THE IMPACT OF LEAN THINKING ON OPERATIONAL EFFICIENCY IN A RURAL DISTRICT HOSPITAL OUTPATIENT DEPARTMENT IN KWAZULU-NATAL

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by

Dr. Logandran Naidoo
Student number: 993212931

Supervisor: Dr. O. Mahomed

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ABSTRACT

Introduction

Health-care service in South Africa, especially in the public sector, is fraught with numerous problems, including ineffective operations management in health care facilities. This contributes to poor service delivery and a lackluster work environment. Non-value-adding activities result in, *inter alia*, long cycle and waiting times, and low staff morale. With Lean thinking, health care managers could tackle specific issues to improve operational efficiency.

Aim

The purpose of the study was to apply Lean thinking, and to determine its effect on efficiency and staff morale within the outpatient department at Catherine Booth Hospital, in order to inform recommendations to improve operational efficiency in rural district hospital outpatient departments.

Methods

An operational action-research study design was used. The study sample consisted of all service nodes and employees of the outpatient department in Catherine Booth Hospital. Cycle and waiting times were iteratively measured for all service nodes. Statistical analyses on pre- and post-intervention results were carried out.

Results

Cycle and waiting time targets were met and exceeded in three service nodes, but only the Investigations node showed statistically significant results (cycle time reduced from 16.7 to 12.2 minutes; $p=0.04$; and waiting time reduced from 11.93 to 10 minutes; $p=0.03$). The waiting time for Consulting Rooms improved significantly (80.95 to 74.43 minutes; $p<0.0001$). Significant decreasing trends in waiting times over the study period were found in Patient Administration ($p=0.04$), Patient Screening ($p<0.0001$) and Consulting Rooms ($p<0.0001$). The trend in average operational efficiency improved over time from 16.35% to 20.13%.

The implementation of Lean had a positive impact on the proportion of OPD staff satisfied with their jobs (increased from 21.1% to 77.8%; $p<0.0001$) and proportion of staff that felt motivated (increased from 15.8% to 77.8%; $p<0.0001$).

Discussion

Rural public sector hospitals require a novel and evidence-based approach to improving operational efficiency and staff morale in OPDs and other departments. Lean implementation had a positive impact on cycle and waiting times in all service nodes. Attitude towards teamwork and communication strength are positively impacted by the process of Lean implementation. However, factors such as differing priorities and logic among staff in the OPD and management negatively affect the outcomes of Lean implementation.

Conclusion and recommendations

The application of Lean principles, tools and techniques is possible in a rural district hospital OPD, without any demands on staff in terms of learning and adopting a new quality-improvement management approach by which to improve operational efficiency. The lessons learnt from the implementation of Lean thinking at a rural hospital used in this study may be emulated for quality improvement across similar hospitals and its sustainability can be assessed further.

(Word count: 456 words)

DECLARATION

I, Dr. Logandran Naidoo, declare that:

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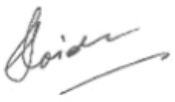
Student: Dr. L. Naidoo Signature:  Date: 4 February 2013

Department of Public Health Medicine
Nelson R. Mandela School of Medicine
University of KwaZulu-Natal, South Africa

DEDICATION

Dedicated in loving memory
of my mother, Tholsiamma Naidoo,
who conveyed to me the value of
education, as encapsulated in the phrase
“Knowledge is Power”.

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ACRONYMS AND ABBREVIATIONS

AIDS:	Acquired immune deficiency syndrome
ARV:	Anti-retroviral
CBH:	Catherine Booth Hospital
CLAB:	Central-Line Associated Bloodstream
DOH:	Department of Health (South African)
HCW:	Health care worker
HIV:	Human immunodeficiency virus
Lean:	Lean systems, Lean thinking or Lean philosophy
MDR-TB	Multidrug-resistant Tuberculosis
NHS:	National Health System
OPD:	Outpatient department
PDCA:	Plan-Do-Check-Act
PPC:	Perfecting Patient Care
TOP:	Termination of pregnancy
VSM:	Value Stream Map
XDR-TB:	Extremely drug-resistant Tuberculosis

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CHAPTER I: INTRODUCTION

1.1 Introduction

South African public health-care facilities are fraught with delivery of poor health-care service, partly owing to problems inherent in operations management.[1] The problems are reflected in long patient waiting and cycle times, and staff discontentment in outpatient departments (OPDs).[1, 2] Lean is a novel management approach that offers the potential benefit of improving health-care service-delivery through the reduction of inefficiency.[3] Little is known about the applicability of Lean and its impact on operational efficiency and staff morale in South African rural district hospital OPDs.

1.2 Background

Health-care service in South Africa, especially in the public sector, is fraught with numerous problems ranging from a paucity of health-care workers (HCWs) and inefficient use of resources, to poor quality of health care (Table 1 and Table 2). The Department of Health (DOH) of South Africa, in their 2009/2010 Annual Report have acknowledged these challenges, which are complemented by an unacceptably high burden of diseases, consisting of HIV, AIDS and tuberculosis (TB); high maternal and child mortality; non-communicable diseases; and violence and injuries.[4]

The challenges identified in the health-care sector are of a systemic nature and span across the health system building blocks. Two of these challenges point towards poor operations management as a potential source of poor service delivery. Harrison identified the "ten biggest challenges facing the health sector for 2010-2015" in Table 1,[1] wherein he recognizes the latter five as major problems within the health-systems management, and more specifically operations-management, domain. Table 2 clearly illustrates some operations-management problems contributing to poor quality.

Lean is a highly reputable management approach employed to identify and successfully resolve operational problems, providing better health care to patients, while reducing inefficiency and cost.[3, 5]

Table 1: Principal shortcomings of the health care sector in South Africa.[1]

Insufficient prevention and control of epidemics	
1	Limited effort to curtail HIV/AIDS
2	Emergence of MDR-TB and XDR-TB
3	Lack of attention to the epidemic of alcohol abuse
Persistently skewed allocation of resources between public and private sectors	
4	Inequitable spending patterns compared to health needs
5	Insufficient health professionals in public sector
Weaknesses in health systems management	
6	Poor quality of care in key programmes
7	Operational inefficiencies
8	Insufficient delegation of authority
9	Persistently low health worker morale
10	Insufficient leadership and innovation

Table 2: Key problems with quality in health care in South Africa.[2]

Operations management problems	**Other health systems management problems**
Underuse and overuse of services	Lack of resources
Avoidable errors	Inadequate diagnosis and treatment
Variation in services	Problems relating to reallocation of funds from "better off" to "historically poor" communities and facilities
Inefficient use of resources	Disregard for human dignity
An inadequate referral system	Poor information
Drug shortages	
Records not well kept	
Poor delivery systems	

Catherine Booth Hospital in KwaZulu-Natal (uThungulu District) is a 170-bed rural public hospital that endures several of the above challenges typically experienced in many public health-care facilities. The outpatient department reflects the outcome of these challenges in long patient queues, a disorganized department, and disgruntled employees, all of which are not uncommon to other public hospitals. This hospital provides an ideal setting in which to determine the impact of Lean on operational efficiency.

1.3 Problem statement

In addition to having insufficient resources for health-care provision at many district hospitals in Kwazulu-Natal, ineffective operations-management greatly contributes to poor health-care service-delivery to patients, and a lack of motivation in hospital staff .[1] Work procedures and methods in public sector OPDs become fraught with numerous unnecessary activities ('wastes' or *muda*) owing to lack of process-planning.[1, 2, 6] These result in, *inter alia*, long patient waiting and cycle times in OPDs. There is little evidence to suggest that the South African public health-care sector invests widely in novel management approaches, such as Lean (systems or thinking), to address such problems at a health-care facility level.

1.3.1 Research question

Could the application of Lean in a rural district hospital OPD improve cycle and waiting times, and staff attitudes and morale through its impact on operational efficiency?

1.4 Significance of the problem

With the pressing need for quality improvement in a crisis-ridden health-care sector, especially with the proposed National Health Insurance project nearing its start, it is an opportune time to investigate the implementation of Lean in South African rural district hospitals. Long cycle and waiting times in many district hospitals result in baulking and reneging of patients from queues; overworked and frustrated staff; and poor quality of care.

Figure 1 summarizes the intricacy of the problem, with the likely causes of long cycle and waiting times and a lacklustre work environment on the left, and the likely effects on the right. Avoidable internal 'wastes', operational and staffing factors and unavoidable factors contribute to the problem. The effects are both patient- and staff-related.

1.5 Purpose of the study

The purpose of the study is to apply Lean principles, tools and techniques, and to determine the impact on efficiency and staff morale within the OPD at Catherine Booth Hospital, Amatikulu, Kwazulu-Natal from March to July 2012. This will enable the investigator to inform recommendations for improving operational efficiency in rural district hospital OPDs. The study is not intended to determine or assess the sustainability of Lean implementation at Catherine Booth Hospital.

1.6 Specific objectives of the research

The specific research objectives are:

- To describe patient flow, and cycle and waiting times during weekdays, using a current and future-state Value Stream Map;
- To describe the process and application of Lean principles, tools and techniques with action-research participants (*kaizen* team);
- To analyse the changes in observed and *takt*-based waiting and cycle times before and after the implementation of Lean);
- To determine the change in morale and attitudes among employees working in the OPD at the hospital before and after the implementation of Lean; and
- To use the study findings to make recommendations on the application of Lean in rural district hospital OPDs.

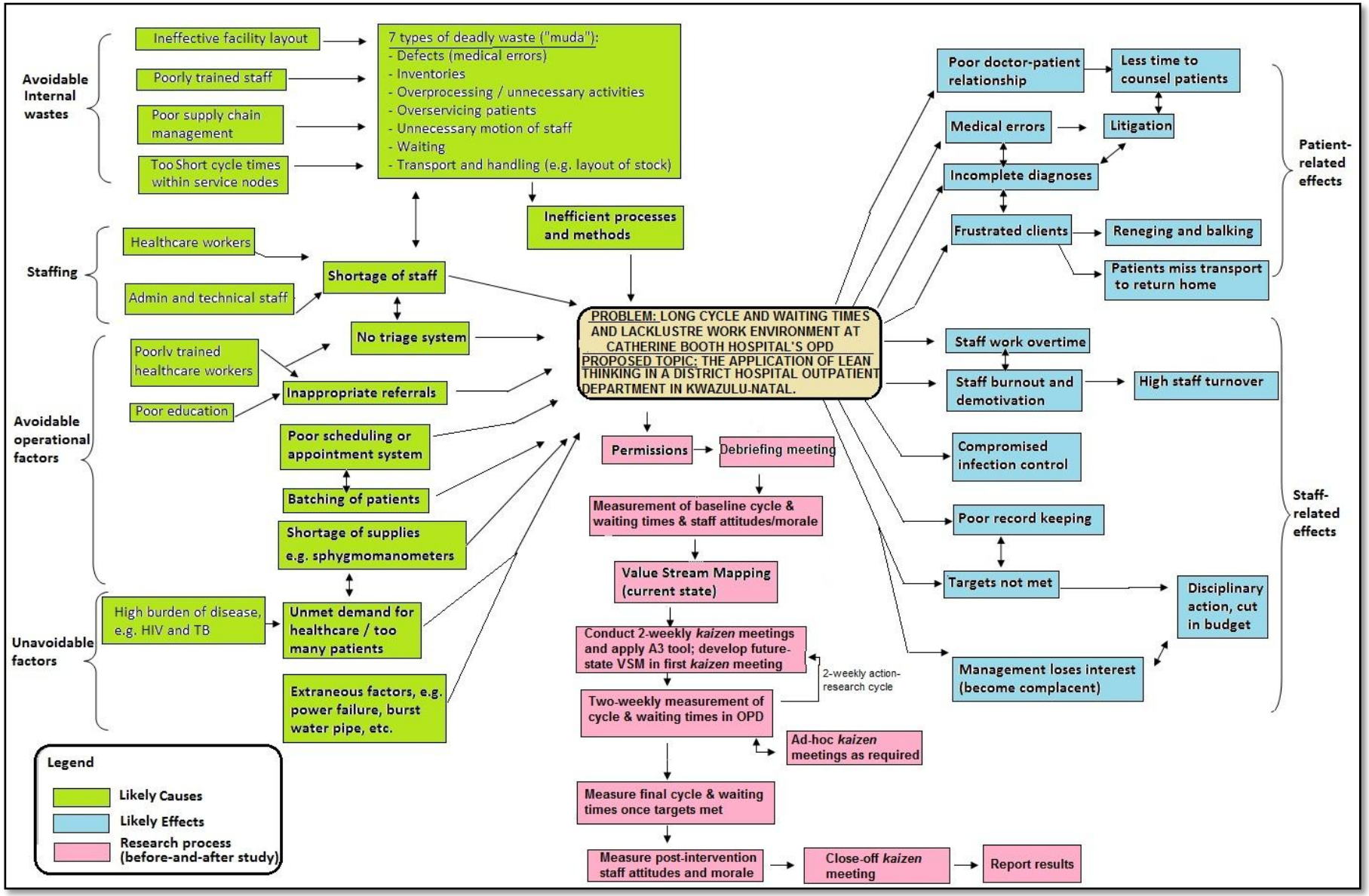


Figure 1: Problem analysis diagram

1.7 Significance of the study

The implementation of Lean, if proven successful in a rural district hospital OPD, could be piloted as a novel operations-management approach across other similar public health-care facilities and functional departments in KwaZulu-Natal. This could result in widespread improvements in patient waiting times, cycle times, patient value streams and other efficiencies, even with limited or fewer resources. Since Lean aims to 'achieve more with less', even in systems with high variability such as hospitals,[7] it could result in greater achievement of health-care objectives and outcomes with better process efficiencies at facility level.

Figure 1 demonstrates the problem described above by showing the likely causes and effects of long cycle and waiting times, it also displays the research process.

1.8 Assumptions underlying the study

It is assumed that:

- activities carried out by health-care workers at each service node are similar in nature for each patient and on different occasions;
- the performance of each health-care worker in a particular service node is similar, for example, Nurse A performs her duties much the same as Nurse B; and
- basic resources required by staff to execute regular duties are available.

1.9 Operational definitions used in the study

Baulk:	Refusal to join a queue owing to long waiting time[8]
Cycle-time:	Duration of a point in time of a cycle until the same point of time in the next cycle; time to complete a function, job or task from start of cycle 1 to start of cycle 2 in a service node[9]
Gemba:	Japanese term for "actual place" where value is created. In this study, the OPD is the *Gemba*[9]
Health-care worker:	Anyone involved in the provision of health services to a patient; includes doctors, nurses, pharmacists, etc.
Jidoka:	interaction of humans with machinery and tools[10]

Kaikaku:	Japanese term for "radical improvement"[11]
Kaizen:	Japanese term for "gradual improvement"[12]
Kaizen team:	A group of workers (Quality Circle) who meet regularly to identify, analyse and solve work-related problems
Operations management:	An area of business concerned with the production of goods and services; involves the responsibility of ensuring that operations are efficient in terms of using as few resources necessary, and effective in meeting customer requirements
Outpatient department:	Common service areas in the hospital which an outpatient usually experiences in a general district hospital, e.g. registry, triage, doctor-consultation, pharmacy, etc. It excludes day-case theatres, and the ARV, TOP, dental and therapist clinics
Renege:	In the context of queuing theory, implies leaving a queue after joining, owing to a long waiting time[8]
Service node:	Any station or service point that usually succeeds a waiting area and provides a particular service to a patient
Six Sigma:	A quality improvement approach to remove root causes of errors and reduce defects to 3.4 per million items[13]
Takt-based waiting time:	Indicates the total time spent waiting based on demand for service. Calculated by the formula: $(Takt\ time) \times (number\ of\ patients\ waiting)$
Takt time:	Derived from the German word *Taktzeit*; it is the time which identifies the cycle time necessary in the process to meet the demand of the customer[12]
Value:	The augmented utility and effectiveness of any activity or process which the patient would be satisfied. Value arises with the elimination of waste in each step along the patient's care pathway in a health-care facility
Value stream:	All value-adding and non-value-adding activities and associated information required to bring a patient through the value-adding process from beginning to end[7]
Waiting (lead) time:	Duration of time that patients wait idle before experiencing a value-added work activity or function[12]

1.10 Scope of the study

The study examines the impact of Lean on operational efficiency only in the OPD; it does not extend to other departments in the hospital. The applicability of Lean is determined for the duration of the study, and the effect on cycle and waiting times and staff attitudes and morale is looked at, but the sustainability thereof is not explored. The study makes use of several of the various tools and techniques in the Lean artillery.

1.11 Organization of the report

The dissertation comprises six chapters. Chapter One provides an introduction and background to the study. The problem statement, research question, study purpose, objectives and significance are also contained in this chapter.

Chapter Two presents an outline of the current literature dealing with the body of knowledge apropos the study topic. Existing literature on operations-management problems in health care, and South Africa's response thereto are described. A conceptual framework for the study is established, and the concept of Lean and its tools and techniques is explored. Relevant studies on the application of Lean in health care are appraised.

Chapter Three provides an outline of the methods used in this study, including study design, study population and sampling, data collection and analysis. The action-research spiral illustrates the study process. Credibility (trustworthiness) and reliability are also discussed, and ethical considerations are presented.

Chapter Four focuses on the results of the study using appropriate summary measures in the form of tables, summary statistics and appropriate figures.

Chapter Five provides an in-depth discussion of the study findings in line with the study objectives. It also clarifies the credibility and reliability of the study findings and objectives.

Chapter Six concludes the dissertation with recommendations based on the findings.

1.12 Summary

Poor operations management in public health-care facilities manifest in operational inefficiencies and low staff morale. This chapter outlines the consequences of inferior operations-management practice, and introduces Lean as a novel approach to operations-management in health care. The purpose, objectives and significance of the study are also described in the context of Lean application in a rural district hospital OPD.

CHAPTER II: LITERATURE REVIEW

2.1 Introduction

The application of Lean in health care has been practised in various health-care institutions in several countries, but its use in the South African health-care sector is limited. Moreover, Lean has not widely been used to address the problems resulting from poor and ineffective operations-management practises in rural public hospitals, mostly because managers in these facilities may not be familiar with the concept.

Literature on the application and benefits of Lean in health-care facilities is available; however, it is predominant for studies in the U.S.A., Australia and United Kingdom. Thus the value of the application of Lean in South African public health-care institutions is yet to be well established, by building on its body of knowledge.

2.2 Purpose of the literature review

Recent literature on the application of Lean in health care has been critically reviewed to determine the benefits and impact thereof. The response of South African health authorities in addressing the public health operations-related problems was also reviewed. Some studies on Lean have been carried out in South Africa, but from those studies reviewed, the investigator also sought a typical study model that can be adapted to and applied in the South African health-care context. The Lean concept, principles, tools and techniques were also explored in order to support the study methods.

In providing an overall critique of studies recently conducted and the South African response to operations-related problems in health care, Donabedian's Structure/Process/Outcome (SPO) model was used as a suitable conceptual framework for this study.

2.3 Scope of literature review

The literature review was limited to studies on the application of Lean in health-care facilities, wherein Lean tools and techniques used would also be accessed by the present study. The review excluded studies involving the use of similar quality improvement management tools and techniques such as Six Sigma. In light of the paucity of studies on Lean in health care in South Africa, more attention was paid to the study methods used in the application of Lean rather than on the results thereof, mainly because the present study is aimed at determining Lean's applicability and impact on the South African health-care context, as a novel approach to quality improvement.

2.4 Sources of literature reviewed

The electronic databases *PubMed* and *Google Scholar* were searched for studies on the application of Lean in health care. The keywords and phrases, "Lean thinking", "Lean manufacturing", "Lean in health care", "cycle times" and "waiting times" were used with or without the Boolean operators "and" and "or". Relevant citations in the identified literature were also used to search for further information.

2.5 South Africa's response to operations-related problems in health care

Although primary health care is a national priority there is little evidence to suggest that the South African public health-care sector widely employs approaches to address operations problems at a health-care facility level. The DOH's National Strategic Plan 2010/11 – 2012/13 firmly focuses on a list of ten priorities that were adopted as the Ten-Point Plan 2009-2014.[6] The accomplishment of two of these priorities (Table 3) predominantly involves the utilization and execution of effective operations-management tools and techniques. However, the Plan provides insufficient nicety on how to achieve "enhanced operational management of health-care facilities" as one of its deliverables which pervades four of the ten priorities.[6] Some authorities on health policy also neglect in their proposals (Figure 2) to give detailed reasons for the way in which operations-management approaches can assist health-care managers in realizing the goals of their facilities.

Table 3: Two of the priorities from the Ten-Point Plan and Medium-Term Strategic Framework (MTSF) 2009-2014 (Adapted from Department of Health, 2010).[6]

Priority	Key activities	Deliverables from the MTSF 2009-2014
Improving the quality of health services	Improve service delivery in all 52 districts, with a special emphasis on 18 priority districts. Refine and scale up the detailed plan on the improvement of quality of services and directing its immediate implementation. Consolidate and expand the implementation of the health facilities' improvement plans. Establish a national quality management and accreditation body.	Improved patient care and satisfaction. Accreditation of health facilities for quality.
Overhauling the health care system and improving its management: Improve the functionality and management of the health system	Assess the qualification, skills and competencies of Hospital CEOs, Senior Managers and District Managers. Training managers in leadership, management and governance. Decentralisation of management. Development and implementation of an accountability framework for the public and private sectors. Establish a management and leadership academy for health managers.	Revitalisation of the Primary Health Care approach. Enhanced operational management of health facilities.

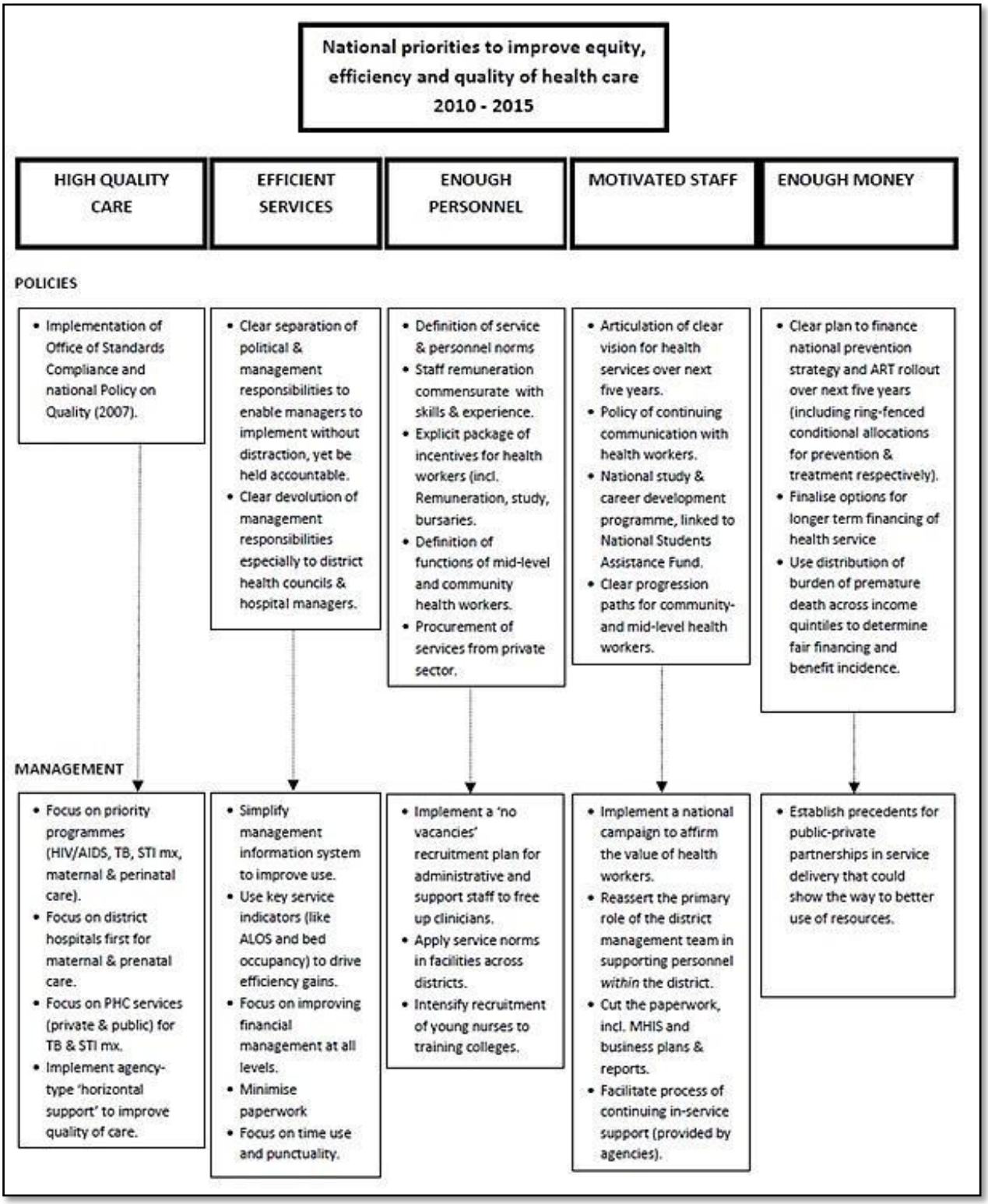


Figure 2: Proposal of policy and management instruments to improve the state of the health-care system.[1]

2.6 Applying Lean in health care

Lean has been globally revolutionizing manufacturing and service industries for many years, and is advocated to "create a balance between quality and finance by developing the most efficient and effective method of providing value to the customer".[3] Faull posits that the application of Lean to health care has begun in earnest, mainly in the U.S.A., United Kingdom and Australia.[14]

Its burgeoning use in public-health services is very likely to diffuse increasingly in the sector as governments adopt it as quality-improvement and cost-reduction processes. Because virtually all public health-care facilities face the common challenge of improving quality of care, reducing waiting times, and serving more patients with already-sweated assets, doing more with less beckons for an appropriate process-improvement approach such as Lean.[15]

2.7 The origin and principles of Lean

Several operations-management techniques have yet to be fully embraced in the health-care sector. One of these techniques is Lean; a philosophy involving proven operations practices and techniques with which to improve the quality and efficiency of production and service delivery, by creating flow, and eliminating waste in an organization.[3] The term "Lean thinking" is an intellectual paradigm underpinning "lean management"; which in turn makes use of "lean tools" for particular process improvement and operational tasks. This report makes use of the term "Lean" which implies "Lean thinking", unless otherwise stated.

