Addis Ababa University

College of Technology and Built Environment (CTBE)
School of Mechanical and Industrial Engineering

Industrial Engineering Stream

Developing a Lean Service Quality Improvement Model to Enhance Medical Tourism in Healthcare Sector: A Case of Ethiopia

By: Berhanu Tolosa Garedew

June 2025

Addis Ababa, Ethiopia

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A Dissertation Submitted to School of Mechanical and Industrial Engineering

Presented in Fulfilment of the Requirements for the Degree of Doctor of Philosophy (Ph.D.) in Mechanical engineering (Industrial Engineering)

College of Technology and Built Environment (CTBE)
Addis Ababa University

Addis Ababa, Ethiopia

ADDIS ABABA UNIVERSITY

COLLEGE OF TECHNOLOGY AND BUILT ENVIRONMENT (COTBE)
SCHOOL OF MECHANICAL AND INDUSTRIAL ENGINEERING

INDUSTRIAL ENGINEERING STREAM

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Authors Declaration

I hereby announce that this dissertation entitled Developing a Lean Service Quality Improvement Model to Enhance Medical Tourism in the Ethiopian Healthcare Sector: A Case Study of St. Paul`s Hospital Millennium Medical College is my original research work and has been carried out under the guidance of Professor Daniel Kitaw, Dr. Kassu Jilcha and Dr. Sisay Sirgu Addis Ababa Institute of Technology. This research work has not been submitted for the award of any other degree or diploma at any other university or institution. I affirm that the research work presented in this dissertation is the result of our original research. I have appropriately acknowledged all the contributions of others, including the use of any published or unpublished sources, data, or ideas. All the references and sources cited in the dissertation have been duly acknowledged.

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We hereby certify that this dissertation entitled Developing a Lean Service Quality Improvement Model to Enhance Medical Tourism in the Ethiopian Healthcare Sector: A Case Study of St. Paul's Hospital Millennium Medical College was conducted under our supervision.

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Acknowledgment

Primarily, I would express my thankfulness to the almighty GOD. I want to convey my sincere appreciation to all those who have guided me during the process of completing this dissertation. First and foremost, I would like to extend my heartfelt thanks to my **supervisor Professor Daniel Kitaw, co-supervisors Dr. Kassu Jilcha and Dr. Sisay Sirgu** for their invaluable guidance, patience, and expertise. Their constant support, insightful feedback, and constructive criticism have played a crucial part in shaping this research.

I am also indebted to the members of Industrial Engineering Chair for their time, expertise, and valuable input. Their insightful comments and suggestions have greatly contributed to the overall quality of this dissertation.

Furthermore, I would like to thank my wife Jalene Bekuma who has provided me with encouragement, loves, support, unwavering belief and willingness to assist me throughout this journey.

Finally, I want to thank my family from the bottom of my heart, especially Reta Tolosa, and my friend Alemayehu Mengistu whom I never forget throughout my life, and. Their love, understanding, and unwavering support have been the driving force behind my academic pursuits. I am forever grateful for their sacrifices and encouragement.

I am aware that any attempt to acknowledge everyone who has contributed to this dissertation may fall short. However, please know that your support, encouragement, and guidance are deeply appreciated.

Dedication

This dissertation is dedicated to my beloved brother, Dame Tolosa. Although you are no longer with us physically, your spirit, love, and unwavering support continue to inspire us every day. I am forever grateful for the memories we shared, the laughter we enjoyed, and the lessons you taught us. Your kindness, compassion, and generosity touched the lives of many, and your legacy lives on in the hearts of those who were fortunate enough to know you. Though this dissertation represents my individual achievement; it is also a tribute to the support and love you provided. Your memory fuels my determination to make a meaningful impact, just as you did during your time with us. I dedicate this dissertation to you, dear brother, with profound love and gratitude. Your spirit will forever guide and inspire us as I continue to pursue knowledge and strive for excellence.

Abstract

Healthcare is a sector with unique features where defects and errors cannot be tolerated. Its service delivery is one of the principals and most complex systems on the globe due to rapidly growing pressure, waiting time, an aging population, increasing patients flow, limited resources and competing social needs to sustain life. Thus, the sector has turned its attention to a lean approach due to a growing influence in reducing waiting time to enhance service quality and increasing flexibility. The researcher begins the investigation by discussing the current healthcare challenges long waiting time (95 minutes in averages), long length of stay (15 days in average), lack of access to some services in the country, and driving factors that have contributed to the improvement of service quality, particularly at St. Paul's Hospital Millennium Medical College. Hence, the study's primary goal is to develop lean quality service improvement model aimed at enhancing the patient satisfaction in the Ethiopian healthcare sector, specifically within the case healthcare, thereby increasing medical tourism. The study utilized various databases to conduct a comprehensive assessment of the literature and enhance service quality.

