issues plaguing the as-is process. The possibilities for eliminating a major cause of errors can be explored by improving or redesigning the system to avoid error-inducing scenarios (Holden, 2011).

1.1.2 Wastes reduction Concepts and Operationalization

The right to safe medication administration is outlined in standards for professional organizations (Joint Commission, 2015; Nursing Council of Kenya, 2009). Joint Commision advocates for continuous process improvement to help decrease medication errors and promote patient safety (Joint Commission, 2015). Failure to administer medications at *the right time* is the error that occurs most frequently in the medication administration process (Medved, 2016). Past studies suggest that up to 73% of medication administration procedures suffer some delay in acute care settings (Berdot et al., 2013). With the increasing demand in healthcare, more healthcare facilities are coming up, increasing competition. Sound strategy becomes an important determinant for survival. Lean principles helps eliminate wastes and errors across hospital processes. Elimination of waste (steps that do not add value to the users) can increase patient satisfaction and reduce operational costs, wastages, waits and errors (Cohen, 2018).

The 2001 report by the Institute of Medicine on "Crossing the Quality Chasm" emphasizes the need to improve the design of healthcare systems and processes for patient safety. The report proposes six aims for improvement in the healthcare system: (1) safe, (2) effective, (3) patient-centered, (4) timely, (5) efficient, and (6) equitable (Wolfe, 2001). Even though this section highlights importance of timeliness in medication administration, any improvement aims can become a driver of another. For instance, safety, timeliness and efficiency can be related: inefficient processes can create delays in care and, therefore, rendering potential harm to patients. Improving the efficiency of care processes can have a direct impact on patient safety. Delay between prescription of an antibiotic medication and its administration to septic shock patients is clearly related to patient outcomes: each hour of delay in administration of antibiotic medication is associated with an average increase in mortality of 7.6% (Kumar et al., 2006). Therefore, improving the efficiency and timeliness of the medication process can improve quality and safety of care.

1.1.3 Medication administration process conceptualization

Institute for Safe Medication Practices (2011) defines medication turnaround time as the interval from the time a medication order is written (manually or electronically) to the time the medication is administered. Medication administration is a multi –stage process that involves members from different disciplines, the management of medications must therefore be a joint effort of those who prescribe, those who dispense and those who administer medication (Manojlovich and DeCicco, 2007). Medication management practices in any facility is influenced by policies and standards, regulatory bodies and organization structures. Many of the risks associated with each part of the medication management pathway can be avoided by using systems and processes that are designed to improve safety and are based on evidence from initiatives that have demonstrated significant benefit (Medved, 2016). There are five stages of the medication process: (a) prescribing, (b) verification (c) dispensing (d) administering, and (e) monitoring (Joint Commission, 2015).

The "rights" of medication administration include right patient, right drug, right time, right route, and right dose. These rights are critical for nurses. The essential environmental conditions conducive to safe medication practices include (a) the right to complete and clearly written orders that clearly specify the drug, dose, route, and frequency (b) the right to have the correct drug route and dose dispensed from pharmacies (c) the right to have access to drug information (d) the right to have policies on safe medication administration (e) the right to administer medications safely and to identify problems in the system and (f) the right to stop, think, and be vigilant when administering medications (Massachusetts Nurses Association Association, 2006). Delay in starting of initial medications to a patient can occur at any stage between the steps as a result of non-value laden processes. Elimination of wastes becomes imperative to improve patient experiences (Grabans, 2016). Lean methodology will help to identify wastes in the medication administration processes with the goal of improving quality, increasing productivity and teamwork, and reducing costs (Cohen, 2018).

1.1.4 Gertrude's Childrens' Hospital

Gertrude's Children's hospital (GCH) is a private hospital located in Nairobi, Kenya. The Hospital has over seventy doctors and two hundred nurses, with over 800 employees in total (Gertrude's Children Hospital, 2017). The hospital has expanded through introducing 13 clinic branches and recently achieved Joint Commission International accreditation award. As hospitals seek to strengthen, it is important that they understand and improve medication delivery process. These can improve its reputation and reduce costs (Bates, 1997; Hug, Keohane, Seger, Yoon and Bates, 2012; Karnon, Campbell, and Czoski-Murray, 2009). The outpatient medication administration process starts when a patient is declared an admission and the doctor send the computerized order. The current process flow is illustrated in the following fig 1.1 below.

The medication administration process flow chart at Gertrude's Children hospital outpatient

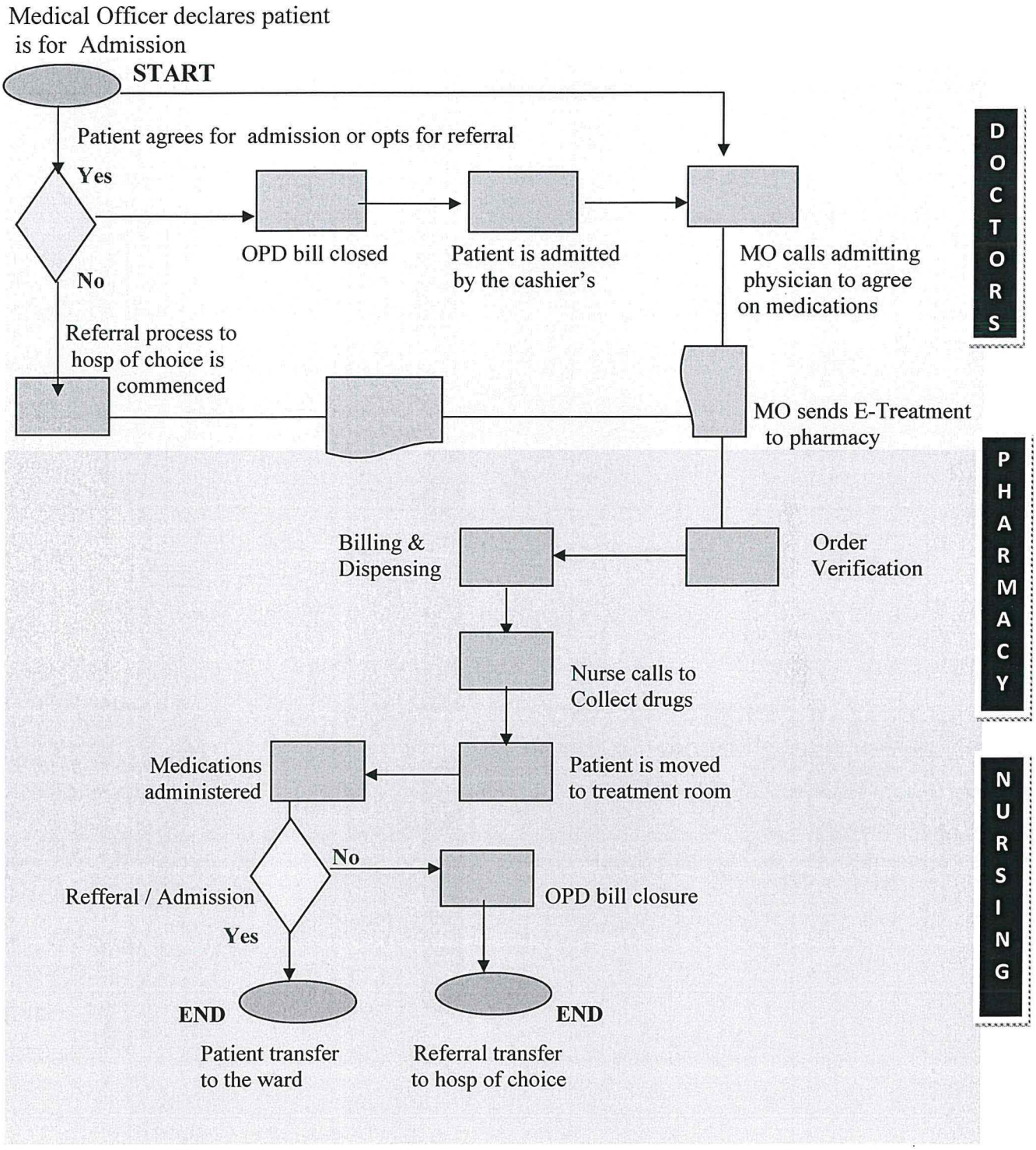


Figure 1. Current process flow illustration at Gertrude's Hospital outpatient

1.2 Statement of the problem

The nursing council of Kenya scope of practice and regulations mandates nurses to administer medications (Nursing Council of Kenya, 2009). Employers are also responsible for providing and offering organizational support and systems necessary for safe and timely medication administration. Thus, different institutions have medication standards and policies that all involved healthcare professionals are obliged to comply.

Gertrude's Children Hospital has a policy of starting initial medications that stipulates that all prescribed medications for admission patients be administered within one hour as the patient awaits transfer to the wards. The policy has outlined the steps involved and the responsibilities of each player. However, senior management have reported observing significant deviation from this protocol, with a large number of patients not receiving medication when needed. This non-conformance has contributed to patient complaints.

Ongoing process improvements that streamline operations, while also driving the highest quality care, demand initiatives that balance the needs of all stakeholders – patients, nurses, clinicians, pharmacy, and the healthcare organization as a whole. Strategies that can help reduce medication administration delays include; maintaining adequate pharmacist and nurse staffing, improving nurses' workflow, adopting effective communication, reliable technology and fostering an institutional culture of excellence and quality care. This study will analyze the extent to which lean methodology can contribute in reducing wastes in the medication administration processes. The study will propose an alternative workflow process that reduces wastes so as to improve timeliness in medications administration.

1.3 Study Objectives

1.3.1 Broad Objective

To identify wastes in the outpatient medication administration process at the Gertrude's Childrens' Hospital using Lean Operations principles.

1.3.2 Specific Objectives

1. To determine factors contributing to wastes across the medication process pathway at Gertrudes Children Hospital outpatient department
2. To develop a medication administration model that reduces medication administration wastes at Gertrudes Children Hospital outpatient department
3. To validate the practicability of the model at Gertrude's Hospital outpatient department

1.4 Study Research Questions

1. What are the factors contributing to wastes in the medication process at Gertrude's Children Hospital outpatient?
2. Does the new developed model reduce wastes in the medication administration process at the Gertrude's outpatient department?
3. Is the new model practicable for the medication administration at Gertrude's Childrens' Hospital outpatient?

1.5 Scope of the study

The study will cover the five components of work system in contributing to wastes in the medication administration processes at Gertrude's Childrens' Hospital outpatient department. The work system components adopted include lean human, lean organization, lean technologies, lean tasks, and lean environment. Information will be gathered from doctors, nurses and pharmacist who participate in the frontline of medication administration process at Gertrude's outpatient department.Both primary and secondary data will be used in this study. Findings may not be directly generalizable across the country; however, given that the majority of hospitals share similarities in operations, findings will inform hospital managers on how to streamline medication processes to improve safety and quality.

1.6 Significance of the study

The study will have significance at different levels.

To Gertrude's Hospital, findings will inform management on current operations in the medication process and provide feedback on how to improve efficiency and safety in medication administration practices.

