

Applicability of Lean healthcare in Sri Lankan Healthcare Supply Chains

Rangi Lakma Wijewardana*, Thashika Rupasinghe#

Department of Industrial Management, University of Kelaniya
Dalugama, Kelaniya, Sri Lanka

*rangiwiwardana@yahoo.com

#thashika@kln.ac.lk

Abstract— This paper aims to evaluate the applicability of lean healthcare concept in to Sri Lankan healthcare supply chains with the intention of achieving process improvement since there is no evidence for lean healthcare, an emerging concept applied in Sri Lankan context. Available literature on lean applied in commercial supply chains, healthcare supply chains and lean applied in healthcare were reviewed and Sri Lankan context is studied mainly through observation and available information. Though it has been proven that lean thinking can be adopted in healthcare it remains a challenge to practically implement with the rigid healthcare structure in Sri Lanka. However the literature review implies that performance excellence can be achieved through lean best practices. Since lean is an emerging concept being applied in healthcare for more than ten years, no effort has made to analyze the applicability in to Sri Lankan context. In addition healthcare supply chain has been defined in different perspectives which cannot be aligned with Sri Lankan scenario.

Keywords— *Lean, Lean tools, Healthcare Supply Chain, Value Stream Mapping, Medicinal Supplies, treatment Process*

1. Introduction

Sri Lanka is a country which provides the public healthcare service for free of charge. Healthcare services provided by the state sector stands at the 80% of inpatient volumes dominating the healthcare sector. Government of Sri Lanka spends around 2.0 % of the for treating 4.3 .million patients per year [Figure 1].

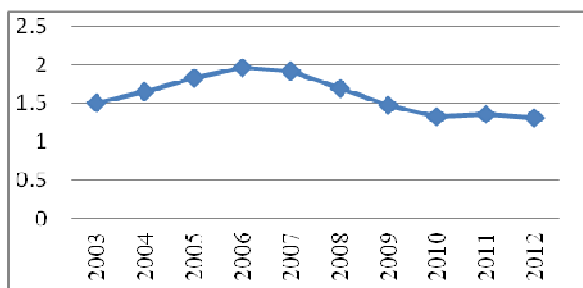


Figure 1: Total Healthcare expenditure

Source: Central Bank Report-2012

The Ministry of Health functions under a Cabinet Minister, is primarily responsible setting policy guidelines, medical, nursing and paramedical education & training, management of Line Ministry Institutions and bulk purchase of medical requisites as its key functions.

With the implementation of the Provincial Councils Act in 1989, the government health services were devolved. As a result health care institutions at national level are administered by Ministry of Health and separate Provincial Ministries of Health in the nine provinces. The network of government curative care institutions ranges from Teaching Hospitals including National Hospital with specialized consultative services to small Central Dispensaries. People have access to a health facility within 3 km radius distributed island wide [2]. (Table1)

Table 1: Healthcare referral system

Type of hospital	Number
National Hospital of Sri Lanka	1
Teaching hospitals-except National hospital	20
Provincial General Hospitals	3
District General Hospitals	18
Base Hospitals Type – A	20
Base Hospitals Type – B	46
Divisional Hospital type - A (More than 100 patients Beds)	42
Divisional Hospitals type - B (Between 50 to 100 patients Beds)	129
Divisional Hospitals type - C (Less than 50 patients Beds)	322
Board Managed Hospitals	02
Primary Medical Care Unit (Central Dispensaries & Maternity Homes)	474
Special Hospitals	05

Sri Lankan hospital cluster, subjected to governance of Ministry of Health, is represented by the Pharmaceuticals, Surgical consumables and Non consumables namely medical devices, instrument and equipments procurement Process, resource acquisition for organ and blood transplants, supply of knowledge healthcare resource personals, hospital administration and supply of care for the transformation process of patient in to recovered state.