A thorough review of the literature was conducted to investigate the concepts, practices, and challenges related to healthcare service quality improvement. The review process identified literature gaps, including the dimensions of healthcare service quality improvement, service quality and lean thinking integration, the absence of service design thinking in service quality improvement, and their impact on patient satisfaction and medical tourism, which prior work has not sufficiently addressed. The study adopted a mixed-methods approach, incorporating both primary and secondary data gathering methods. The Define, Measure, Analyse, Improve, and Control (DMAIC) technique was also used. To quantify service quality gaps, patient expectations and perceptions were gathered during the Define Phase. During the Measure Phase, the high weighted scores obtained from patient input were evaluated using Quality Function Deployment (QFD). In the Analyse Phase, a cause-and-effect diagram was used to determine the underlying reasons behind these high results.

In the Improve Phase, inputs, resources, and methods were considered major causes, along with possible solutions. In the Control Phase, machine learning tools such as random forest, neural networks (NN), and support vector machines (SVM) were employed to predict healthcare patient waiting times, ensuring sustained service quality and patient satisfaction. Performance

comparison metrics, including Root Mean Square Error (RMSE), Mean Absolute Error (MAE), and coefficient of determination (R^2), were assessed to identify the predictive model's accuracy. The study employs a dual approach of Structural Equation Modelling (SEM) and Artificial Neural Networks (ANN) to develop a model that identifies dimensions significantly impacting patient satisfaction and medical tourism. Additionally, sensitivity analysis was used to rank these dimensions, providing better insights and alternatives. A total of 225 patient data points were collected from respondents through a questionnaire to develop a lean service quality framework using SPSS, AMOS, and Artificial Neural Network (ANN).

Among the three models for predicting waiting time, the support vector machine model demonstrated better prediction accuracy compared to the neural network and random forest models when assessing actual data. The support vector machine effectively mimics waiting time, significantly improving service quality.

Based on the developed model, five components with significant factor loadings exceeding 0.50 have been identified. These components are service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism considerations. The results were further analyzed to assess the model's fit. A decent model fit is implied by the RMSEA value of 0.05, which is below the permissible limit of 0.08. At 0.82, the Adjusted Goodness of Fit Index (AGFI) score is nearly at its suggested level. Tucker-Lewis Index, or TLI, is 0.96; the Normed-Fit Index (NFI) is 0.92; and the Comparative Fit Index (CFI) is 0.97. Since the NFI, CFI, TLI, and IFI values are higher than the suggested value of 0.9, they indicate strong model fits.

The structural equation modelling is used as the input unit of the artificial neural network model to detect both nonlinear and linear relationships without robust speculative or theoretical bases. Artificial neural networks identify all linear, nonlinear, and non-compensatory relationships by avoiding assumptions in distribution and model development. The RMSE value of the artificial neural network model (0.88) indicates good predictive accuracy for the lean service quality improvement model. Regarding the dimension of healthcare lean service quality improvement, there is no weak effect in the verified model of the artificial neural network. The normalized importance levels for all dimensions are greater than 80%, which is very high. It showed a significant relationship with both structural equation modelling and artificial neural network model analysis. Hence, the dimensions in model 1, 2, and 3 indicated a significant relationship with each other.

The study proposed the integration of lean thinking and service quality due to lack of available literature and the need for additional research on lean service quality adoption gaps, waiting time prediction, and improvement opportunities in the healthcare sector. The study is also original in its focus on developing a lean service quality model using a dual approach within the context of the healthcare sector. It contributes to healthcare lean service quality improvement based on quality function deployment, Six Sigma, and an artificial intelligence approach. It also ranked the importance levels of the lean service quality improvement dimensions through artificial neural network sensitivity analysis.