To other hospitals, findings advise on potential contributors to medical process wastes and inefficiencies, and how a hospital-driven process can help improve the situation.

To researchers and the broader academic communities, findings will add to a growing body of literature on how operations management approaches such as lean operations can be used to improve patient safety and quality of care in key hospital processes.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter is dedicated to literature review on the theoretical underpinnings and reviews as well as literature from researchers regarding aspects of lean operations in reducing medication wastes. The reviews are emphasized along the relationships between the study variables. It also indicates the relationship of the conceptualized variables of the study Studies carried out in various areas have also been reviewed in this chapter. The important aspects of the chapter are propositions emerging from the theoretical and empirical gaps.

2.2 Theoretical Review

This study was premised on the various concepts and constructs anchoring two key model inthis study. The two models are the Avedi's Donabedian Model and the Systems Engineering Initiative for Patient Safety (SEIPS) model which all highlight work in health quality and work systems respectively.

2.2.1 The Avedis Donabedian Model

The Donabedian Model (1988) focuses on improving quality in healthcare through defining and strengthening structure, processes, and outcomes. Avedis Donabedian proposed a linear relationship between the three constructs with respect to quality of care (Donabedian, 1988). Structure represents the characteristics of the setting where care occurs, the quality of material and human resources, and the organizational structure. For instance these can include medication, environmental, and patient factors. In the case of medication factors, an example would be medication route and the influence of this factor on the timeliness of administration (Teunissen, Bos, Pot, Pluim and Kramers, 2013). For example, injectable medications sometimes take longer to prepare and may take longer to administer because of the need to position patients correctly prior to administration. Processes are activities of providing care (by the practitioners)

and receiving care (by the patient) (Donabedian, 1988). This refers to the actual chain of events before the patient gets the drugs. The aspect of timeliness comes into play. Donabedian theorizes that good structure enhances the possibility of good processes, which in turn enhances good (quality) outcomes (Donabedian, 1988). Outcomes can be patient satisfaction, quality care or reduction in costs, morbidity and mortality.

2.2.2 The Systems Engineering Initiative for Patient Safety (SEIPS) model

The 2005 report by the National Academy of Engineering and the Institute of Medicine advocates for increased involvement of human factors and systems engineering to improve healthcare delivery (Reid, Compton & Grossman, 2005). The SEIPS model provides a framework to analyze factors affecting medication safety by examining the work system concepts of technology, tasks, persons, environment, and organization that threaten safe medication practices. Patient safety researchers clearly recognize the need for human factors engineering and systems approaches to patient safety research, analysis, and improvement. According to Carayon et al (2006), SEIPS model goes further by specifying the system components that can contribute to causes and control of medical incidents showing the nature of the interactions between the components, showing how the design of the components and their interactions can contribute to good or bad processes.

The SEIPS work system is composed of five components, (i) Person refers to individuals at the centre of the system. Can be single individual (e.g physician, nurse or patient) or can be a group of individuals (e.g team, organizational unit). Individual characteristics include: physical characteristic (strength, height, weight), cognitive characteristics (expertise, experience) and psychosocial characteristics (motivation, or need for social support). (ii) Tasks refers to description of characteristics and task; variety, content, physical and psychological demands (iii) Tools and Technologies includes health information technologies, medical devices, and other tools and technologies used in the outpatient medication process (iv) Physical environment entails, physical layout, workstation design, noise, lighting, temperature and humidity and air quality in reference to the Gertrude's Hospital outpatient (v) Organization refers to formal and

informal organization, organization culture and climate, rules, policies and procedures applied in medication processes, organization structure and management.

SEIPS model nests itself to Donabedian's quality model (Donabedian, 1988). Whilst the Donabedian's model focuses on care processes—that is, how care is provided, delivered and managed, the SEIPS model expands the concept of process to include not only care processes but also other processes that support the care process such as maintenance, housekeeping and supply chain management. These other processes need to be designed to support the delivery of safe care. For instance, performance obstacles such as inadequate supplies, layout designs can lead to delay in care as identified among the eight types of lean wastes. The Avedis Donabedian model (1988) is a widely diffused model within the quality health assessment area and is directly connected to the search for continuous quality improvements, as well as lean thinking (Grabans, 2016). While the Donabedian model continues to serve as a touchstone framework in health services research, potential limitations have been suggested by other researchers, and, in some cases, adaptations of the model have been proposed. The sequential progression from structure to process to outcome has been described by some as too linear of a framework (Mitchell, Ferketich and Jennings, 1998) and consequently has a limited utility for recognizing how the three domains influence and interact with each other (Carayon et al., 2006).

The model has also been criticized for failing to incorporate antecedent characteristics such as patient characteristics and environmental factors which are important precursors to evaluating quality care (Coyle and Battles, 1999). Coyle and Battles suggest that these factors are vital to fully understanding the true effectiveness of new strategies or modifications within the care process (Agency for Healthcare Research and Quality, 2013). According to Coyle and Battles, patient factors include genetics, socio-demographics, health habits, beliefs and attitudes, and preferences (Agency for Healthcare Research and Quality, 2013). Environmental factors include the patients' cultural, social, political, personal, and physical characteristics, as well as factors related to the health profession itself (Agency for Healthcare Research and Quality, 2013).

The SEIPS model allows for examination of components of work system that can lead to inefficiencies in patient care such as human resource, tasks, tools and technologies, environment and organization (Carayon et al., 2006). The strength of this model is that, it focuses on system design and how it impacts on processes and outcomes. According to Carayon et al (2006), the SEIPS model allows for thorough examination of system processes compared to Donabedian model. This model adds more to the Donabedian in that; it describes relationships between the components, it gives a more comprehensive view of the structure element and looks at the heathcare system as whole rather than its part.

2.3 Empirical review of literature

This section presents the empirical review of the studies that are related to the study. Empirical review in the study has been done based on the study objectives of the study. In a global context, countries like Sweden, Japan, Canada, America, and Russia have implemented lean in healthcare and are very successful in the overview of value stream mapping; while the lean management is implemented only in very few health care services in India (Vinodhini , Seethalakshmi & Sowdamini, 2018). A review of the literature concerning trends in healthcare shows that 73.44% of the existing lean studies are based on manufacturing industry, while the healthcare sector constitutes 3% of these studies (Jastia and Kodali, 2015). Thus there is very limited studies on lean application in the medication process. In North America, there are many examples of Lean healthcare interventions but the largest Lean transformation in the world was attempted in the province of Saskatchewan, Canada (Saskatoon, 2014). The Health Quality Council of Saskatchewan concludes on its web-site that Lean increases patient safety by eliminating errors, increases patient satisfaction, reduces cost and improves patient health outcomes (Health Quality Council, 2015).

At Virginia Mason Medical Center (Seattle), the Collaborative Alliance for Nursing Outcomes (CALNOC) Medication Administration Accuracy Quality Study was used in combination with Lean quality improvement in efforts to address medication administration safety. The resesearchers found that Lean process improvements coupled with direct observation can contribute to substantial decreases in errors in nursing medication administration (Ching, Long,

Williams and Blackmore, 2013). In another study to look at impact of lean methodology in intravenous medication processes in a children's hospital, researchers found that wastages in doses reduced by 16.6% resulting to 2.6% reduction on annual expenditure on medications (L'Hommedieu and Kappeler, 2010). Table 1 below shows the benefits of lean in the medication process in few selected studies.

Table 1. Benefits of lean methods in selected medication process studies

Application Area	Benefits	Authors
Inpatient Pharmacy-sterile products area	Work flow improvement Waste reduction Decreased staff requirements Reduction in missing doses, expired products and production errors Annual cost saving Quality andpatientsafety improvement	(Hintzen, Knoer, Van Dyke, & Milavitz, 2009)
Inpatient pharmacy inventory area	Decreasednumber of outdated drugs Reduction inmedication inventory	(Hintzen et al., 2009)
Inpatient Units	Medication administration errors reduction Medication room layout improvement	(Ching et al., 2013)
Community Hospital	Medication administration safety improvement Staff and physician satisfaction improvement	(Critchley, 2015)
Pharmacy division	Reduction in missing medication	(Kumar & Steinebach, 2008)

Source: Trakulsunti & Antony (2018)

2.4 Research gap analysis

Lean method has been mainly developed for manufacturing industries (Likert, 2004); nowadays, companies in different areas are trying to adopt it in order to expand their production effectively and efficiently (Moraros et al., 2016). According to Grabans (2016), healthcare is one of the sectors where the introduction of the concepts of lean production and Toyota Production System has given good results in terms of eliminating waste, keeping inventory low, increasing

efficiency, valuing people, and non-stop improving. Lean methods and lean tools, benefits and challenges of application in the context of medication administration wastes ,has not been reported before in the literature and therefore this paper could bridge this gap. Most significant percentage of this literature that has been reviewed is from developed countries and very little from the developing world.

Harrison et al (2016) conducted a review of Lean projects implemented in five different health care settings, to advance understanding of the context's influence on increasing efficiency and reducing cost in a variety of healthcare systems. Among the key factors contributing to success they identified were the commitment and support provided to the effort by top organizational leaders; previous experiences with quality improvement initiatives; aligning Lean mplementation with the organizational mission and vision; and dedicating resources—including assigning experts—to Lean (Harrison et al., 2016). In a recent review, Mazzocato, Savage, Brommels, Aronsson and Thor (2010), concludes that lean has been applied successfully in healthcare institutions worldwide. However, most studies have a narrow technical application with a limited organisational reach. Many are single case studies, some quite anecdotal, while others are biased or characterised by a weak study design. Some reviews suggest that inappropriate analyses, a lack of alternative hypotheses and other methodological limitations undermine the validity (Kontos and Poland, 2009; Young and McClean, 2008). This makes it difficult to rule out confounding explanatory factors, to measure the outcomes and generalise the results from lean interventions. Daultani, Chaudhuri & Kumar (2015) describe that different healthcare services pose unique challenges to lean implementation due to their inherent characteristics of service delivery.

2.5 Conceptual framework

There are several emerging issues and incrasing competition in the health market hence hospitals that have developed lean operations in their care processes. This study has conceptualized humans (staff and patients),organization, technology, tasks and environment as independent variables and timely administerd medications as dependent variable. The model given in figure

2.1 indicate that lean human, lean organization, lean technology, lean tasks and lean environment contributes to lean operations in the medication process and hence has an effect effect on medication administration timeliness. It indicates that timely administration of medications is reliant on the lean operation process that has the components given in conceptual framework.