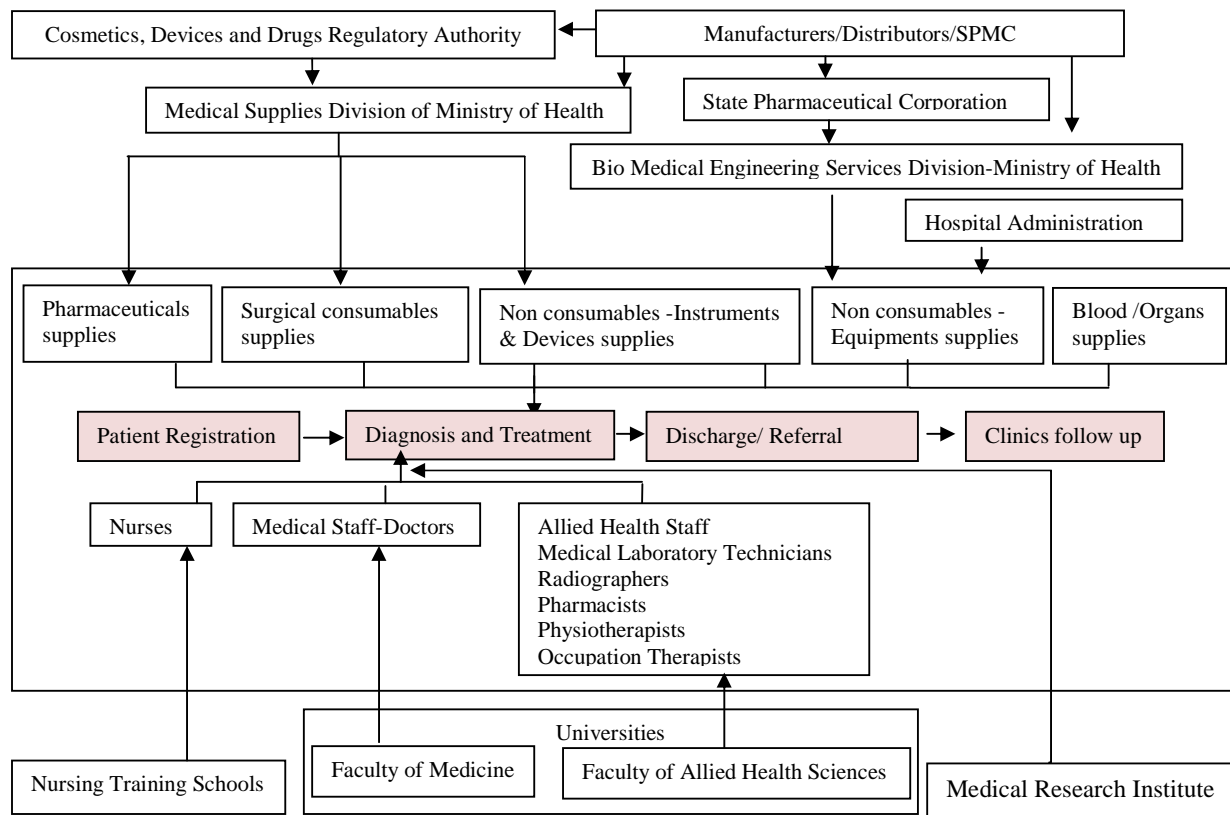


Figure 2: Sri Lankan Hospital cluster

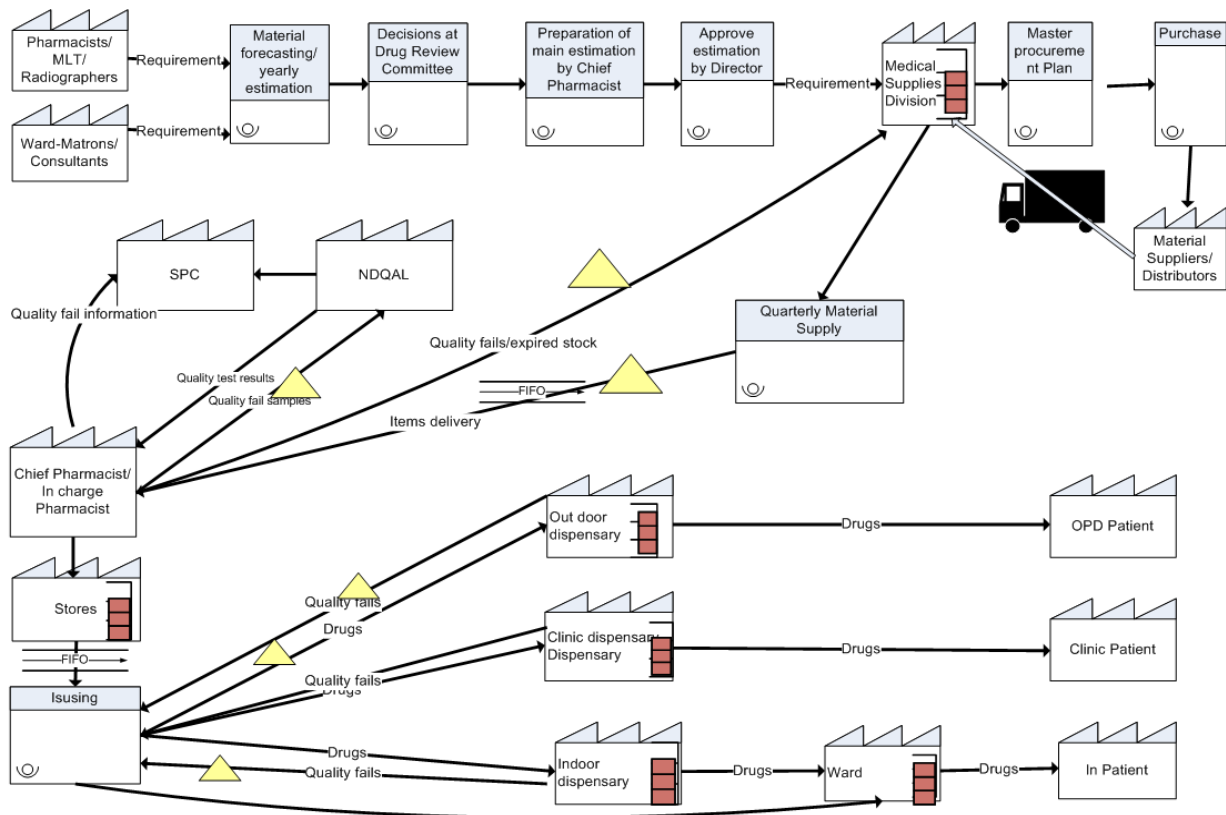


Figure 3: Value Stream Mapping for current receiving and issuing process of pharmaceuticals supply at a hospital

There are several institutions responsible for healthcare supply chains established under the purview of Ministry of Health to support the medical supplies required by the healthcare institutions and to ensure the quality and the safety of the service provided.[Figure 2]. With the participation of these institutions pharmaceuticals supplies process exists at a hospital[Figure 3]

The Cosmetics, Devices & Drugs Regulatory Authority (CDDRA) has authority to ensure that the Pharmaceuticals, Medical Devices and Cosmetics available to the public are up to the required standards of quality and are within the existing legislative framework with respect to the production, marketing and dispensing of these items. All devices and drugs to be imported into Sri Lanka need to be registered with the CDDRA. Suppliers who quote against SPC tenders for pharmaceuticals have to register with the CDDRA.

Bio Medical Engineering Service Division of ministry of Health is responsible for procurement, maintenance and repair and management activities related to medical equipments in the government hospital.