Keywords: Healthcare service quality, lean thinking, medical tourism, service quality, six-sigma, DMAIC, QFD, SEM, Machine learning

Contents

List of Tables

List of Figures

Acronyms

DMAIC	Define, Measure, Analyze, Improve Control
QFD	Quality Function Deployment
CFA	Confirmatory Factor Analysis
SEM	Structural Equation Modeling
RMSE	Root Mean Square Error
ANN	Artificial Neural Network
SEMANN	Structural Equation Modeling Artificial Neural Network
NN	Neural Network
SVM	Support Vector Machine
RF	Random Forest
VSM	Value Stream Mapping
GDP	Gross Domestic Product
LOS	Length of Stay
VAA	Value Added Activities
SERVQUAL	Service Quality
PubHosQual	Public Hospital Quality
HEALTHQUAL	Health Quality
SERPERF	Service Performance
LibQual	Library Quality
HoQ	House of Quality
LSQ	Lean Service Quality
NVAA	Non-Value-Added Activity
HCSQ	Healthcare Service Quality
HCSQI	Healthcare Service Quality Improvement
LSS	Lean Six Sigma
LT	Lean Thinking
SQ	Service Quality
PS	Patient Satisfaction
LSQ	Lean Service Quality
MT	Medical Tourism

CHAPTER ONE

Introduction of the Study

1.1. Introduction

The service sector has had extraordinary development recently. However, its productivity is only 0.1% per year as compared to the 3% growth rate of manufacturing in the worldwide economy from 1981- 2010 (Morales-Contreras et al., 2020; Suárez-Barraza et al., 2012). This growth rate difference has continued until today with low productivity, and due to this extreme range (2.9%), service quality enhancements in education, healthcare, and financial institutions are given attention (Puthanveettil et al., 2021; Zhang et al., 2020).

Healthcare is a sector characterized by unique features where defects and errors are intolerable. It operates as a dynamic organization, presenting both opportunities and challenges. The opportunities lie in delivering high-quality services through new technologies, diagnostics, and therapeutic innovations. Conversely, the challenges include increasing realistic and unrealistic patient expectations, mastering new technologies, prioritizing service delivery based on patients' pain levels, and staying informed about advancements to maintain quality relationships with patients. Therefore, healthcare is one of the fastest-growing sectors and is under immense pressure to provide continuous service in both developed and developing countries (Bartel et al., 2020; Dey et al., 2006).

Healthcare service quality is a complex issue globally, driven by increasing demand, limited resources, and competition to meet social needs essential for sustaining life (Sarıyer et al., 2020). As a country's population and average age increase each year, the strain on its healthcare system becomes inevitable. This strain is primarily due to the increased clinical attention required by older individuals and the growing size of the aging population. To address this complexity, governments, medical professionals, top management, and stakeholders play crucial roles in enhancing patient satisfaction (Henrique & Godinho Filho, 2020).Therefore, in order to satisfy patients, it is imperative that service providers understand the significance of service quality (Arasli & Ahmadeva, 2004; Bertsimas et al., 2021).

According to Raina et al. (2018), healthcare service quality encompasses understanding patient needs, measuring the level of service quality, bridging gaps between service expectations and perceptions, and delivering both technical (clinical) and functional (non-clinical) qualities within the sector. As noted by Henrique & Godinho Filho (2020), achieving healthcare service

quality involves reducing patient waiting times, length of stay (LOS), and non-value-added activities.

Service quality is an abstract dimension in which various practitioners, professionals, government and non-government organizations, stakeholders, and academics have made significant contributions to identifying metrics and developing and testing theoretical and empirical models (Alodan et al., 2020). According to Untachai, (2013) and Syadia et al. (2013), healthcare service quality is a multidimensional concept focused on achieving patient satisfaction. It is defined as value, excellence, meeting and/or exceeding patient expectations, and consistently delighting the customer. Mosadeghrad (2014) further defines excellent healthcare as continually pleasing the patient by offering efficacious, effective, and efficient healthcare services according to the latest clinical guidelines and standards, which meet patients' requirements and please providers. Service quality is defined by Parasuraman et al. (1985) as the discrepancy between what consumers anticipate and what they perceive. Meuter et al. (2000) define service quality as the patient's overall impression. These impressions are shaped by lean thinking, which aims to reduce prolonged waiting times, response times, and enhance patient safety.

Lean thinking in healthcare focuses on the continuous effort to minimize embedded waste, reduce response and lead times, and enhance quality to improve patient safety in everyday practices. This is achieved through a joint framework that integrates lean thinking and service quality to enhance service quality, ensuring patient satisfaction, attracting medical tourism, and promoting economic growth. Thus, the integration of service quality and lean thinking is essential for fostering active patient involvement (Swarnakar et al., 2021). This connection between service quality and lean thinking can serve as a foundation for developing a lean service quality approach.