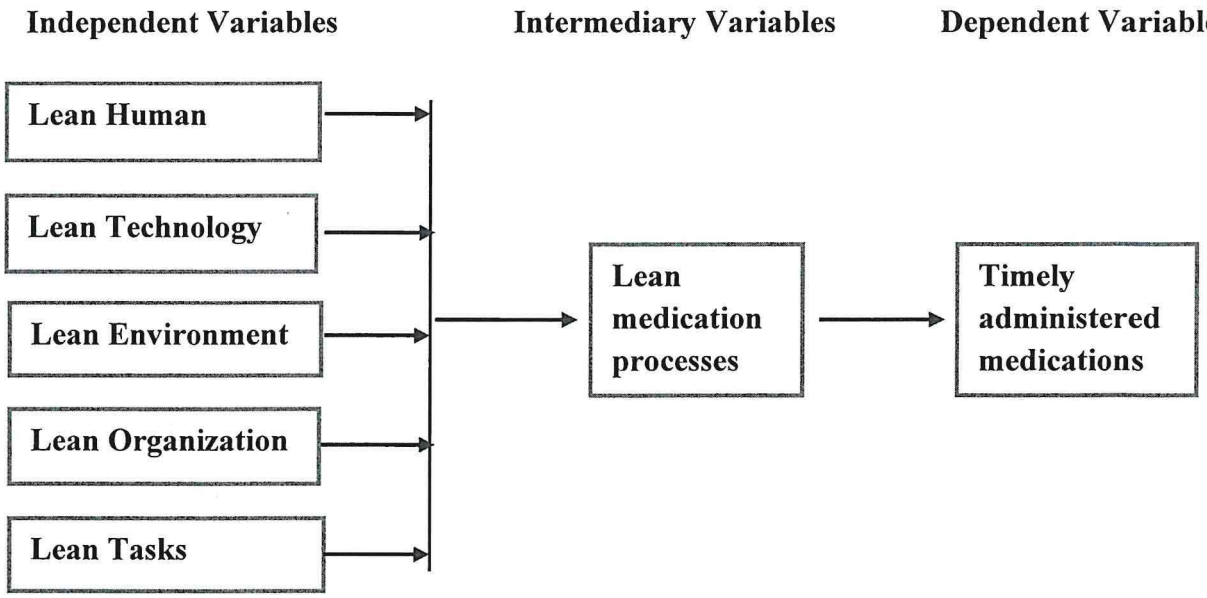


Figure 2. Conceptual Model

Source: Author, 2019

Lean Human: Humans (individuals/staff) are fallible and prone to mistakes (Karavasiliadou & Athanasakis, 2014). These involve: miscommunication, non-adherence to the proper steps of medication preparation (checking-rechecking, application of the five rights which includes the right patient, right drug, right route, *right time,* right dose), personal neglect, difficulties in using infusion devices, nurses' physical exhaustion, and problems with physicians' prescription (illegible handwriting, unclear verbal orders). Nursing factors such as age and experience have also been shown to be related to the occurrence of medication delays in the acute care setting as a result of competing priorities (Fasolino, 2009; Jones and Treiber, 2010).

Lean Technology: Information Technology (IT) for medication administration has a far-reaching impact on the entire healthcare community. Apart from decreasing the rates of

medication errors it has also assisted the nurses in the medication administration process by checking the 5Rs- Right (patient, drug, dose, route and time) at the point-of-care. The Electronic Medical Record system helps reduce patient waiting time through avoiding the need for written records and making record retrieval easier and faster, ensures patient information confidentiality, improves clinical decision making and which all lead to better patient and provider satisfaction (Waithera, Muhia, and Songole, 2017). If there is no technology to support nursing workflow at the bedside, nurses will often intentionally circumvent hospital protocols or procedures with a goal of expediting delivery of the medication to the patient in a more timely manner (Hurley et al., 2007).

Lean Environment: Productivity increases when workgroups are kept small and well-integrated, sources of distraction are kept to a minimum, and the design of the work setting is comfortable, safe, and healthy (Leaman & Bordass, 2000). Personal control over environmental variables also aids in improving an individual's performance and job satisfaction (Leaman & Bordass, 2000). A lean environment utilizes the 5S's in keeping the working space orderly for patient safety. This helps to save time in resources utilization.

Lean Organization: Improving communication is another recommended practice to reduce medication administration inefficiencies. The 2002 Joint Commission *Sentinel Event Alert,* Delays in Treatment, reported communication breakdown was responsible for 84% of health care sentinel events (The Joint Commission, 2002). In a comparison of healthcare and aviation safety, poor teamwork and communication problems was linked to unfavorable outcomes (Gaba, Singer, Sinaiko, Bowen and Ciavarelli, 2003). The 2005 American Association of Critical Care Nurses study, *Silence Kills,* identified seven crucial concerns in healthcare (Vital Smarts, 2005). The seven concerns were broken rules, micromanagement, mistakes, disrespect, incompetence, poor teamwork, and lack of support. These crucial concerns can cause inefficiencies in medication process. The study encourages leaders to design environments where staff can speak up where such concerns arise.

Lean tasks: Research demonstrates that increased nurse workload can influence timely medication administration (Biron, 2009; Duffield et al., 2011; Kim, Kwon, Kim, and Cho, 2011). Increased workload was observed in a series of studies, conducted in pediatric and other hospital

settings (Kim et al., 2011; Tang, Sheu, Yu, Wei and Chen, 2007). Researchers argue inadequate nurse staffing affects timeliness in medication administration (Deans, 2005; Duffield et al., 2011; Jones and Treiber, 2010 and Kim et al., 2011). Nurses usually are expected to fulfill many responsibilities and duties during their working shift, thus the possibility of late administration is increased particularly when nursing staff shortage is dominant. The requirement that certain high-alert medications be double-checked with a second nurse takes additional time (Institute for Safe Medication Practices (ISMP), 2013; Jarman, Jacobs and Zielinski, 2002). These medication step can add up to 20 minutes to the medication administration process, suggesting that this may contribute to medication administration timeliness in the clinical setting (Jarman et al., 2002). Working long hours has detrimental effects on patient care. Error rates were found to be three times higher when nurses worked shifts lasting 12.5 hours or more in a study by (Rogers, Hwang, Scott, Aiken & Dinges, 2004).

2.6 Summary of Literature review

Lean offers significant advantages over various other quality improvement models by increasing efficiency and reducing waste while simultaneously improving quality of patient care. With its focus on increasing value, lean has the potential to help balance the cost associated with healthcare, increase the job satisfaction of healthcare professionals, and fundamentally improve the health of the patients. The work by "Peter Senge and the learning organization" shares similarity with lean. The idea of a "learning organization," as promoted by Peter Senge in his book *Fifth Discipline*, is not something different from lean management (Senge, 1991). Rather, it is embedded within lean management. A learning organization is an organization in which individuals and teams watch and learn, make changes, experiment, and then learn from those experiments. This should be going on every day within every team at every level. While lean approach is usually bottom-up, the role of management support cannot be over emphasized. Juran's work highlighted 14 philosophies integral for continous improvement among which support by management is very imperative.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This section presents a detailed description of the research methodology and approaches that were adopted in conducting this study. These include research design, population of the study (target) and sample size. The type and source of data are explained as well as the methods of data collection. It also outlined methods of data analysis and the ethical consideration.

3.2 Study Design

Research design refers to the outline on how the research is conducted Garg and Kothari (2014). Both the qualitative and quantitative approach to research was employed in this study. This was a descriptive cross sectional study where data was collected at one point in time. This study design was preferred because the study sought to identify what factors causing wastes in the medication administration process consequently affecting timely medication administration to patients at Gertrude's Hospital outpatient in particular. According to Jonassen (2001) descriptive research design attempts to answer the " what? " question and provides objective reliable and scientifically valid descriptions of what people think, say and do, It answers the what questions about a single variable.

3.3 Population and Sampling

3.3.1 Target population

The target population of the study was all clinical staff involved in medication process in outpatient. Gertrude's outpatient of main hospital was chosen because it's the entry for all admission patients. The target population for the study was a total of 60 clinical staff; 20 nurses, 18 doctors and 20 pharmacists.

3.3.2 Sampling Design

Sampling techniques describes the different sampling methods. This study employed census technique where the entire population was enrolled (Polit and Beck, 2010) except for those who were on leave. The staff population was small and confined to one location under study.

3.4 Data Collection

3.4.1 Data Collection Instruments

The study was be conducted between in 26thApril to 15thMay 2019 using the following tools;

Questionaire: The questionnaire was administered to the front line staff in the medication administration process. The questionnaire constructs included questions to identify areas describing the work system categories adopted from SEIPS model: person, tasks, technology, environment, process, and organization in their contribution to wastes in the medication administration process. The questionnaire was evaluated by pretesting the tool at Rongai outpatient branch. Admission process in the satellites is similar to that in outpatient Muthaiga.

Value Stream Mapping Tool: This tool was used to identify and show the various steps a patient goes through along the medication process. Data was capturing all the process steps a patient goes through, the staff he/she interacts with and communication channels involved in the entire process. This was guided by the ideal patient pathways adopted by Gertrude's Childrens' Hospital outpatient department.

In-depth Interviews: In-depth interviews were conducted with purposively selected healthworkers using an interview topic guide. Those who were interviewed included nurses, doctors and pharmacists who were involved in medication administration. The number of interviews was dependent on attainment of saturation. Indepth interview was conducted to few purposively selected healthworkers. Qualitative studies usually involve smaller samples as compared to quantitative studies as qualitative studies focus on meaning instead of making generalized hypothesis. A small sample ensures the researcher can form a more meaningful bond and establish rapport with the participants for a richer discussion and interview process.

3.4.2 Data Collection Procedures

The study used questionnaires and Value Stream Mapping Tool to collect data. Secondary data was collected from documented sources such as library books, magazines and newspapers and internet literature. For the main purpose of this research, the study collected primary data but relied on the secondary data for the literature review. The researcher engaged the help of one research assistant in the data collection process where he was assigned to collect data to the staff who are working at night throught the study period. The research assistant was briefed and trained by the researcher on the purpose of this study and the modalities of the data collection process. Specifically, the research assistant was trained on ethics to ensure that he approaches respondents in a polite way. In addition, the knowledge about the purpose of the study was given to him to enable him guide the respondents appropriately so as to achieve the required information.

3.5 Research Quality

3.5.1 Reliability

The pilot test was conducted at Gertrude's Rongai out patient clinic to all the four nurses and two doctors working in the facility. The aim of the pilot was to test the validity and the reliability of the study instrument. Cronbach's alpha is a popular method for estimating the reliability of an instrument. The questionnaire was subjected to overall reliability analysis for internal consistency. Internal consistency measures the correlations between different items on the same test (or the same subscale on a larger test) and whether several items that propose to measure the same general construct produce similar scores. The pilot survey revealed Cronbach's alpha of 0.784. A cronbach's alpha (α) value obtained above 0.7 was considered to have good internal consistency denoting the questionnaire was objective in nature. This indicated that the data collection instruments were reliable and would give the same outcome in case of repeated analysis. For the qualitative data, the researcher ensured trustworthiness among respondents to enhance credibility of data, transferability, dependabability and confirmability(neutrality of

researcher). The respondents were explained the data procedures correctly and the clear purpose of the study. They were given ample time to answer questions so as to elicit correct answers.