Medical Supplies Division (MSD) of Ministry of Health which functions for estimating, indenting, procuring, storing, monitoring, distributing and accounting of medical supplies is the central organization responsible for providing all Pharmaceuticals, Surgical items, Laboratory Items, Radioactive Items and Printed materials etc. needed by Hospitals and healthcare institutions throughout the country and supplying the private sector with all dangerous drugs and essential medical items which are not available in the open market.

MSD indents total requirements of medical items mainly through State Pharmaceutical Corporation (SPC). In addition MSD purchase emergency local supplies and selected items on regular basis from overseas and local sources. MSD manages the activities of receiving and distributing donations from donor agencies such as WHO and UNICEF. MSD directly distributes to 50 major Line ministry hospitals and 26 Regional Medical Supplies Divisions (RMSD) which are responsible for the supply of medical items to healthcare institutions under the purview of Provincial Councils.

State Pharmaceutical Corporation (SPC) which is the procurement agent for MSD is the sole supplier of pharmaceuticals, surgical consumable items, laboratory chemicals and equipment to all institutions administered by the health ministry for the past 28 years.

State Pharmaceutical Manufacturing Corporation (SPMC) is a state owned enterprise for pharmaceutical manufacturing. SPC and MSD are the distributors for government medical supplies.

Medical Research Institute (MRI) is serving all hospitals with specific diagnostic laboratory tests in addition to conducting bio-medical and applied health research.