Lean service quality improvement significantly contributes to patient satisfaction, attracts medical tourism, and promotes national growth by reducing embedded healthcare waste, saving patients' productive time, and increasing overall production time (Kumar et al., 2022; Swarnakar et al., 2021). The service sector accounts for more than 50% of the global economy (D. Singh & Dixit, 2020). This sector is growing at a faster rate compared to manufacturing, which comprises around 10% of the world's GDP. Consequently, the service sector presents ample opportunities for developing countries. Within this sector, healthcare is the utmost complex and widely utilized service, primarily due to its substantial impact on patient satisfaction (D. Singh & Dixit, 2020).

Patient satisfaction is crucial for healthcare providers and patients, driven by rising expectations, competitiveness, and medical tourism (Murti et al., 2013). The study aims to determine service quality improvement dimensions impacting medical tourism and investigate their relationships. Patients are seeking a higher level of service quality; however, the healthcare system is overburdened and facing issues such as rising costs, long waiting times, waste, and low levels of public confidence and corporate image (Endeshaw, 2021). These factors contribute to the inadequacies of healthcare service quality in Ethiopia, which affects patient satisfaction. As a result, a significant number of Ethiopian patients travel to neighbouring countries in search of better medical treatment to address the issues like long waiting times, low patient satisfaction, high costs, and rising patient expectations is crucial (Taqdees et al., 2017). Furthermore, enhancing weaker aspects of healthcare service delivery Swain & Singh (2021, such as inadequate service quality (Cheng San, 2022) and defects (Jesumoroti et al., 2022), can improve service quality and patient satisfaction.

Patients assess non-technical aspects of healthcare service quality. According to RiyazhKhan & Haq (2019), healthcare service quality has several definitions. It is described as "the application of medical science and technology in a manner that increases healthcare advantages while reducing risks" (Donabedian, 1988). Mosadeghrad (2014) further defines it as consistently delighting patients by delivering effective and efficient service quality based on modern clinical standards and guidelines that exceed their needs.

Practitioners, academics, decision-makers, and policymakers are exploring effective tools to differentiate between healthcare service quality challenges and embedded waste (Ahmed et al., 2018b; Donabedian, 1988; Parasuraman et al., 1991; RiyazhKhan & Haq, 2019). Additionally, providing significant lean service quality is a fundamental concern for the Ministry of Health, the government, and other stakeholders (Zhang et al., 2020). The increasing pressure in healthcare necessitates an evaluation of patient-based medical service quality and healthcare waste.

By examining the various effects of healthcare accessibility, affordable medical care costs, medical technicalities, and the interpersonal behavior of medical staff on medical tourists' perceptions of service quality and their satisfaction, this study offers a managerial perspective to enhance service quality and lean thinking, aimed at satisfying patients and attracting medical tourism. To operationalize high-quality medical care services, healthcare should utilize healthcare technicalities and tools, such as new technologies and methodologies. Support from

healthcare policymakers is also essential for allocating the resources needed to ensure that medical tourists receive high-quality care.

1.2. Background and justification

The healthcare is the most poorly managed, high-risk (Morales-Contreras et al., 2020), overlooked, and adverse event (Vincent, 2020). The sector is placing significant emphasis on improving service quality due to the high volume of patient visits (Akdag et al., 2014; Rosa et al., 2023). This arrival of patients leads to long waiting times, congestion, and persistent issues in various countries (Zepeda-Lugo et al., 2020). These challenges require careful attention to provide urgent services and implement immediate improvements, given their critical consequences, such as extended suffering, illness, safety concerns, and patient dissatisfaction (Hamdan et al., 2019). This is a prevalent problem in underdeveloped nations like Ethiopia, where patients experience discomfort and discontent due to lengthy wait periods and limited access to treatment (Endeshaw, 2021).

In Ethiopia, discussions often center around waiting time perceptions and the lack of patient satisfaction (Endeshaw, 2021). This is a fundamental issue that contributes to discomfort and dissatisfaction among patients. Therefore, reducing waiting times is a key strategy for enhancing healthcare quality and improving medical tourism, as well as addressing negative perceptions and low trust in service quality. Moreover, improving patient service quality is a significant priority in all countries, particularly in developing nations where access is limited and waiting times are lengthy (Fiorillo, 2021). It is essential to measure service quality levels to ensure they meet patient expectations and satisfaction.

Several challenging issues that affect service quality include rapidly increasing costs, waiting times, and LOS (Sarıyer et al., 2020), as well as rising patient expectations and the need to maintain competitive advantage (Bhat et al., 2014). As per a report conducted by Ahmed et al. (2018a), approximately 98,000 people die annually in the USA due to medical errors. Additionally, patient safety reports that each year, between 210,000 and 400,000 patients die from preventable adverse events in US (S. Ahmed et al., 2018a). These statistics clearly highlight the adverse effects of low service quality in the healthcare system, including in Ethiopia.