3.5.2 Validity

Validity is the accuracy and meaningfulness of inferences, based on the research results (Polit and Beck, 2010). The study used content validity to ascertain the validity of the questions. Content validity in the study was ascertained by giving the research instrument to the supervisor whose recommendations were intergrated in the study. The validity test was done using the data collected from the pilot test then tested against Cronbach's α value where the α value obtained was compared to ideal value of $\alpha = 0.7$. For the qualitative data, the researcher ensured validity theoretical foundations and also trustworthinesss. Respondents were given ample time to answer the questions to elicit correct responses.

3.6 Data analysis and Presentation

The data collected was edited first to eliminate errors and check for completeness then analyzed using descriptive statistics. The descriptive data derived included frequencies and percentages. Inferential statistics were used to make inferences from sample statistics to population parameters in oder to make generalization on the findings. Analysed information was to be discussed, interpreted, summarized and presented. SPSS software was used to perform the quantitative analysis involving inferential statistics. Qualitative data was first transcribed from the unstructured field notes in order to insights and concepts. Then data was organized into related concepts. Thirdly the data was coded into various emerging themes and was manually analyzed using thematic framework approach.

3.7 Ethical Considerations

Confidentiality, anonymity and privacy was provided by avoiding use of individual names and with the right to withdraw from the study at any point in time. Participants were given the right to know the purpose of the study, accept to participate willingly and give consent in writing. Strathmore University Institutional Research and Ethics Committee approved the research

proposal before it was executed. Permission by Gertrude's Hospital Ethics and Research Committee was also obtained before data collection. Sudy approval was also sought from the National Commision for Science Technology and Innovation (NACOSTI).

CHAPTER FOUR

RESEARCH FINDINGS AND INTERPRETATION

4.1 Introduction

The main objective of the study was to determine factors contributing to medication administration wastes with effect on timeliness in medication administration. This chapter presents an analysis of data that was collected and interpretation of the findings. Presentations of the results are on tables and figures where appropriate. The choice of presentation depends on the best suitable method that would have a first impression on the reader giving clear indication of the data being presented. Both descriptive and inferential analysis techniques were employed in the analysis. The results are presented according to the research objectives and the chapter is organized according to the themes derived from the research questions. The first part of the analysis chapter provides descriptive results while the second part gives inferential results showing the relationship between the variables of the study. A total of 58 questionnaires were administered. From this number, 52 questionnaires were duly filled and returned. This represented an overall successful response rate of 89.7% as given in figure 4.1 above. Mugenda and Mugenda (2003) asserted that response rate of 50% is acceptable to analyse and publish, 60% is good and 70% is very good. The 89.7% response rate was good enough to serve as a representative of the population. This means the findings can be representative of the population.

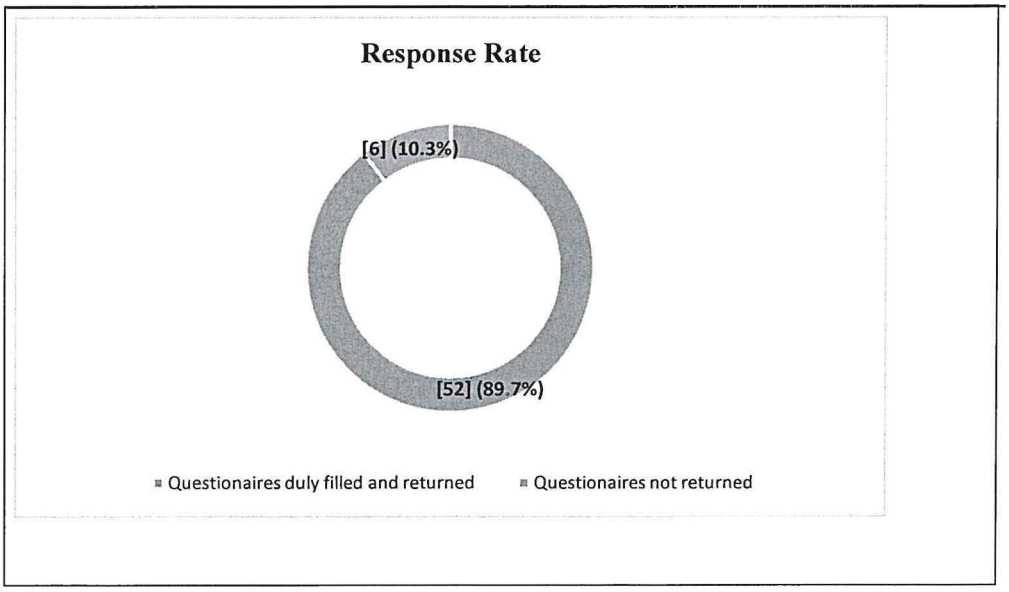


Figure 3. Respondents Response Rate

4.2 Social Demographic Characteristcis of respondents

The study also sought to analyse the demographic characteristics of the respondents in terms of gender, professional cadre, age bracket, and work experience this was done to enable the researcher get knowledge of the respondents characteristics and assess whether the respondents possesses information relevant to the study.

Table 2. Respondents Demographic Characteristics

Baseline variables	Categories	Frequency (n=52)	Percentage (%)
Gender	Male	19	36.5%
	Female	33	63.5%
Proffessional Candres	Doctors	16	30.8%
	Pharmacists	18	34.6%
	Nurses	18	34.6%
Years of Experience	Less than 3years	8	15.4%
	4years to 7years	18	34.6%
	8years to 11years	15	28.8%

	12years to 15years	9	17.3%
	16years and above	2	3.9%
Age of Respondents	0- 25years	1	1.9%
	26-30	7	13.5%
	31-35	20	38.5%
	36-40	15	28.8%
	41-45	6	11.5%
	Over 45years	3	5.8%

The respondents were asked to indicate their gender. Results in table 4.1 reveal that majority (63.5% n=33) of the respondents were female while 36.5% (n=19) were male. This implied that most of the employees working in hospital such as doctors, nurses, and pharmacists are female. Nevertheless, the number of male employees in hospital is reasonable as shown in Fig 4 below.

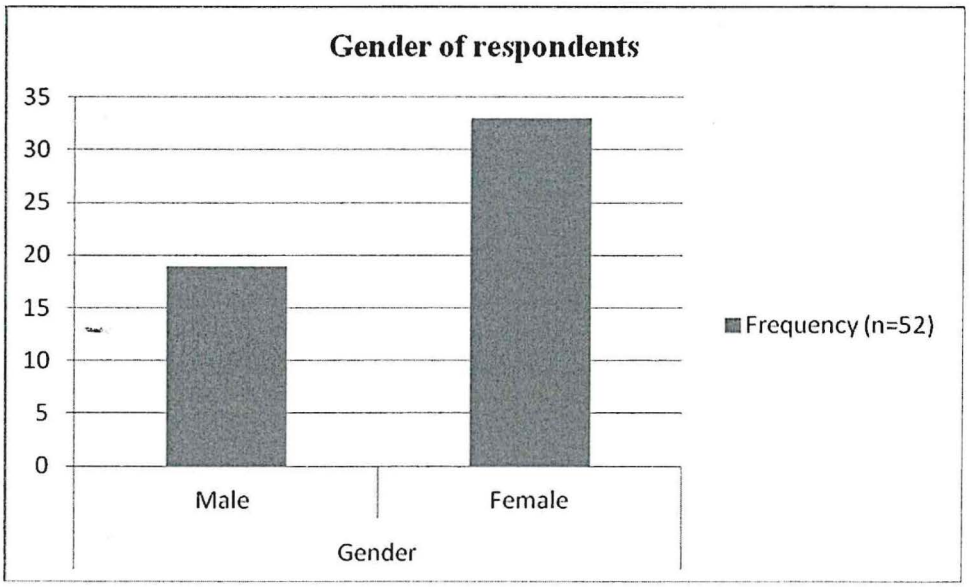
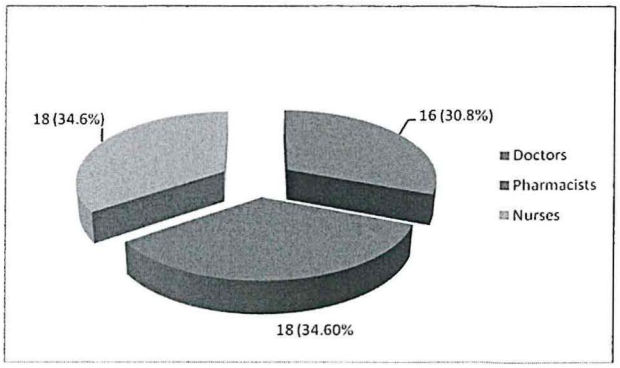


Figure 4. Respondents Gender

In addition, results in the same table reveal that (34.6% n=18) of the respondents were pharmacists, which was similar to nurses (34.6% n=18) while Doctors were 30.8% (n=16); The number of doctors equals to that of nurses because two staff were on leave for each group at the time of data collection.

Figure 5.Respondents Work Candres



Similarly, the respondents were asked to indicate the number of years they had worked in the hospital in order to elicit length of experience. The results showed that majority 34.6% (n=18) of the respondents had worked in their current employment between 4 –78 years followed by those who had worked for between 8 – 11 years (28.8% n=15). The results therefore indicate that majority of the respondents had proper experience in understanding the organization, the medication process and the processes flow regarding the outpatient department. The study results can be relied on since the respondents had vast experience as illustrated in fig 6 below.

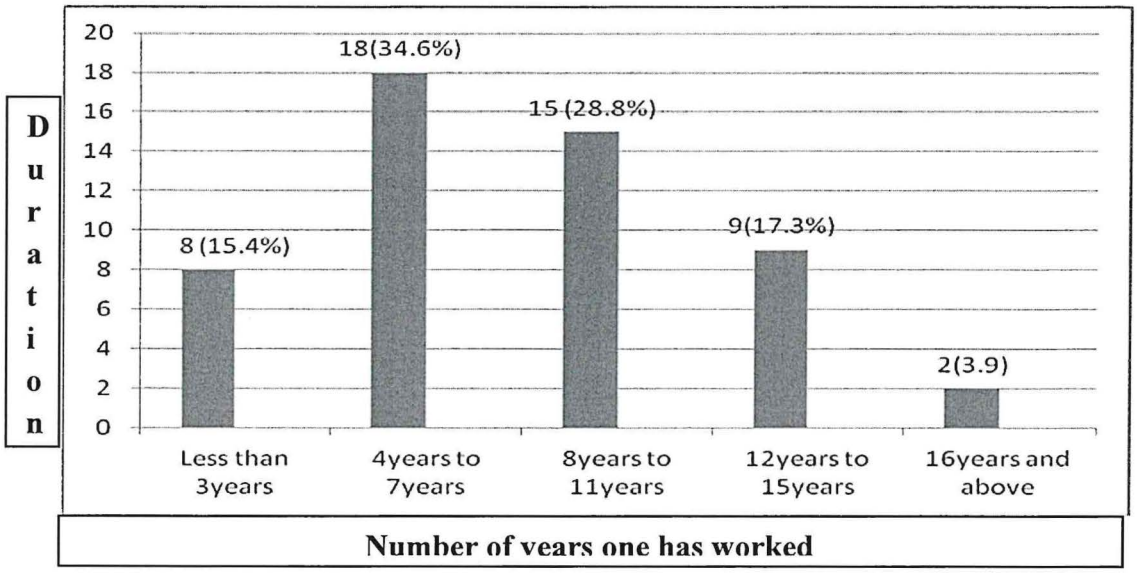


Figure 6. Respondents number of years worked in hospital

In addition the results revealed that majority of the respondents (38.5% n=20) were aged 31 – 35years followed by (28.8% n=15). Only a few employee were noted to have over 40 (11.5% n=6) and (over 45years 5.8% n=3). Only 1 respondent (1.95) had age below 25years, denoting this could have been a new employee who recently joined the proffesion. The bargraph in Fig 7 below gives visual display of this data.