Healthcare treatment process starts with the patients' registration at the Emergency and Accident Service or Out Patient Department where as emergency and accident service serves the patients affected by external causes while OPD is serving patients with chronic internally caused diseases.[Figure 4]

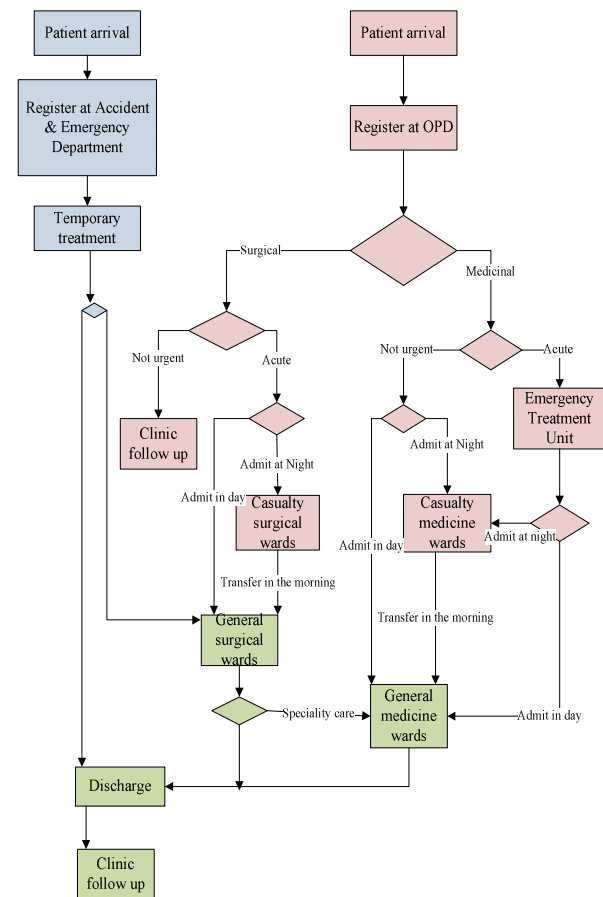


Figure 4: Patient flow at National Hospital

1.1 Healthcare supply chains

Aronsson, et al [6] distinguishes healthcare supply chains from commercial supplychains indicating characteristics of Healthcare supply Chain as

- Large extension of lead time uncertainties in individual functions due to difficulties to predict the time-ex: surgical procedure
- Organized in functions with lack of a systems view/overall strategy
- Lack of strategy for sub processes within each department
- Volumes are relatively low and variety is high
- Mix of highly standardized treatments and new experimental treatments with high variation in the degree of standardization between different treatments.

Significant differences exist between healthcare and commercial supply chains according to Towill & Christopher [8] are

- Healthcare delivery has become a major political issue. Policies and practices are influenced more by electoral and ideological considerations than by basic rules of management best practice.
- Difficult for long term strategy improvements due to distorted statistics

2. Issues in the current system

State spending is leading to stagnation in capacity. Restricted availability of medicine and resources such as laboratory, equipment indicates the capacity constraints. Though World Health Organization standards recommends one doctor for every 600 people for effective provision of healthcare, on average one doctor treats 2061 people in Sri Lanka.[1]

Although GDP capita in Sri Lanka is above US\$ 2000, majority of the population is not in an economic position to afford medical facilities offered at a fee by private institutions due to unequal income distribution. In addition, there is a trust that the reliability of health service provided by state sector is significantly higher than others

With the higher life expectancy rate with the demographic transition, possibility of exposing human to wide range of health risks for longer durations is higher.

Sri Lanka is in a transitional position where cardiovascular and cerebrovascular diseases, diabetes, and cancer are emerging as a result of unhealthy life styles. Increase in the incidence and Diarrheal diseases due to inadequate shelter, damage / disruption to water and sanitation systems and in-sanitary conditions of some slum areas has not been overcome yet. Meanwhile the need of providing disability services has increased with the ending up of warfare. Therefore the number of people with more frequent requirement for intensive healthcare requirements is severely increasing.