In their 1990 book, *"The Machine that Changed the World"*, Womack, Jones and Roos introduced to the world the concept of *Lean* (originally coined by John Krafcik in 1988) in order to describe the Toyota Production System (TPS) which eliminates waste and does more with less in their production and service processes.[12] One critical aspect of Lean is the empowerment of employees to make changes to their work, thereby improving processes from the floor upwards. On an organizational level, mapping the entire process allows management to augment process steps that are value-adding and relevant to the final product or service for the customer, while systematically eradicating those that fail to add value.[16]

The primary focus of Lean is on reducing waste, synchronizing flows and managing variability in (process) flows.[17] Lean methodology is pinned on five tenets:[9, 12]

- ***Specify value*** by asking oneself what is valuable to the end-user (the patient);
- ***Identify the value stream*** using a Value Stream Map (VSM);
- ***Make the value stream flow*** by restructuring process steps and eliminating, non-value-adding steps (eliminating bottlenecks);
- ***Pull***: The forerunning process (e.g. collect medication from pharmacy) down the value-stream signals when upstream activities (e.g. doctor consultation) can begin in order to stabilize demand on the system; and
- ***Pursue perfection*** through continuous improvement.

2.8 Lean concepts, techniques and tools

2.8.1 Lean concepts and techniques

Lean classifies activities in a value stream into three categories: (1) value-added work, (2) type 1 non–value-added work is necessary but does not add value from the standpoint of the patient, and (3) type 2 non–value-added work (waste or "*muda*") which does not add value to the patient and should be eliminated.[3] Taiichi Ohno, an earlier vice president of Toyota, identified seven types of wastes which Zidel adapted to health care (Table 4).[3]

Table 4: Examples of the seven wastes (Type 2 non-value-added work) in health care.[3]

Delay	Waiting for bed assignments, waiting to be discharged, waiting for treatment, waiting for diagnostic tests, waiting for supplies, waiting for approval, waiting for the doctor, waiting for the nurse
Overprocessing	Excessive paperwork, redundant processes, conducting unnecessary tests, using an IV when oral medication would suffice, multiple bed moves
Inventory	Lab specimens awaiting analysis, emergency department patients awaiting a bed assignment, patients awaiting diagnostic tests, excess supplies kept on hand, dictation awaiting transcription
Transportation	Transporting lab specimens, transporting patients, transporting medication, transporting supplies
Motion	Searching for charts and supplies, delivering medications, nurses caring for patients on different wings
Overproducing	Mixing drugs in anticipation of patient needs
Defects	Medication errors, wrong-site surgery, improper labeling of specimens, multiple sticks for blood draws, injury caused by defective drugs or restraints or lack of restraints

Cycle-time is a measure of speed of performing a job or group of activities in a service node and *waiting-times* represent the length of time that patients follow queues before experiencing a value-added work activity. Very long cycle and waiting times inevitably result in dissatisfaction, and baulking and reneging of patients from queues. This situation also exposes patients to infectious diseases while they wait in queues.

After a dramatic process change (*kaikaku*), one of the key techniques supporting the implementation of Lean is continuous improvement (*kaizen*) which may be practised using the iterative, 4-step Shewart or Deming cycle, also called the PDCA (*P*lan, *D*o, *C*heck, *A*ct) cycle.[12] The A3 report augments the PDCA cycle; the process may be facilitated through regular *kaizen* team (or Quality Circle) meetings. The *kaizen* team usually consists of frontline workers from the *Gemba* (actual place where value is being created, such as an OPD) and key role-players who identify problems and plan, implement, and adjust improvements.[15]

Using the five principles of Lean, people become involved and empowered in the process of transformation at three levels of *kaizen*:[7]

i. Point *kaizen*: Improving the way each work-related action is performed (related to cycle times and work efficiencies).
ii. Value-stream *kaizen*: Redesigning the patient's complete journey along the value stream from beginning to end (related to waiting-times and flow).
iii. System *kaizen*: Philosophical shift of the way the health-care facility manages the patient's journey and synchronizes the necessary support activities (related to *kaizen* team meetings, the PDCA cycle and A3 report).

2.8.2 Lean tools

The primary tool of Lean for identifying work activities and waste in the value stream is the current- and future-state Value Stream Map (VSM). This is a process flowchart which presents information about speed (cycle, lead and *takt* times) of value-added work, types 1 and 2 non-value-added work and the continuity of flow.[17]

Kaizen team meetings can help eliminate wastes and improve flow to move the process toward the idealized future state.

A tool that principally empowers employees in its application is the A3 report, which is the core of Toyota's success in problem-solving. This tool, which harmonizes the PDCA cycle, is an 11-by-17 inch sheet of paper that is used to analyse the way in which a process may be improved in the value stream. On the left-hand side of the sheet, the problem background is described, and a root-cause analysis is determined by frontline workers. The right-hand side allows role-players to develop solutions to the problems. By empowering workers, A3 thinking is often the first step toward culture change; this inculcates a spirit of teamwork by fostering work across functional boundaries or "silos".[18]

The 5-Why analysis tool for root-cause analysis and identifying wastes during *kaizen* team meetings is also part of the Lean toolbox.[3] The 5S (*sort*, *straighten*, *scrub*, *standardize*, and *sustain*) tool helps with housekeeping, standardization and systemization of work.[3]

2.9 Donabedian's model as a conceptual framework

Lean implementation is closely related to the Donabedian model of structure-process-outcome, both employing a systems approach (input-process-output and feedback loop) to evaluating and improving quality and outcomes in health. The Donabedian model is a tried and tested means of performing work in addressing quality and outcomes; thus it was adopted as the conceptual framework for conducting the current study.[19]

The three components of Donabedian's framework (Figure 3) relate to the implementation of Lean as follows:[19]

- ***structure*** (what is physically needed to achieve quality) coincides with the planning phase of Lean implementation, wherein static characteristics (resources) are determined, value is specified and value-stream mapping is conducted;
- ***process*** (what must be done to achieve quality) relates to the implementation phase of Lean, where the value stream is made to 'flow' through technical and interpersonal interactions, for example, *kaizen* meetings; and

- ***outcomes*** (what we are aiming to achieve) relate to the "check" phase of Lean implementation, where perfection is pursued through continuous improvement with the aim of achieving the desired value for the client.

It has been suggested that each of the above dimensions work in harmony but can be judged independently or in conjunction with each other.[19] Similarly, Lean comprises various components that are used in its implementation (such as value-stream mapping, *kaizen* team meetings and continuous improvement) but each element may be implemented and/or assessed independently, for example, value-stream mapping may be conducted independently, without the need for including results in *kaizen* team-meeting discussions.

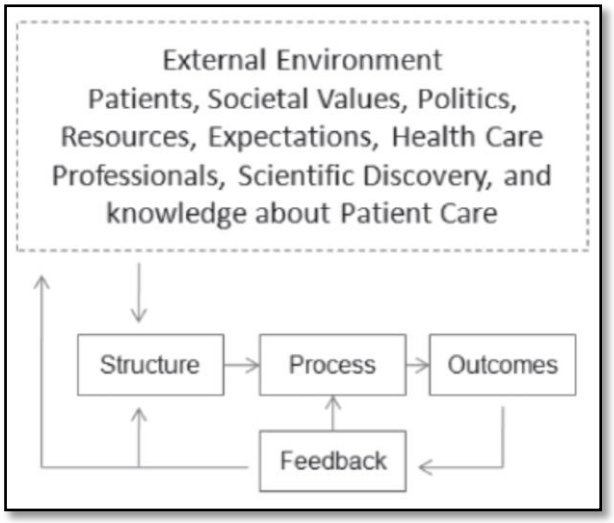


Figure 3: Donabedian's model for quality.[19]

2.10 Evidence for benefits of Lean in health care

In the U.S.A., a pre-surgical nursing unit at the Western Pennsylvania Hospital managed significantly to reduce lead and cycle times by eliminating ambiguities through Lean in the following processes, *inter alia*, signing in before registration (from "up to 2 hours" down to zero); time spent in registering patients (from "12 minutes to 1 hour" down to three minutes); and time spent each day assembling patients' charts (from "9 hours" down to 2¼ hours).[20] Perfecting Patient Care (PPC) through Lean is the Pittsburgh Regional Healthcare Initiative's flagship process improvement methodology.

Numerous hospitals participating in PPC instituted a plethora of combined countermeasures to eliminate Central-Line Associated Bloodstream (CLAB) infections. In Allegheny General Hospital, the number of CLAB infections and associated deaths declined from 37 to 6 and 19 to 1 year-on-year, respectively.[20] In the participating LifeCare hospitals, there was an 87% reduction in CLAB infections, despite an increase in the number of central lines placed by 9.75% during the study period.[20]

Also in the USA, iterative trials and experiments using Lean in the South Side Hospital in Pittsburgh, showed that the time spent searching for medications decreased by 60% and stock-outs fell by 85% in the pharmacy, without investment in additional technology.[20] The nearby Shadyside Hospital adapted the Lean methodology from South Side Hospital. Their iterative experiments and trials revealed that an estimated 2 900 nurse-hours per year were saved on time spent on patient-controlled anaesthesia pumps.[20] Patient falls in the same hospital had occurred on average every 12 hours, but this dramatically declined to zero falls in 95 days since the implementation of Lean.[20]

Similar results from studies involving the application of Lean have been replicated in health care in the United Kingdom. In the pathology department at Bolton Hospital (an NHS facility) in the United Kingdom, significant improvements were reported after Lean implementation: 70% reduction in the number of steps needed to complete most tasks; 40% reduction in required floor space; and up to 90% reduction in the cycle-times taken to conduct tasks.[7] These results resonated with what the Toyota Production System and Lean stood for – achieving more with less. The successes at Bolton Hospital were achieved with fewer, not more, staff.[7]

In 2006, at the 500-bed Flinders Medical Centre in Adelaide, Australia, Lean was implemented in the form of the Redesigning Care programme, after it was reported that the emergency department was "bursting at the seams" with up to 1 000 patients per month waiting for more than 8 eight hours before being treated.[7, 21] Lean tools and techniques such as point *kaizen*, Value Stream Mapping and a series of PDCA cycles benefited the centre by reducing average patient waiting-times by 25% (70% of patients going home within 4 hours), as well as patients reneging from queues without seeing a doctor fell by 41%.[7, 21] The study also reported an easing of pressure felt by staff.[7, 21]

Locally, Faull *et al*. experimented with Lean by conducting action-research in 2006 at G.F. Jooste Hospital in Manenberg, Cape Town, which sees up to 70 000 patients per year in the Accident and Emergency unit alone.[14] The research team proved that Lean improves patient flow, patient service level and attitude amongst key staff. Average lead time achieved (89 minutes) exceeded the target of 120-150 minutes, and 100% of patients and staff surveyed were satisfied with the achievements and service-delivery.[14]

DelliFrane *et al.* postulated from a systematic review of 34 articles (spanning 1999 to 2008) based on studies on Lean and Six Sigma in health care that there is insufficient evidence of substantial benefits of these quality improvement methods in health care.[22] However, the authors suggest that there is a trade-off between depth and breadth of reporting results in reviewed studies owing to likely space limitation in most journals (many articles reported the results of Lean implementation in multiple projects but did not report in-depth statistical findings, and hence had lower evidence scores).[22] Nevertheless, using Slavin's classification system for evidence-based practices, the review concludes that there is slightly stronger evidence that Lean improves processes of care than the evidence that it improves clinical outcomes.[22] Furthermore, five of the reviewed articles on Lean showed improved Emergency Room throughput, and 12 articles showed reduced patient waiting-times.[22] Four of these articles (Bush *et al*., Chan *et al*., Godin *et al.*, and Raab *et al.*) showed statistically significant reductions in patient turnaround and waiting times in different departments.

2.11 The success and sustainability of Lean in health care: The human side to Lean

It is important that Lean should not be seen as a "production-line" panacea for operations-management-related problems in health care. Avant-garde research on Lean in health care concluded that the main organizational factors influencing the adoption and success thereof comprise, *inter alia*, culture and climate; leadership style; power balances; social relations; attitudes to risk-taking; intra-organizational communication and collaboration; and absorptive capacity for new knowledge.[23] Two basic Lean concepts are highlighted: the relentless elimination of waste and the empowerment of workers.[16] The usual focus in non-Lean health-care environments is on clinicians, but Lean shifts the focus onto patients who epitomize the purpose of a value stream.

Empowered frontline workers, having direct contact with patients, are instrumental in steering the Lean process. Solutions to problems generate new insights which are deployed systematically by frontline workers, and facilitated by managers who undergo a paradigm shift in realizing the continuous improvement philosophy of Lean.[20]

2.12 Limitations of reviewed studies

There is a paucity of studies on Lean in health care in South Africa. Moreover, some of the evidence for Lean in health care is weak, mainly owing to poorly designed studies. Of the studies that have been reviewed, most were conducted in health-care facilities in the U.S.A., Australia and United Kingdom.[20] Comprehensive descriptions of research methods, including study sampling, validity and reliability, have not been provided for most studies.

DelliFrane *et al.* reviewed 34 articles, but only one was quasi-experimental, one used a non-equivalent control group, and the others were based on observational study designs without control groups.[22] Hence, evidence scores were low, mainly owing to weak study designs. Furthermore, the systematic review reported that studies reflected a wide array of Lean applications across multiple projects and departments in health-care facilities, rather than narrowing the study scope to fewer and smaller departments and distinct variables which could demonstrate statistically significant results. The authors suggested that future research should focus on specific areas that may demonstrate statistically significant results. This supports the study objectives which focused on data-collection of specific and measurable variables.

2.13 Summary

The reviewed literature in this chapter reflects a number of studies on the application of Lean in health care that have been previously conducted, but with few in rural South African hospitals. Studies conducted in other countries mostly unveil poor study designs and study settings not typical of the South African rural health-care delivery context. The literature that was explored also provided a conceptual framework and a refined study design and methods for the research, which is reported on in Chapter Three.

CHAPTER III: METHODS

3.1 Introduction

While the benefits of Lean in health care are apparent from reviewed literature, the paucity of studies in South Africa inconclusively reflects the true effects on and applicability of Lean in rural public-health institutions. This study determined the impact of Lean on operational efficiency in a rural district hospital; the application thereof was confined to one area within the institution, as suggested by authorities in the field. Chapter Three describes the research methods used in this study, including study design, study population and sampling, data collection and analysis. An illustration of the research process is presented in an action-research spiral, and the credibility (trustworthiness) and reliability of the study are discussed. Ethical considerations are also described.

3.2 Type of research

The type of study is health-systems research.

3.3 Study design

An operational action-research (before-and-after study) design was used.

3.4 Study setting

Catherine Booth Hospital (CBH) is a 170-bed rural district hospital situated in Kwa-Khoza Reserve, Umlalazi Municipality, Amatikulu, in the uThungulu Health District on KwaZulu-Natal's north coast. CBH offers multidisciplinary medical and surgical services for both inpatients and outpatients, serving a population of over 200,000 people.[24] The OPD consists of three consulting rooms, a nursing assessment station, a four-bed emergency cubicle and a waiting area. However, the study includes all major areas (patient administration, screening, consultation rooms, investigations, X-ray department and/or pharmacy) through which a typical general outpatient usually has to pass in the health-care service-delivery process before exiting the hospital.

3.5 Target population

Although the study findings are not intended to be generalized, the target population, to which the transferability of results is anticipated, comprised the OPDs in public-sector rural district hospitals in KwaZulu-Natal, South Africa.

3.6 Study population

The study population, from which the three categories of samples were drawn, consisted of service nodes, outpatients and employees of the OPD in Catherine Booth Hospital.

3.6.1 Inclusion and exclusion criteria

Service nodes: Any service node that was substantially short-staffed (40% or more absent) in the short-term (for example, workers were on sick leave), or closed during the iterative data-collection process, were excluded from the study sample.

Outpatients: Anyone that required emergency care, an extraordinary length of time to be attended to, or anyone who reneged from queues during data-collection, was excluded from the study sample.

Employees in the OPD: Only HCWs (excluding students) and support staff (such as porters and administration workers) who had worked for longer than 3 consecutive months in any of the OPD service nodes, and were stationed there during the study period, were included in the study.

3.7 Sampling

Three categories of samples were drawn pre- and post-Lean implementation from the study population for measuring cycle-times (*service nodes*), waiting-times (*outpatients*), and attitudes and morale (*employees in the OPD*). The selection of the action-research participants (*kaizen* team) is described below.

3.7.1 Sampling method

CBH was judgementally selected based on the investigator's experience of operational problems in the OPD. The following seven *kaizen* team members, who play an important role in the OPD value stream, were purposively selected: two senior managers of the hospital (e.g. Nursing Manager and Hospital Manager), the OPD unit manager, one OPD doctor, and a representative from patient administration (registry), pharmacy and the X-ray department.

Service nodes: Average cycle-time measurements of all service nodes were conducted iteratively by means of a census. The number of cycle-time measurements of service nodes was determined by the sample size formula indicated under Section 3.7.2.

Outpatients: Non-probability, judgemental sampling was carried out during a standardized time in each action-research cycle, as described under Section 3.7.2.

Employees in the OPD: Questionnaires were distributed to all OPD staff (census), taking into account the inclusion and exclusion criteria.

3.7.2 Sample size

Service nodes: The number of cycle-time measurements (*n*) for each service node was calculated using the following formula after measuring 5 cycle times in a pilot study:[25]

$$\boxed{n = \left(\frac{zs}{e}\right)^2}$$

where: z = 1.96 (number of standard deviations from the mean reflecting level of statistical significance)

s = sample standard deviation of cycle-time from the pilot study

e = 2 minutes (absolute amount of acceptable error)

Level of confidence = 95%

For example, if the standard deviation for ***one*** of the service nodes was 6 minutes, then the sample size (number of cycle-time measurements) for that node would be 35.

Outpatients in queues: A sample in each action-research cycle comprised all outpatients observed in a queue preceding each service node during a midweek two-hour standard observation period.

Employees in the OPD: Since a small number of employees (less than 40) worked in the OPD, questionnaires were administered to all OPD staff (taking into account the inclusion and exclusion criteria).

The number of action-research cycles (and *kaizen* team meetings) was determined by the achievement of realistic cycle- and waiting-time targets that were set by the *kaizen* team. Each (PDCA) cycle was of variable duration, with a minimum of two weeks each.

3.8 Data sources

3.8.1 Measurement instruments

Employee morale and attitudes: Self-administered questionnaires (Addendum 6).

Cycle and waiting times: These were measured via observation using a watch; results were recorded directly onto table templates (Addendum 7).

Kaizen team meetings: Minutes of each end-of-cycle and ad-hoc *kaizen* team meeting were kept. The A3 reports and current- and future-state VSMs were used for records of baseline and progressive problem-identification, problem-solving and cycle- and waiting-times. The researcher also kept a journal of all observations and experiences during the action-research cycles.[26]

3.8.2 Data-collection techniques

Figure 4 demonstrates the data-collection within iterative action-research cycles. Cycle- and waiting-times were measured by direct observation on two occasions *before*, approximately two-weekly *during*, and on two occasions *after* Lean implementation (Figure 4). Self-administered questionnaires were distributed to OPD staff before and after Lean implementation, in order to measure baseline and post-Lean attitudes and morale, respectively (Figure 4). Completed questionnaires were collected from the staff on the same day. The investigator involved relevant frontline workers in the development of a current-state VSM, using the averages of the two baseline cycle- and waiting-time data sets; and the future-state VSM and A3 reports were developed in conjunction with the *kaizen* team during each end-of-cycle and ad-hoc *kaizen* team meeting. The researcher kept a journal of observations and experiences throughout all the action-research cycles.

3.8.3 *Kaizen* team meetings

A typical *kaizen* team meeting broadly included a presentation by the researcher of the previous waiting- and cycle-time measurements (outcomes of action) and a synopsis of what had been implemented and the operational impact thereof in the various service nodes and queues. Thereafter, the action-research participants were given the opportunity to critically reflect on and question the effects of the previous cycle's actions. This then led on to the action planning for the next cycle.

Beckhard and Harris proposed the following questions for action planning which were considered during *kaizen* team meetings: *What needs to change and in which parts of the organization? What types of change are required? Whose support is needed? How is commitment built? How is resistance managed?*[26] Once action plans were implemented between *kaizen* team meetings, evaluation of the results of the previous cycle involved reflecting on the outcomes and a review of the process in order to ensure the next cycle of planning and action benefited from the experience of the previous cycle.[26]

Kaizen team meetings took place at the end of each action-research cycle, but there were some *ad hoc* problem-focused meetings.

3.9 Researcher's role in the study

The researcher's role was to facilitate, as an "outside agent", the correct and effective use of lean techniques.[26] The sustainability of Lean implementation was not an objective of the study.

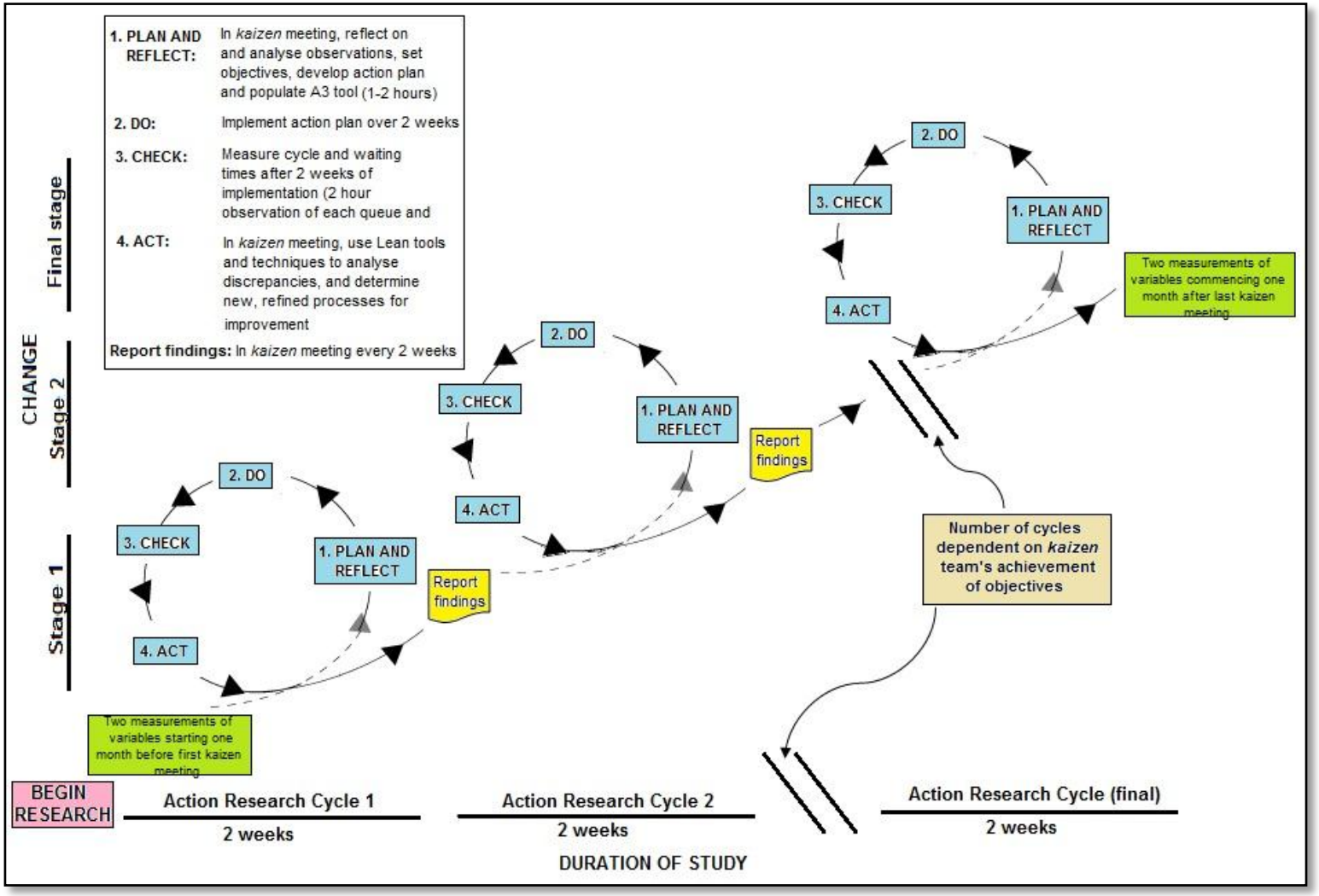


Figure 4: The study process: The action-research spiral.

3.10 Variables

The following table lists the variables that were used in the study.

Table 5: List of variables

	Conceptual definition of variable	Operational definition / indicator	Objective covered	(Scale of) Measurement	Data-collection technique / tool
Dependent variables	Staff attitudes and morale	Response to specific questions on attitudes and morale related to working in OPD	Objectives number (ii) and number (iv)	Mixed ordinal (Likert scale), nominal and open-ended questions	Questionnaire (Pre- and post-intervention)
	Processing time	Cycle time	Objective number (i)	Continuous (in minutes)	Watch and table templates
	Idle time in queues (waste)	Waiting time	Objective number (i)	Continuous (in minutes)	Watch and table templates
Exposures (independent 'variables')	Lean tools	Application of VSM and A3 reports	Objective number (iii)	Qualitative and quantitative data	*Kaizen* meeting minutes, VSMs and A3 reports
	Lean techniques	Application of PDCA cycle, Lean principles, 5-Why analysis	Objective number (iii)	Qualitative data	*Kaizen* meeting minutes

3.11 Measures to ensure validity

3.11.1 Credibility / Trustworthiness

Hawthorne effect: It is important to note that action research may be argued in validation of the Hawthorne effect, especially in the context of Lean philosophy, where the facilitator intentionally plays out his/her role in a real, participatory sense instead of reducing the effect as in a positivistic, laboratory setting.[27]

Nevertheless, the Hawthorne effect, even if thought to validate action research, was minimized by carrying out *two* baseline measurements of variables *before* and *two* measurements *after* Lean implementation at dispersed intervals.

Triangulation: This provides a rich resource for improving credibility by the inclusion of all stakeholders relevant to the issue investigated (purposively selecting the *kaizen* team), the observation of multiple service nodes and events relevant to the investigation, the use of various measurement instruments (VSMs, A3 reports, questionnaires and *kaizen*-team meeting minutes), and by using a qualitative and quantitative enquiry.

Respondent validation ("member checking"): The investigator's interpretation and account of the collected data was compared with those of the *kaizen* team members during two-weekly meetings, in order to establish the level of congruence between the two data sets. The participants' reactions to the analyses were then incorporated into the study findings.

Clear exposition of study methods: Kaizen team members were briefed in an initial meeting which was held to present the research procedures and concepts of Lean, and to clarify the participants' ways of describing and interpreting problems and events.

Prolonged engagement: With the investigator's prolonged engagement with the *kaizen* team and study setting in a series of iterative action-research cycles, research credibility is likely to be increased.

Participatory validity: This is enhanced by the involvement of frontline workers and managers.

3.11.2 Transferability

Although the results are not intended to be generalized to all health-care settings in South Africa, detailed Lean methods to emulate similar research in settings with such a comparable study context as CBH is described in this chapter.