Figure 7. Showing respondents age brackets

4.3 Internal Consistency of the questionnaire instrument

An internal Consistency analysis was conducted for the questionnaire tool as shown in table below. Analyses of inter-item internal consistency of the questionnaire items demonstrated that all the measures obtained internal consistency at Cronbach's alpha coefficient (α) of 0.78. Reliability was assessed using the standardized Cronbach's alpha coefficient for the measure of inter-item covariance. Reliability was equally high (Cronbach's Standardized Alpha=0.796).

Table 3. Showing internal consistency of the items

Cronbach's Coefficient Alpha	
Variables	**Alpha**
Raw	**0.776**
Standardized	**0.796**

4.4 Factors contributing to medication process wastes

The study sought to identify factors contributing to wastes in the medication administration process. A questionaire with Likert scale was used to derive ratings as given by the respondents. process at Gertrude's Children Hospital outpatient

4.4.1 Factors influencing timely medication administration wastes

4.4.1.1 Lean Organizational factors

To examine the influence of organizational factor on managing medication administration process wastes, several statements were made to help the research explore all the organizational factors influencing timely medication administration. Different reactions were observed as shown in the table 4.2 below

Table 4. Organizational factors in medication administartion wastes

Statements	1 SD	2 D	3 N	4 A	5 SA
The management is keen in ensuring timely medication delivery		1 (2%)	4 (9%)	23 (50%)	18 (39%)
There is a culture of team work in outpatient department	3 (7%)	14 (30%)	8 (17%)	10 (22%)	11 (24%)
Induction to relevant policies is done appropriately in OPD	1 (2%)	7 (15%)	12 (26%)	22 (48%)	4 (9%)
There is continuous trainings in medication safety to improve care	1 (2%)	2 (4%)	4 (9%)	22 (48%)	16 (35%)
Admission process is a key function of main hospital process		1 (4%)	7 (15%)	11 (24%)	26 (57%)

On the statement of the management is keen in ensuring timely medication delivery received differences in reaction where 89% of the respondents were in agreement, 9% neither agree nor disagree with the statement and 2% were in contrary opinion claiming that management have not been keen in ensuring timely medication delivery. The researcher wanted to explore more on whether there is a culture of team work in outpatient department within the hospital and 46% agreed to the statement and said that there is great team work in OPD, 17% neither agreed nor disagreed to the statement on the issue of team work while 37% of those who responded disagreed to the statement asserting that there is no team work within the outpatient department and hence teamwork needs to be addressed in outpatient. Majority were in agreement on various items (above 50%) except for the statement on teamwork. When asked about the organization medication process, all the respondents indicated the organizations commitment to timely medications. Respondent three denoted, *"the policy is well explained and outlined for each*

candre and their role. Hapo hakuna confusion- the problem is each candre we work in silos' meaning the policy is explicit and no one can get confusion".

4.4.1.2 Lean Environmental factors

Table 5. Environmental Factors on medication administration wastes

	1 SD	2 D	3 N	4 A	5 SA
The medication room is well lit, designed and easily accessible		6 (13%)	2 (4%)	20 (44%)	18 (39%)
All equipment for drugs administration are easily available		5 (11%)	4 (9%)	25 (54%)	12 (26%)
Disruptions such as calls and noises in the OPD occur frequently	4 (9%)	18 (39%)	13 (28%)	9 (20%)	2 (4%)
The work station and medication rooms apply "5S "on a daily basis		13 (28%)	5 (11%)	19 (41%)	9 (20%)
The layout and rooms are well labelled with directional signage		5 (11%)	9 (20%)	19 (41%)	12 (26%)

The researcher wanted to explore and know if the medication room is well lit, designed and easily accessible to all patients and the medical staff within the facility and 83% of those who responded agreed to the statement saying that the room and are well lit, designed and easily accessible. All equipment for drugs administration are easily available within the hospital as required 80% of those who agreed to the statement said that all equipment for drug administration are easily available. The also researcher wanted to know if the work station and medication rooms apply "5S"on a daily basis and among those who responded to the statement 61% agreed to the statement that the work station medication room apply the "5S", 11% neither

agreed nor disagreed to the statement while 28% disagreed to the statement that the "5S" are not being applied on daily basis.

4.4.1.3 Lean Human Factors

Table 6. Human factors on medication administration wastes

	1 SD	2 D	3 N	4 A	5 SA
The patients have varying needs				20 (35%)	32 (65%)
The shifts (day and night) are allocated optimum staff	4 (11%)	26 (50%)	11 (24%)	6 (13%)	2 (2%)
Every staff knows their job description and roles	1 (2%)	5 (11%)	5 (11%)	18 (39%)	17 (37%)
Patients are easily identified using key identifiers			2 (4%)	15 (33%)	35 (63%)
The parents/guardian participate in every part of care delivery		1 (2%)	5 (11%)	21 (46%)	19 (41%)

The statements elicited both positive and negative responses as shown above. The most notable statement was that of optimal shift allocation of staff which was seen to be a false by majority of the respondents where 61% fails to agree with the statement claiming that allocation of shifts are usually not done effectively, 24% neither agreed nor disagreed while only 15% of the respondents agreed and asserting that they cannot complain with the allocation of the shifts in the hospital. This call for hospital to check on the outpatient staffing ratios. From the indepth interview, respondent One a doctor who has worked for six years denoted that the units has medical staff with different personalities, that there are those who will work and those who just like to be pushed. He said,

"...once I inform the nurse there is an admission, my work is to prescribe the medications on E-treatment sheet when am told the patient is admitted. I continue to see other patients. After that, I wait to be alerted that patient admission is done after which I reach the primary doctor and agree on the medications required. I do not know what nurses do after that....." (With a smile)"

4.4.1.4 Lean Technological factors

Table 4.5 Technological factors and rating on medication administartion wastes

Statements	1 SD	2 D	3 N	4 A	5 SA
"Kranium" technology system is efficient in orders transfer		3 (7%)	3 (7%)	32 (65%)	10 (22%)
Medication instructions are easy to access on the Electronic Medical Record System		1 (2%)	6 (13%)	31 (67%)	8 (17%)
Electronic Medical Record System is easy to use for all staff		4 (9%)	11 (24%)	29 (57%)	5 (11%)
Communication from one team to another is smooth in OPD	5 (11%)	38 (37%)	7 (15%)	10 (28%)	4 (9%)
There is duplication of EMR system to manual notes quite often	6 (13%)	12 (26%)	14 (30%)	12 (26%)	2 (4%)

The study also explore how technological factors influences management of medication administration of waste process were several statement were used to explore more and different reactions were observed and on the statement of "Kranium" technology system is efficient in orders transfer, 87% of the respondents were in agreement that the system since the installation have not fail to function properly in the hospital, 7% of the respondents neither agreed nor disagreed with the statement and the remaining 65 of the respondents disagreed and claiming that

there are more advance technology that can be used rather than the so called Kranium technology system. Of key concern is the statement relating to communication from one team to another is smooth in OPD majority of the respondents summing up to 48% of the respondents disagreed with the statement claiming that OPD is not effective channel of communication and more ways should be adopted to enhance the communication in the process pathway. Other statements had positive rating in terms of technology performance. One of the respondent number six from the interview, a pharmacist had this to say,

"Kranium is not that bad but there are times it can go down and kazi inasimama kiasi na lazima dawa ziwekwe otherwise utazilipa" meaning - there are few times the software technology can be offline causing work to drag and yet the medications must be put or else one will be asked to pay. *"One key advise I can give is to have communication alert such as prescription is sent, processed so that we stop tracking manually, like the way patient alerts for allergy pick in RED in the system, hence you cannot miss a patient with allergy'* he continued.

4.4.1.5 Lean Task factors

Table 7. Taks factors on medication administration wastes

Statement	1 SD	2 D	3 N	4 A	5 SA
Numerous patients procedures happen at the same time	3 (7%)	13 (28%)	11 (24%)	13 (28%)	6 (13%)
There is a lot of nurse workload and time pressure	1 (2%)	6 (13%)	16 (35%)	11 (24%)	12 (26%)
There is a lot of doctors workload and time pressure	1 (2%)	7 (15%)	20 (44%)	10 (22%)	7 (15%)
There is a lot of pharmacist workload and time pressure		8 (17%)	17 (37%)	10 (22%)	11 (24%)
There is team work and collaboration in medication	1 (2%)	18	8	11	8

related tasks		(39%)	(17%)	(24%)	(17%)

In table 4.6 above, the researcher adopted several statement to explore more on task factors and wastes in process. Majority of the respondents summing up to 41% were in agreement with the statement-numerous procedures happen at the same time. Some elicited negative rating but however, regarding the statement that is a lot of nurse workload and time pressure were observed and opinion given where majority of the respondents summing up to 50% were in agreement with 44% mentioning workload for doctors, and pharmacist 48% respectively. Team work was highlighted as lacking (40%) by respondents. Two respondents said the outpatient layout is spacious with good ambience. That this does not interfere with the process flow. This is what they said,

Respondent five on a phone call, *"....space and layout is not the issue. Delay comes from communication lapses from one process to another. That is what you should try to address Naomi....."*(she laughs)

The nurse respondents two and four denoted that, there are times when the department is busy and you can have several patients with various procedures or one patient with wanting needs.

Respondent two had this to say,

"Since online documentation was started, there became increased workload especially us the nurses. You keep checking if the doctor has done this, if the pharmacist has done this or that, yet you are having other patients. If the hospital can have an alert system prompt on kranium this can reduce calling....at time's phones are not picked... (makes a face)...such as, an alert for doctor once patient is admitted and an alert for pharmacy that admission order is sent. This can reduce non formal communication that I have to chase the prescription pathway

4.4.2 Summary Statistics of the Subscales relating the Lean factors

Table 8. Statistics for overall means and standard deviations for the items

Variable	Mean	SD	N	Skewness	Kurtosis
Lean Organizational Factors	17.62	6.72	36	1.05	2.02
Lean Technological Factors	26.79	6.35	38	-0.28	-0.74
Lean Environmental Factors	8.70	1.82	24	-0.53	0.74
Lean Task Factors	17.81	3.67	32	0.27	0.50
Lean Human Factors	12.37	2.14	22	0.76	1.69

The overall mean for lean organizational factors is higher, followed by those for lean human factors and subsequently lean technological, task and environmental factors. This denotes they have positive influence on timeliness of medication factors

4.4.3 Regression Analysis

Multiple regression analysis was conducted to establish the relationship between the organizational factor, environmental factor, human factor, Technological factor, Task factors and timeliness in medication administration. Multiple Regressions Analysis was done to analyse how a number of covariates affect a specific response to variable (Cohen, West & Aiken, 2003).