With operating under capacity constraints, catering to rapidly increased demand for health care supply is difficult in current operational context. Operational inefficiencies such as resource wastages, poor health information systems that provide unreliable data on leading causes of deaths and hospitalization and unsystematic health referral systems act as obstacles for capacity utilization. There is no systematic procedure for donations of organs as patients can receive the expected services efficiently. Seven types of lean wastes found in literature review can be summarized as Table 2

Since increasing consumption rate is impracticable mutual exchange between other hospitals should exist causing extra movements of medicinal supplies due to several reasons [Figure 5]. The most severe problem related to medicinal supplies is frequent quality failures. Higher supply lead time occurs as the estimation for year 2014 prepared in year 2013 is received in 2015. These issues directly affect the quality of the treatment process

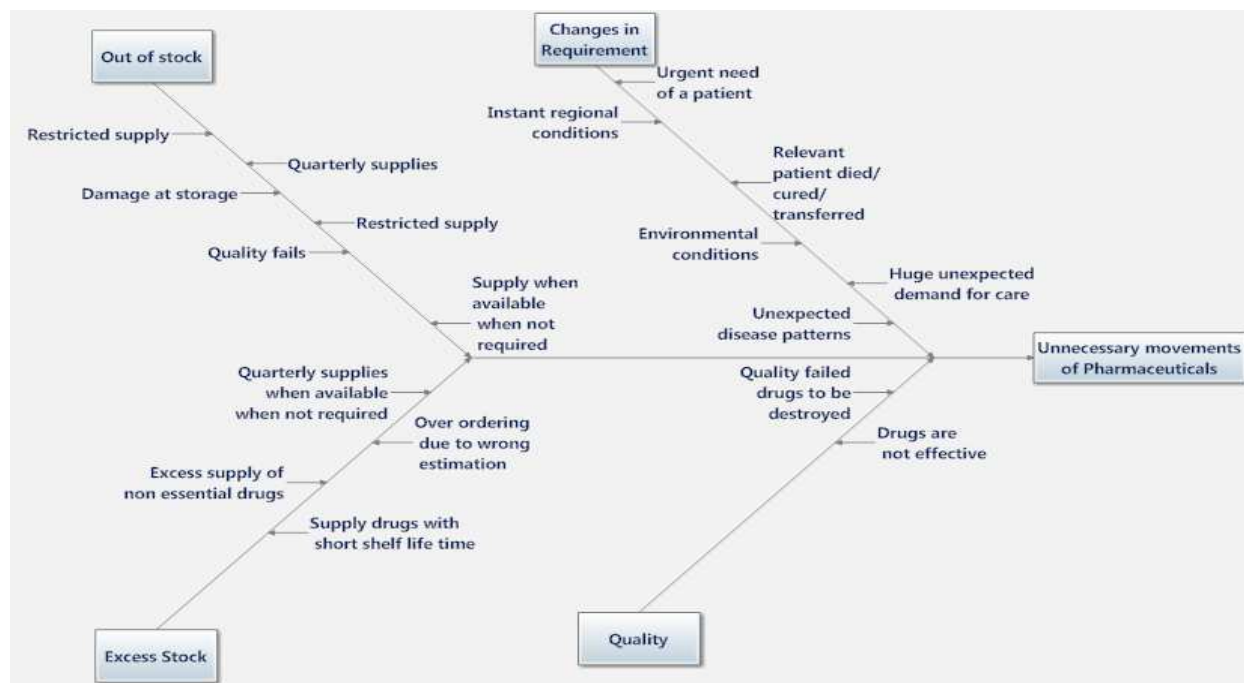


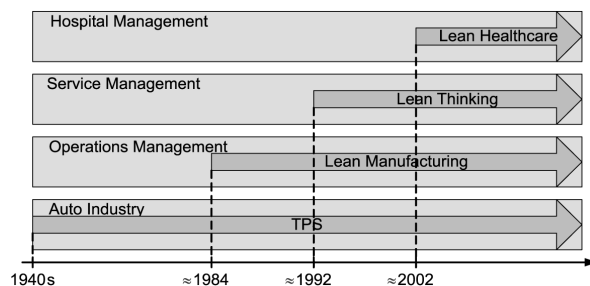
Figure 5: Root Cause Analysis for unnecessary movements of pharmaceuticals