3.11.3 Bias

3.11.3.1 Selection bias

A census of OPD staff (who meet the inclusion criteria) and service nodes for measuring attitudes / morale and cycle times, respectively, reduced selection bias. Standardized times for observation of queues during fixed time periods minimized sampling bias.

3.11.3.2 Information bias

Refer to Section 3.11.1.

3.11.3.3 Confounders

- Any change in management style that may influence OPD operations;
- Any new OPD or management staff incumbent employed during the study;
- New policy, protocol or mandate beyond the ambit of Lean implementation; and
- Change in technology or expertise beyond the ambit of Lean implementation.

The Hawthorne effect is addressed under Section 3.11.1.

3.12 Dependability / Reliability

Although an external inquiry audit would be ideal to establish the dependability of the results, it was beyond the manageable scope of the study. The investigator therefore made available to the *kaizen* team the details of the research process.

3.13 Pilot study

A limited pilot study was conducted involving the observation of only five cycle times in each service node of the OPD. The results were used to calculate the number of cycle-time measurements for each service node. The pilot study also allowed the investigator to revise the cycle- and waiting-time measurement templates.

3.14 Statistical methods

3.14.1 Descriptive methods

A descriptive summary of the samples for cycle and waiting times, and the participants completing the questionnaires, is provided in Chapter Four. Descriptive methods were also used to summarize the application of Lean tools and the *kaizen* meetings that took place.

3.14.2 Analytical methods

3.14.2.1 Staff attitudes and morale

Fixed response data was coded and captured onto Microsoft Excel®, and missing values were identified. Staff attitudes and morale were categorized into several themes and these were scored by summing the responses to each Likert-scale item. At the 95% confidence level, pre- and post-intervention scores were compared using paired t-tests or Wilcoxon paired signed-rank tests depending on data distribution. Bivariate analyses for proportions were carried out using Fisher's test to compare relevant pre- and post-intervention categorical variables. The questionnaire scores were evaluated by node only in instances where there were more than two measurements at each time point in the node.

3.14.2.2 Cycle and waiting times

Since pre- and post-intervention groups did not contain paired data (different participants at each pre- and post-intervention time point), they were considered independent. Therefore, independent samples t-tests were carried out to compare pre- and post-intervention cycle and waiting times where the assumptions were met. Where the assumptions underlying the t-test were not met, the Wilcoxon signed-rank test was used to compare the baseline and post-intervention measurements. The test for trend was conducted by fitting a linear regression, and evaluating the slope of the time variable.

Statistical analyses were carried out using the SPSS® software package.

3.15. Ethical considerations

3.15.1 Permissions

Permission to conduct the study was obtained from the Postgraduate Education Committee (Addendum 1), the Hospital Manager of CBH (Addendum 3), the Department of Health's uThungulu District Manager and the Provincial Health Research Committee (Addendum 4).

3.15.2 Institutional Ethical Review Board

A complete research protocol and supporting documentation was submitted to the Biomedical Research Ethics Committee of the University of KwaZulu-Natal (UKZN); approval (BE097/11) was granted. (Addendum 2)

3.15.3 Informed consent, information leaflets, and confidentiality

Information leaflets (Addendum 5 – Section A) were provided to action-research participants (*kaizen* team), senior managers of CBH, all employees in the OPD and anyone being observed during cycle- and waiting-time measurements. Written informed consent (Addendum 5 – Section B) was obtained from the action-research participants (*kaizen* team) and employees that answered questionnaires. To maintain confidentiality and anonymity, participants returned completed questionnaires by depositing them into a sealed box which was securely kept in the Medical Manager's office.

The routine management of patients was not negatively affected by the study, and no staff, patient or medical records were required. Furthermore, the details of action-research participants and employees that answered questionnaires, minutes of and action plans that arose from *kaizen* meetings, and any other information deemed to be confidential, was kept confidential.

3.16 Summary

This study investigated the implementation of Lean in a rural district hospital outpatient department and the effect which the application of Lean principles, tools and techniques had on patient waiting times and cycle times, as well as staff attitudes and morale. This chapter specifically describes the study design, study population and sampling, data-collection and analysis that was employed in the study. Measures to ensure validity and dependability, and ethical considerations, are also described.

CHAPTER IV: RESULTS

4.1 Introduction

The purpose of the study was to apply Lean principles, tools and techniques, and to determine the impact on efficiency and staff morale. Waiting and cycle times as measures of operational efficiency were observed from samples which were drawn pre- and post-Lean implementation from the study population across two categories: service nodes (cycle times) and outpatients (waiting times). Staff attitudes and morale were determined before and after Lean implementation through questionnaires administered to OPD staff by adhering to inclusion and exclusion criteria.

4.2 Study sample

4.2.1 Service nodes

Six service nodes were identified as fundamental in the delivery of outpatient services:

- *Patient administration,* where patients retrieve their files upon entering the OPD;
- *Patient screening,* where nurses carry out clinical observations (measurement of blood pressure, pulse rate, respiratory rate and temperature), and record the patient's medical complaint, including other relevant information for the doctor;
- *Consulting room,* where the patient consults with a medical doctor (before and after further investigations and procedures may be requested by the doctor);
- *X-ray department,* where X-rays are taken by a radiographer, as ordered;
- *Investigations station,* where nurses and/or a doctor carry out further special tests and/or procedures (such a blood and urine test, as requested by a medical doctor after the doctor-patient consultation); and
- *Pharmacy,* where patients are provided with their medication to take home, as well as where necessary counselling is provided on treatment compliance and how to take the medication.

All six service nodes were included throughout the study period. Four of the 32 employees in the OPD were excluded from the study because they worked there for less than three consecutive months. Patients that were excluded according to the criteria were not counted.

4.2.2 Cycle times within service nodes

From the pilot study, the number of measurements of cycle times (*n*) for each of the six service nodes was determined. Table 6 provides a summary of the sample sizes.

Table 6: Sample sizes for cycle times

Service node	***Maximum time***	***Minimum time***	***Standard deviation***	***n***
Patient Administration	13	5	3.54	12
Patient Screening	12	8	1.67	3
Consulting room	20	5	5.94	33
X-ray	22	18	1.48	2
Investigations	13	8	2.17	5
Pharmacy	20	12	3.08	9

The average of each service node's cycle-time measurements, after applying exclusion criteria, was regarded as the actual cycle time of that node.

4.2.3 Waiting times

Since the number of waiting-time measurements (*n*) before each service node during the 2-hour observation periods depended on the nature of patient illness and the type of work carried out at the node, *n* was variable during each action-research cycle (Table 7).

Table 7: Sample sizes for waiting times

Service node	**Sample size for waiting times (*n*) during each action-research cycle**					
	First baseline	***Second baseline***	***Cycle 1***	***Cycle 2***	***First post-Lean***	***Second post-Lean***
Patient Administration	13	15	10	12	13	13
Patient Screening	14	12	14	13	12	14
Consultation room	41	44	45	44	39	45
X-ray	4	5	3	3	4	3
Investigations	8	6	10	12	9	6
Pharmacy	18	14	22	19	18	16

4.2.4 Employees in the OPD

Of the 28 employees sampled in the OPD before Lean implementation, there was a response rate of 67.9% (*n*=19), which were all valid and completed questionnaires.

After Lean implementation, the questionnaire response rate achieved was 64.29% (*n*=18) as summarized in the table below.

Table 8: Summary of questionnaire respondents

Service node	**Baseline**				**Post-Lean**			
	n	***Male***	***Female***	***Average years of service***	***n***	***Male***	***Female***	***Average years of service***
Patient Administration	2	0	2	>5	2	1	1	>5
Patient Screening	4	0	4	3	4	0	4	3-5
Consulting room	2	1	1	1	1	0	1	<1
X-ray	1	0	1	<1	1	0	1	<1
Investigations	3	0	3	5	4	0	4	5
Pharmacy	7	3	4	>5	6	5	1	>5
Total	**19**	**4**	**15**		**18**	**6**	**12**	

4.3 A summary of the process and application of Lean tools and techniques

4.3.1 Pre-intervention briefing

A one-hour pre-intervention briefing meeting was hosted by the researcher on 28 February 2012 at CBH with the purpose of introducing the study to *kaizen* team members. All *kaizen* meeting team members that were invited attended, except one who was on leave. The six available members consented to participation in the research, and were very interested in observing the effect that Lean would have in the OPD.

The researcher delivered a PowerPoint presentation, briefing everyone on the research problem, purpose and objectives of the study, and research methods to be used. The attendees were satisfied with the content of the presentation; they understood the way in which the research was to be conducted. The acting hospital manager also attended as a neutral observer; she was very much enlightened, anticipating a favourable research outcome.

4.3.2 *Kaizen* meetings and A3 tools

The details of the *kaizen* team meetings are discussed under Section 4.5.

4.3.2.1 Targets

After two baseline measurements of cycle and waiting times at the specified intervals and the baseline survey (Section 3.8.2), the first *kaizen* meeting was held, where targets were set (Table 9; Addendum 8). From this meeting, information was gathered by the facilitator (researcher) with which to develop the future-state VSM (Section 4.5.2.2*)* and the first A3 report (Figure 7), upon reflecting on the baseline cycle and waiting times.

Table 9: Target cycle and waiting times as determined by the kaizen team

Service node	Current cycle time (min)	Target (min)	Current waiting time (min)	Target (min)
Patient Administration	9.25	8.79	44.05	39.64
Patient Screening	12.17	11.56	15.44	13.90
Consultation room	7.18	6.82	80.95	72.86
X-ray	19.50	18.53	23.30	20.97
Investigations	16.70	15.87	11.77	10.59
Pharmacy	11.00	10.45	14.51	13.06
Total	**75.80**	**72.01**	**190.02**	**171.02**

4.3.2.2 Kaizen team meetings

After the pre-intervention briefing meeting, two action-research cycles were completed and three *kaizen* team meetings were held (Addenda 8 to 10). The details of the meetings are discussed under Section 4.5. During each meeting, the facilitator delivered a PowerPoint presentation which included the latest results of the cycle- and waiting-time measurements. The 5-why analysis and the A3 tool were used for problem-solving.

4.3.2.3 The A3 reports

Three A3 reports (refer to Section 4.5), each of which was developed at every *kaizen* team meeting, proved to be successful as tools with which to engage with *kaizen* team members in problem-solving, using techniques such as 5-why. Non-value-adding items (*muda*), which contributed to long cycle and waiting times, were identified and listed in the A3 tool. An action plan with specific actions, responsible persons and time-frames, was compiled. This was implemented immediately after the *kaizen* team meeting which then heralded the start of the next action-research cycle.

4.4 *Takt* time

The duration of all six service nodes that were open and operational during an ordinary weekday was 540 minutes (9 hours) with 100 per cent uptime. The average patient throughput during this 540-minute period was 120. Therefore, the 9-hour *takt* time for the OPD (the cycle time necessary in the process to meet the demand of the patients) was calculated to be 4.5 minutes. In other words, in an ideal 'production factory' setting, the OPD staff would spend 4.5 minutes 'processing' each 'inventory unit' (patient) in order to finish a 9-hour day's work of 120 units (patients).

4.5 Action research cycles

4.5.1 Value Stream Maps

An average outpatient would go through the six service nodes in the sequence described in Section 4.2.1, each of which is generally preceded by waiting in a queue. It is perceived that a patient values receiving (quality) services at some or all of the service nodes in the OPD rather than waiting in queues (*muda*). The time spent within each of the service nodes (being "processed") is reflected in the VSM as cycle times, interspersed with the non-value-adding waiting time before each service node.

Before each service node, patients (*I*=inventory) would wait in queues; the lengths of the queues ranged from 1 to 55 patients (*P*) being observed during the observation period. At each service node, the number of patients (*P*) being processed simultaneously depended, *inter alia*, on the available human resources (*D*=doctors; *A*=assistants, *N*=nurses). It was observed that the uptime (*U/T*) for each service node was 100 per cent because lunch and tea breaks were staggered and service nodes were not shut down at any time during the 9-hour OPD operating period (540 minute availability). The set-up (*S/U*) time for each service node was zero minutes, patients being immediately attended to upon entering the node.

4.5.2 Pre-intervention phase

4.5.2.1 Pre-intervention (baseline) results

The flow of patients and the baseline cycle and waiting times observed on the 14-15 March 2012 and 20-22 March 2012 for the six service nodes are summarized in Table 10 and Figure 5. These results were presented in the first *kaizen* team meeting held on 3 May 2012. Each patient spent on average 189.8 minutes (range 2-23 minutes) waiting in queues and 75.8 minutes (range 5-94 minutes) in the service nodes being "processed". The lengths of the queues varied during the observation periods.

Table 10: Baseline cycle and waiting times with minimum and maximum queue lengths and cycle and waiting times

Service node	Baseline cycle time (min)	Baseline waiting time (min)	Max. queue length	Min. queue length	Max. cycle time (min)	Min. cycle time (min)	Max. waiting time (min)	Min. waiting time (min)
Pt. Admin.	9.25	44.14	21	9	15	5	64	25
Pt. Screening	12.17	15.27	17	8	15	10	22	9
Consult. room	7.18	80.95	55	23	18	2	94	60
X-ray	19.50	23.33	5	1	23	17	30	18
Investigations	16.70	11.93	8	3	23	12	18	5
Pharmacy	11.00	14.16	21	13	15	7	22	8
Total	**75.80**	**189.78**						

4.5.2.2 Future-state Value-Stream Map

As mentioned under Section 4.3.2, the targets that were set for cycle and waiting times (5% and 10% reduction respectively) were used to develop a future-state VSM which served as an indication of what the kaizen team would like to achieve. The future-state VSM is shown in Figure 6.

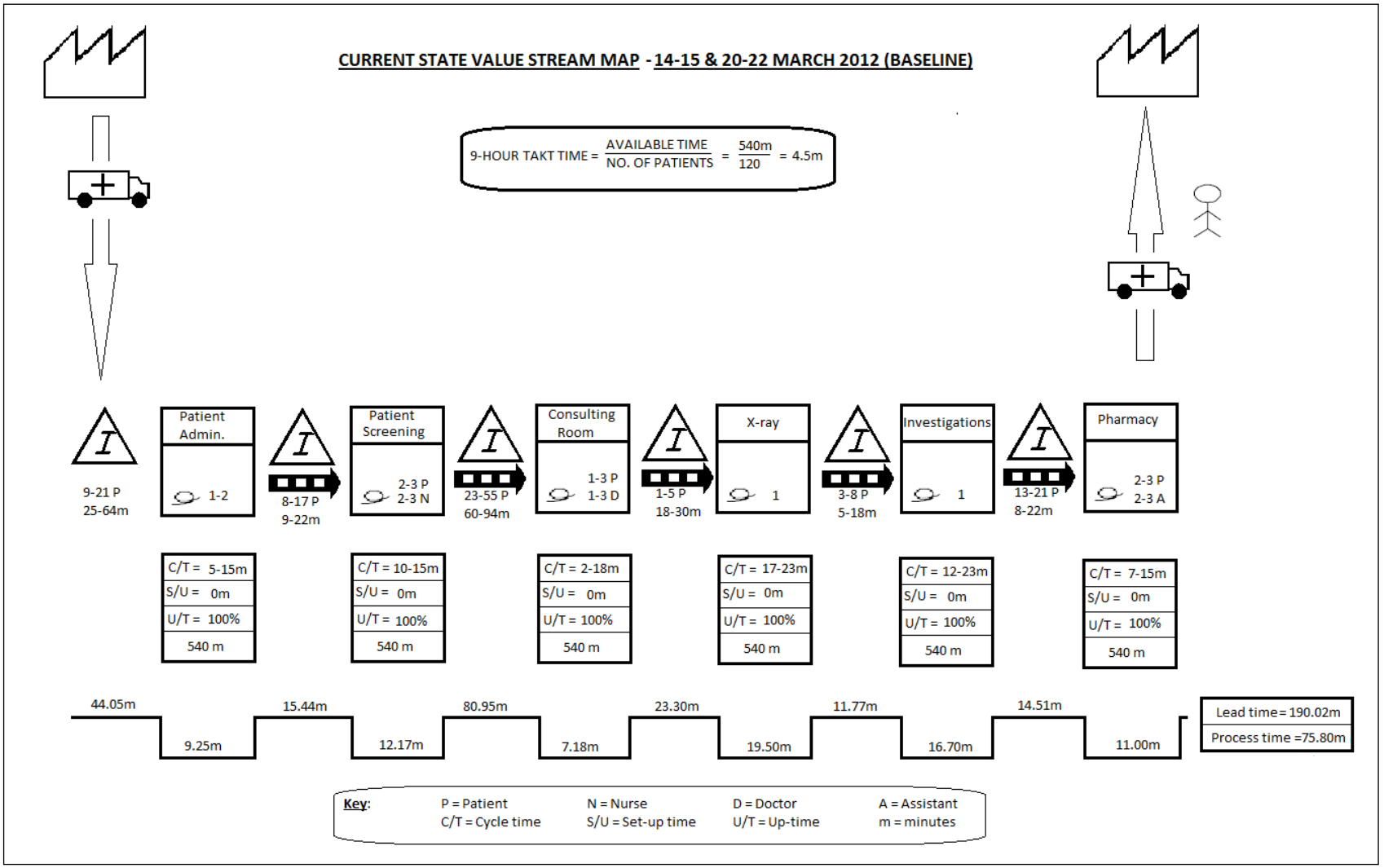


Figure 5: Current state (baseline) Value Stream Map

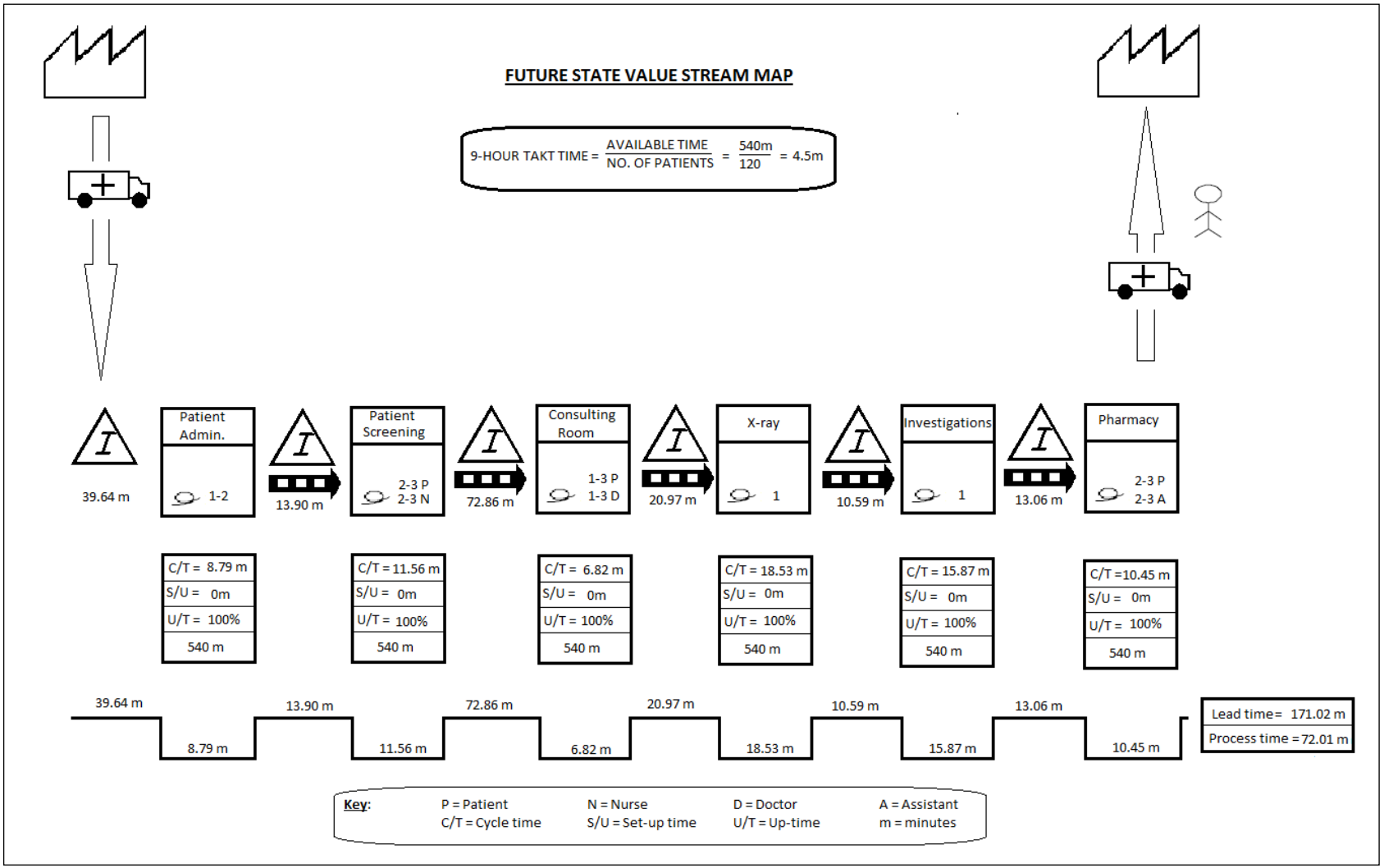


Figure 6: Future state Value Stream Map

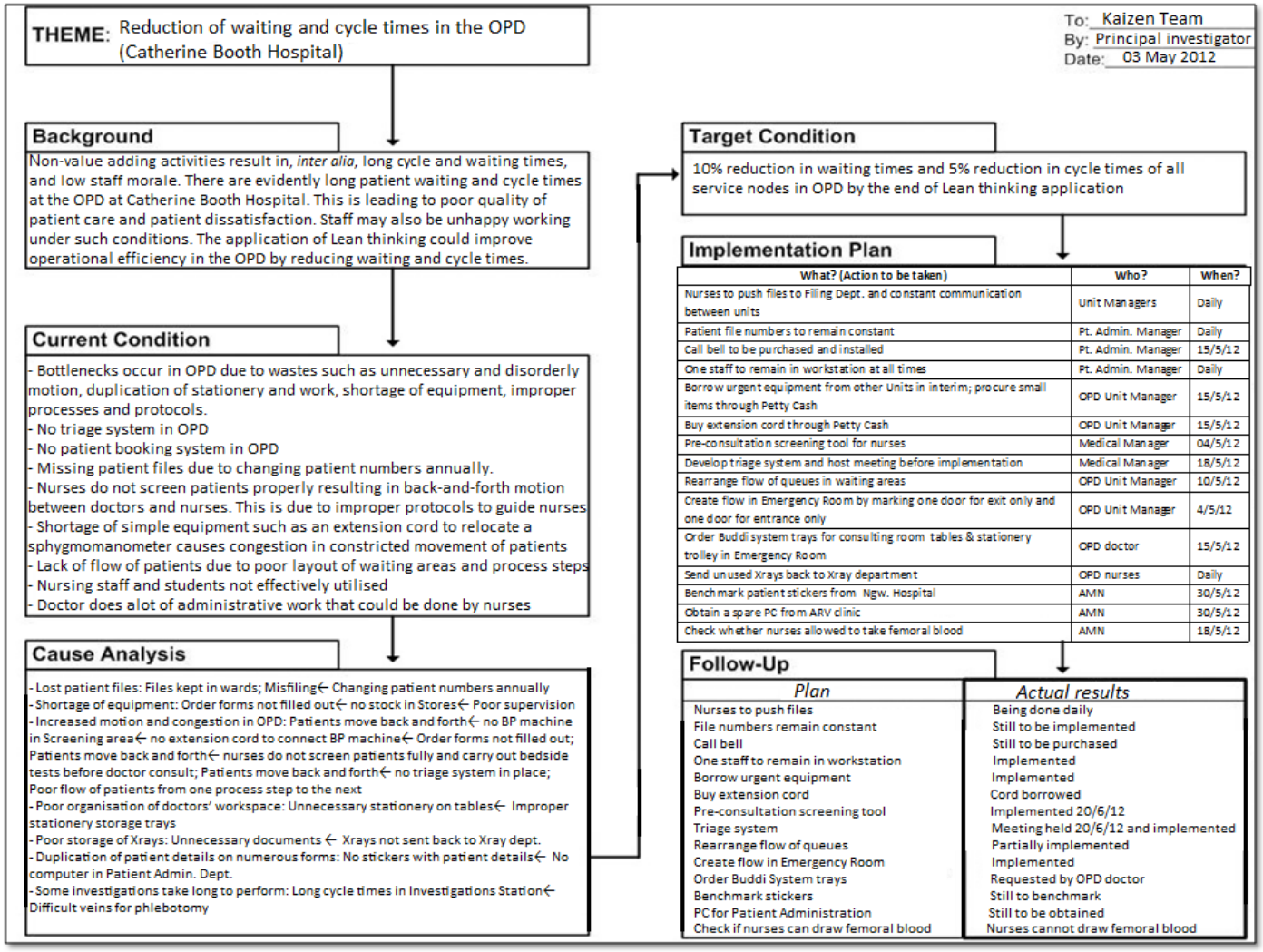
4.5.2.3 Action planning for action research cycle one

In the first *kaizen* team meeting, the team members also identified (using the 5-why analysis and A3 tool) various problems that may be contributing to the current cycle and waiting times which were presented. The following list of problems was identified:

- Lost patient files were contributing to longer cycle times for file retrieval;
- The Patient Administration staff were not visible at their workstation by clients;
- Shortage of equipment, resulting in borrowing from other departments;
- High levels of and disorderly motion in OPD;
- Poor x-ray storage facility;
- Duplication of patient details on numerous forms; and
- Poor organisation of doctors' workspace.

The team members populated the first A3 report template (Figure 7) by reflecting upon the root causes of each of the problems, and an action plan was drawn up. One of the key interventions planned was the implementation of a patient triage system in the OPD. This would improve the quality of service offered to the patients waiting in the queues by ensuring the more acutely ill and elderly or disabled patients are seen first. Related to this is the rearrangement of the patient queues and flow in OPD to address the high levels of unnecessary movement and segregate patients with communicable diseases from those at risk, such as children.

Furthermore, a pre-consultation screening tool was to be developed and implemented which would speed up the doctor consultations by ensuring that nurses perform necessary tests before the patient is seen by a doctor. This tool was to include evidence-based clinical guidelines for nurses to follow, which must also be within their scope of practice. This tool would then help reduce the to-and-fro movement of patients after being seen by a doctor, thus impacting positively on the Consultation Room cycle and waiting times.



THEME: Reduction of waiting and cycle times in the OPD (Catherine Booth Hospital)

To: Kaizen Team
By: Principal investigator
Date: 03 May 2012

Background

Non-value adding activities result in, *inter alia*, long cycle and waiting times, and low staff morale. There are evidently long patient waiting and cycle times at the OPD at Catherine Booth Hospital. This is leading to poor quality of patient care and patient dissatisfaction. Staff may also be unhappy working under such conditions. The application of Lean thinking could improve operational efficiency in the OPD by reducing waiting and cycle times.