A multivariate regression model was used to link both the independent and dependent variables as outlined below.

$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + u$ Where:

Y = Timely medication administration process α = Constant and the

Terms $\beta 1$, $\beta 2$, $\beta 3$, $\beta 4$ and $\beta 5$= Regression coefficients of the independent variables (for Lean Organizational , Lean Environmental, Lean Human , Lean Technological and Lean Task factors)

X1= Lean Organizational factors

X2= Lean Environmental factors

X3= Lean Human factors

X4= Lean Technological factors

X5= Lean Tasks factors

u = Error term

Table 9. Regression coefficients on timely medication administration to patients

	Unstandardized Coefficients		Standardized Coefficient		
Model	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
Constant	2.0800	.7954		2.62	.014
Human	.0267	.1300	.0352	.21	.838
Organizational	.2545	.1932	.2681	1.32	.198
Technological	.1617	.1634	.2046	.99	.330
Tasks	.1543	.1434	.2145	.83	.302
Organizational	.2465	.1267	.2312	.79	.332

a. Dependent Variable: Timely Admninstarion of Medications in outpatient among staff

The findings revealed that all the coefficient values were positive, suggesting that they positively influence timely medication administration to pateints in outpatient. However, it can also be seen that all the variables have an insignificant positive relationship with timely medication administration due to high p-values above the significance level of 0.05. Moreover, the study findings indicate that even though people, organizational, tasks, environmental and technological factors affect timeliness in medication process, the significant effect of the factors has not been fully seen as evidenced by an insignificant positive relationship. Hence, management must efficiently develop ways of reducing wastes in the medication process at the outpatient.

4.4.4 Pareto Analysis for different factors as rated by respondents

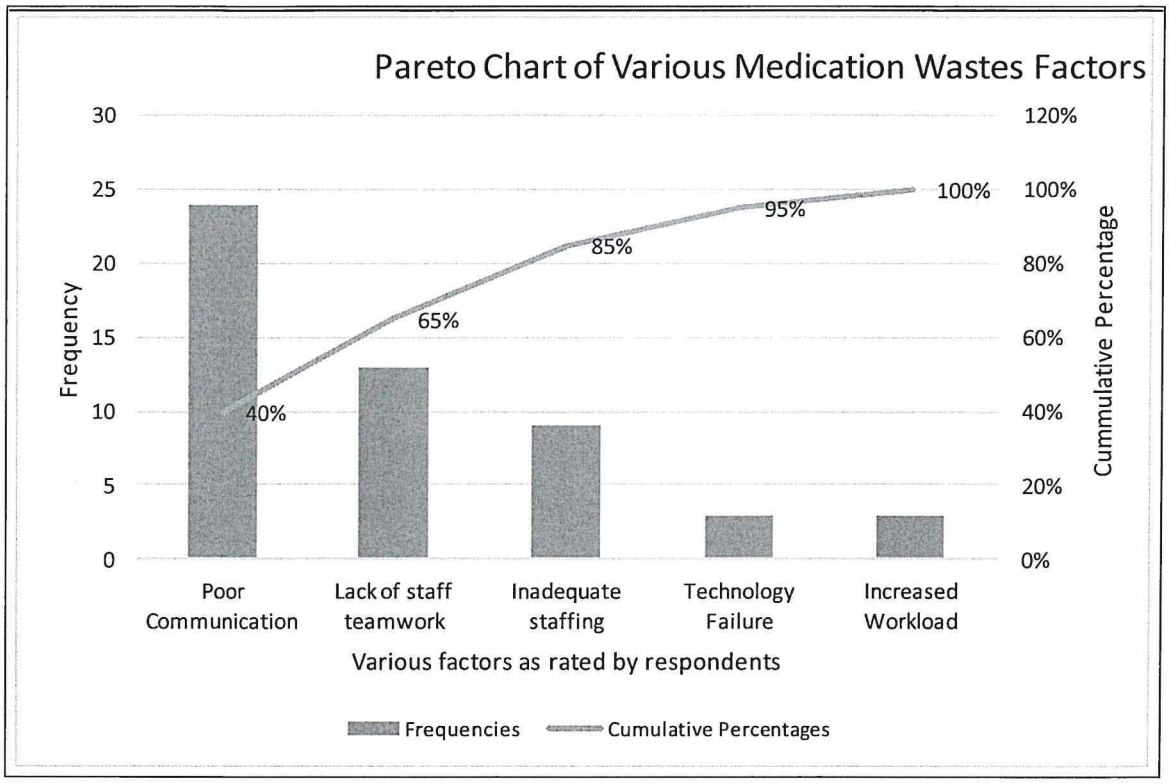


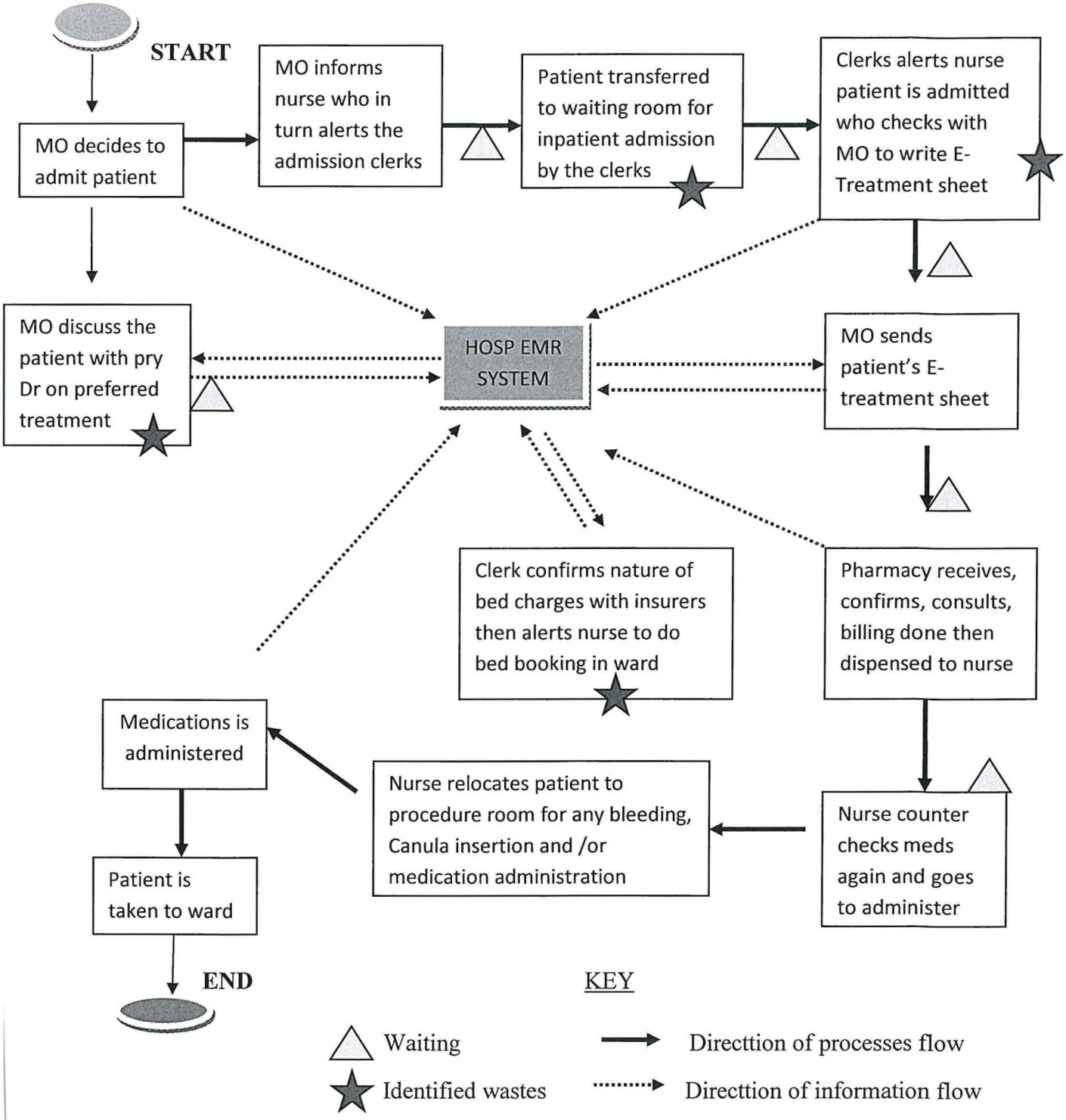
Figure 8. Pareto Chart for various factors as rated by respondents

Having obtained a positive relationship for organization, task, people, technology and environmental factors, the researcher sought to establish the weighted rating for different aspects of the negative responses in medications wastes. Figure 4.6 above shows various factors as was rated. The most weight was communication (40%) which if addressed will reduce wastes significantly followed by lack of teamwork (65%).