Service quality is a critical success factor in today's healthcare sector, where customer connections are paramount (Ladhari, 2009). It is an essential approach that addresses the

increasing and realistic expectations of patients by enhancing patient-centered care that is individually tailored to their needs, supported by conscious and continuous effort (Ullah et al., 2020). Factors such as patient overcrowding, resource shortages and limited service delivery capacity hinder service quality in Ethiopia (Bigelow et al., 2019). As the focus on service quality intensifies, the importance of improving service quality such as reducing waiting times, length of stay (LOS), building trust, and fostering positive word-of-mouth becomes increasingly significant (Ladhari, 2009). Additional challenges in the sector include rapidly growing pressure, an aging population (Ampaw et al., 2020), increasing patient flow, mounting treatment demands, and technological considerations (Zhang et al., 2020). Patient satisfaction improves substantially when the commitments of medical professionals, administrators, and other stakeholders are strengthened.

In the healthcare sector, customers are the immediate patients, along with their families and friends (S. Ahmed et al., 2018a), as the outcomes of services can significantly impact their lives (Srivastava & Prakash, 2019). This impact extends beyond individual lives to encompass economic and social development (Rahi et al., 2021), employee engagement (C. N. L. Tan et al., 2019), and the production time of patients and their families (Mazzocato et al., 2014, Hydes et al., 2012), as well as the national economy (Ampaw et al., 2020). Moreover, healthcare systems that fail to deliver consistent quality services ultimately suffer losses in production time and resources. Conversely, enhancing service quality can be a powerful driver of economic growth, particularly in light of demographic shifts, reduced production time, increased affluence, and the fulfillment of patient expectations (Kaouthar, 2020).

The healthcare sector faces significant patient dissatisfaction and quality issues (S. Ahmed et al., 2018a) due to unnecessary duplication of services, embedded waste, and prolonged waiting times. As a result, it struggles to meet patients' expectations for service quality. To address these quality challenges, the sector employs a lean thinking approach aimed at improving service quality. This technique benefits the healthcare sector by eliminating waste, reducing long cycles and variations, balancing workloads, and minimizing waiting times between value-added activities (VAA) to enhance service quality (Molla et al., 2018).

Lean thinking, a systematic and widely adopted approach, aids in cutting costs, reducing waste, and improving quality to satisfy patients (Shah & Ward, 2007). This methodology is also applied to improve operations, minimize waiting times (Molla et al., 2018), optimize hospital bed usage, enhance patient flow, and promote continuous improvement (Al Eideh et al., 2022),

all while fostering service quality and eliminating waste to meet current patient demands. Additionally, there are complex yet critical processes involved in overstocking, extending shelf life, and managing near-expiry supplies (Sadegh et al., 2018). There is also a risk of failing to provide the most appropriate medications (Jiang et al., 2024) due to issues such as a lack of drug acceptance, follow-up, and proper storage.

Recently, lean thinking has emerged as one of the key techniques for improving service quality (Glasgow et al., 2010; Sakthivelmurugan et al., 2021) by reducing non-value-added activities that contribute to process variation in healthcare (Prasad et al., 2020). It has been significant in service sectors for minimizing costs and enhancing service quality (Alsmadi et al., 2012). Bowen & Youngdahl (1998) initially recognized its potential for adoption in the service sector. Lean thinking is often combined with Six Sigma to create Lean Six Sigma (Prasad et al., 2020), which serves as a framework for continuous improvement in healthcare. Consequently, this study focuses on the relevance of lean thinking to healthcare service quality and examines how lean service practices have developed over time.

Administrative and management insights into lean thinking in the healthcare sector are crucial for enhancing service quality. This approach involves redesigning service processes to be waste-free, focusing on a patient-centered perspective to achieve efficient operations and increased productivity. Lean thinking, in relation to healthcare service quality improvement, enhances patient satisfaction when medical staffs understand the operational processes affecting patients, thereby improving healthcare production time. Lean thinking is a technique that has attracted interest from a variety of areas for its potential to drive improvements, particularly in decreasing waiting times that significantly affect patient perceptions (Scala et al., 2021).