Current Condition

- Bottlenecks occur in OPD due to wastes such as unnecessary and disorderly motion, duplication of stationery and work, shortage of equipment, improper processes and protocols.
- No triage system in OPD
- No patient booking system in OPD
- Missing patient files due to changing patient numbers annually.
- Nurses do not screen patients properly resulting in back-and-forth motion between doctors and nurses. This is due to improper protocols to guide nurses
- Shortage of simple equipment such as an extension cord to relocate a sphygmomanometer causes congestion in constricted movement of patients
- Lack of flow of patients due to poor layout of waiting areas and process steps
- Nursing staff and students not effectively utilised
- Doctor does alot of administrative work that could be done by nurses

Cause Analysis

- Lost patient files: Files kept in wards; Misfiling← Changing patient numbers annually
- Shortage of equipment: Order forms not filled out← no stock in Stores← Poor supervision
- Increased motion and congestion in OPD: Patients move back and forth← no BP machine in Screening area← no extension cord to connect BP machine← Order forms not filled out; Patients move back and forth← nurses do not screen patients fully and carry out bedside tests before doctor consult; Patients move back and forth← no triage system in place; Poor flow of patients from one process step to the next
- Poor organisation of doctors' workspace: Unnecessary stationery on tables← Improper stationery storage trays
- Poor storage of Xrays: Unnecessary documents ← Xrays not sent back to Xray dept.
- Duplication of patient details on numerous forms: No stickers with patient details← No computer in Patient Admin. Dept.
- Some investigations take long to perform: Long cycle times in Investigations Station← Difficult veins for phlebotomy

Target Condition

10% reduction in waiting times and 5% reduction in cycle times of all service nodes in OPD by the end of Lean thinking application

Implementation Plan

What? (Action to be taken)	Who?	When?
Nurses to push files to Filing Dept. and constant communication between units	Unit Managers	Daily
Patient file numbers to remain constant	Pt. Admin. Manager	Daily
Call bell to be purchased and installed	Pt. Admin. Manager	15/5/12
One staff to remain in workstation at all times	Pt. Admin. Manager	Daily
Borrow urgent equipment from other Units in interim; procure small items through Petty Cash	OPD Unit Manager	15/5/12
Buy extension cord through Petty Cash	OPD Unit Manager	15/5/12
Pre-consultation screening tool for nurses	Medical Manager	04/5/12
Develop triage system and host meeting before implementation	Medical Manager	18/5/12
Rearrange flow of queues in waiting areas	OPD Unit Manager	10/5/12
Create flow in Emergency Room by marking one door for exit only and one door for entrance only	OPD Unit Manager	4/5/12
Order Buddi system trays for consulting room tables & stationery trolley in Emergency Room	OPD doctor	15/5/12
Send unused Xrays back to Xray department	OPD nurses	Daily
Benchmark patient stickers from Ngw. Hospital	AMN	30/5/12
Obtain a spare PC from ARV clinic	AMN	30/5/12
Check whether nurses allowed to take femoral blood	AMN	18/5/12

Follow-Up

Plan	*Actual results*
Nurses to push files	Being done daily
File numbers remain constant	Still to be implemented
Call bell	Still to be purchased
One staff to remain in workstation	Implemented
Borrow urgent equipment	Implemented
Buy extension cord	Cord borrowed
Pre-consultation screening tool	Implemented 20/6/12
Triage system	Meeting held 20/6/12 and implemented
Rearrange flow of queues	Partially implemented
Create flow in Emergency Room	Implemented
Order Buddi System trays	Requested by OPD doctor
Benchmark stickers	Still to benchmark
PC for Patient Administration	Still to be obtained
Check if nurses can draw femoral blood	Nurses cannot draw femoral blood

Figure 7: First A3 report

4.5.3 Intermediate results

At the end of each action-research cycle, the cycle and waiting times were measured, in order to determine trends and to evaluate implemented decisions for feedback during *kaizen* meetings. Because only two further action-research cycles were sufficient to reach the targets that were set at the outset, two sets of observations (16-17 May and 4-5 July 2012) are reported below.

4.5.3.1 Action research cycle one

The cycle and waiting time results and the Value Stream Map derived from action research cycle one are displayed in Table 11 and Figure 8 respectively. In the *kaizen* team meeting held on 22 June 2013, the team members scrutinised the cycle and waiting time results that were presented. The overall targets were still not met, and the previous action plan was reviewed. Another A3 tool (Figure 9) was used to identify and refine the problems and develop another action plan.

Table 11: Cycle 1 waiting and cycle times with minimum and maximum queue lengths and cycle and waiting times

Service node	Cycle 1 cycle time (min)	Cycle 1 waiting time (min)	Max. queue length	Min. queue length	Max. cycle time (min)	Min. cycle time (min)	Max. waiting time (min)	Min. waiting time (min)
Pt. Admin.	8.17	42.20	18	6	13	4	62	25
Pt. Screening	11.67	14.00	12	9	12	11	20	9
Consult. room	6.03	78.38	54	14	18	2	95	60
X-ray	26.50	23.33	3	0	28	25	30	15
Investigations	12.60	10.80	6	2	18	8	15	6
Pharmacy	9.78	13.41	20	14	15	6	20	8
Total	**74.74**	**182.12**						

The team members focused on the congestion in the OPD reflecting poor flow and an ineffective triage system that was implemented on 20 June 2013. It was now decided that the Public Relations Officer needed to educate patients daily on the purpose of the triage system. The Unit Manager was also required to monitor the system closely.

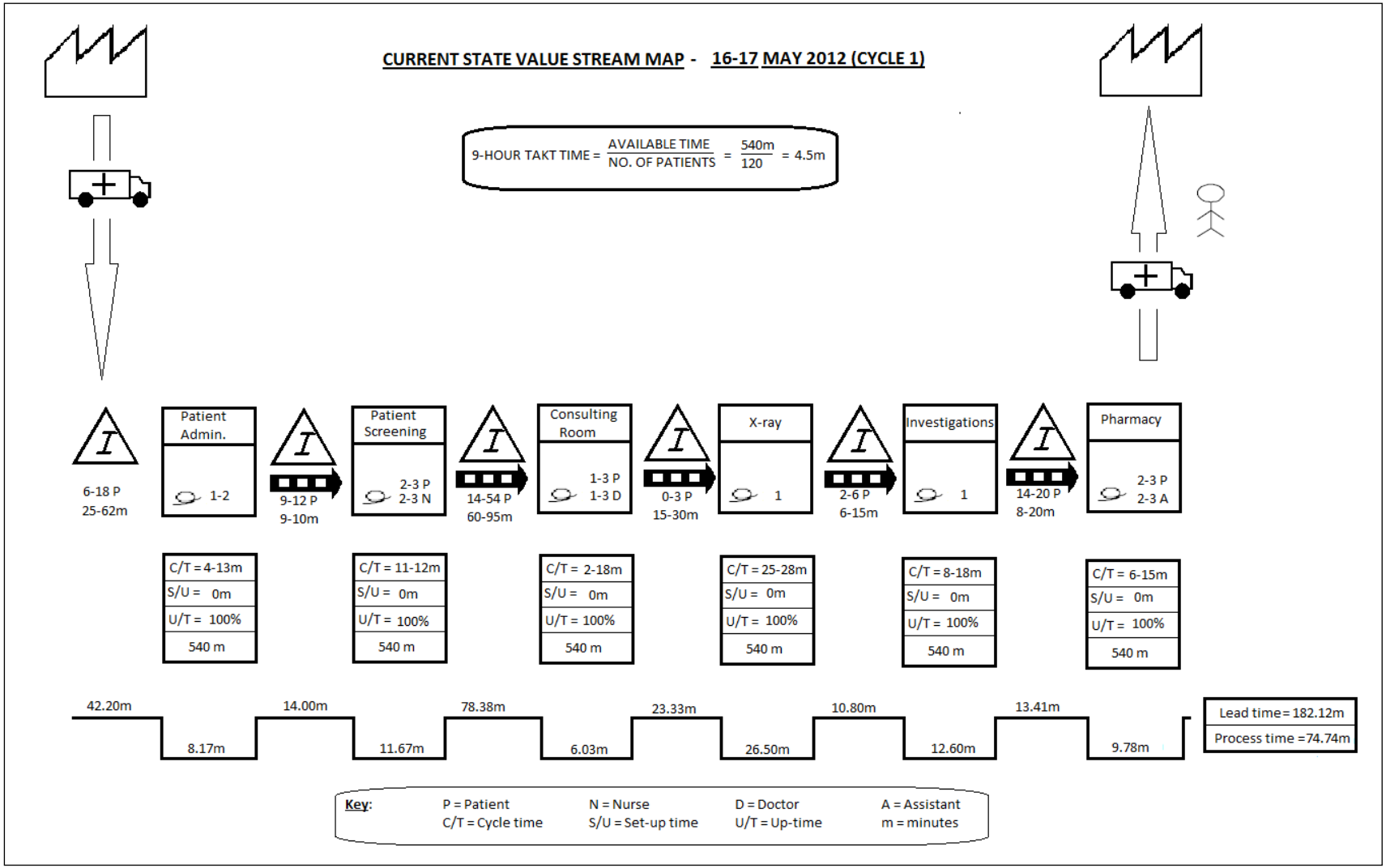


Figure 8: Cycle 1 Value Stream Map

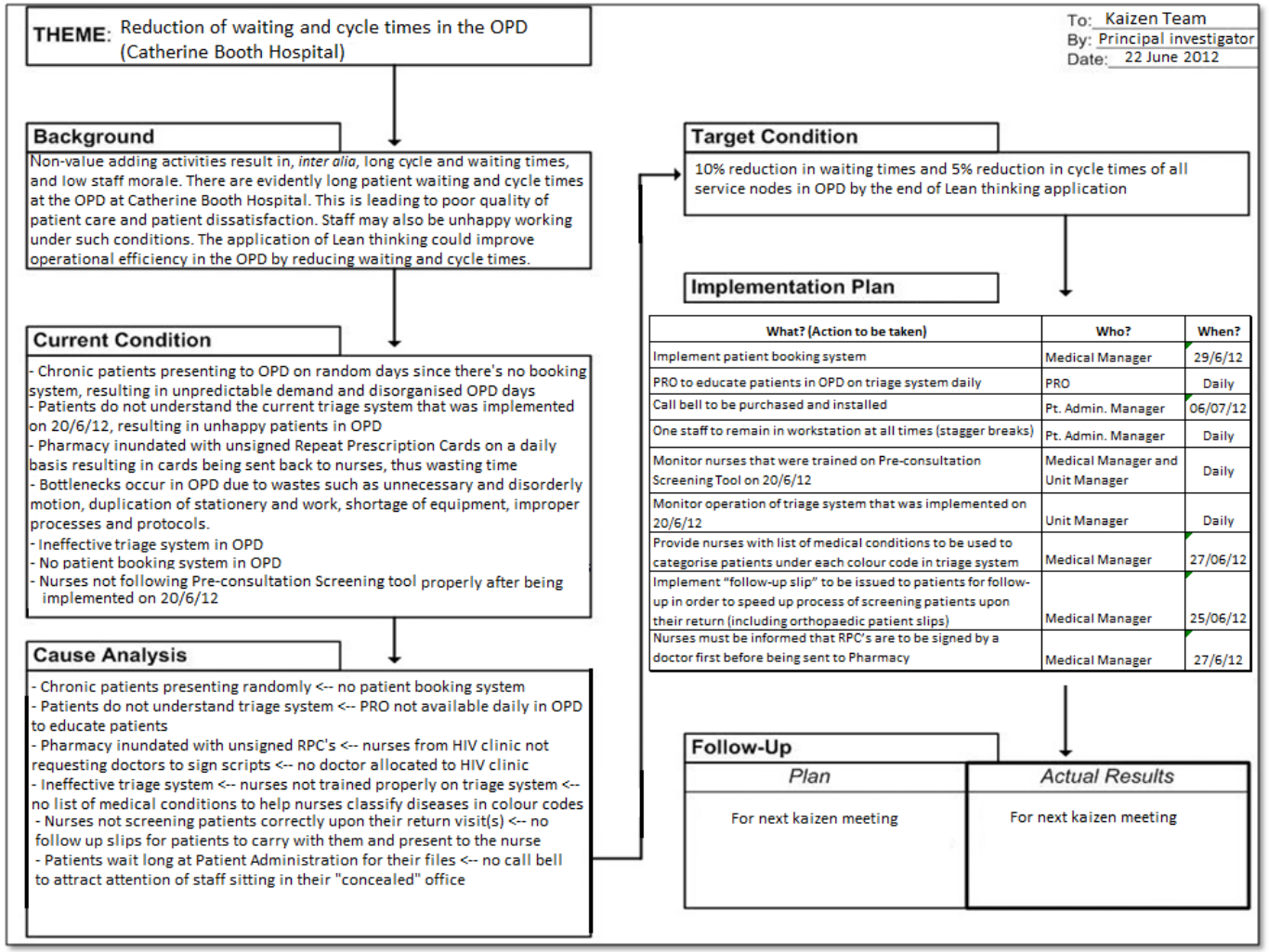


Figure 9: Second A3 report

The nurses that were trained on the use of the pre-consultation screening tool on 20 June 2013 were to be closely monitored. Two major interventions were planned for implementation in action research cycle two: a patient appointment booking system for the Patient Administration node and follow-up slips for the Patient Screening node.

4.5.3.2 Action research cycle two

The cycle and waiting time results and the Value Stream Map derived from action research cycle two are displayed in Table 12 and Figure 10 respectively. Since the overall targets for cycle and waiting times were now met, the facilitator and the team members decided to conclude the *kaizen* team meetings.

Table 12: Cycle 2 waiting and cycle times with minimum and maximum queue lengths and cycle and waiting times

Service node	**Cycle 2 cycle time (min)**	**Cycle 2 waiting time (min)**	**Max. queue length**	**Min. queue length**	**Max. cycle time (min)**	**Min. cycle time (min)**	**Max. waiting time (min)**	**Min. waiting time (min)**
Pt. Admin.	8.08	37.42	17	5	12	5	60	28
Pt. Screening	10.33	9.85	14	8	12	9	22	4
Consult. room	6.85	76.86	40	14	20	2	94	50
X-ray	20.00	22.33	4	0	22	18	25	20
Investigations	12.40	10.00	6	1	15	9	15	4
Pharmacy	11.22	11.16	22	10	15	8	28	4
Total	**68.89**	**167.62**						

The close monitoring of the pre-consultation screening tool implementation and the triage system seemed to have contributed to the targets being met. However, the booking system that was planned was not implemented in this action research cycle as the responsible person was on maternity leave. Minor operational problems such as equipment shortage were seen to stifle the progress made in some of the service nodes. For these, a third A3 report was developed (Figure 11). The triage system was working very well, and the initial problems experienced soon after its implementation were considered temporary.

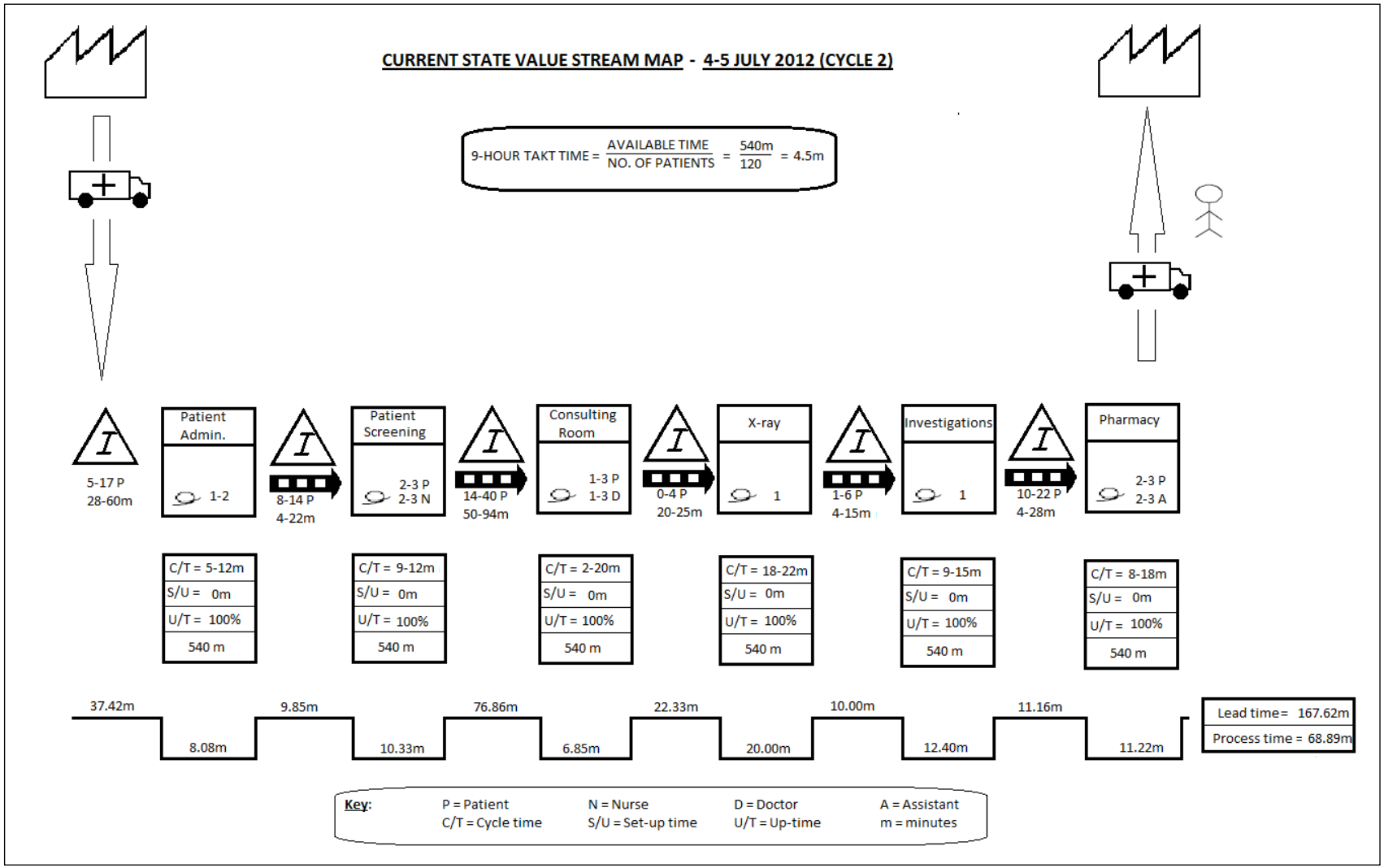


Figure 10: Cycle 2 Value Stream Map

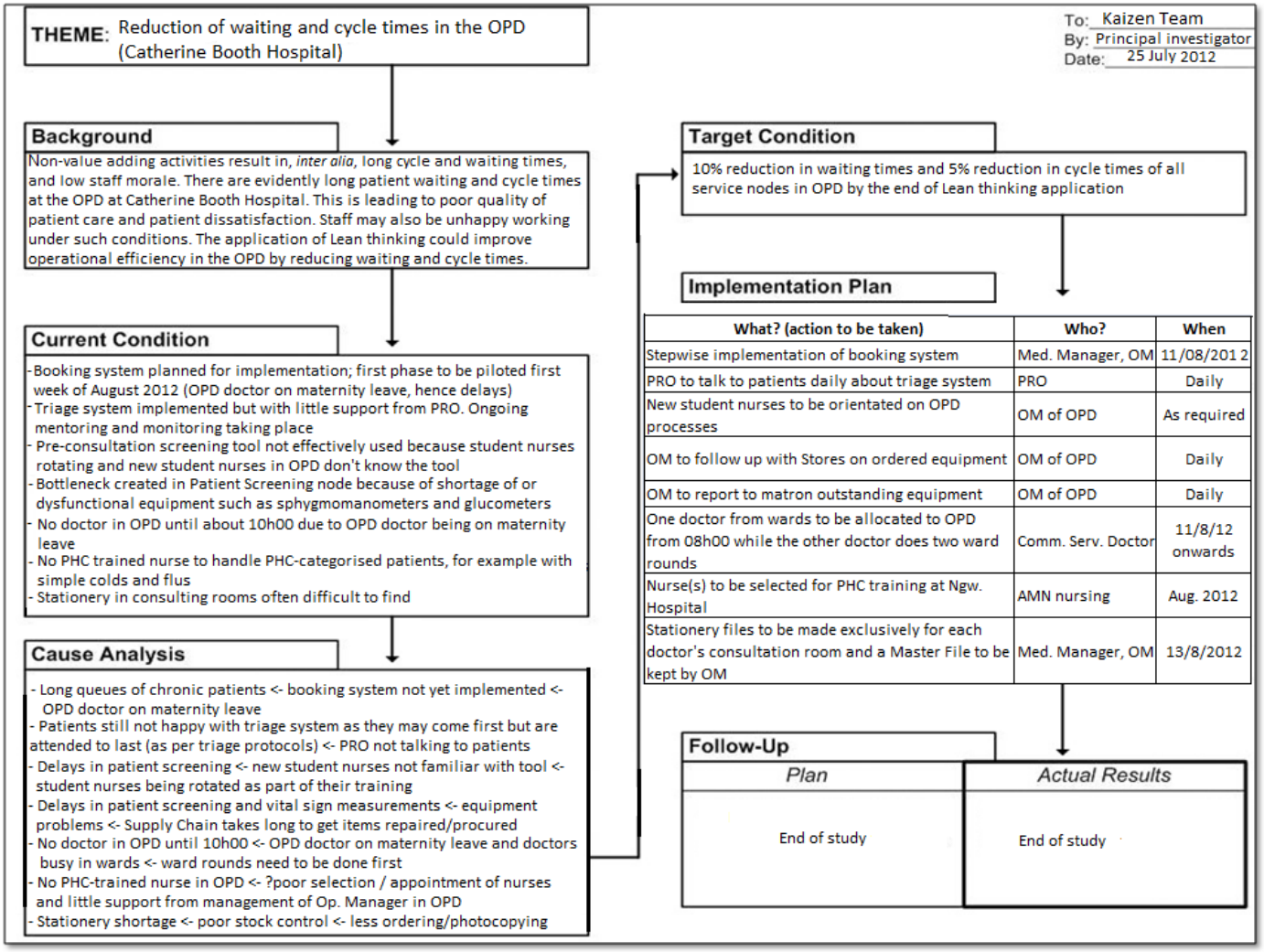


Figure 11: Third A3 report

4.5.4 Post-intervention results

Once the target total cycle and total waiting times (5% and 10% reduction respectively) were reached after two action research cycles, a final post-intervention measurement was carried out on 8-10 August 2012 (Table 13).

Table 13: Post-intervention waiting and cycle times with minimum and maximum queue lengths and cycle and waiting times

Service node	Post-Lean cycle time (min)	Post-Lean waiting time (min)	Max. queue length	Min. queue length	Max. cycle time (min)	Min. cycle time (min)	Max. waiting time (min)	Min. waiting time (min)
Pt. Admin.	8.00	37.77	15	5	14	4	63	23
Pt. Screening	10.33	9.15	12	5	13	9	15	5
Consult. room	7.03	74.43	45	17	16	2	90	51
X-ray	19.00	22.57	5	0	21	17	29	19
Investigations	12.20	10.00	6	1	16	8	17	4
Pharmacy	10.78	14.03	19	8	15	7	22	7
Total	**67.34**	**167.95**						

4.5.4.1 Cycle times

In comparison with baseline and target *cycle* times (Table 14), post-intervention observations showed that the set targets were met (and exceeded) in the following service nodes: Patient Administration (8 minutes; p=0.16); Patient Screening (10.33 minutes; p=0.28); and Investigations (12.2 minutes; p=0.04). The only significant cycle-time reduction was achieved in the Investigations node (from 16.7 to 12.2 minutes; p=0.04). Nevertheless, reductions in cycle times were noted in all six service nodes.

Table 14: Progressive cycle-time measurements

Service node	Baseline (min)	Cycle 1 (min)	Cycle 2 (min)	Post-Lean (min)	Target (min)	p-value for baseline versus post-Lean (α=0.05)
Pt. Admin.	9.25	8.17	8.08	8.00	8.79	0.16[a]
Pt. Screening	12.17	11.67	10.33	10.33	11.56	0.28[b]
Consulting room	7.18	6.03	6.85	7.03	6.82	0.82[a]
X-ray	19.50	26.50	20.00	19.00	18.53	1.00[b]
Investigations	16.70	12.60	12.40	12.20	15.87	0.04[b]
Pharmacy	11.00	9.78	11.22	10.78	10.45	0.79[b]
Total	**75.80**	**74.75**	**68.88**	**67.34**	**72.01**	

4.5.4.2 Waiting times

Post-intervention waiting times also showed reductions for all six service nodes (Table 15), however, the targets were met (and exceeded) for the same nodes as with the cycle times: Patient Administration (37.77 minutes; p=0.07); Patient Screening (9.15 minutes; p=0.25); and Investigations (10 minutes; p=0.03). The only two significant waiting-time reductions that were achieved were for the Investigations node (from 11.93 to 10 minutes; p=0.03), where the target was met, and for the Consulting Room node (from 80.95 to 74.43 minutes; p<0.0001), where the target was *not* met.

Table 15: Progressive waiting-time measurements

Service node	Baseline (min)	Cycle 1 (min)	Cycle 2 (min)	Post-Lean (min)	Target (min)	p-value for baseline versus post-Lean (α=0.05)
Pt. Admin.	44.14	42.20	37.42	37.77	39.64	0.07[a]
Pt. Screening	15.27	14.00	9.85	9.15	13.90	0.25[b]
Consulting room	80.95	78.38	76.86	74.43	72.86	<0.0001[a]
X-ray	23.33	23.33	22.33	22.57	20.97	1.00[b]
Investigations	11.93	10.80	10.00	10.00	10.59	0.03[b]
Pharmacy	14.16	13.41	11.16	14.03	13.06	0.78[b]
Total	**190.02**	**182.12**	**167.62**	**167.95**	**171.02**	

[a] t-test was used where assumptions were met, otherwise the Wilcoxon test was used
[b] Wilcoxon test comparing baseline and post-intervention cycle times

4.6 Trends and changes in observed and *takt*-based waiting and cycle times

4.6.1 Trends in observed waiting and cycle times

The observed waiting and cycle times for each service node were trended over time before, during and after the implementation of Lean in the OPD. The test for trend was conducted by fitting a linear regression, and evaluating the slope of the time variable.

4.6.1.1 Cycle-time trends

Changes in cycle times showed no significant trends over time except for the Investigations service node (p=0.01) (Table 16 and Figure 12).