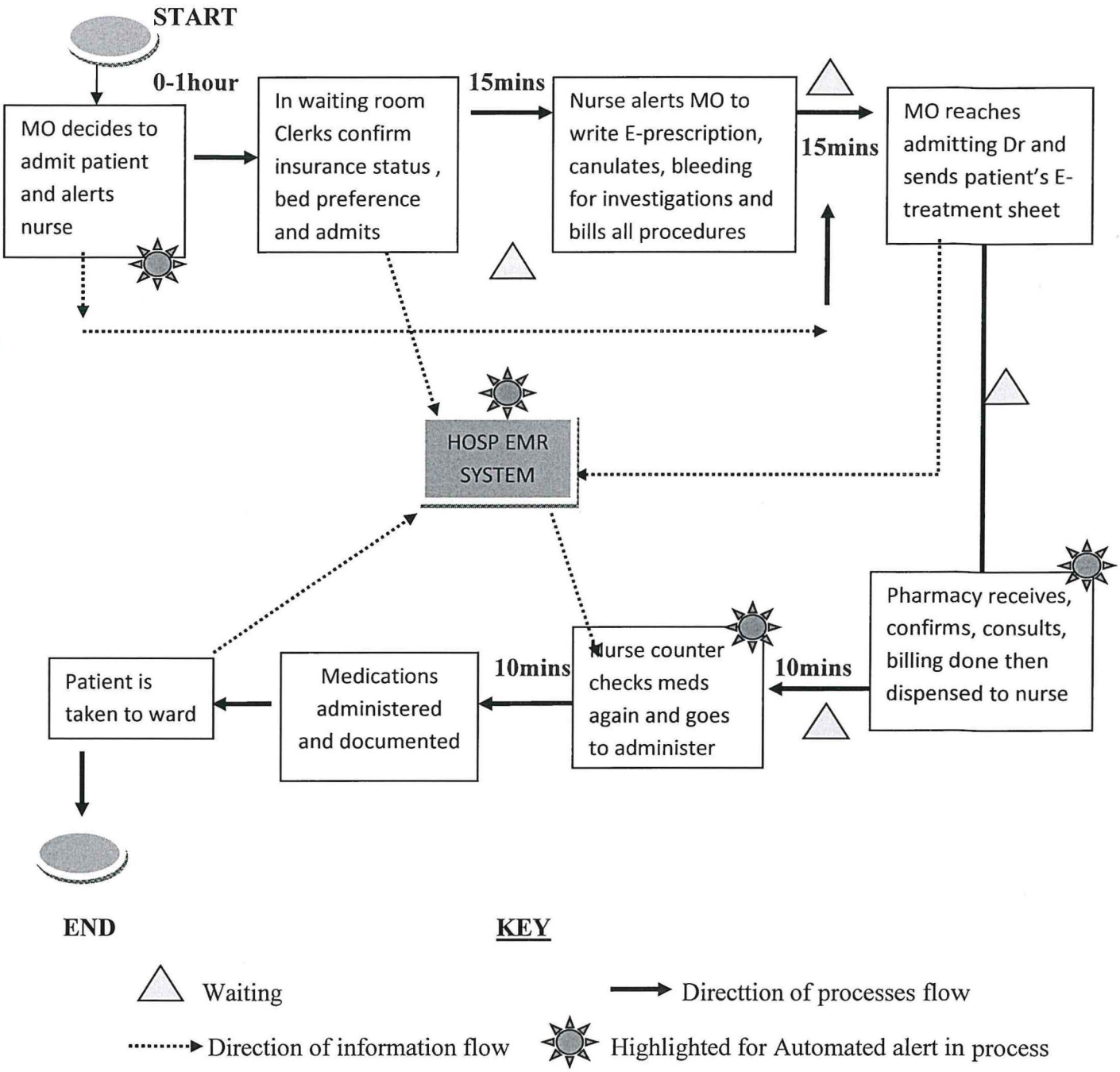
4.5 The New Developed Process Model

The research question sought to analyze whether the new developed model is able to identify wastes in the medication administration process. This was derived by having interviews with the staff and identifying gaps from the mentioned factors contributing to wastes. The task was done by mapping the process using a Value Stream Map and highlighting time taken between different steps to identify the bottlenecks.

4.5.1 Value Stream Mapping Tool with identified Medication Process Wastes



4.5.2 New Improved medication model with reduced process wasting



4.6 Model Practicability in outpatient Gertude's Hospital

The question sought to find out if the new process model can work in outpatient with reduced wastes. The following responses in table below were elicited from 75% of the respondents ; 10 doctors, 14pharmacists and 16nurses, (n=40)

Table 10. Responses given on adoption of new process model in outpatient

Staff Candre	**Frequency (n)**	**Percentage(%)**
Yes	36	90
No	4	10
Total	**40**	**100%**

An interview to afew nurses, doctors and pharmacist elicited the following reactions.

' this is workable Naomi because the alerts will trigger action on the side of the process flow, especially pharmacy' said one nurse.

'I do not think there should be an issue since the communication alert highlight time to process an order, most people forget until you are ambushed,- where are the medications?' as said by a pharmacist.

'this should have been put long time ago like the way the allergies alert blinks on the system. You cannot miss it because it promts you to think and act... ' was said by one of the doctors.

CHAPTER FIVE

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents summary, conclusions and recommendations of results of the study that sought to determine factors contributing to wastes in medication administration of process at Gertrude's Children's Hospital, Nairobi, Kenya. Study limitations and areas for further study is given.

5.2 Discussions

5.2.1 Lean Organizational factors on medication administration process wastes

To explore more on organizational factors and its subsequent influence on medication administration wastes a lot of statements were made and on the statement that management is keen in ensuring timely medication delivery received different reaction where majority of the respondents were in agreement claiming that management are keen in ensuring timely medication delivery and on whether there is a culture of team work in outpatient department within the hospital majority of the respondents agreed asserting that there is great team work in OPD, and hence a lot needs to be done in the department to maintain the power of the teams. Respondents further stress that induction to relevant policies is done appropriately in OPD, leading to employees to work more efficiently and work is done in accordance with the policies in place. The support of the management in any quality improvement is very imperative. The application of lean principles depends on an organization's commitment to continuously improve the value provided to a customer. The implication of thie findings is that for any quality improvement work to succeed and achieve organizational excellence, the support of managemgent is key. This agrees with the work authored by Grabans (2016), that support by management is key for quality work

5.2.2 Lean Environmental factors on medication administration process wastes

On the environmental factors influencing medication administration wastes process, researcher explored if the medication room is well lit, designed and easily accessible to all patients and the medical staff within the facility majority of those who responded agreed to the statement saying that the rooms are well lit, designed and easily accessible. Further asserts that all equipment for drugs administration are easily available within the hospital and on whether there are disruptions such as calls and noises in the OPD occur frequently majority of the respondents disagreed to the statement saying that there is no noise disruptions in the OPD. The researcher wanted to know if the work station and medication rooms apply "5S"on a daily basis and it was realized from majority of the respondents that 5S is being applied on daily basis. And further stress that the layout and rooms are well labelled with directional signage to ease the movement and direction within the hospital for both the patients and the medical staff. The implication of thie findings is that for any quality improvement work to succeed and achieve organizational excellence, the support of managemgent is key. This findings implie that Lean process improvements coupled with direct observation can contribute to substantial decreases in errors in nursing medication administration (Ching, Long, Williams and Blackmore, 2013). The environment that supports lean work is able to reduce waste significantly.

5.2.3 Lean Human Factors on medication administration process wastes

On exploring how human factors affect medication administration wastes, several statements were made and on the statement of patients have varying needs was reacted upon by different respondents as true where most of them agreed that patients' needs varies since the ailments also differs and sickness also strikes at different time within a day, a week or a month and on the statement that the shifts (day and night) are allocated optimum staff was disagreed upon by majority of the respondents claiming that allocation of shifts are usually not done effectively. This was further rated on pareto analysis as the second most factor in leading to medication administration wastes. Age and experience can affect lean human and as this was shown in a study by Fasolino (2009) whereby the study showed nursing factors such as age and experience

have also been shown to be related to the occurrence of medication delays in the acute care setting as a result of competing priorities

5.2.4 Lean Technological factors on medication administration process wastes

The study also explore how technological factors influences management of medication administration of waste process where several statement were used to explore more and different reactions were observed, on the statement of "Kranium" technology system is efficient in orders transfer, majority of the respondents were in agreement asserting that the system since the period of installation have not fail to function properly in the hospital and is very useful as one of the equipment used in the hospital. Majority of the respondents further stressed that medication instructions are easy to access on the Electronic Medical Record System though is prone to network failures and the backup system should be avails to them. Majority of the respondents asserts that communication from one team to another is smooth in OPD and being an effective channel of communication and more ways should be adopted to enhance the communication in the facility and on the statement of there is duplication of EMR system to manual notes quite often were observed and different reactions were noted where majority disagreed with the statement claiming that they have not witness any of the duplication issues for the same.

5.2.5 Task related factors on medication administration process wastes.

On task and managing medication administration of waste process, researcher adopted several statement to explore more on it and different reactions were observed and on the statement of numerous patients' procedures happen at the same time, majority of the respondents summing up to 41% were in agreement with the statement, 24% neither agree nor disagreed with claiming that they have no idea of procedures happening to other patients and the remaining 35% disagreed that numerous patients procedures usually happens to the patients and further asserting that patients have various needs which call for various procedure but not numerous procedures to be performed to a patient. On the statement of there is a lot of nurse workload and time pressure different reactions were observed and opinion given where majority of the respondents were in agreement, claiming that it is upon the nurses to take care of the patients since they were the only

individuals working a lot in the hospital for doctors workload and time pressure majority of the respondents had no opinion some suggest that the question should be directed to doctors. On the statement of there is a lot of pharmacist workload and time pressure majority of the respondents agreed with the statement claiming that after prescription of medicine it is upon the pharmacist to give the drugs to the patient Last but not least on the statement of there is team work and collaboration in medication related tasks the answer is no from majority and stressing that there is specialization and one is supposed to do what is within his or her scope.

5.3. Conclusion

The study found that factors leading to medication delays identified are, poor communication, lack of teamwork and inadequate staffing.

5.4 Recommendations

In view of the factors identified above, there is need for management to look into outpatient staffing ratios, to enhance a culture of teamwork among stsff and put in place in the system , process alerts in the system as recommended by the respondents to promt action on the online computerized order system.

5.5 Areas for future research

It would be important to have a follow-up study looking at the related patient outcomes in regards to medication administration timeliness so as to inform process interventions.

5.6 Limitations of the study

The study did not look at patient outcomes for research however this can form a recommendation for future research.

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Appendix 1: STUDY CONSENT

Study Title: USING LEAN OPERATIONS TO REDUCE WASTES IN THE MEDICATION ADMINISTRATION PROCESS AT GERTRUDE'S CHILDREN HOSPITAL, KENYA

Investigator: WAMBUGU-NYARANGI NAOMI *(Master of Business Administration in Healthcare Management)* STRATHMORE BUSINESS SCHOOL, STRATHMORE UNIVERSITY.
Contact Telephone Number(s): 0720983289 **Email**: naomi.wambugu@gmail.com

Purpose of study: The present study will look at factors contributing to wastes (delays) in the medication administration process for admission patients before going to the ward. These data will assist to improve on the medication administration by eliminating non-value added steps in the process. This will play a big role in enhancing patient safety and preventing possible hazards.

How to Participate: You will be asked to give responses and your opinion to some questions which will be asked regarding the medication adminisatrtion process ~taking approx 10-15mins.

Right to refusal or withdrawal: Taking part in this study is your choice; you may choose not to be in it. Your participation is voluntary and you are free to agree or disagree to participate in this study. You may withdraw from the study at any time even after signing this form and there will be no victimization.

Confidentiality and privacy: Your involvement in this research study will be kept confidential by identifying you in the study records by a code/unique number. The study results/report that will be used in final the publication (thesis) will not use your name.

Risks and benefits: There are no risks or discomforts associated with this study and neither are there any direct benefits to you for taking part in.

For further clarifications or questions on this study, please contact me
Investigator: Naomi Wambugu (Mobile:0720983289) Email *naomi.wambugu@gmail.com* OR

My Supervisor: Dr. Francis Wafula (Mobile: 0722679467: Email: *fwafula@strathmore.edu* OR

Enquiries to: The Secretary- Strathmore University Institutional Ethics Review Board,
P.O BOX 59857-00200, NAIROBI. Email: ethicsreview@strathmore.edu
Tel number: + 254 703 034 375

Your signature indicates that this research study has been explained to you, that you've been given the opportunity to ask questions, and that you agree to take part in this study.