Long wait times in healthcare are considered a form of lean waste that detrimentally impacts patient satisfaction and service quality because they influence how patients perceive their care (Fiorillo, 2021). While this waste may be unavoidable, accurate predictions and providing appropriate information to patients can enhance their satisfaction. The fundamental impact of lean thinking in healthcare, particularly in relation to high waiting times, is to improve low patient safety, low service quality, low patient satisfaction, low production time, low productivity, and contribute to national economic growth (Hamdan et al., 2019). Therefore, lean thinking is a valuable philosophy for the healthcare system, facilitating improvements in service quality and a deeper understanding of service productivity enhancement (Carlborg et al.,

2013). Patients consistently expect accurate, reliable, and responsive services due to the risks and suffering they may experience, which can be psychological, financial, or moral (Mosadeghrad, 2014a). These risks and potential medical errors require critical attention, as they can lead to loss of life (Baashar et al., 2020).

As Aydin et al. (2020) emphasize, patients often play a passive role in lean thinking because this approach focuses on eliminating waste to deliver value in isolation from the patient. Therefore, patients do not play a role in addressing both predictable and unpredictable waste generation for efficient service (Vanichchinchai, 2021). Consequently, lean thinking remains confined within the healthcare sector, leading to inefficiencies. In contrast, patient involvement and collaboration is fundamentally aimed at enhancing service quality and productivity, ultimately saving resources such as time, effort, and other resources in healthcare. Thus, patients are active participants in ensuring service quality (Verma et al., 2022). The mindset that "the customer is king" in healthcare encourages patients and various stakeholders to improve service quality, indicating that service quality extends beyond the confines of the healthcare sector (Batra & Taneja, 2021). Hence, integrating lean thinking with service quality is crucial for improving healthcare service quality.

Lean service qualities can overcome these barriers by broadening the scope of lean service quality through patient training beyond healthcare boundaries. This study combines lean thinking with service quality to develop a robust technique aimed at improving responsiveness, service quality, patient safety, and patient satisfaction. The integration of service quality and lean thinking intends to reduce medication errors, delays, and waiting times, while also improving production time and productivity and addressing other factors that hinder service quality enhancement (Trakulsunti & Antony, 2018). The primary benefits of lean service quality in healthcare include enhanced patient safety, increased patient satisfaction, improved employee morale, and better teamwork dynamics (Swarnakar et al., 2021).

Lean Service Quality is designed to address common healthcare issues such as waste of time, money, supplies, and goodwill (Voehl & Elshennawy, 2021). This approach focuses on improving healthcare activities and processes by identifying and eliminating wasteful practices while emphasizing patient value-based activities to enhance overall patient satisfaction. The integration of Lean Service Quality in healthcare offers several benefits, including a reduction in mistakes, improved patient training and clinical outcomes, decreased waiting times,

increased patient satisfaction, and enhanced healthcare productivity (Voehl & Elshennawy, 2021).

Among the most important elements of healthcare reforms, enhancing patient satisfaction and attracting medical tourism are particularly significant. Patients are drawn to seek medical care in the country as a more affordable alternative. The government should recognize this opportunity and strive to exceed patient needs to effectively serve a diverse international market. Such enhancements would increase the region's appeal for medical travel.

Factors contributing to medical travel include a lack of efficient medical services, limited accessibility, outdated technologies, healthcare technicalities (such as expertise, skills, and knowledge), and interpersonal behaviors (including perception, communication skills, patient-doctor relationships, friendliness, courtesy, and motivation) (Ariffin et al., 2022) which also belongs to the Ethiopian healthcare problem. Additionally, low confidence in local medical treatments further drives patients to seek care abroad. Therefore, the Ethiopian healthcare sector should develop a service quality improvement model to improve the current level of service quality and ultimately enhancing medical tourism attraction.

This study presents a combination of service quality, lean thinking, lean service quality, and patient satisfaction to improve medical tourism. Furthermore, the concept of machine learning is applied to healthcare service quality to provide essential benefits, such as announcing patient waiting times to reduce time waste, identifying non-value-added activities, and improving patient satisfaction because availability of medical staff, the pace at which they investigate patients, an increase in patient flow, high workloads, and limited resources are the primary determinants of waiting times in the healthcare sector (Naidoo & Mahomed, 2016).

The integration of lean service quality with machine learning algorithms has significantly contributed to enhancing healthcare service quality (Moyo et al., 2018). In addition, this approach requires active involvement from decision-makers, leaders, and medical staff to effectively reduce healthcare waste (El-Bouri et al., 2021). There is limited literature on waiting time prediction to improve healthcare service quality. Given the challenges of accurately estimating waiting times, machine learning algorithms emerge as an optimal solution. These algorithms are effective techniques for predicting healthcare waiting times using complex datasets. This study was conducted at St. Paul’s Hospital millennium medical college, where there is a high patient volume and long waiting times, along with data availability. Using

machine learning techniques, the study developed a model that reliably predicts healthcare waiting times.