Table 16: Cycle-time trend over the study period

Service node	Baseline (min)	Cycle 1 (min)	Cycle 2 (min)	Post-Lean (min)	p-value for trend (α=0.05)
Pt. Administration	9.25	8.17	8.08	8.00	0.14
Pt. Screening	12.17	11.67	10.33	10.33	0.08
Consulting room	7.18	6.03	6.85	7.03	0.98
X-ray	19.50	26.50	20.00	19.00	0.60
Investigations	16.70	12.60	12.40	12.20	0.01
Pharmacy	11.00	9.78	11.22	10.78	0.98
Total	**75.80**	**74.75**	**68.88**	**67.34**	

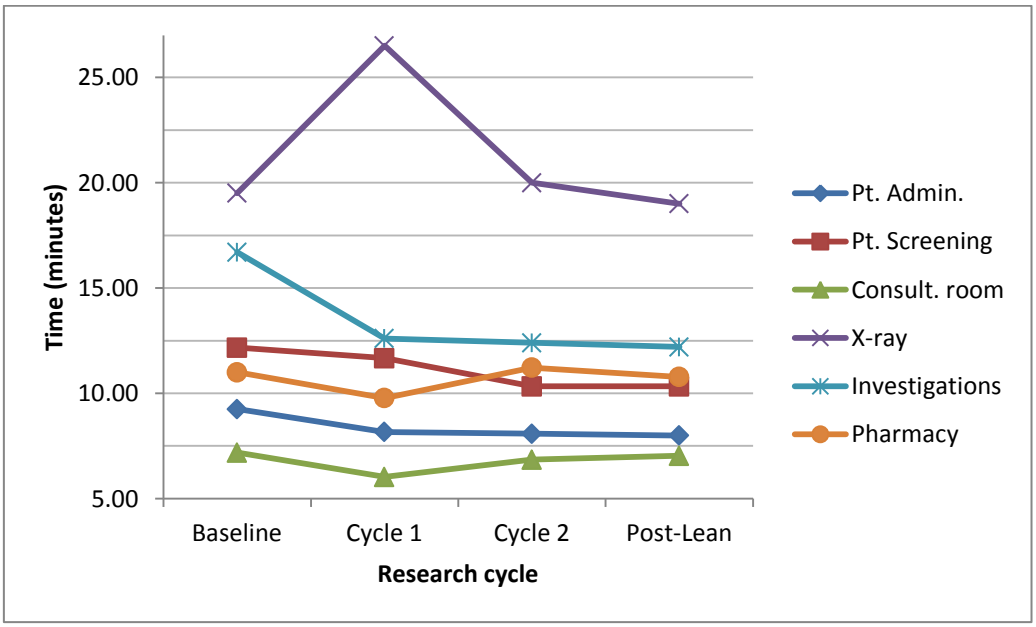


Figure 12: Cycle-time trend over the study period

4.6.1.2 Waiting time trends

Significant trends over time were noted in changes in waiting times for the Patient Administration (p=0.04), Patient Screening (p<0.0001) and Consulting Room (p<0.0001) service nodes (Table 17 and Figure 13).

Table 17: Waiting-time trend over the study period

Service node	Baseline (min)	Cycle 1 (min)	Cycle 2 (min)	Post-Lean (min)	p-value for trend (α=0.05)
Pt. Administration	44.14	42.20	37.42	37.77	0.04
Pt. Screening	15.27	14.00	9.85	9.15	<0.0001
Consulting room	80.95	78.38	76.86	74.43	<0.0001
X-ray	23.33	23.33	22.33	22.57	0.71
Investigations	11.93	10.80	10.00	10.00	0.16
Pharmacy	14.16	13.41	11.16	14.03	0.69
Total	**190.02**	**182.12**	**167.62**	**167.95**	

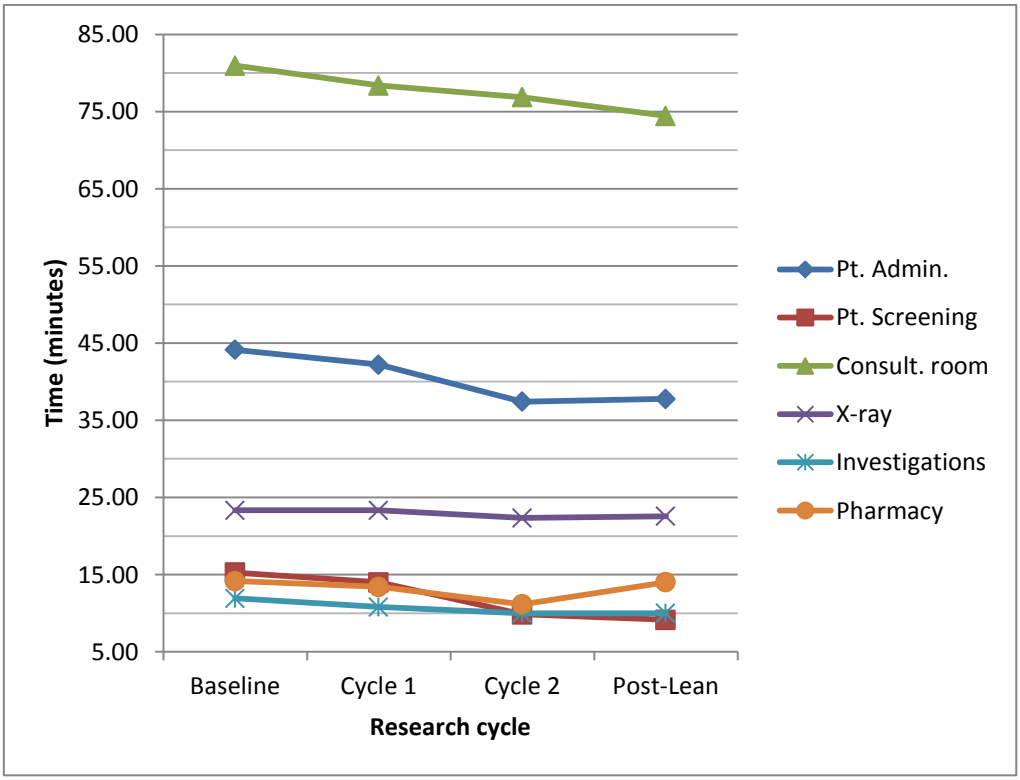


Figure 13: Waiting-time trend over the study period

4.6.2 Changes in *takt*-based waiting times and efficiency

The *takt*-based waiting times indicate the total time spent waiting based on demand for service. It is calculated by the formula: $(takt\ time) \times (number\ of\ patients\ waiting)$. The *takt*-based waiting time (*A*) added to the cycle time (*B*) for each service node provides us with the total time (*A*+*B*) spent by the patient in the OPD based on demand. Thus the value-adding cycle time (*B*) as a percentage of the total time (*A*+*B*) reflects the efficiency of the OPD.

4.6.2.1 Baseline results of takt-based waiting times and efficiency

Before the implementation of Lean, the *takt*-based waiting times were calculated (Table 18).

Table 18: Baseline cycle times and takt-based waiting-time calculations

Service node	**9-hour *takt* time**	**Number of patients**			**Time (minutes)**					
		Waiting in queue		*Being "processed"*	*Observed cycle time*		*Observed waiting time*		*Takt-based waiting time*	
		Min	*Max*		*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
Pt. Admin.	4.5	9	21	1	5	15	25	64	41	95
Pt. Screening	4.5	8	17	2	10	15	9	22	34	74
Consult. room	4.5	23	55	2	2	18	60	94	101	248
X-ray	4.5	1	5	1	17	23	18	30	5	23
Investigations	4.5	3	8	1	12	23	5	18	14	36
Pharmacy	4.5	13	21	2	7	15	8	22	59	92

Table 19 shows that the pre-intervention (baseline) efficiency in the OPD using *takt*-based calculations ranged from 16.00% (with maximum demand) to 16.69% (with minimum demand). In other words, between 16.00% and 16.69 % of a patient's time in the OPD is spent receiving a service. The rest of the time is non-value-adding because it is spent waiting for a service.

Table 19: Baseline efficiency in OPD in terms of takt-based cycle and waiting times

Service node	Time spent in OPD (minutes)			
	Observed		***Takt*-based**	
	Min.	*Max.*	*Min.*	*Max.*
Pt. Administration	25	63.5	41	95
Pt. Screening	9	22	34	74
Consulting room	60	93.5	101	248
X-ray	18	30	5	23
Investigations	5	17.5	14	36
Pharmacy	8	22	59	92
Total waiting times (A)	**125**	**249**	**252**	**567**
Total cycle times (B)	**50.5**	**108**	**50.5**	**108**
Total (A+B)	**175**	**357**	**303**	**675**
Efficiency [B÷(A+B)]	**28.86%**	**30.29%**	**16.69%**	**16.00%**

4.6.2.2 Intermediate results of takt-based waiting times and efficiency

The following tables display the takt-based waiting times for each service node during action-research cycles 1 and 2.

Table 20: Cycle 1 cycle times and takt-based waiting-time calculations

Service node	9-hour *takt* time	Number of patients			Time (minutes)					
		Waiting in queue		*Being "processed"*	*Observed cycle time*		*Observed waiting time*		*Takt-based waiting time*	
		Min	*Max*		*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
Pt. Admin.	4.5	6	18	1	4	13	25	62	27	81
Pt. Screening	4.5	9	12	2	11	12	9	20	41	54
Consult. room	4.5	14	54	2	2	18	60	95	63	243
X-ray	4.5	0	3	1	25	28	15	30	0	14
Investigations	4.5	2	6	2	8	18	6	15	9	27
Pharmacy	4.5	14	20	2	6	15	8	20	63	90

Table 21: Cycle 2 cycle times and takt-based waiting-time calculations

Service node	9-hour *takt* time	Number of patients			Time (minutes)					
		Waiting in queue		*Being "processed"*	*Observed cycle time*		*Observed waiting time*		*Takt-based waiting time*	
		Min	*Max*		*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
Pt. Admin.	4.5	5	17	1	5	12	28	60	23	77
Pt. Screening	4.5	8	14	2	9	12	4	22	36	63
Consult. room	4.5	14	40	2	2	20	50	94	63	180
X-ray	4.5	0	4	1	18	22	20	25	0	18
Investigations	4.5	1	6	2	9	15	4	15	5	27
Pharmacy	4.5	10	22	2	8	15	4	28	45	99

The efficiency ranged from 16.98% (maximum demand) to 21.66% (minimum demand) during action research cycle 1 (Table 22)

Table 22: Cycle 1 efficiency in OPD in terms of takt-based cycle and waiting times

Service node	Time spent in OPD (minutes)			
	Observed		***Takt*-based**	
	Min.	*Max.*	*Min.*	*Max.*
Pt. Administration	25	62	27	81
Pt. Screening	9	20	41	54
Consulting room	60	95	63	243
X-ray	15	30	0	14
Investigations	6	15	9	27
Pharmacy	8	20	63	90
Total waiting times (A)	**123**	**242**	**203**	**509**
Total cycle times (B)	**56**	**104**	**56**	**104**
Total (A+B)	**179**	**346**	**259**	**613**
Efficiency [B÷(A+B)]	**31.28%**	**30.06%**	**21.66%**	**16.98%**

The efficiency in the OPD during action-research cycle 2 ranged from 17.16% (maximum demand) to 22.97% (minimum demand) (Table 23).

Table 23: Cycle 2 efficiency in OPD in terms of takt-based cycle and waiting times

Service node	**Time spent in OPD (minutes)**			
	Observed		***Takt*-based**	
	Min.	*Max.*	*Min.*	*Max.*
Pt. Administration	28	60	23	77
Pt. Screening	4	22	36	63
Consulting room	50	94	63	180
X-ray	20	25	0	18
Investigations	4	15	5	27
Pharmacy	4	28	45	99
Total waiting times (A)	**110**	**244**	**171**	**464**
Total cycle times (B)	**51**	**96**	**51**	**96**
Total (A+B)	**161**	**340**	**222**	**560**
Efficiency [B÷(A+B)]	**31.68%**	**28.24%**	**22.97%**	**17.16%**

4.6.2.3 Post-intervention results of takt-based waiting times and efficiency

After Lean implementation, the *takt*-based waiting times were calculated (Table 24).

Table 24: Post-intervention cycle times and takt-based waiting time calculations

Service node	**9-hour *takt* time**	**Number of patients**			**Time (minutes)**					
		Waiting in queue		*Being "processed"*	*Observed cycle time*		*Observed waiting time*		*Takt-based waiting time*	
		Min	*Max*		*Min*	*Max*	*Min*	*Max*	*Min*	*Max*
Pt. Admin.	4.5	5	15	1	4	14	23	63	20	65
Pt. Screening	4.5	5	12	2	9	13	5	15	23	54
Consult. room	4.5	17	45	2	2	16	51	90	74	203
X-ray	4.5	0	5	1	17	21	19	29	0	20
Investigations	4.5	1	6	1	8	16	4	17	2	25
Pharmacy	4.5	8	19	2	7	15	7	22	36	83

The efficiency after Lean implementation was shown to have increased from baseline to a range from 17.2% (maximum demand) to 23.05% (minimum demand) (Table 25).

Table 25:Post-intervention efficiency in terms of takt-based cycle and waiting times

Service node	**Time spent in OPD (minutes)**			
	Observed		***Takt*-based**	
	Min.	*Max.*	*Min.*	*Max.*
Pt. Administration	23	63	20	65
Pt. Screening	5	15	23	54
Consulting room	51	90	74	203
X-ray	19	29	0	20
Investigations	4	17	2	25
Pharmacy	7	22	36	83
Total waiting times (A)	**108**	**236**	**155**	**450**
Total cycle times (B)	**46.5**	**94**	**46.5**	**94**
Total (A+B)	**154**	**330**	**202**	**544**
Efficiency [B÷(A+B)]	**30.19%**	**28.38%**	**23.05%**	**17.20%**

4.6.3 Trend in efficiency in the outpatient department

The efficiency measured by the total observed cycle time as a percentage of the total time spent in the OPD based on demand, changed over time since the implementation of Lean. The *average* efficiency increased from 16.35% (baseline) to 20.13% (post-intervention). During periods of maximum demand, the efficiency increased from 16.00% (baseline) to 17.20% (post-Lean), and during periods of minimum demand, the efficiency increased from 16.69% (baseline) to 23.05% (post-Lean).

Table 26: Trend in efficiency in the OPD over the study period

Research cycle	**Baseline**		**Cycle 1**		**Cycle 2**		**Post-Lean**	
Efficiency based on	Min. demand	Max. demand	Min. demand	Max. demand	Min. demand	Max. demand	Min. demand	Max. demand
Efficiency	16.69%	16.00%	21.66%	16.98%	22.97%	17.16%	23.05%	17.20%
Average efficiency	16.35%		19.32%		20.07%		20.13%	

The following graph illustrates the trend of average efficiency in the OPD since the implementation of Lean.

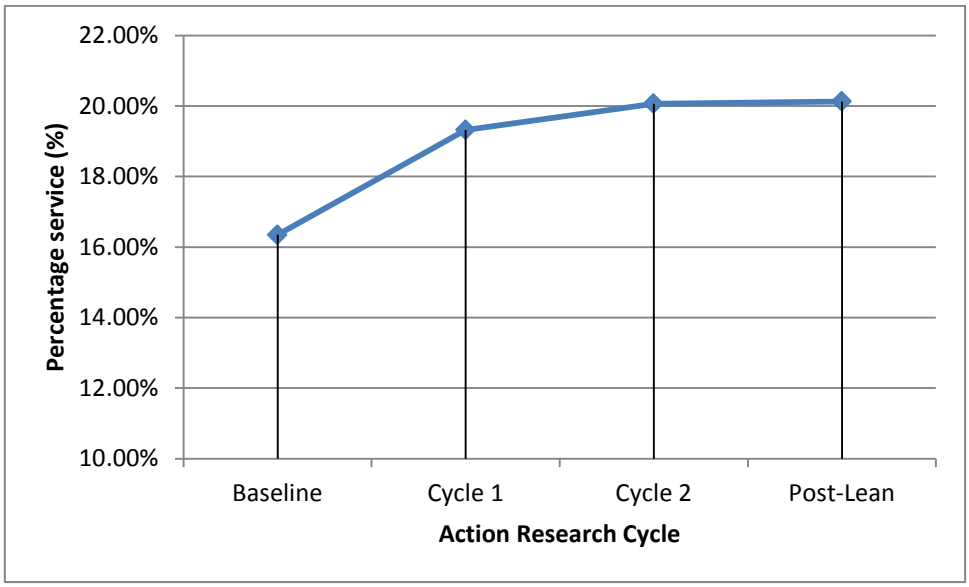


Figure 14: Trend in average efficiency over time in the OPD

4.7 Staff attitudes and morale

Participant responses to questions about their attitudes and morale were categorized into the following seven themes (Table 27), each of which was scored by summing the responses to each Likert-scale item (the more positive and/or optimistic the response, the higher the score):

Table 27: Attitude and morale themes and maximum scores

Attitude and morale themes	Maximum score
Attitude to teamwork	35
Communication strength	65
Empowerment of staff	15
Attitude towards the supervisor	30
Attitude towards work	30
Attitude towards clients	18
Attitude towards promoting the hospital	12

At the 95% confidence level, pre- and post-intervention scores were compared using paired Wilcoxon paired signed-rank tests. Before and after scores for all service nodes were grouped together and compared for each theme (Table 28). Scores for all themes except "Empowerment of staff" showed statistically significant improvements after Lean implementation.

Table 28: Comparison of pre- and post-intervention scores of the seven themes of attitude and morale for all service nodes

Attitude and morale themes (all service nodes)	**Baseline average score *(std. deviation)***	**Post-Lean average score *(std. deviation)***	**p-value (α=0.05)**
Attitude to teamwork	17.9 *(7.3)*	25.3 *(6.2)*	0.002
Communication strength	34.1 *(8.2)*	46.4 *(10.4)*	0.0003
Empowerment of staff	10.0 *(2.3)*	10.6 *(2.5)*	0.48
Attitude towards the supervisor	19.2 *(5.5)*	23.6 *(4.8)*	0.01
Attitude towards work	17.9 *(4.7)*	23.3 *(4.8)*	0.002
Attitude towards clients	14.2 *(2.1)*	15.7 *(2.1)*	0.04
Attitude towards promoting hospital	6.2 *(3.0)*	9.6 *(3.3)*	0.002

Before and after scores were also compared separately for the Patient Screening (Table 29) and Pharmacy (Table 30) service nodes. Statistical analyses could be conducted because the number of respondents from these nodes was sufficiently high.. Statistically significant improvements after Lean implementation in the Patient Screening node were noted in the communication strength (p=0.02), and attitude towards the supervisor (p=0.04) and work (p=0.09).

Similarly, in the Pharmacy node, statistically significant improvements were noted in communication strength (p=0.004) as well as in attitude towards teamwork (p=0.04), the supervisor (p=0.06), work (p=0.03), clients (p=0.005) and promoting the hospital (p=0.007). A slight improvement of the score for "Empowerment of staff" for both service nodes was observed, but this was not significant (p>0.05).

Table 29: Comparison of pre- and post-intervention scores of the seven themes of attitude and morale for the Patient Screening service node

Attitude and morale themes (Patient Screening node)	**Baseline average score *(std. deviation)***	**Post-Lean average score *(std. deviation)***	**p-value (α=0.05)**
Attitude to teamwork	16.1 *(7.9)*	25.3 *(8.9)*	0.24
Communication strength	30.1 *(5.9)*	42.5 *(11.4)*	0.02
Empowerment of staff	9.1 *(2.0)*	9.6 *(2.7)*	1.00
Attitude towards the supervisor	16.0 *(4.5)*	22.8 *(6.1)*	0.04
Attitude towards work	16.7 *(3.4)*	22.1 *(5.8)*	0.09
Attitude towards clients	14.3 *(2.4)*	15.6 *(1.6)*	0.14
Attitude towards promoting hospital	6.7 *(2.2)*	9.3 *(3.5)*	0.14

Table 30: Comparison of pre- and post-intervention scores of the seven themes of attitude and morale for the Pharmacy service node

Attitude and morale themes (Pharmacy node)	**Baseline average score *(std. deviation)***	**Post-Lean average score *(std. deviation)***	**p-value (α=0.05)**
Attitude to teamwork	19.0 *(6.4)*	26.3 *(3.2)*	0.04
Communication strength	36.9 *(10.3)*	55.7 *(4.1)*	0.004
Empowerment of staff	10.0 *(2.8)*	11.7 *(1.2)*	0.19
Attitude towards the supervisor	21.0 *(4.6)*	24.8 *(2.7)*	0.06
Attitude towards work	19.3 *(5.8)*	25.8 *(2.0)*	0.03
Attitude towards clients	13.7 *(1.5)*	17.0 *(0.9)*	0.005
Attitude towards promoting hospital	6.7 *(4.0)*	12.0 *(0)*	0.007

Bivariate analyses for proportions were also carried out using Fisher's test to compare pre- and post-intervention results for the following three issues involving binary responses ('yes' or 'no'):

- whether one was satisfied with his/her job in general;
- whether one feels things are getting better in his/her department; and
- whether one feels inspired (motivated/stimulated) in his/her job.

Before and after scores for all service nodes were grouped together and compared for each of the above issues (Table 31). Statistically significant improvements from baseline ($p<0.0001$) were noted in all three aspects after the implementation of Lean. The proportion of staff satisfied with their jobs and those that felt inspired or motivated increased from 21.1% to 77.8% ($p<0.0001$) and 15.8% to 77.8% ($p<0.0001$) respectively. The proportion of staff who felt that things were getting better in their department increased from 21.1% to 83.3% ($p<0.0001$).

Table 31: Bivariate analyses comparing binary responses of attitude and morale pre- and post-intervention

Attitude and morale themes	**Baseline average score *(std. deviation)***	**Post-Lean average score *(std. deviation)***	**p-value (α=0.05)**
Proportion of staff satisfied with job	21.1%	77.8%	<0.0001
Proportion of staff that feel things are getting better in their department	21.1%	83.3%	<0.0001
Proportion of staff that feel inspired/motivated	15.8%	77.8%	<0.0001

Before and after scores were also compared separately for the Patient Screening (Table 32) and Pharmacy (Table 33) service nodes. Statistical analyses could be conducted as the number of respondents from these nodes was sufficiently high.

In the Patient Screening service node, the proportions of staff satisfied with their jobs, feeling things were getting better, and feeling inspired or motivated increased after the implementation of Lean, albeit significant improvements were noted only for the latter two attitude and morale themes (p=0.04)

Table 32: Bivariate analyses comparing binary responses of attitude and morale pre- and post-intervention for the Patient Screening service node

Attitude and morale themes (Patient Screening node)	**Baseline average score *(std. deviation)***	**Post-Lean average score *(std. deviation)***	**p-value (α=0.05)**
Proportion of staff satisfied with job	14.3%	62.5%	0.12
Proportion of staff that feel things are getting better in their department	14.3%	75.0%	0.04
Proportion of staff that feel inspired/motivated	14.3%	75.0%	0.04

In the Pharmacy service node, statistically significant increases in the proportions of staff satisfied with their jobs, feeling things were getting better, and feeling inspired or motivated, from 28.6% to 100% (p=0.02) were observed after Lean implementation.

Table 33: Bivariate analyses comparing binary responses of attitude and morale pre- and post-intervention for the Pharmacy service node

Attitude and morale themes (Pharmacy node)	**Baseline average score *(std. deviation)***	**Post-Lean average score *(std. deviation)***	**p-value (α=0.05)**
Proportion of staff satisfied with job	28.6%	100.0%	0.02
Proportion of staff that feel things are getting better in their department	28.6%	100.0%	0.02
Proportion of staff that feel inspired/motivated	28.6%	100.0%	0.02

4.8 Summary

The results of the study clearly indicated that Lean tools and techniques may be effectively applied in a rural district hospital OPD. The outcomes showed that cycle and waiting times in some service nodes significantly improved after Lean implementation. Operational efficiency in periods of both low and high demand also improved over time with Lean. The implementation of Lean had a positive impact on OPD staff attitude and morale; overall job satisfaction and motivation were enhanced.

CHAPTER V: DISCUSSION

5.1 Introduction

The pre- and post-intervention results of the cycle and waiting times, and staff attitude and morale, are discussed in this chapter. The results are compared with existing knowledge, and possible explanations for the findings are provided. The study findings are also considered in light of the possible biases and limitations of the study design, the data-collection process and results obtained in the study. The transferability of the study findings to other rural district hospitals in South Africa is also discussed.

5.2 Findings

5.2.1 The process and application of Lean tools and techniques

Nutt explains two methods of arriving at workable solutions to problems: idea imposition and discovery.[28] The former method is erratic in that the decision-makers jump to conclusions and then try to implement the solutions that 'they stumble upon'. However, with discovery, '*decision-makers work their way through a process that stresses claim validation, implementation, and direction-setting'.*[28] The *kaizen* team meetings used discovery as a method with which to arrive at solutions to the identified problems, whereby learning is fostered in the discovery of solutions.[28]

The baseline measurement of cycle and waiting times was conducted using similar methods to those used by other studies.[3, 12, 14, 21] The pre-intervention briefing meeting sought to explain the process of Lean to *kaizen* team members, and was well understood even though it was a new concept to them. The tools and techniques that were used were simple enough for the *kaizen* team members to use themselves in the meetings. The researcher, however, developed the VSMs with the results of the cycle- and waiting-time measurements. This graphical representation of the flow of patients through the OPD gave everyone a more vivid and clear description of the process. Team members also found the 5-why technique and 5-S tool valuable in identifying wastes and creating an environment suitable for process enhancement. The targets that were set by the team were realistic. Owing to factors such as establishing patient rapport, counselling patients, standard history-taking and examination, it was impossible to set a greater cycle-time reduction target.

5.2.2 Value Stream Maps, A3 reports and bottlenecks

Value-stream mapping was carried out by the researcher because team members needed more time to learn the process. The A3 reports revealed problems that were not uncommon in many public-hospital OPDs.

The problems and wastes that were identified were multifarious. Patients with chronic medical conditions (such as hypertension and diabetes) presented on random days because there was no booking system, resulting in unpredictable demand. There was no patient triage system extant in the OPD. The wastes and bottlenecks included: unnecessary and disorderly movement of staff (and patients), duplication of stationery and work, shortage of equipment, and improper processes and controls. Nurses were also not properly screening patients, resulting in back-and-forth movement of patients in OPD, because doctors would not have the information they required during consultations.

5.2.3 Measures implemented from *kaizen* team meetings

A pre-consultation screening tool consisting of a list of standing orders for various medical conditions was implemented for use by the nurses in the Patient Screening node. A modified patient-triage system was also developed and implemented after training the nurses in the Patient Screening node. Patient queues and flows were re-organized such that the movement was more orderly and minimal. A one-way entrance and exit was created in the emergency room to facilitate flow of patients and staff.