Signature: ..... Date: .....

For Official Use

Name: ..... Signature: ..... Date: .....

(Of Research Personel)

Appendix 2: STUDY QUESTIONNAIRE

Questionnaire No …….. **Date administered ……..**

INSTRUCTIONS

The information you give will be treated with utmost confidentiality. Do not indicate your name. Please indicate by putting a tick (√) in the space(s) provided or filling in the blank space(s) your response (s)

PART 1: RESPONDENTS SOCIAL DEMOGRAPHIC INFORMATION

		Indicate your choice respectively		
QS 1	**Gender of respondent**	Male	1	
		Female	2	
QS 2	**Professional Cadre**			
	Doctor	1		
	Nurse	2		
	Pharmacy	3		
	Others Specify	4		
QS 3	**How old are you? ……. Years**			
QS 4	**For how long have you worked in the hospital? ……..**			

PART 2: FACTORS CAUSING MEDICATION ADMINISTRATION DELAYS FOR ADMISSIONS

Indicate your opinion for the responses shown below

1= Strongly disagree (SD) 2= Disagree (D) 3= Neutral (N) 4= Agree (A) and 5= Strongly agree (SA)

	Organization	**SD**	**D**	**N**	**A**	**SA**
Q5	The management is keen in ensuring timely medication delivery	1	2	3	4	5
Q6	There is a culture of team work in outpatient department	1	2	3	4	5
Q7	Induction to relevant policies is done appropriately in OPD	1	2	3	4	5
Q8	There is continuous trainings in medication safety to improve care	1	2	3	4	5
Q9	Admission process is a key function of main hospital process	1	2	3	4	5
	Environment	**SD**	**D**	**N**	**A**	**SA**
Q10	The medication room is well lit, designed and easily accessible	1	2	3	4	5
Q11	All equipment's for drugs administration are easily available	1	2	3	4	5
Q12	Disruptions and noises in the OPD occur frequently	1	2	3	4	5

Q13	The work station and medication rooms apply "5S "on a daily basis	1	2	3	4	5
Q14	The layout and rooms are well labeled with directional signage	1	2	3	4	5
	Staff and patients	**SD**	**D**	**N**	**A**	**SA**
Q15	The patients have varying needs	1	2	3	4	5
Q16	The shifts (day and night) are allocated optimum staff	1	2	3	4	5
Q17	Every staff knows their job description and roles	1	2	3	4	5
Q18	Patients are easily identified using key identifiers	1	2	3	4	5
Q19	The parents/guardian participate in every part of care delivery	1	2	3	4	5
	Technology and tools	**SD**	**D**	**N**	**A**	**SA**
Q20	"Kranium" technology system is efficient in orders transfer	1	2	3	4	5
Q21	Medication instructions are easy to access on the Electronic Medical Record (EMR) system	1	2	3	4	5
Q22	Electronic Medical Record system is easy to use for all staff	1	2	3	4	5
Q23	Communication from one team to another is smooth in OPD	1	2	3	4	5
Q24	There is duplication of EMR system to manual notes quite often	1	2	3	4	5
	Tasks	**SD**	**D**	**N**	**A**	**SA**
Q25	Numerous patients procedures happen at the same time	1	2	3	4	5
Q26	There is a lot of nurse workload and time pressure	1	2	3	4	5
Q27	There is a lot of doctors workload and time pressure	1	2	3	4	5
Q28	There is a lot of pharmacist workload and time pressure	1	2	3	4	5
Q29	There is team work and collaboration in medication related tasks	1	2	3	4	5

Thank you for your co-operation.

Appendix 3: IN-DEPTH GUIDE TOOL

Study Title: Using Lean Operations to Reduce Wastes in the Medication Administration Process at Gertrude's Children Hospital Outpatient, Nairobi, Kenya

This interview seeks to elicit factors that contribute to delay in administration of initial medications for admission patients.

1. Tell me a little bit about yourself, and your involvement in care processes for children here at the Hospital?

Probe: Involvement in medication administration processes and/or decisions

2. In your opinion, would you say the medication administration process is sound?

Probe:

What does the process look like? Timeliness across different stages?
What is good? What is not so good?

3. What are the factors that hinder timely administration of initial medications in the outpatient?

Probe:

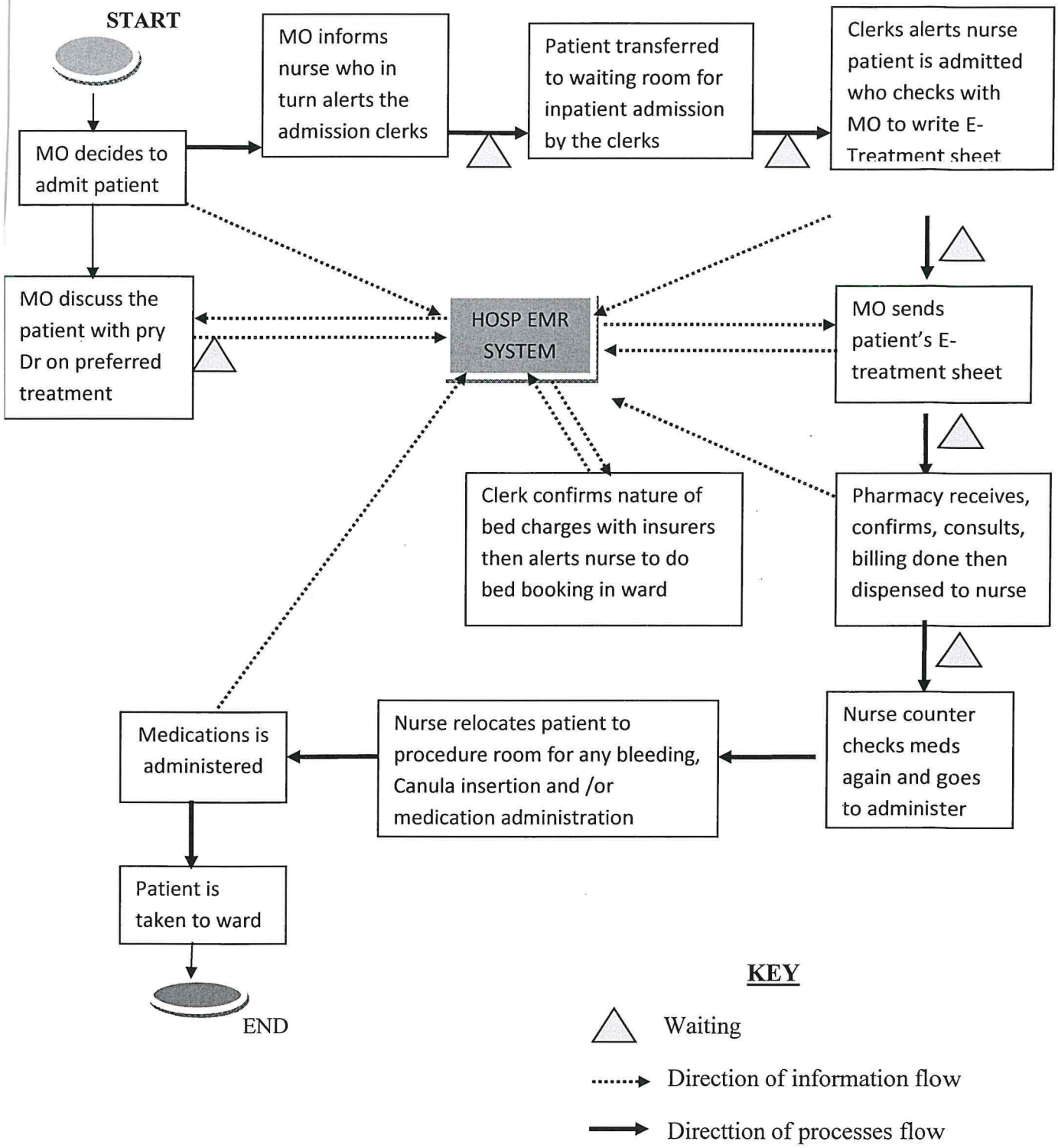
Person factors (staff/patients)
Tools and technologies
Organizational factors
Workflow arrangements
Administrative elements
Environment/context
Tasks

4. In your opinion, what can be done to hasten the medication processes (from the time patient is declared admission to when they receive the drugs)?

Thank you for your time and responses given.

Appendix 4: VALUE STREAM MAPPING TOOL

Medication Administration Process In Outpatient



Appendix 5: TENTATIVE STUDY TIMELINE

Activity Yr 2018 -2019	Jan-Feb 2018	Mar-Apri	May-June	Jul-Aug	Sep-Oct	Nov-Dec	Jan-Feb 2019	Mar-Apr	May-Jun
Proposal dev	←	—	—	—	—	→			
Lite. review	←	—	—	—	—	→			
IRB- Submission						←	→		
IREC- Approval							↔		
Data collection								↔	
Data analysis								↔	
Thesis writing & Marking								↔	
Final defense									↔
Graduation									↔

Appendix 6: STRATHMORE UNIVERSITY STUDY APPROVAL

Strathmore UNIVERSITY

22nd January 2019 SU-IERC0290/18

WAMBUGU-NYARANGI NAOMI
P.O. Box 752 – 00511
Nairobi

Email: naomi.wambugu@strathmore.edu

Dear Naomi,

REF **Student Number:** MBA/HCM 100578/17 **Protocol ID:** SU-IERC0290/18
USING THE LEAN APPROACH TO ELIMINATE WASTE IN THE MEDICATION ADMINISTRATION PROCESS AT THE GERTRUDE'S CHILDREN HOSPITAL, NAIROBI, KENYA

We acknowledge receipt of your application documents to the Strathmore University Institutional Ethics Review Committee (SU-IERC) which includes:

1. Cover letter
2. Research Proposal version 2 date January 18, 2019
3. Participant Information Sheet and Consent form version 2 date January 18, 2019
4. Research tools (In-depth tool guide and value stream mapping tool)
5. CV

The committee has reviewed your application, and your study *"Using The Lean Approach to Eliminate Waste in The Medication Administration Process at The Gertrude's Children Hospital, Nairobi, Kenya"* has been granted **approval**.

This approval is valid for one year beginning **22nd January 2019** until **21st January 2020**

In case the study extends beyond one year, you are required to seek an extension of the Ethics approval prior to its expiry. You are required to submit any proposed changes to this proposal to SU-IERC for review and approval prior to implementation of any change.

SU-IERC should be notified when your study is complete.

Thank you

Sincerely,

Amina Salim
Regulatory Affairs Fellow

STRATHMORE UNIVERSITY INSTITUTIONAL ETHICS REVIEW COMMITTEE (SU-IERC)
22 JAN 20..
TEL: +254 (0)703 034 000
P. O. Box 59857 - 00200
NAIROBI - KENYA