Several researchers have developed models such as the Donabedian, SERVQUAL, and PubHosQual, and other models using different dimensions for measuring healthcare service quality. These dimensions are explored based on the extent to which service quality, patient satisfaction, and productivity are achieved according to criteria established by patient requirements (Al-Mhasnah et al., 2018). However, these models still contain controversial dimensions that hinder improvements in healthcare service quality. Numerous researchers have applied the SERVQUAL model to measure healthcare service quality in order to enhance patient satisfaction (RiyazhKhan & Haq, 2019). However, the development of service quality improvement models varies by region, influenced by patients' psychological, social, economic, and cultural backgrounds. Consequently, patients tend to prefer services that they trust and that meet or exceed their expectations. This study aims to examine the ideas of healthcare service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism. These dimensions were identified to assess healthcare lean service quality and patient satisfaction to enhance medical tourism within the Ethiopian context through SEM.

SEM is a well-known method introduced to identify linear relationships among dimensions, verify hypotheses, and analyze their impact on endogenous variables (Islam et al., 2023). However, SEM does not account for non-linear relationships or non-parametric complex models. To address this limitation, the study incorporates machine learning models into SEM to capture non-linear relationships, improve model prediction accuracy, and facilitate causal analysis. This hybrid approach, combining SEM and artificial neural networks (SEMANN), offers new perspectives on assessing lean service quality and medical tourism. In this context, artificial neural networks (ANN) are selected to estimate factor loadings, regression relationships and predictions during the SEM construction. The SEMANN approach has been applied by a limited number of researchers in fields such as banking, mobile commerce, and mobile payment services (Islam et al., 2023; Muñoz-Leiva et al., 2017). Thus, the SEMANN approach is utilized in the lean service quality and patient satisfaction to enable a deeper understanding of healthcare service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism. It also identifies factors that significantly impact medical tourism attraction and the adequacy of healthcare service quality.

1.3. Problem Statement

Nowadays, Ethiopia has been striving to increase healthcare coverage. However, there remains a lack of reliable and effective service quality. This issue is compounded by a growing population, an aging demographic, and rising patient expectations (Bradley et al., 2015; Cham, Cheng, et al., 2021).

As a result, disparities in patient satisfaction levels are widely identified, alongside a substantial variation in the quantity and quality of services offered. The healthcare sector, which aims to position itself among the best in the country, is facing challenges that influence both service quality and economic factors. To better meet patient preferences, numerous academics have focused on researching methods to enhance healthcare service quality.

Recently, practitioners have focused more on the healthcare sector due to issues such as prolonged hospital stays, long waiting times, resource waste, escalating costs, and medication errors, all of which undermine individual and community trust in the services provided (Oraedu, 2019). This sector is regarded as one of the high-risk, most poorly managed areas (Morales-Contreras et al., 2020), and has frequently ignored and adverse events (Vincent, 2003). While it offers similar types of services, the quality of care varies significantly.

According to Bigelow et al. (2019), researchers in healthcare service quality frequently report issues such as long waiting times, extended LOS, and high readmission rates. In Ethiopia, the healthcare sector faces various challenges, including rapidly rising service costs, an average waiting time of 95 minutes, a length of stay averaging 15 days, and increasing customer expectations regarding service quality. The waiting times presented in Table 1.1 reflect randomly selected data from different departments within the healthcare sector.

Table 1.1: Healthcare waiting time (Source: St. Paul`s Hospital)

Patient ID	Time	Department	Arrival Time	Phy. Seen Time	Waiting Time in Min.
10001	1/1/2022 0:00	OPD	155	280	125
10002	1/2/2022 0:00	OPD	160	230	70
10003	1/3/2022 0:00	OPD	130	210	80
10456	3/31/2022 0:00	Medical	165	355	190
10457	4/1/2022 0:00	Medical	155	545	430
10458	4/2/2022 0:00	Medical	177	550	413
10508	5/22/2022 0:00	Internal Medicine	134	174	40

10509	5/23/2022 0:00	Internal Medicine	156	232	76
10510	5/24/2022 0:00	Internal Medicine	198	328	130
10561	7/14/2022 0:00	Ent	190	470	280
10562	7/15/2022 0:00	Ent	201	539	338
10685	11/15/2022 0:00	Surgical	188	310	122
10686	11/16/2022 0:00	Surgical	197	338	141

The healthcare sector also faces several challenges, including patient misunderstandings, service level issues (Ograjenšek, 2020), and overcrowding that hinder timely patient treatment (Kainzinger et al., 2009). As a result of these factors, many patients have unmet needs and low trust in the quality of healthcare in our country. Moreover, the aging population, unequal access to services, and the uneven distribution of medical staff and infrastructure significantly impede improvements in healthcare quality.