A call bell was purchased and installed at the Patient Administration service node so that patients could alert staff that they need to be attended to immediately upon presentation. Lunch and tea breaks were staggered amongst doctors and nurses so as to maintain the 100% uptime. A "follow-up" slip was implemented. Once these were issued to patients who required follow-up, slips would be presented to the nurse in the Patient Screening node on their follow-up visit. This would then expedite service delivery: it would make the nurse aware of the specific reason for the patient's return, for example, for blood results. A dedicated file containing stationery used only by doctors was created for each consulting room so as to reduce time searching for such stationery.

5.2.4 Cycle times

A definite improvement of total cycle time was noted throughout the Lean process from 75.8 to 67.34 minutes, similar to the findings at other centres.[7, 14, 21] The targeted total cycle time was exceeded, but was not met in three service nodes: consulting room, X-ray department and pharmacy. The most likely reason for this is that these three stations consisted of the scarcest set of skilled health-care professionals in the hospital: doctors, radiographers and pharmacists.

Thus the implementation of Lean in these three service nodes did in fact reduce the cycle times from baseline, but the targets could not be met over a short period. Extrapolating the trend indicates that the targets for these three nodes would be met over a longer period of Lean implementation.

The only significant improvement in cycle times was noted in the Investigations section (p=0.04). The primary reason was the implementation of the pre-consultation screening tool which the nurses used. This tool empowered nurses to make decisions without being given instructions by doctors. This reinforces the human side of Lean.[20, 23]

Cycle time trends over time showed improvements in all service nodes, but these were significant only in the Investigations node (16.7 to 12.2 minutes; p=0.01). The trends fluctuated in some service nodes, and cycle times even increased in the intermediate action-research cycles (in the Consulting Room, X-ray and Pharmacy) most probably owing to fluctuating staff levels (for example, a doctor on maternity leave); equipment problems (for example, x-ray machine breakdown); patient profiles; and disease acuity levels.

5.2.5 Waiting times

Targets were exceeded for the same nodes as with the cycle times: Patient Administration (37.77 minutes; p=0.07), Patient Screening (9.15 minutes; p=0.25) and Investigations (10 minutes; p=0.03). Once again, the reasons for neither meeting nor exceeding the targets in the other three nodes are the same as with the cycle times. Even though the target waiting time was not met for the Consulting Room node, the reduction in waiting time was significant (p<0.0001).

The improvements were mainly owing to the following interventions: call bell for Patient Administration, pre-consultation screening tool and triage system for Patient Screening, staggered lunch breaks, and "follow-up slips" for Investigations and Patient Screening.

Significant trends over time were noted in changes in waiting times for the Patient Administration (p=0.04), Patient Screening (p<0.0001) and Consulting Room (p<0.0001) service nodes; however, the downward trend was consistent only for Patient Screening, Consulting Room and Investigations.

The modified triage system, coupled with the changes in layout and flow of patients in waiting areas, were the most important contributors of waiting-time reductions for the Patient Screening and Consulting Room nodes. The changes in waiting-room layout allowed for patients to sit closer to the proceeding service node and move in a one-way direction (flow).[3, 14, 29] Furthermore, the layout allowed for segregation of high-risk groups (coughing adult patients) from susceptible groups (children and the elderly) for infection control purposes, thus contributing to the quality aspect of Lean.

The X-ray and Pharmacy waiting times did not change much from baseline, most likely owing to the inflexible nature of the tasks carried out and the critical shortage of skilled labour within these nodes. Another factor was that the waiting areas for Pharmacy and Patient Administration were shared, because the same doorway was used for both entrance and exit of the OPD. This was difficult to correct during the study because it required infrastructural changes.

5.2.5 Trend in efficiency in the outpatient department

The efficiency measured by the total observed cycle time as a percentage of the total time spent in the OPD based on demand improved over time (from 16.35% to 20.13%). In mathematical terms, this implies that the total cycle time had to increase or the total waiting time had to decrease to improve efficiency. Since the aim was to *reduce* both the cycle and waiting times, with an observed improvement in efficiency, it is obvious that the waiting times proportionately decreased more than the cycle time.

In times of high demand, the efficiency was 16% at baseline, but improved to 17.2%. In times of low demand, the efficiency improved from 16.69% at baseline to 23.05%. Patients were thus spending more time obtaining a value-adding service thanks to the reduction in waste since the implementation of Lean. The combined effect of the interventions by the *kaizen* team resulted in a more efficient OPD.

5.2.6 Staff attitude and morale

Even though the Lean process was carried out over a short period of time, the results suggest that there was an overall inclination towards a positive change of culture of the OPD in terms of staff behaviour, attitude and morale. Questionnaires reflected definite and statistically significant improvements in scores after Lean implementation for all themes of attitudes and morale, except for empowerment of staff (p=0.48). With the bureaucracy and red tape that generally exists in decision-making across the public sector hospitals, empowering of staff was impeded (score increased from 10.0 to only 10.6; p=0.48).

Owing to the nature of the Lean philosophy of using together a team of empowered staff to bring about improvements in a particular process or service, the attitudes of staff towards teamwork and the communication strength amongst those involved improved significantly. Veech argued the importance of adopting a person-centred approach in order to sustain a 'Lean house' (Figure 15) built on a foundation of stability and employee satisfaction.[10]

The Just-In-Time (JIT) column reflects Lean tools and techniques such as 5-Why and 5-S (*sort, straighten, scrub, standardize,* and *sustain*) that are used in making a system 'go' faster and more efficiently. *Jidoka* reflects the interaction of humans with the machinery and tools used to do their job, such as mistake-proofing and visual controls.[10] Thus the results of this study have shown that the human elements of Lean (stability and employee satisfaction) exhibited in this study by attitude towards teamwork and communication strength are very closely related to and are positively affected by the process of Lean implementation (through a *kaizen* team).

Veech elaborates that stability contains four elements, all of which were incorporated into the Lean process as used by this study: trust between the workforce and management; commitment from leaders; situational awareness; and an empowered workforce.[10]

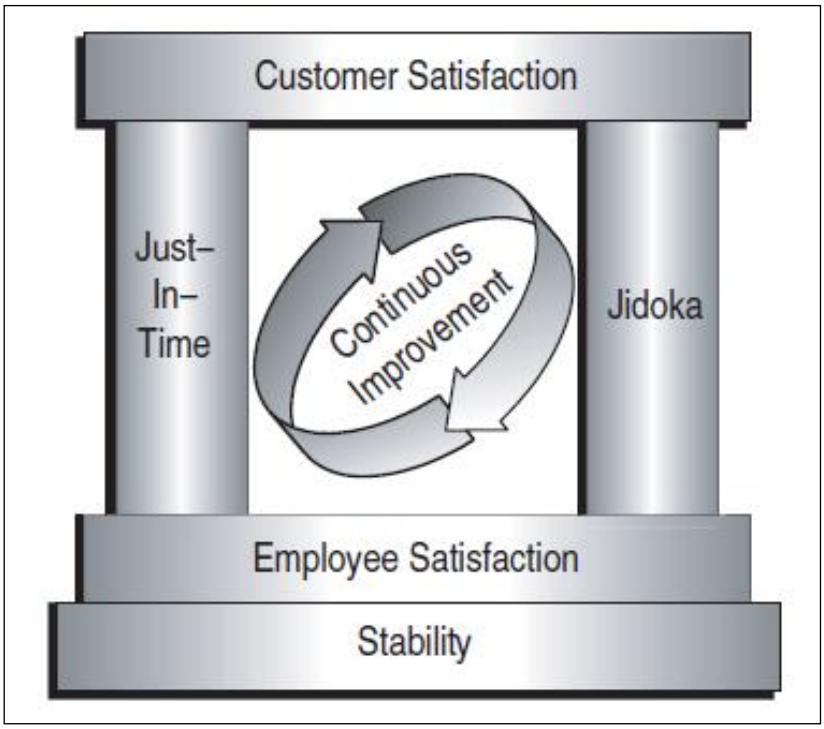


Figure 15: The 'Lean House'.[10]

Since Lean and *kaizen* methodology create a system for breaking down boundaries and eliminating silo functions, teamwork emerges as a new approach to performing tasks. Attitude towards the supervisor, work, and clients all improved significantly with Lean implementation, most likely owing to this dismantling of barriers to information flow, and the cross-functionality inspired by Lean.[13]

The Pharmacy node in particular showed above-average improvements in staff attitude and morale. The employees in the Pharmacy work in a 'laboratory' environment, with more self-contained interaction amongst themselves. Thus, the *kaizen* approach is more conspicuously manifested through significantly improved communication (p=0.004); teamwork (p=0.04); and attitudes toward the supervisor, work and clients.

Staff attitude toward promoting the hospital in respect of attracting clients and new employees also significantly improved after Lean implementation (p=0.002), implying that they were happier working in the OPD.

Subsequent to Lean implementation, more staff felt that things were getting better in their respective departments compared to the baseline results (p<0.0001). This recapitulates the continuous improvement characteristic of *kaizen* and Lean. In contrast with Hasle and Bojesan's findings that Lean may be considered a limitation and an attack on the professionalism of nursing staff in hospitals, the perceived improvement of conditions and increased motivation and job satisfaction after Lean implementation at the OPD is quite significant in the present study (p<0.0001).[30]

5.3 Validity

Both internal and external validity of the study are discussed in this section. Internal validity refers to whether the study measured what it set out to measure, whereas the transferability of the findings is assessed as external validity.

5.3.1 Credibility and trustworthiness (internal validity)

As mentioned in Chapter 3, action-research validates the Hawthorne effect, especially in the context of Lean philosophy, where the facilitator intentionally plays out his/her role in a real, participatory sense, instead of reducing the effect as in a positivistic, laboratory setting.[27] Social relationships between the investigator and the participants are considered essential to the successful outcomes of action-research. A congruent relationship between the investigator and participants validates an ideal climate for generating trust.[27] Nevertheless, the Hawthorne effect, even if considered validating action-research, was minimized by carrying out two baseline measurements of variables before and two measurements after Lean implementation at dispersed intervals.

The purposive selection of specific *kaizen* team members aims to improve credibility by involving participants that are relevant to the issue investigated. With triangulation, the use of various measurement instruments (VSMs, A3 reports, questionnaires and *kaizen* team meeting minutes), and the use of a qualitative and quantitative enquiry, improved trustworthiness of the results.

A journal was kept by the investigator throughout the study period; his interpretation and account of the collected data was compared with those of the *kaizen* team members during *kaizen* meetings, in order to establish the level of congruence between the two data sets. The participants' reactions to the analyses were then incorporated into the results (respondent validation).

Kaizen team members were briefed in an initial meeting at which the research procedures and concepts of Lean were presented, clarifying the participants' ways of describing and interpreting problems and events. This clear exposition of study methods and the investigator's prolonged engagement with the *kaizen* team and study setting in a series of iterative action-research cycles increases research credibility.

5.3.2 Transferability

Although the results are not intended to be generalized to all health-care settings in South Africa, the Lean methodology which emulates similar research in settings with a comparable study context such as CBH, is described in Chapter 3. As this study uses action-research as a qualitative approach to the research method, the findings cannot be generalized to other rural district hospital OPDs. Rather, the methods used can be emulated for quality improvement across similar hospitals.

5.4 Bias and limitations

A census of OPD staff (who meet the inclusion criteria) and service nodes for measuring attitudes / morale and cycle times, respectively, reduced selection bias. Standardized times for observation of queues during fixed time periods minimized sampling bias.

One of the limitations of the study was the lack of enthusiasm from some of the staff in implementing decisions made by the *kaizen* team. Owing to the short study period, the change in culture of the organization with Lean implementation was impeded, even though this was not one of the objectives of the study. The differing rationalities, priorities and logics existing among staff in the OPD and management created obstacles for the successful implementation of Lean.[30]

A further limitation to the study was the postponement of some of the scheduled *kaizen* meetings owing to other staff engagements and priorities. This caused minor interference with the intervals for measurement of cycle and waiting times in each action-research cycle.

The inherent variability in dealing with patients and the nature of the work in the OPD, creating stable and predictable flow, a key prerequisite for Lean, is an important limitation to the study.[30]

5.5 Summary

The study demonstrates that Lean has a significant positive impact on cycle and waiting times in some service nodes. The scarcity of skilled health-care professionals and the various rationalities, priorities and logics existing among staff in the OPD and management negatively affect the impact of Lean. The human elements of Lean are very closely related to and are positively impacted by the process of Lean implementation. Action-research validates the Hawthorne effect in this study. The methods used in this study may be emulated for quality improvement across similar hospitals, but the findings cannot be generalized. The inherent variability in dealing with patients, creating stable and predictable flow is an important limitation to the study.

CHAPTER VI: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

Lean principles, tools and techniques were applied effectively in a rural district hospital OPD. Both cycle and waiting times were reduced in all six service nodes after the implementation of Lean in the OPD, with statistically significant improvements shown in some of the nodes. More noteworthy and statistically significant changes in trends over time were observed for waiting times compared with cycle times. The efficiency in the OPD, measured by the total observed cycle time as a percentage of the total time spent based on demand, improved over time since the implementation of Lean. There were also significant improvements in most themes representing attitude and morale of OPD staff.

6.2 Conclusions

The application of Lean principles, tools and techniques is possible in a rural district hospital OPD, without any demands on staff in terms of learning and adopting a new quality-improvement management approach by which to improve operational efficiency. The VSM can effectively and succinctly describe the flow of patients in an OPD once the major service nodes are identified, and after cycle and waiting times are observed. A *kaizen* team with commitment to resolving identified problems must steer the whole quality-improvement cycle. The use of the A3 tool simplifies and facilitates the problem-identification, decision-making and problem-solving process.

Lean has a positive impact on both cycle and waiting times for all OPD service nodes, but less so for stations consisting of scarce skilled health-care professionals in a hospital. The inflexible nature of the tasks carried out and the critical shortage of skilled labour within some nodes impedes the positive impact of Lean. Trend analysis, however, shows that improvements even in these nodes could be sustained over a longer period of Lean implementation. Minor changes in patient flows and protocols used in the OPD can have significant improvements in waiting and cycle times.

In times both of low and high demand, the efficiency in OPD was improved from baseline after Lean implementation. Patients thus spend more time obtaining a value-adding service owing to the reduction in waste after the implementation of Lean.

There was an overall inclination towards a positive change of culture in the OPD in terms of staff behaviour, attitude and morale, even though the Lean process was carried out over a short period of time. Improvement in empowerment of staff is impeded owing to the inherent bureaucratic nature and red tape existing in the hospital. Attitudes of OPD staff towards teamwork and the communication strength amongst those involved, as well as overall motivation and job satisfaction, improved significantly after Lean was implemented.

6.3 Recommendations

Based on the findings of this study, recommendations are made to implement Lean in other departments within the same hospital and in other hospitals. Some of these recommendations may be implemented at facility level, while others require decision-making at higher levels of the public health-care system.

6.3.1 Recommendations for Catherine Booth Hospital

With the potential benefits of Lean in other departments and facets of health care in a hospital setting, the *kaizen* team should extend their quality-improvement efforts to applying Lean elsewhere within the hospital such as to the wards, theatre and pharmacy.[7, 19, 20, 31, 32] Lean could have a positive impact on operational efficiency on the wards of the hospital.[33-35]

More managers and supervisors should participate in the *kaizen* team meetings because decisions made can be facilitated through them; they can incorporate problem-solving and findings into other general meetings routinely held in the hospital. Management support and cultural change is crucial for the transition of the hospital into a Lean enterprise.[5, 36] Lean should be therefore be adopted as an ongoing quality-improvement project for the hospital.

6.3.2 Recommendations aimed at the district and provincial health-system level

The KwaZulu-Natal Department of Health should consider engaging with the Lean Institute of Africa for future Lean projects in the province.[37] The KwaZulu-Natal Department of Health District Office should allocate a *kaizen* team at other hospitals within the health district to roll out Lean in their OPDs, using the same methods that were used in this study. The impact of Lean on other rural district hospital OPDs should then be assessed for possible implementation at regional and tertiary hospitals, both rural and urban, by the KwaZulu-Natal Department of Health Provincial Office.

Lean should be adopted as a new management approach by the KwaZulu-Natal Department of Health's district hospitals owing to its inherent systematic approach to quality improvement. It would provide hospital managers with an evidence-based management approach to resolving problems and improving quality indicators in key focus areas such as patient waiting times. Hagg and Ganti provided useful descriptions for the adaptation and implementation of Lean methodologies in the health-care environment.[11, 38]

Formal teaching should be conducted for health-care managers in the public sector. This training should incorporate Lean concepts, tools and techniques, in order to empower health-care managers to drive the Lean process at their facilities. Some interesting and exciting methods, such as board games, may be used to deliver Lean training.[39] Any infrastructural changes that are to be planned in future at public health-care facilities should also take into account recommendations made by *kaizen* teams at institutions that implement Lean. Patient flow is key in the Lean approach, and thus might require changes in infrastructure.[29]

6.4 Recommendations for future research

Because targets in some of the service nodes were not met for cycle and waiting times, it is recommended that the *kaizen* team at Catherine Booth Hospital continue with Lean as a quality-improvement initiative over a longer period in order to determine whether improvements may be achieved in those nodes. Furthermore, for those nodes where targets have been met, the *kaizen* team should increase the targets.

Owing to time constraints, the impact of Lean was assessed over a short period. It is recommended that a before-and-after study (action-research) to determine the sustainability of Lean and the impact on waiting and cycle times in resource-constrained service nodes be conducted over a longer period of time. Should the *kaizen* team be able to implement Lean on its own, a facilitator will not be required, hence reducing the Hawthorne effect further. Meeting schedules should be strictly adhered to in order to maintain regular intervals for the measurements of the variables. By virtue of inherent variability in dealing with patients and the nature of the work in the OPD, creating predictable flow for more accurate waiting and cycle time measurements can be facilitated by implementing a patient booking system.

6.5 Summary

Rural public sector hospitals require a novel and evidence-based approach to improving operational efficiency and staff morale in OPDs and other departments. It has been shown that Lean can indeed positively impact on cycle and waiting times, and staff attitude, in a rural district hospital OPD in South Africa. By rolling out such a management approach in other similar hospitals, using more refined methods, and by adopting Lean as a systematic way of improving efficiency, the impact on severely resource-constrained service nodes and its sustainability can be assessed further.

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ADDENDA

Addendum 1: Approval from Postgraduate Education Committee

UNIVERSITY OF
KWAZULU-NATAL
INYUVESI
YAKWAZULU-NATALI

19 December 2011

Professsor CC Jinabhai
Department of Public Health
Howard College

Dear Professor Jinabhai

PROTOCOL: "The Impact of Lean Thinking on Operational Efficiency in a District Hospital Outpatient Department in KwaZulu-Natal" L Naidoo 993212931 M-PH

Postgraduates Education Committee ratified the approval of the abovementioned study on 13 December 2011.

Please note:

The Postgraduates Education Committee must review any changes made to this study.

The study may not begin without the approval of the Biomedical Research Ethics Committee.

May I take this opportunity to wish you student every success with study.

Yours sincerely

M Coetzee

PP Professor SJ Botha
Chair Postgraduate Education Committee

CC. Dr L Naidoo

Biomedical Research Ethics Committee
Westville Campus

Postgraduate Education Administration
Medical School Campus
Postal Address: Private Bag 7, Congella, 4013, South Africa
Telephone: +27 (0) 31 260 4327 Facsimile: +27 (0)31 260 4401 Email: heslopd@ukzn.ac.za Website: www.ukzn.ac.za

Addendum 2: Biomedical Research Ethics Committee Approval

UNIVERSITY OF
KWAZULU-NATAL
INYUVESI
YAKWAZULU-NATALI

RESEARCH OFFICE
BIOMEDICAL RESEARCH ETHICS ADMINISTRATION
Westville Campus
Govan Mbeki Building
Private Bag X 54001
Durban
4000
KwaZulu-Natal, SOUTH AFRICA
Tel: 27 31 2604769 - Fax: 27 31 260-4609
Email: BREC@ukzn.ac.za
Website: http://research.ukzn.ac.za/ResearchEthics/BiomedicalResearchEthics.aspx

04 April 2012

Dr. L Naidoo
Department of Public Health Medicine
Nelson R. Mandela School of Medicine
University of KwaZulu-Natal
e-mail: lnaidoo@saol.com

Dear Dr Naidoo

PROTOCOL: The Impact of Lean Thinking on Operational Efficiency in a District Hospital Outpatient Department in KwaZulu- Natal. REF: BE097/11

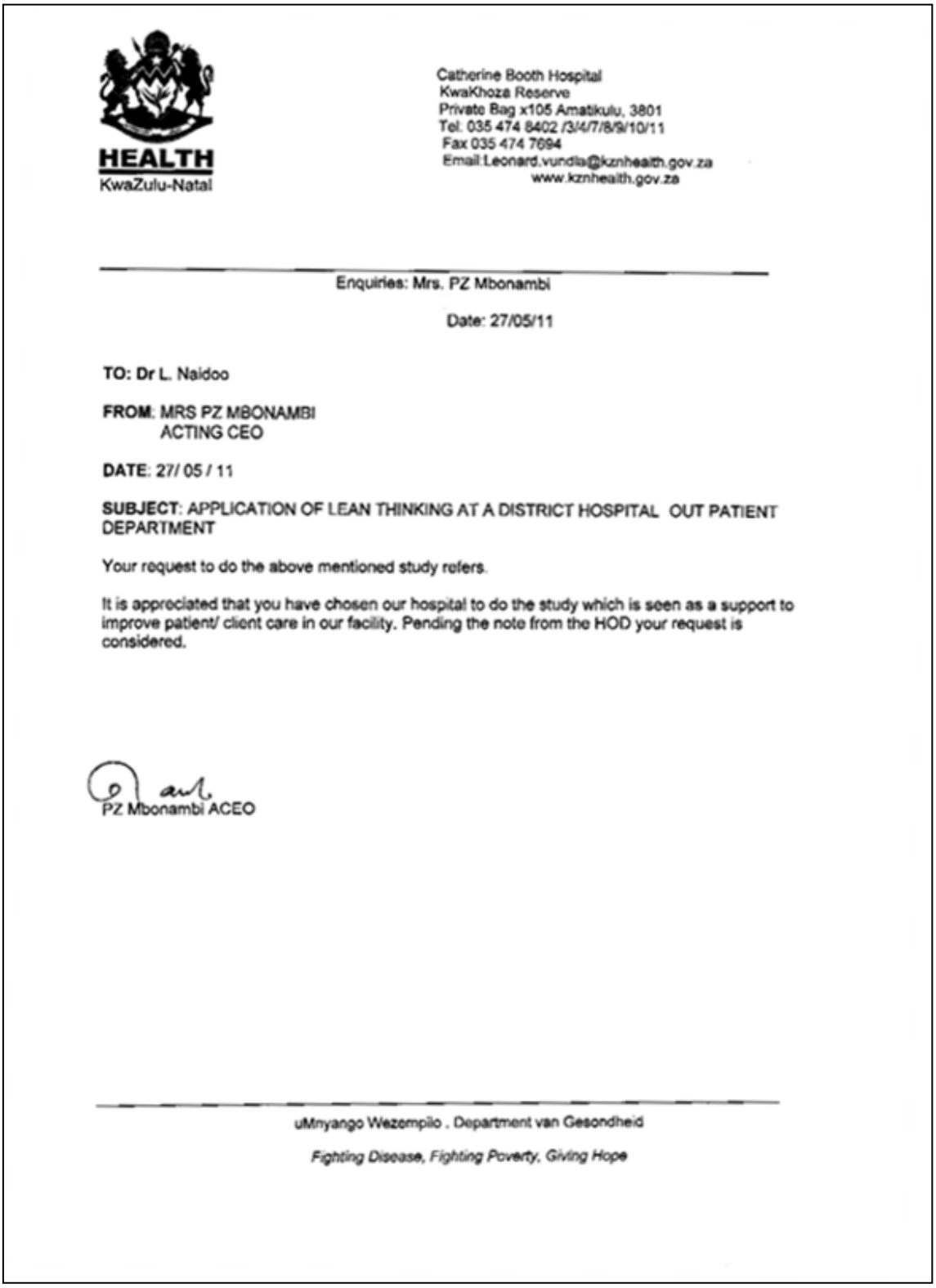
EXPEDITED APPLICATION RATIFICATION

Further to our letter to you dated 20 January 2012, this letter serves to notify you that at a full sitting of the Biomedical Research Ethics Committee meeting held on **14 February 2012**, the Committee RATIFIED the sub-committee's decision to approve the Expedited Application received on 02 June 2011.

Yours sincerely

Professor D Wassenaar
Chair: Biomedical Research Ethics Committee

Addendum 3: Permission from hospital to conduct study



HEALTH
KwaZulu-Natal

Catherine Booth Hospital
KwaKhoza Reserve
Private Bag x105 Amatikulu, 3801
Tel. 035 474 8402 /3/4/7/8/9/10/11
Fax 035 474 7694
Email:Leonard.vundla@kznhealth.gov.za
www.kznhealth.gov.za

Enquiries: Mrs. PZ Mbonambi

Date: 27/05/11

TO: Dr L. Naidoo

FROM. MRS PZ MBONAMBI
ACTING CEO

DATE: 27/ 05 / 11

SUBJECT: APPLICATION OF LEAN THINKING AT A DISTRICT HOSPITAL OUT PATIENT DEPARTMENT

Your request to do the above mentioned study refers.

It is appreciated that you have chosen our hospital to do the study which is seen as a support to improve patient/ client care in our facility. Pending the note from the HOD your request is considered.

PZ Mbonambi ACEO

Addendum 4: Permission from the Department of Health Research Committee

health

Department:
Health
PROVINCE OF KWAZULU-NATAL

Health Research & Knowledge Management
10 – 103 Natalia Building, 330 Langalibalele Street
Private Bag x9051
Pietermaritzburg, 3200
Tel.: 033 – 395 2895
Fax.: 033 – 394 3782
Email.: hrkm@kznhealth.gov.za
www.kznhealth.gov.za

Reference : HRKM 010/11
Enquiries : Mr X. Xaba
Telephone : 033 – 395 2805

Dear Dr L. Naidoo

Subject: Approval of a Research Proposal

1. The research proposal titled **'The impact of Lean thinking on operational efficiency in a rural district hospital outpatient department in KwaZulu Natal'** was reviewed by the KwaZulu-Natal Department of Health.

   The proposal is hereby approved for research to be undertaken at Catherine Booth Hospital for a period of 8 months.

2. You are requested to take note of the following:
   a. Make the necessary arrangement with the identified facility before commencing with your research project.
   b. Provide an interim progress report and final report (electronic and hard copies) when your research is complete.