Table 2: Types of wastes in healthcare

Waste type	Causes [7],[9],[10]
Transport	Movements of patients, lab specimens, medication, supplies and equipment
Inventory	Unneeded stocks/ supplies, Holding discharged patients, Patients awaiting a bed assignment and diagnostic tests, Lab specimens awaiting analysis, Over ordering material ,Non-optimized resource levelling
Motion	Inefficient patient/staff/ information flow, Searching for information and supplies, Delivering medications, Nurses caring for patients on different wings
Waiting/ wasting time	Waiting for paper work, response, approvals, bed assignments, to be discharged, treatment, diagnostic tests, supplies, doctor/nurse
Over-production	Unnecessary tests, Large batches of material and supplies, Mixing drugs, surgical supplies in anticipation of patient needs
Inappropriate processing	Stressed overworked staff, Redundant activities, Excessive paperwork
Defects	Misdiagnosis, Medication errors, Infections, Incorrect information and instructions, Wrong-site surgery, Poor labelling of specimens, Injury caused by defective/restrained drugs or lack of restraints, Poor equipment maintenance, Defects not reworked on, Cost of patient readmissions

3. Why Lean?

Though lean principles were initially used to improve car production, lean principles could be applied to manufacturing, service and healthcare systems.[Figure 6]



Source: Adapted from Laursen (2003)

Figure 6: The appearance of Lean healthcare
Adopted from Souza, 2009

Number of publications proves that there is an importance of lean in Healthcare service performance.[Figure 7]

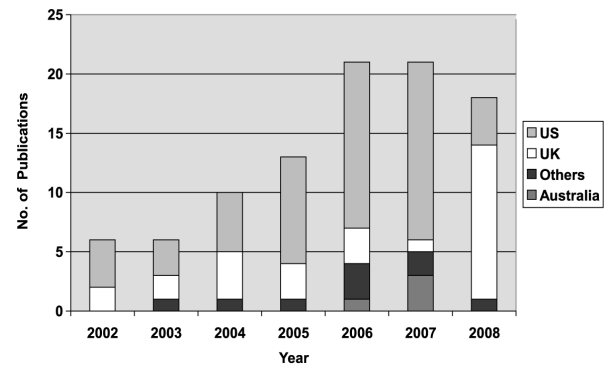
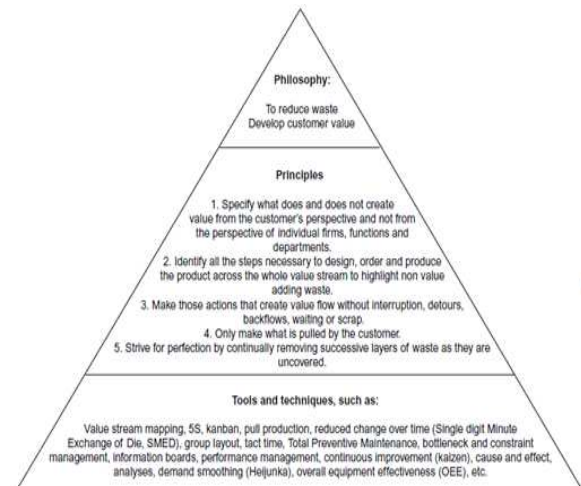


Figure 7: Number of publications per year
Adopted from Souza, 2009

Lean theory which focuses eliminating waste to develop customer value is generally based on five key principals [19] [Figure 8]



Source: Arlbjorn et al. (2008a, p. 55)

Figure 8: Five key principles of lean concept

Cost components of healthcare inclusive of medications, durable medical equipments, long term care, consultations and referrals, diagnostic tests and procedures can be reduced while level of service quality and results are uplifting through lean applications.[Figure 9]

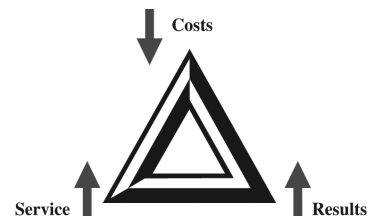


Figure 9: The value equation
Adopted from Chadha & Kalra, 2012

Burgess & Randor [16] discuss and evaluate how lean is implemented in English hospitals by content analysing all annual reports and web sites which indicates lean

approaches taken by staff considering large number of data (300) within two time periods to increase accuracy. Lean implementations may not be actually in the process though it is stated in those sources. Sources can be biased, incomplete, distorted and not updated. This method cannot be used since annual reports are not available where public sector hospitals are not business organizations. In the other hand there is no evidence that Sri Lanka has transferred lean into healthcare.

A qualitative case study on UK National Health Service [13] addressed a gap to identify the role of dynamic actor associations in shaping continuous improvements in a public sector context. Continuous improvements aim to achieve operational effectiveness, efficiency and strategic flexibility through cost effectiveness, administration efficiency and waste reduction. This UK based research mainly focused on actor associations using Kaizen blitz and Value Stream mapping as lean tools.