3. Your final report must be posted to **HEALTH RESEARCH AND KNOWLEDGE MANAGEMENT, 10-102, PRIVATE BAG X9051, PIETERMARITZBURG, 3200** and e-mail an electronic copy to hrkm@kznhealth.gov.za

For any additional information please contact Mr X. Xaba.

Yours Sincerely

Dr E. Lutge
Chairperson: Provincial Health Research Committee
KZN Department of Health
Date: 30/04/2012

Addendum 5: Research Information Sheet and Consent Form

THE IMPACT OF LEAN THINKING ON OPERATIONAL EFFICIENCY IN A RURAL DISTRICT HOSPITAL OUTPATIENT DEPARTMENT IN KWAZULU-NATAL

Research Information Sheet and Consent Form

Section [A]: Research Information Sheet

1. What is this study about?

This study is a quality improvement project being conducted at the outpatient department (OPD) of Catherine Booth Hospital (CBH). Current problems involving operational inefficiency at many public district hospital OPDs, specifically long patient waiting times and the resultant low morale of staff, are well known. Innovative principles, tools and techniques, such as those of Lean thinking, have not been widely used in these hospitals to help resolve these problems, despite their benefits documented in numerous studies. This study will help determine the impact of Lean principles, tools and techniques on operational efficiency and staff morale at the OPD in CBH.

2. What is Lean thinking?

Lean thinking (or "Lean") is a philosophy involving proven operations practices and techniques with which to improve the quality and efficiency of production and service delivery by eliminating non-value-adding processes ("waste") and thereby improving flow. Lean, derived mainly from the Toyota Production System in Japan, drives organisations to enhance process steps that are value-adding and relevant to the final product or service for the client; simultaneously removing those that fail to add value. The application of Lean principles, tools and techniques in various industries, including health care, has proven to be of immense benefit in improving operational efficiency.

3. Who is conducting this study?

The study is being conducted by Dr. L. Naidoo ("the investigator"), a medical doctor and MBA graduate, who is currently a registered Master in Public Health (MPH) student at the Department of Public Health, Nelson R. Mandela School of Medicine, University of KwaZulu-Natal, Durban. The investigator, supervised by Dr. O. Mahomed, of the Department of Public Health will also bring together and steer a "*kaizen* team" (quality improvement team) from CBH which will meet the objectives of the research.

4. ***Where is the study being conducted?***

   The study is being conducted at the OPD of Catherine Booth Hospital. For the purpose of the study, the OPD includes service areas which an outpatient usually experiences in a general district hospital, e.g. registry, triage, doctor consultation, pharmacy, etc. It excludes day-case theatres, and the ARV, TOP, dental and therapist clinics.

5. ***How long will the study take?***

   The study will be conducted until its target cycle and waiting times are met. This could take from 6 to 8 weeks.

6. ***Why is the study being conducted?***

   The purpose of the study is to apply Lean principles, tools and techniques, and to determine the impact on efficiency and staff morale within the OPD at CBH, in order to inform recommendations to improve operational efficiency in rural district hospital outpatient departments.

7. ***What will happen if the study is not conducted?***

   The existing problems involving operational efficiency, namely long cycle and waiting times, and the resultant low staff morale, may persist and deteriorate if proven operations management practices such Lean are not applied. The study will help expose the benefits of Lean in a rural district hospital OPD.

8. ***What will happen if I take part in this study?***

   Unless you are part of the *kaizen* team, you will only be asked to complete two questionnaires (one before and one after the application of Lean). Even if you do not answer the questionnaires, you may also be indirectly involved in minor process changes that may take place in your department as a result of the application of Lean. The information that you may provide in the questionnaire will not negatively affect you, and will be treated in strict confidence. Your name or any other information that could identify you will never be used in any report, publication, or presentation.

   If you are part of the *kaizen* team, you will be involved in regular (generally two-weekly) meetings and you may be given small tasks to carry out in your department. As a result, there may be some minor changes implemented in the OPD and other related departments during the study, in order to improve operational efficiency. Any changes will be implemented only after consultation, and with consent from hospital management and the *kaizen* team. The benefits of these changes may or may not directly be experienced by you and/or patients during and after the study.

9. What are some of the changes I can expect in the OPD?

Changes will involve activities and/or processes that are regarded as non-value-adding ("wastes") to the final product or service delivered to the client. The client may be a patient or another member of staff who works down the value stream, e.g. if you are a triage nurse, your client will be the patient as well as the doctor to whom you may send the patient after triaging.

Some of the changes may include, *inter alia*, the relocation of workstations to minimise distance between client service points, the addition or modification of a triage system, streamlining movement of patients and staff, reduction of duplicate procedures and activities, preventing rework caused by errors in patient management, and the staggering of tea, lunch and smoke breaks.

10. What risks can I expect from participating in the study?

To protect your privacy, you will not be asked to state your name in the questionnaires. The information that you may provide in the questionnaires will not negatively affect you, and will be treated in strict confidence. Your name or any other information that could identify you will never be used in any report, publication, or presentation. Whether or not you're part of the *kaizen* team, you may be involved in the minor process changes that may take place in your department as a result of the application of Lean principles, tools or techniques.

11. What if I decide not to answer the questionnaires?

You are free not to participate in answering the questionnaires. You will not be negatively affected or stigmatised whether or not you choose to answer the questionnaires.

12. What are the costs of participating in this study?

You do not have to pay anything to participate in this study.

13. Will I be paid anything to participate in this study?

You will not be paid to participate in this study.

14. Where may I obtain further information about the study or about my rights apropos the study?

If you have questions or feel that you have been negatively affected by the study, we want you to tell us. You may speak to your supervisor or manager, any one of the *kaizen* team members (names available from the Hospital Manager or Medical Manager), or the principal investigator (Dr. L. Naidoo). Dr. L. Naidoo can be contacted on 0835504811 or 993212931@ukzn.ac.za. You may also contact Prof. C.C. Jinabhai or Dr. O. Mahomed of the Department of Public Health at the University of KwaZulu-Natal on 031-2604058, or you may contact the Biomedical Research Ethics Office on 031-2604769 or 2601074 or email *brec@ukzn.ac.za*

Section [B]: Consent Form

You have been asked by the principal investigator, Dr. L. Naidoo, to participate in a research study described under Section [A]. Your participation in this study by being a *kaizen* team member, answering the questionnaire and/or being observed for cycle time measurements is voluntary, and you will not be penalised if you refuse to participate. Cycle and waiting time observations will not affect your routine work. You may also withdraw at any time from participation in the study.

You may contact the Biomedical Research Ethics Office on **031-260 4769 or 031-260 1074** or via email at *brec@ukzn.ac.za* if you have questions about your rights as a research participant.

If you agree to participate, you will be given a copy of the research information sheet (Section A) which is a written summary of the research. The Consent Form (Section B) must be filled in, signed and returned to the investigator.

The study, including the above information, has been clearly explained to me verbally and a copy of the research information sheet has been given to me. Anything I did not understand was explained to me, and all my questions were answered. I understand what my involvement in the study means, and I hereby voluntarily agree to participate.

_____ _____

Signature of participant Date

_____ _____

Signature of witness Date

_____ _____

Signature of translator (if applicable) Date

Addendum 6: Research questionnaire (to measure staff attitudes and morale)

THE IMPACT OF LEAN THINKING ON OPERATIONAL EFFICIENCY IN A RURAL DISTRICT HOSPITAL OUTPATIENT DEPARTMENT IN KWAZULU-NATAL

RESEARCH QUESTIONNAIRE

This questionnaire consists of 3 sections and 4 pages. Please answer all questions, and respond to the questions as honestly and openly as possible. All information will be kept strictly confidential.

SECTION A: SPECIFIC WORK-RELATED ATTITUDES

This section is intended to collect information about your work attitudes specifically related to teamwork, communication, empowerment and autonomy, and supervisory relations.

On a scale from 1 to 5, how would you rate each of the following statements? Please tick one option for each statement.

1=Strongly agree; 2=Agree; 3=Neither agree/disagree; 4=Disagree; 5=Strongly disagree

No.	Statement	Scale				
A1	**Teamwork**	**1**	**2**	**3**	**4**	**5**
A1.1	Staff in my department work together as a team.					
A1.2	Those in my work group are easy to approach with a work problem.					
A1.3	The people I work with cooperate to get the job done.					
A1.4	In my department, work groups or individuals plan their work together.					
A1.5	Around here, work groups or individuals seem to work against each other.					
A1.6	In my department, my work performance suffers from lack of teamwork between individuals or other work groups.					
A1.7	There is a lack of teamwork between departments, e.g. OPD & Pharmacy.					
A2	**Communication**	**1**	**2**	**3**	**4**	**5**
A2.1	There is an open flow of work information down to me from higher levels.					
A2.2	There is an open flow of work information upward from me to higher levels.					
A2.3	There is a free and open flow of information between the various work groups or departments (e.g. Pharmacy and OPD)					
A2.4	Sufficient effort is made by higher management to solicit the opinions of those who work in my department.					
A2.5	Those in my department have sufficient opportunity to tell supervisors and managers how we feel about matters affecting our work.					
A2.6	I receive enough information from management to help me do my job well.					
A2.7	The information I receive from other staff, departments or management arrives *on time* to help me in my work.					
A2.8	In my department, we are not afraid to say what we really think.					
A2.9	Senior staff seriously listen to what people at my level have to say.					
A2.10	I am given feedback from someone when I make a mistake in my job.					
A2.11	I always know what I must accomplish in my job.					
A2.12	My department's overall work goals are clear to me. *1=Always; 2= Most of the time; 3=Some of the time; 4= Seldom 5=Never*					
A2.13	I am kept informed on how well my own department performs. *1=Always; 2= Most of the time; 3=Some of the time; 4= Seldom 5=Never*					

1=Strongly agree; 2=Agree; 3=Neither agree/disagree; 4=Disagree; 5=Strongly disagree

No.	Statement	Scale				
A3	**Empowerment and autonomy**	**1**	**2**	**3**	**4**	**5**
A3.1	I am able to change the structure and control of my own work.					
A3.2	I have sufficient say in setting my work goals.					
A3.3	I would do my job better if I had more freedom to act on my own.					
A4	**Supervisory relations**	**1**	**2**	**3**	**4**	**5**
A4.1	My supervisor/manager accepts constructive criticism from his/her subordinates.					
A4.2	When I make a serious mistake, I am keen and willing to go to my supervisor/manager for help.					
A4.3	My supervisor/manager deals fairly with everyone.					
A4.4	My supervisor/manager stands up for his/her subordinates.					
A4.5	My supervisor/manager does a good job of building teamwork.					
A4.6	My supervisor/manager maintains high standards of performance.					
A5	**Attitude to work contribution**	**1**	**2**	**3**	**4**	**5**
A5.1	My job makes good use of my skills and abilities.					
A5.2	My work gives me a feeling of personal accomplishment.					
A5.3	In my job, I have a chance to do some things that really test my ability.					
A5.4	My department is productive.					
A5.5	The people in my department put all of their effort into their job.					
A5.7	I am given a real opportunity to improve my skills in this department.					

SECTION B: GENERAL WORK-RELATED ATTITUDES AND MORALE

This section is intended to measure your current level of morale and your general attitude towards work at Catherine Booth Hospital.

Please tick where necessary. Answer all questions as honestly and openly as possible.

No.	Questions
B1	***Are you currently satisfied with your job in general?*** ☐ A] Yes ☐ B] No
B2	***Do you feel things in your department seem to be getting better?*** ☐ A] Yes ☐ B] No
B3	***If you answered "No" to Question B2, state why.*** _____ _____
B4	***On a scale from 1 to 6 (where 1 = very boring and 6 = very exciting), how do you feel about the current tasks and activities you perform in your job?*** ☐ A] 1 ☐ B] 2 ☐ C] 3 ☐ D] 4 ☐ E] 5 ☐ F] 6
B5	***Describe in a few words your mood and attitude about coming to work every day?*** _____
B6	***Do you feel inspired (motivated/stimulated) in your job?*** ☐ A] Yes ☐ B] No
B7	***If your answer to Question B4 is no, state why.*** _____ _____
B8	***What are some of the factors that cause you to dislike or even despise work?*** ☐ A] Performing tasks outside my scope of practice and/or job description ☐ B] Lack of supervision ☐ C] Long patient queues ☐ D] Shortage of equipment ☐ E] Translating languages for others ☐ F] Lack of team work ☐ [G] Other (please specify): _____ _____
B9	***On a scale from 1 to 6 (where 1 = very caring and 6 = very unpleasant), how would you describe your attitude towards external clients (patients)?*** ☐ A] 1 ☐ B] 2 ☐ C] 3 ☐ D] 4 ☐ E] 5 ☐ F] 6
B10	***On a scale from 1 to 6 (where 1 = very caring and 6 = very unpleasant), how would you describe your attitude towards internal clients (work colleagues / other staff)?*** ☐ A] 1 ☐ B] 2 ☐ C] 3 ☐ D] 4 ☐ E] 5 ☐ F] 6
B11	***On a scale from 1 to 6 (where 1 = very caring and 6 = very unpleasant), how would you describe the attitude of internal clients (work colleagues / other staff) to you?*** ☐ A] 1 ☐ B] 2 ☐ C] 3 ☐ D] 4 ☐ E] 5 ☐ F] 6
B12	***On a scale from 1 to 6 (where 1=very likely and 6=very unlikely), how likely are you to recommend your department at Catherine Booth Hospital to someone wishing to apply for a job?*** ☐ A] 1 ☐ B] 2 ☐ C] 3 ☐ D] 4 ☐ E] 5 ☐ F] 6
B13	***On a scale from 1 to 6 (where 1= very likely and 6 = very unlikely), how likely are you to stay and work for at least another year at Catherine Booth Hospital?*** ☐ A] 1 ☐ B] 2 ☐ C] 3 ☐ D] 4 ☐ E] 5 ☐ F] 6

SECTION C: GENERAL INFORMATION
This section is intended to collect general information about you, the participant.

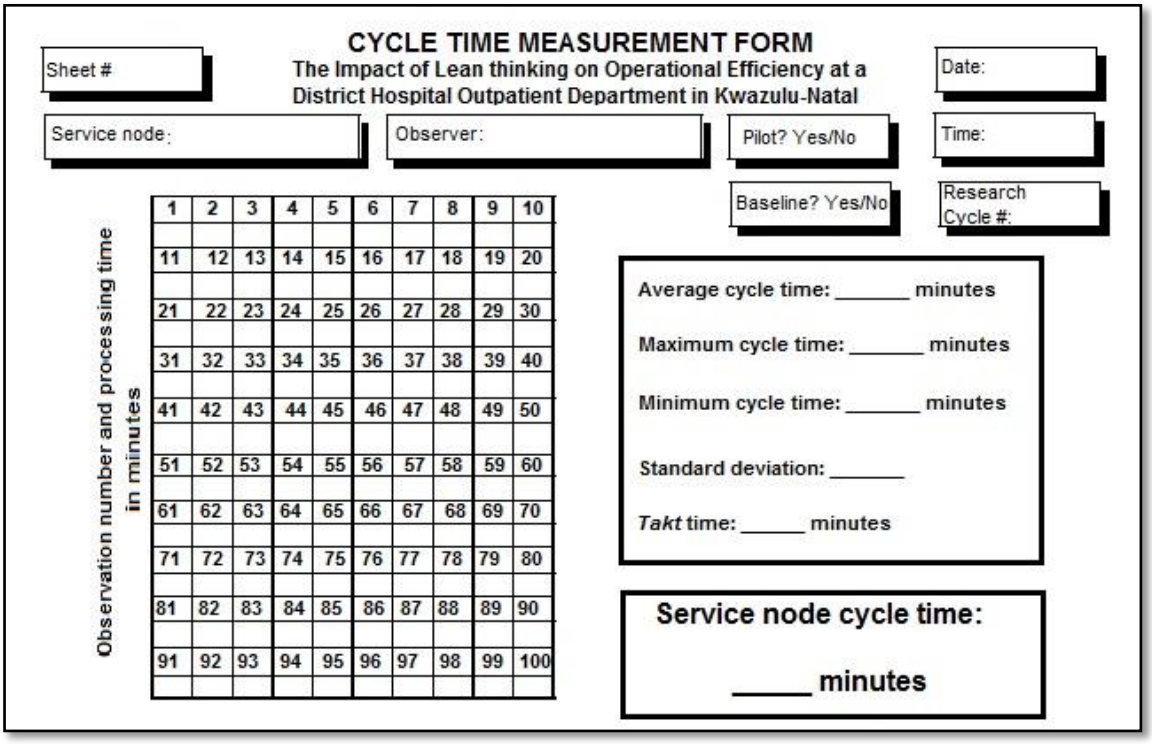
Please tick where necessary, and answer all questions as honestly and openly as possible.

No.	Questions
C1	***Which department do you work in? (Please tick one)*** ☐ A] Patient files / Registry / Admissions / Cashier ☐ B] Outpatient Department ☐ C] Pharmacy ☐ D] X-Ray ☐ E] Other (please specify) _____
C2	***How would you classify your profession?*** ☐ A] Nurse ☐ B] Doctor ☐ C] Administration clerk ☐ D] Pharmacy worker / Pharmacist ☐ E] Radiographer ☐ F] Other (please specify): _____
C3	***Which would you currently describe as the main group of activities and duties that you perform in your job? (Please tick one)*** ☐ A] Administrative work (e.g. paperwork, computer work, typing, filing, dealing with cash) ☐ B] Nursing (e.g. measuring vital signs, administering injections, dressing wounds) ☐ C] Clinical (e.g. diagnosing and treating patients, prescribing, performing clinical tests) ☐ D] Pharmaceutical (e.g. compounding and dispensing medicines) ☐ E] Procedural (e.g. phlebotomy, X-rays, applying POPs, suturing) ☐ F] Other (please specify) _____
C4	***How old are you?*** _____ years
C5	***What is your gender?*** ☐ A] Male ☐ B] Female
C6	***How long have been working at Catherine Booth Hospital?*** ☐ A] Less than 1 year ☐ B] 1 to 3 years ☐ C] More than 3 years but less than 5 years ☐ D] More than 5 years
C7	***How long have been working in your department for?*** ☐ A] Less than 3 months ☐ B] 3 to 6 months ☐ C] More than 6 months but less than 12 months ☐ D] More than 12 months

The investigator would like to thank you for your time and effort in completing this questionnaire.

To maintain anonymity and confidentiality, the completed questionnaire must be sealed in the envelope provided. This must be dropped off in the box located in the Medical Manager's office or returned directly to the investigator (Dr. L. Naidoo).

Addendum 7: Data collection sheet templates for cycle and waiting times



CYCLE TIME MEASUREMENT FORM

The Impact of Lean thinking on Operational Efficiency at a District Hospital Outpatient Department in Kwazulu-Natal

Sheet #

Date:

Service node:

Observer:

Pilot? Yes/No

Time:

Baseline? Yes/No

Research Cycle #:

Observation number and processing time in minutes

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Average cycle time: _____ minutes

Maximum cycle time: _____ minutes

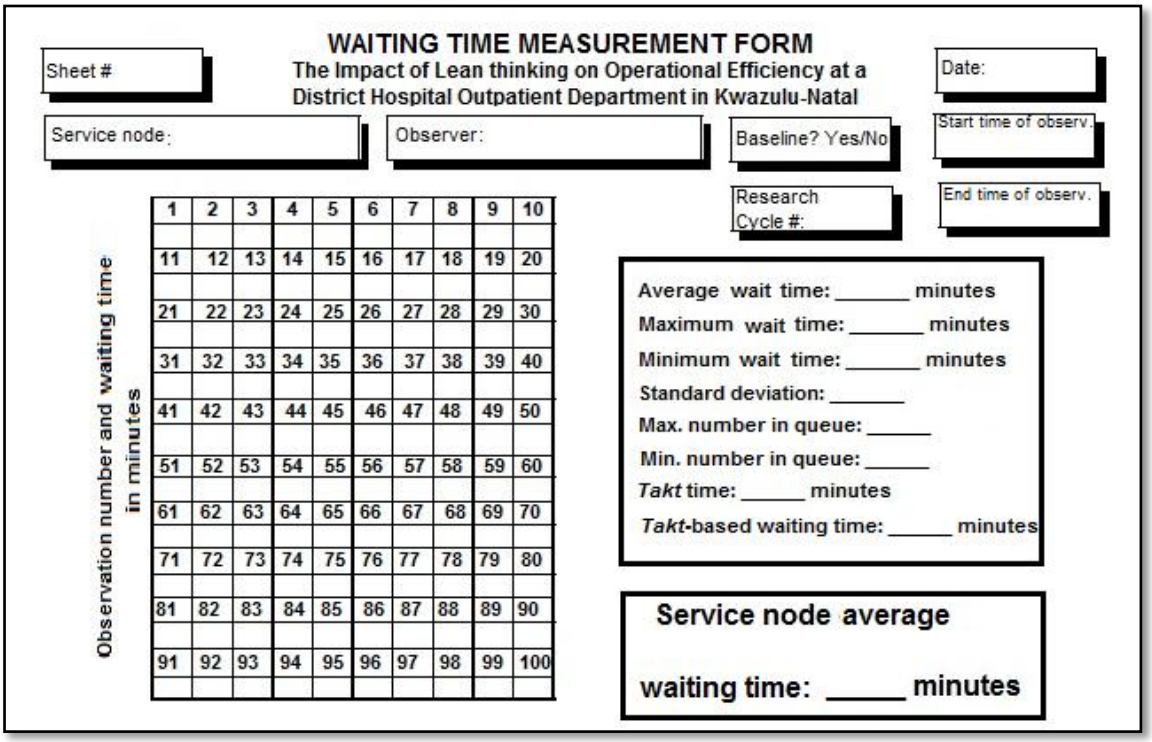
Minimum cycle time: _____ minutes

Standard deviation: _____

Takt time: _____ minutes

Service node cycle time:

_____ minutes



WAITING TIME MEASUREMENT FORM

The Impact of Lean thinking on Operational Efficiency at a District Hospital Outpatient Department in Kwazulu-Natal

Sheet #

Date:

Service node:

Observer:

Baseline? Yes/No

Start time of observ.

Research Cycle #:

End time of observ.

Observation number and waiting time in minutes

1	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100

Average wait time: _____ minutes

Maximum wait time: _____ minutes

Minimum wait time: _____ minutes

Standard deviation: _____

Max. number in queue: _____

Min. number in queue: _____

Takt time: _____ minutes

Takt-based waiting time: _____ minutes

Service node average

waiting time: _____ minutes

Addendum 8: Minutes of first kaizen meeting

MINUTES OF THE KAIZEN MEETING #1 HELD AT CATHERINE BOOTH HOSPITAL BOARDROOM AT 12H00 ON 3 MAY 2012

1. Welcome

- The Principal Investigator welcomed all attendees and thanked them for their participation.

2. Attendance register

- Attached.

3. Apologies

- Dr. Mabaso – on maternity leave
- Mr. C.E. Ojo (Pharmacy) and Ms. N. Mthembu (X-ray dept.) – Busy with patients
- Mrs. Mpanza (Patient administration) – In another meeting

4. PowerPoint® presentation

- The Principal Investigator presented the following:
    - Refresher on the Lean process
    - Presentation of baseline cycle and waiting times and current-state VSM

5. Application of A3 tool (attached)

- The A3 tool was drafted in the meeting by the Principal Investigator through the participation of the team members
    - Background and current condition was already tabled at the previous Pre-intervention Briefing meeting.
    - Root cause analysis of problem was carried out using the 5-Why technique and action plan compiled.

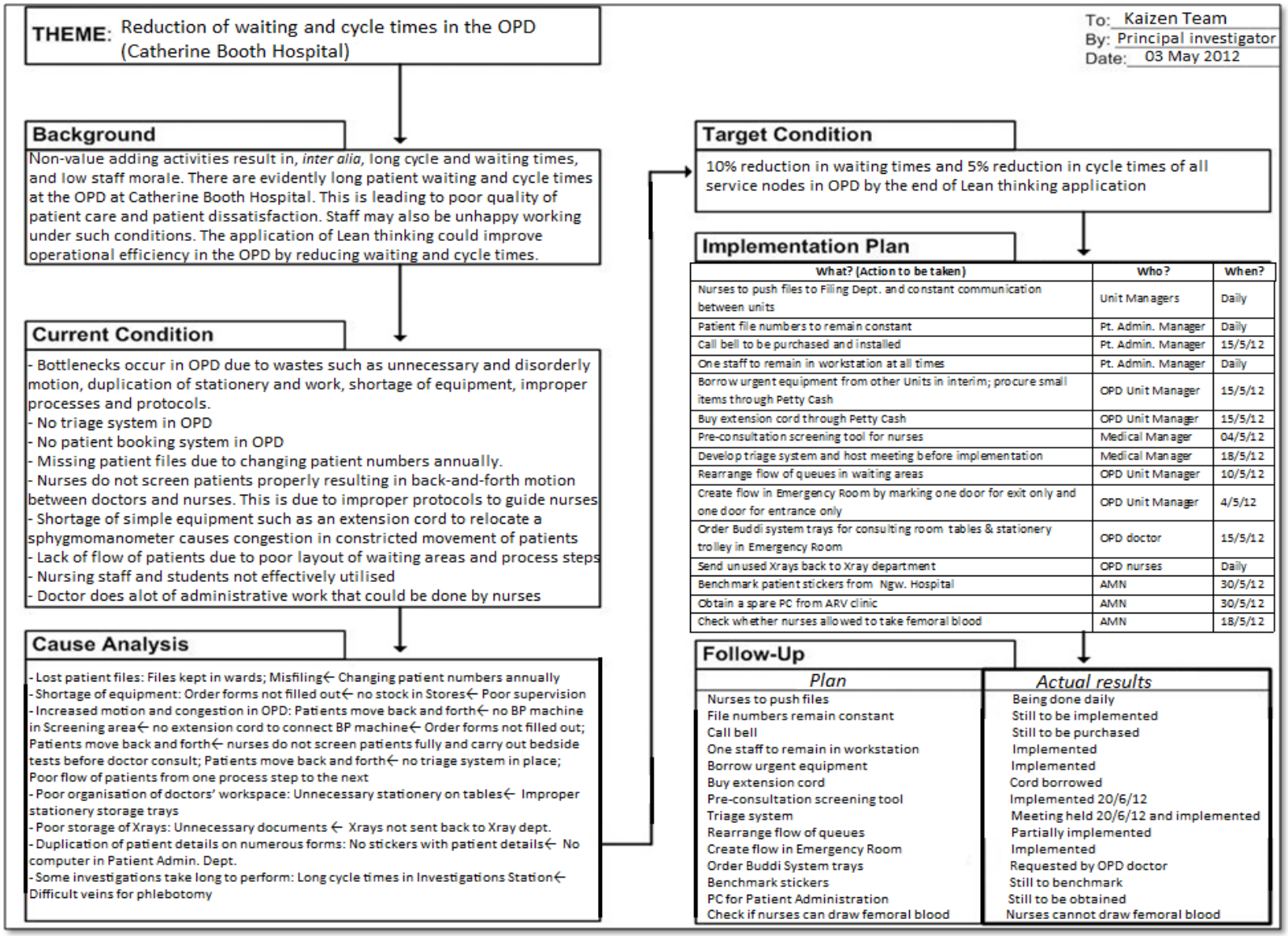
List of Problems	Why? (Causes)	What? (Action to be taken)	Who? (Responsible persons)	When? (Due date)
Lost patient files	Files kept in ward/units	Nurses to push files to Filing Dept. and constant communication between units	Unit Managers	Daily
	Misfiling← Changing patient numbers annually	Patient file numbers to remain constant	Pt. Admin. Manager	Daily
Staff rest in tearoom and not visible by patients	No windows/viewing hatch and no call-bell for patients	Call bell to be purchased and installed	Pt. Admin. Manager	15/5/12
		One staff to remain in workstation at all times (stagger breaks)	Pt. Admin. Manager	Daily
Shortage of equipment	Order forms not filled out← no stock in Stores← Poor supervision in Stores	Borrow urgent equipment from other Units in interim; procure small items through Petty Cash or SCM delegation 1	OPD Unit Manager	15/5/12
Increased motion and congestion in OPD	Patients move back and forth← no BP machine in Screening area← no extension cord to connect BP machine← Order forms not filled out	Buy extension cord through Petty Cash	OPD Unit Manager	15/5/12
	Patients move back and forth← nurses do not screen patients fully or carry out bedside tests before doctor consult	Draw up and implement Pre-consultation screening tool for nurses to use during patient screening for guidance with bedside tests, etc. to reduce motion	Medical Manager	04/5/12
	Patients move back and forth← no triage system in place	Develop triage system and host meeting before implementation	Medical Manager	18/5/12

List of Problems	Why? (Causes)	What? (Action to be taken)	Who? (Responsible persons)	When? (Due date)
Increased motion and congestion in OPD (continued)	Poor flow of patients from one process step to the next	Rearrange flow of queues in waiting areas for Patient Screening, Doctor Consultation and Investigations	Medical Manager and OPD Unit Manager	10/5/12
		Create flow in Emergency Room by marking one door for exit only and one door for entrance only	OPD Unit Manager	4/5/12
Poor organisation of doctors' workspace	Unnecessary stationery on tables← Improper stationery storage trays	Order Buddi system trays for consulting room tables & stationery trolley in Emergency Room	OPD doctor and OPD Unit Manager	15/5/12
Poor storage of X-rays	Unnecessary documents on tables← X-rays not sent back to X-ray department	Send unused X-rays back to X-ray department	OPD nurses	Daily
Duplication of patient details on numerous forms	No stickers with patient details← No computer in Patient Admin. Dept.	Benchmark patient stickers from Ngwelezana Hospital	AMN	30/5/12
		Obtain a spare PC from ARV clinic	AMN	30/5/12
Some investigations take long to perform	Long cycle times in Investigations Station← Difficult veins for phlebotomy	Check whether nurses allowed to take femoral blood if they encounter difficult veins on arms/forearms	AMN	18/5/12

- Target setting
    - It was agreed by the Kaizen team that it is was acceptable and realistic to reduce the waiting times and cycle times for each service node by 10% and 5% respectively.

6. Closure

- The meeting closed at 13h50.



THEME: Reduction of waiting and cycle times in the OPD (Catherine Booth Hospital)

To: Kaizen Team
By: Principal investigator
Date: 03 May 2012

Background

Non-value adding activities result in, *inter alia*, long cycle and waiting times, and low staff morale. There are evidently long patient waiting and cycle times at the OPD at Catherine Booth Hospital. This is leading to poor quality of patient care and patient dissatisfaction. Staff may also be unhappy working under such conditions. The application of Lean thinking could improve operational efficiency in the OPD by reducing waiting and cycle times.

Current Condition

- Bottlenecks occur in OPD due to wastes such as unnecessary and disorderly motion, duplication of stationery and work, shortage of equipment, improper processes and protocols.
- No triage system in OPD
- No patient booking system in OPD
- Missing patient files due to changing patient numbers annually.
- Nurses do not screen patients properly resulting in back-and-forth motion between doctors and nurses. This is due to improper protocols to guide nurses
- Shortage of simple equipment such as an extension cord to relocate a sphygmomanometer causes congestion in constricted movement of patients
- Lack of flow of patients due to poor layout of waiting areas and process steps
- Nursing staff and students not effectively utilised
- Doctor does alot of administrative work that could be done by nurses

Cause Analysis

- Lost patient files: Files kept in wards; Misfiling← Changing patient numbers annually
- Shortage of equipment: Order forms not filled out← no stock in Stores← Poor supervision
- Increased motion and congestion in OPD: Patients move back and forth← no BP machine in Screening area← no extension cord to connect BP machine← Order forms not filled out; Patients move back and forth← nurses do not screen patients fully and carry out bedside tests before doctor consult; Patients move back and forth← no triage system in place; Poor flow of patients from one process step to the next
- Poor organisation of doctors' workspace: Unnecessary stationery on tables← Improper stationery storage trays
- Poor storage of Xrays: Unnecessary documents ← Xrays not sent back to Xray dept.
- Duplication of patient details on numerous forms: No stickers with patient details← No computer in Patient Admin. Dept.
- Some investigations take long to perform: Long cycle times in Investigations Station← Difficult veins for phlebotomy

Target Condition

10% reduction in waiting times and 5% reduction in cycle times of all service nodes in OPD by the end of Lean thinking application

Implementation Plan

What? (Action to be taken)	Who?	When?
Nurses to push files to Filing Dept. and constant communication between units	Unit Managers	Daily
Patient file numbers to remain constant	Pt. Admin. Manager	Daily
Call bell to be purchased and installed	Pt. Admin. Manager	15/5/12
One staff to remain in workstation at all times	Pt. Admin. Manager	Daily
Borrow urgent equipment from other Units in interim; procure small items through Petty Cash	OPD Unit Manager	15/5/12
Buy extension cord through Petty Cash	OPD Unit Manager	15/5/12
Pre-consultation screening tool for nurses	Medical Manager	04/5/12
Develop triage system and host meeting before implementation	Medical Manager	18/5/12
Rearrange flow of queues in waiting areas	OPD Unit Manager	10/5/12
Create flow in Emergency Room by marking one door for exit only and one door for entrance only	OPD Unit Manager	4/5/12
Order Buddi system trays for consulting room tables & stationery trolley in Emergency Room	OPD doctor	15/5/12
Send unused Xrays back to Xray department	OPD nurses	Daily
Benchmark patient stickers from Ngw. Hospital	AMN	30/5/12
Obtain a spare PC from ARV clinic	AMN	30/5/12
Check whether nurses allowed to take femoral blood	AMN	18/5/12

Follow-Up

Plan	*Actual results*
Nurses to push files	Being done daily
File numbers remain constant	Still to be implemented
Call bell	Still to be purchased
One staff to remain in workstation	Implemented
Borrow urgent equipment	Implemented
Buy extension cord	Cord borrowed
Pre-consultation screening tool	Implemented 20/6/12
Triage system	Meeting held 20/6/12 and implemented
Rearrange flow of queues	Partially implemented
Create flow in Emergency Room	Implemented
Order Buddi System trays	Requested by OPD doctor
Benchmark stickers	Still to benchmark
PC for Patient Administration	Still to be obtained
Check if nurses can draw femoral blood	Nurses cannot draw femoral blood

Addendum 9: Minutes of the second kaizen meeting

MINUTES OF KAIZEN MEETING #2 HELD AT CATHERINE BOOTH HOSPITAL BOARDROOM AT 12H00 ON 22 JUNE 2012

1. Welcome

- The Principal Investigator welcomed all attendees and thanked them for their participation.

2. Attendance register

- Attached.

3. Apologies

- Dr. Mabaso – on maternity leave

4. PowerPoint® presentation

- The Principal Investigator presented the following:
    - Refresher on the Lean process
    - Presentation of cycle and waiting times and current-state VSM from Cycle #1 measurements on 16-17 May 2012
    - Future-state VSM

5. Application of A3 tool (attached)

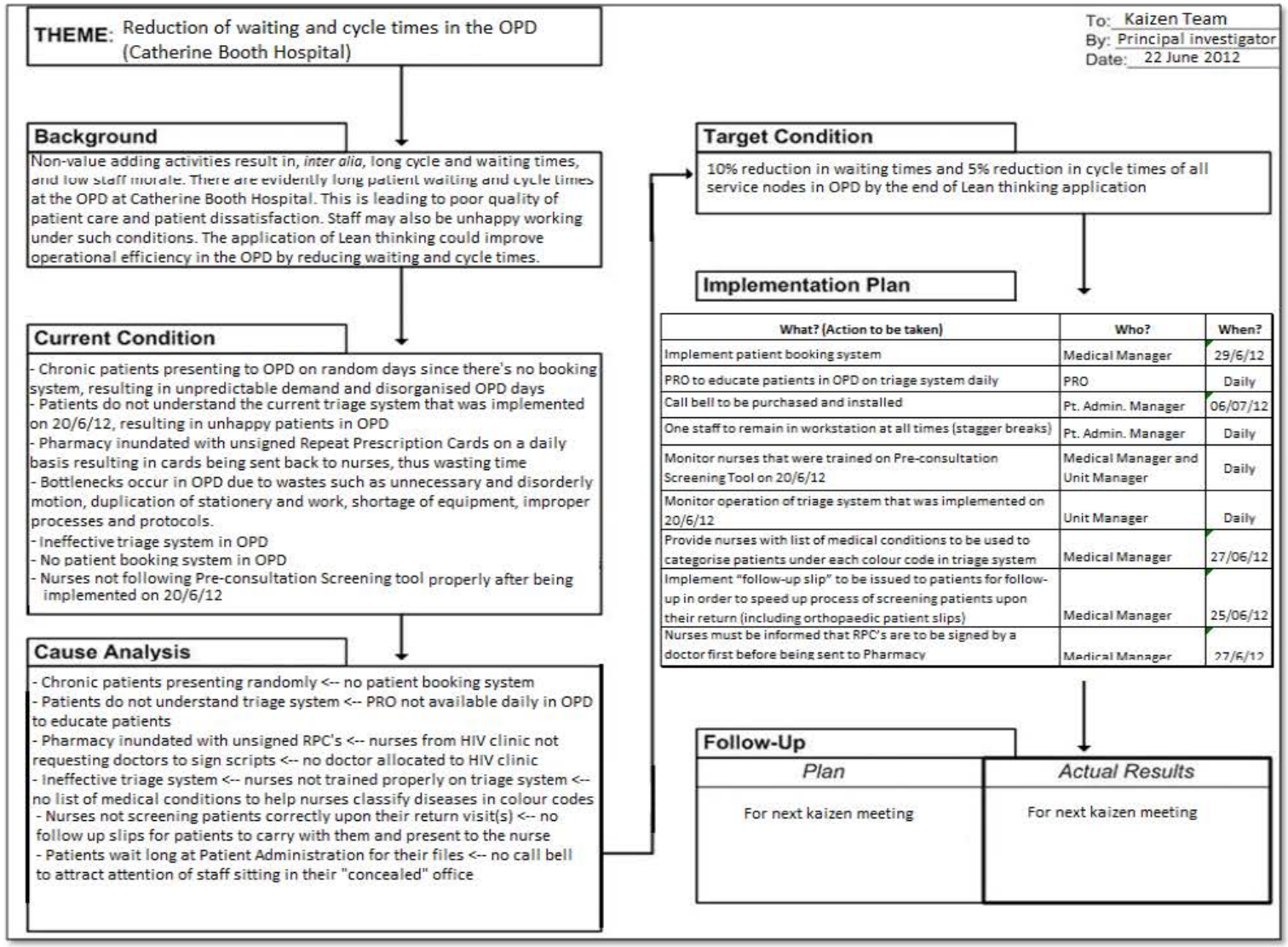
- The A3 tool was drafted in the meeting by the Principal Investigator through the participation of the team members
    - Background and current condition had already been tabled at the previous Pre-intervention Briefing meeting.
    - Root cause analysis of problem was carried out using the 5-Why technique and action plan compiled.

List of Problems	Why? (Causes)	What? (Action to be taken)	Who? (Responsible persons)	When? (Due date)
Pt. Admin. staff rest in tearoom and not visible by patients	No windows/viewing hatch and no call-bell for patients	Call bell to be purchased and installed	Pt. Admin. Manager	6/7/12
		One staff to remain in workstation at all times (stagger breaks)	Pt. Admin. Manager	Daily
Increased motion and congestion in OPD	Doctors send patients back and forth from consulting rooms for various purposes← Patients not being screened properly by nurses← Pre-consultation screening tool not being followed by nurses in OPD	Monitor nurses that were trained on Pre-consultation Screening Tool on 20/6/12	Medical Manager and Unit Manager	Daily
	Patients move back and forth← triage system in place but not fully effective yet	Monitor operation of triage system that was implemented on 20/6/12	Unit Manager	Daily
		PRO to be present daily in OPD to explain to patients about the new triage system	PRO	Daily
		Provide nurses with list of medical conditions classified under each colour-code in triage system	Medical Manager	27/6/12
		Implement “follow-up slip” to be issued to patients for follow-up in order to speed up process of screening patients upon their return	Medical Manager	25/6/12

List of Problems	Why? (Causes)	What? (Action to be taken)	Who? (Responsible persons)	When? (Due date)
Chronic patients randomly presenting with various conditions on a daily basis	Chronic patients requiring repeat medication present to hospital whenever they feel the need to← No booking system	Implement booking system whereby demand becomes predictable (e.g. hypertension patients come only on Wednesdays)	Medical Manager OPD Unit Manager	29/6/12
Pharmacy inundated on a daily basis with unsigned Repeat Prescription Cards	RPC's sent with patient from HIV/ARV clinic without a doctor renewing the cards← shortage of doctors in OPD	Nurses must be informed that RPC's are to be signed by a doctor first before being sent to Pharmacy	Medical Manager	27/6/12

6. Closure

- The meeting closed at 13h00.


THEME: Reduction of waiting and cycle times in the OPD (Catherine Booth Hospital)
To: Kaizen Team
By: Principal investigator
Date: 22 June 2012
Background
Non-value adding activities result in, inter alia, long cycle and waiting times, and low staff morale. There are evidently long patient waiting and cycle times at the OPD at Catherine Booth Hospital. This is leading to poor quality of patient care and patient dissatisfaction. Staff may also be unhappy working under such conditions. The application of Lean thinking could improve operational efficiency in the OPD by reducing waiting and cycle times.
Current Condition
- Chronic patients presenting to OPD on random days since there's no booking system, resulting in unpredictable demand and disorganised OPD days
- Patients do not understand the current triage system that was implemented on 20/6/12, resulting in unhappy patients in OPD
- Pharmacy inundated with unsigned Repeat Prescription Cards on a daily basis resulting in cards being sent back to nurses, thus wasting time
- Bottlenecks occur in OPD due to wastes such as unnecessary and disorderly motion, duplication of stationery and work, shortage of equipment, improper processes and protocols.
- Ineffective triage system in OPD
- No patient booking system in OPD
- Nurses not following Pre-consultation Screening tool properly after being implemented on 20/6/12
Cause Analysis
- Chronic patients presenting randomly <-- no patient booking system
- Patients do not understand triage system <-- PRO not available daily in OPD to educate patients
- Pharmacy inundated with unsigned RPC's <-- nurses from HIV clinic not requesting doctors to sign scripts <-- no doctor allocated to HIV clinic
- Ineffective triage system <-- nurses not trained properly on triage system <-- no list of medical conditions to help nurses classify diseases in colour codes
- Nurses not screening patients correctly upon their return visit(s) <-- no follow up slips for patients to carry with them and present to the nurse
- Patients wait long at Patient Administration for their files <-- no call bell to attract attention of staff sitting in their "concealed" office
Target Condition
10% reduction in waiting times and 5% reduction in cycle times of all service nodes in OPD by the end of Lean thinking application
Implementation Plan
What? (Action to be taken) | Who? | When?
Implement patient booking system | Medical Manager | 29/6/12
PRO to educate patients in OPD on triage system daily | PRO | Daily
Call bell to be purchased and installed | Pt. Admin. Manager | 06/07/12
One staff to remain in workstation at all times (stagger breaks) | Pt. Admin. Manager | Daily
Monitor nurses that were trained on Pre-consultation Screening Tool on 20/6/12 | Medical Manager and Unit Manager | Daily
Monitor operation of triage system that was implemented on 20/6/12 | Unit Manager | Daily
Provide nurses with list of medical conditions to be used to categorise patients under each colour code in triage system | Medical Manager | 27/06/12
Implement "follow-up slip" to be issued to patients for follow-up in order to speed up process of screening patients upon their return (including orthopaedic patient slips) | Medical Manager | 25/06/12
Nurses must be informed that RPC's are to be signed by a doctor first before being sent to Pharmacy | Medical Manager | 27/6/12
Follow-Up
Plan
For next kaizen meeting
Actual Results
For next kaizen meeting

Addendum 10: Minutes of the third kaizen meeting

MINUTES OF KAIZEN MEETING #3 HELD AT CATHERINE BOOTH HOSPITAL MEDICAL MANAGER'S OFFICE AT 14H00 ON 25 JULY 2012

1. Welcome

- The Principal Investigator welcomed all attendees and thanked them for their participation. He also highlighted that this is the last *kaizen* meeting, the study's action research cycles having come to an end.

2. Attendance register

- Attached.

3. Apologies

- Dr. Mabaso – on maternity leave

4. PowerPoint® presentation

- The Principal Investigator presented the following:
    - Refresher on the Lean process
    - Presentation of cycle and waiting times and current-state VSM from Cycle #2 measurements on 4-5 July 2012
    - Future-state VSM

5. Application of A3 tool (attached)

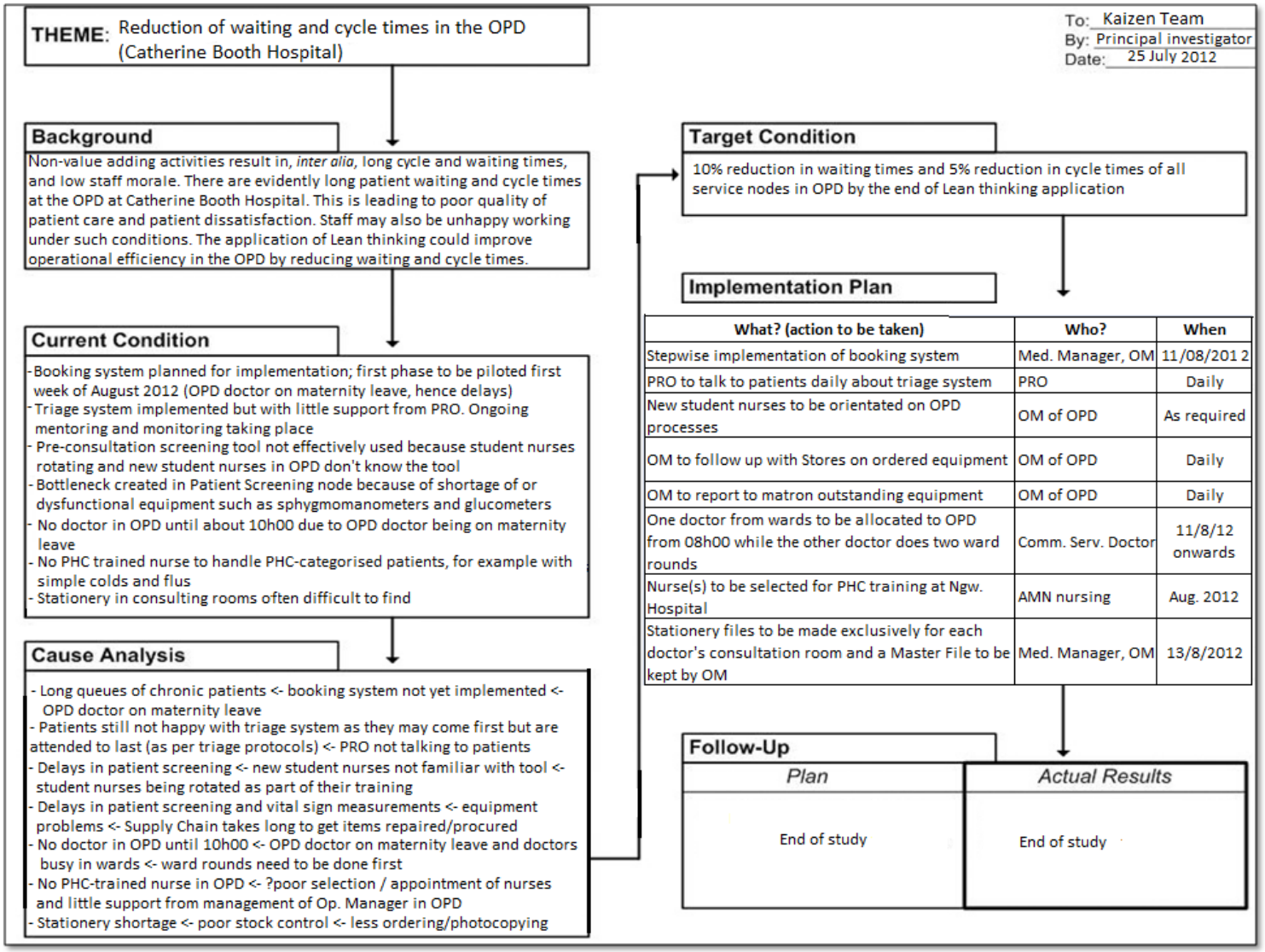
- The A3 tool was drafted in the meeting by the Principal Investigator through the participation of the team members
    - Background and current condition had already been tabled at the previous Pre-intervention Briefing meeting.
    - Root cause analysis of problem was carried out using the 5-Why technique and action plan compiled.

List of Problems	Why? (Causes)	What? (Action to be taken)	Who? (Responsible persons)	When? (Due date)
Chronic patients randomly presenting with different conditions on daily basis	Chronic patients requiring repeat medication present to hospital whenever they feel the need to← No booking system	Stepwise implementation of booking system whereby demand becomes predictable (e.g. hypertension patients come only on Wednesdays)	Medical Manager OPD Unit Manager	11/8/12
Patients complaining about triage system	PRO not addressing patients' concerns in OPD	PRO to address patients in OPD on a daily basis	PRO	Daily
Delays in patient screening node	Student nurses being rotated and new nurse not familiar with OPD processes	New nurses to be orientated on all processes in OPD	OPD Unit Manager	As required
	Shortage of equipment owing to delays in SCM processes to order and/or repair equipment	OPD Unit Manager to follow up daily with Stores Department	OPD Unit Manager	As required

List of Problems	Why? (Causes)	What? (Action to be taken)	Who? (Responsible persons)	When? (Due date)
No doctor in OPD until about 10h00 daily	OPD doctor on maternity leave and other doctors busy in wards during mornings <- ward rounds need to be conducted early	A Comm. Service Doctor must be permanently allocated to OPD from 08h00 while another doctor covers his/her ward	Medical Manager	11/8/12 onwards
Not enough or no stationery to be found in doctors' consulting rooms	Unit manager not replenishing stock; and poor organisation of items on desks in consulting rooms	One lever arch file with all stationery for doctors to be created for each consulting room (x3) and one master file for Unit Manager	Medical Manager and OPD Unit Manager	13/8/12

6. Closure

- The Principal Investigator thanked all kaizen team members for their participation in the research and for their active roles played in the improvement of cycle and waiting times in OPD. The final results of the research will be presented after the final two measurements are carried out and once the research report has been compiled.
- The meeting closed at 13h00.


THEME: Reduction of waiting and cycle times in the OPD (Catherine Booth Hospital)
To: Kaizen Team
By: Principal investigator
Date: 25 July 2012
Background
Non-value adding activities result in, inter alia, long cycle and waiting times, and low staff morale. There are evidently long patient waiting and cycle times at the OPD at Catherine Booth Hospital. This is leading to poor quality of patient care and patient dissatisfaction. Staff may also be unhappy working under such conditions. The application of Lean thinking could improve operational efficiency in the OPD by reducing waiting and cycle times.
Current Condition
- Booking system planned for implementation; first phase to be piloted first week of August 2012 (OPD doctor on maternity leave, hence delays)
- Triage system implemented but with little support from PRO. Ongoing mentoring and monitoring taking place
- Pre-consultation screening tool not effectively used because student nurses rotating and new student nurses in OPD don't know the tool
- Bottleneck created in Patient Screening node because of shortage of or dysfunctional equipment such as sphygmomanometers and glucometers
- No doctor in OPD until about 10h00 due to OPD doctor being on maternity leave
- No PHC trained nurse to handle PHC-categorised patients, for example with simple colds and flus
- Stationery in consulting rooms often difficult to find
Cause Analysis
- Long queues of chronic patients <- booking system not yet implemented <- OPD doctor on maternity leave
- Patients still not happy with triage system as they may come first but are attended to last (as per triage protocols) <- PRO not talking to patients
- Delays in patient screening <- new student nurses not familiar with tool <- student nurses being rotated as part of their training
- Delays in patient screening and vital sign measurements <- equipment problems <- Supply Chain takes long to get items repaired/procured
- No doctor in OPD until 10h00 <- OPD doctor on maternity leave and doctors busy in wards <- ward rounds need to be done first
- No PHC-trained nurse in OPD <- ?poor selection / appointment of nurses and little support from management of Op. Manager in OPD
- Stationery shortage <- poor stock control <- less ordering/photocopying
Target Condition
10% reduction in waiting times and 5% reduction in cycle times of all service nodes in OPD by the end of Lean thinking application
Implementation Plan
What? (action to be taken) | Who? | When
Stepwise implementation of booking system | Med. Manager, OM | 11/08/201 2
PRO to talk to patients daily about triage system | PRO | Daily
New student nurses to be orientated on OPD processes | OM of OPD | As required
OM to follow up with Stores on ordered equipment | OM of OPD | Daily
OM to report to matron outstanding equipment | OM of OPD | Daily
One doctor from wards to be allocated to OPD from 08h00 while the other doctor does two ward rounds | Comm. Serv. Doctor | 11/8/12 onwards
Nurse(s) to be selected for PHC training at Ngw. Hospital | AMN nursing | Aug. 2012
Stationery files to be made exclusively for each doctor's consultation room and a Master File to be kept by OM | Med. Manager, OM | 13/8/2012
Follow-Up
Plan
End of study
Actual Results
End of study