Kollberg, et al.,[17] looked for performance measuring system to measure changes in lean thinking in Swedish healthcare system following 5 elements in lean. Their studies included acute care model with two hierarchies namely administrative and medical, referral system and appointment system.

Performance indicators developed for implemented system are

- Median waiting time
- Number of appointments
- Comparison of Demand for different type of medical centres
- Number of incoming referrals

However Swedish healthcare system deviates with Sri Lanka scenario.

Current and future challenges are cost savings by productivity savings, capacity analysis and process mapping to reduce waste and increase efficiency and Simulation modelling for process mapping. Simulation modelling is difficult due to bed shortage risk if average bed occupancy rate increases in an acute setting and occupancy targets. Tools to study seven types of wastes are -

- Demand & capacity models -Insight to overproduction, inventory
- Process mapping-transportation, staff movements, unnecessary processing
- Adjacency planning-transportation, staff movements
- Simulation modelling-across full range of seven waste components

In emergency department patient arrival variance, area loading and queues has been focused in lean application [7.]

Excessive Waiting time exists due to poor service design and inadequate capacity to meet rising arrivals.

Through applying JIT, VSM, 5S, one piece flow, visual management, queuing theory integration in following steps Analysing and adjusting patient arrivals flow using injury classes

- Patient's arrivals –Two assumptions
 - Poisson's distribution
 - Health resources utilized during peak hours must be able to support the demands of any other time throughout the day
- Cross functional staff including process, information and clinical experts to eliminate waste and non value adding activities
- De-bottlenecked the process using lean tools- 5S, visual management, one piece flow to lead time adaptation of standard operating procedure.

Since it has been conducted in India it is much similar to Sri Lankan context though some conditions are different. No research has addressed Sri Lankan health care service and available research works cannot be generalize to Sri Lankan context as it is.

Chadha & Kalra [4]suggested a LEAN-HC model that consists of three steps. First, the arriving patient flow must be evaluated against the capacity of the health care facility. The LEAN-HC model uses Physician Directed Priority Class Queuing (PDPCQ), which separates emergency patients at triage into major, medium, and minor injury classes. After the patients are separated, the three categories each have a single queue of patients, which await services that are delivered in multiple phases. The second step involves creating a cross-functional team to understand and develop the value equation () for their health care facility. At the third stage, the process must be continually de-bottlenecked, for which a Continuous Flow Cell (CFC) must be created.[Figure].

One piece flow is useful to move away from backlog and queues. Through adopting lean in healthcare, reduction in paperwork, better multidisciplinary team working, reduction in time taken to get patient into theatre, faster recovery and lower demand on the rehabilitation ward, reduction in Total length of queue, reduction in mortality, reduction in floor space in pathology and increase in income have been achieved [9].This provides better validation since performance has been evaluated prior to redesign and after the redesign. However this assessed an already implemented lean system. Implementation in real world would not be possible in Sri Lanka at once. In addition Sri Lankan health care service is non-profit service.

4. Discussion- lean tools and approaches

With the make use of lean six sigma tools including Value Stream Mapping, JIT, Poka Yoke, Visual Control etc, current issues can be used to enabled more effective and efficient provision of healthcare service in terms of operational excellence, cost effectiveness, capacity utilization through giving evidence that lean six sigma concepts which used to achieve productivity in manufacturing industries can be effectively applied to health care services as indicated in table 3

Table 3: Applicability of Lean tools and techniques

Lean Tool	References	Applicability for the function in concern
Value Stream Mapping	[4], [5], [9], [13]	Reduction in medical errors, Laboratory test, lead time & patient turn around, unnecessary processing
5S	[4], [9], [11],[15]	Reduce medical errors & waste from unorganized work-area, De-bottlenecked the process.
Visual control	[11],[4]	Reduce medical errors, Laboratory test & lead time, De-bottlenecked the process
JIT	[4],[5],[11]	Reduce stock a material, waiting time & space required, Standard inventory control
Kaizen Blitz	[11],[13]	Combine collective talent for continually eliminating wastes from processes.
Poka –Yoke	[11]	Reduce medical errors, Laboratory test & lead time. Avoid defects by preventing, correcting or drawing attention to human errors as they occur
One Piece Flow	[4], [9]	De-bottlenecked the process
Muda (waste)	[15]	Eliminate wasteful activities
Quick Change Over	[15]	Reduce set up time/time required for preparatory
Demand capacity models	[7]	Insight to inventory ,overproduction
Adjacency planning	[7]	transportation, staff movements
Simulation	[7],[11]	Across full range of seven waste components

Lean tools and techniques suggests lean approaches for analysing issues in the current system and provide lean best practices for better service delivery.[Table 4]

A model for lean implementation suggested by Zidel model begins with the hospital's strategic plan and cascades toward organizational transformation via a quality culture and an enhanced care delivery system. [13][Figure 10]

Table 4: Lean approaches to eliminate waste

Waste type	Lean Approach [12]
Transport	Material and stocks are not moved until they are needed
Inventory	Remove extra inventory Inventory planning Restocked when used
Motion	Orderly movements Valued movements
Waiting/ wasting time	Efficiently organized patient flow
Over- production	Produce what is needed when it is needed Minimize anticipations and identify what patient exactly wants
Inappropriate processing	Add value specially from patients perspective Removing inefficiencies simplifying processes
Defects	Rework defects on timely basis Timely routine equipment maintenance

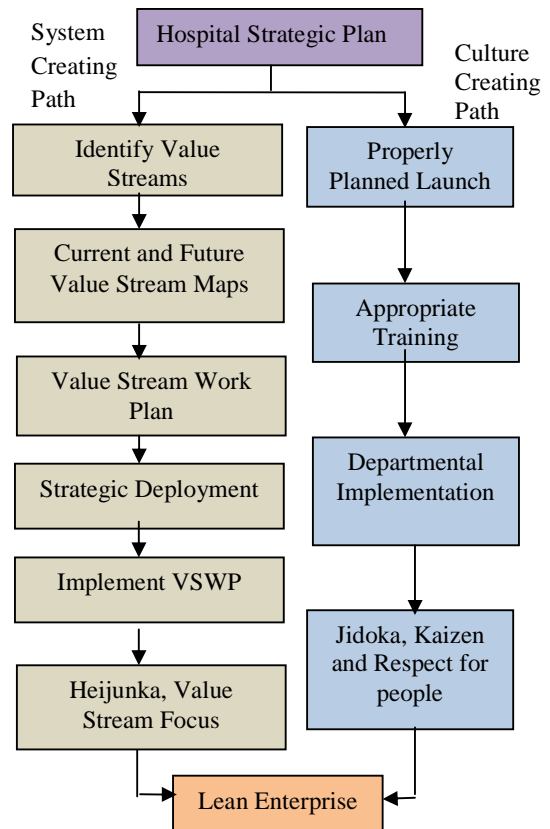


Figure 10: Zidel's model for lean implementation
Adopted from Lean hospitals

5. Conclusion

Healthcare administration, medical staff and patients will be benefited through applying lean thinking. Empirical evidence for successful lean implementations obtained through the literature review favours the applicability of lean. Literature review indicates that benefits are possible in similar ways for similar issues. [Table 5]

Table 5: Evidence for successful lean implementation in healthcare

Reference	Place	Results
[13]	Pathology unit of NHSCO hospital in UK NHS	<ul style="list-style-type: none"> • Improved flow • Removed duplicate steps • More productive staff • Extra space has been created • Minimized staff movements • Standard work
[9]	Bolton hospitals in UK NHS	<ul style="list-style-type: none"> • 42% Reduction in paperwork • Better multidisciplinary team working • Reduction in time taken to get patient into theatre by 38% • Faster recovery and lower demand on the rehabilitation ward • Total length of stay reduced by 33% • Mortality reduced by 36% • 50% reduction of floor space in pathology • 10% Increase in income
[4]	Indian healthcare industry	<ul style="list-style-type: none"> • Improved process flow and capacity • Length of stay for all patient classes in emergency department is decreased. • Detecting opportunities to reduce patient turn around • Identify and shift service bottlenecks • No changes in resource availability, safety and quality • Reduced customer dissatisfaction level
[20]		<ul style="list-style-type: none"> • Better relations between staff and patients • Staff are more attentive to patient needs and demands • People becoming more aware of their responsibilities • A calmer environment
[18]	Rheumatology Department in University Clinical Center Of Kosovo	<ul style="list-style-type: none"> • Waiting Time reduction • Reduction in nurses administration work • Reduction in stress and distraction

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