The quality of healthcare services varies from country to country. Different organizations ranks countries based on their healthcare systems by assessing factors such as patient outcomes, service access, waiting times, and medical staff efficiency. According to this ranking, top-performing countries like Belgium, Japan, Sweden, Switzerland, Norway, France, Germany, and Singapore consistently deliver high-quality services. In contrast, developing countries, particularly in Sub-Saharan Africa, face challenges with inadequate service quality due to insufficient infrastructure. Contributing factors include limited research and development, government policies that do not prioritize the improvement of healthcare service quality, insufficient infrastructure and technology, lack of incentives, and cultural attitudes.

Table1.2: Healthcare service quality score index ranking (source: Legatum Institute's healthcare index)

Rank	**Countries**	**Service quality index Score**
1	Belgium	83.8
2	Japan	83.2
3	Sweden	83.1
4	Switzerland	82.4
5	Norway	82.2
6	Germany	81.1
7	Iceland	81.1
150	**Ethiopia**	**30.3**
151	Pakistan	29.7
152	Niger	29.3
153	Nigeria	28.9
154	Guinea-Bissau	28.8
155	Yemen	28.8

156	Mali	28.6
157	Angola	27.5
158	Eritrea	26.5
159	Liberia	24.2
160	Chad	22.6
161	Afghanistan	22.4
162	Central republic of Africa	21.4
163	Madagascar	19.7
164	Somalia	18.5
165	South Sudan	13.1

Countries like Thailand, Malaysia, Singapore, and India are emerging as medical tourism destinations, leveraging service marketing to boost foreign currency inflow and national economic growth (Ariffin et al., 2022; L. Li et al., 2022). Conversely, factors driving medical travel from Sub-Saharan countries to developed nations include unreliable access to essential medicines and medical services, as well as a lack of trust in the healthcare sector (Darzi et al., 2023; M. S. Rahman et al., 2024), which negatively impacts the quality of care provided to patients. Based on the problem statement, the following research questions have been formulated to improve lean service quality. According to a 2024 Ministry of Health report, Ethiopia loses approximately $700 million annually due to healthcare-related travel. This underscores the urgent need for improvements in our healthcare sector, as well as the necessity to enhance the healthcare quality and technology to align more closely with those in developed countries. Such improvements could help reduce medical travel costs and attract international patients seeking care.

Low healthcare service quality significantly influences both individual and collective economic growth by driving patients to seek care in other countries instead of attracting local and foreign patients (Abbasi-Moghaddam M et al., 2019; M. Zarei et al., 2011). In healthcare service delivery, there should be substantial competition to meet increasing patient demands, high expectations, price competition, and the unique needs of patients particularly in developed countries to attract foreign local patients (Sekaran et al., 2018). High stress levels resulting from a single error, low service quality, and insufficient medical staff experience can endanger patient lives and lead to discomfort, ultimately impacting medical tourism. Beliefs, attitudes, word of mouth (Berry et al., 1988; RiyazhKhan & Haq, 2019), access to information, technology, and social norms significantly influence service quality, medical tourism, and national economic impact (Zhang et al., 2020).

Research question

- What are the current challenges faced by St. Paul's Hospital Millennium Medical College in delivering quality services to satisfy patients?
- What factors enhance healthcare service quality to attract medical tourism?
- How do patients perceive the quality of services offered in the Ethiopian healthcare sector, specifically at St. Paul's Hospital?
- How can healthcare waiting times be predicted to increase patient satisfaction?
- What conceptual framework can be developed to improve patient satisfaction that enhances healthcare medical tourism?

1.4. Objectives of the study

1.4.1. General objective

The main objective is to develop a Lean Service Quality Improvement Model aimed at enhancing the patient satisfaction in the Ethiopian healthcare sector, specifically within St. Paul's Hospital Millennium Medical College, thereby increasing medical tourism.

1.4.2. Specific objectives

The specific objectives of the study are:

- To assess the current challenges of service quality in medical tourism at Case Healthcare.
- To identify key factors affecting patient satisfaction and medical tourism in the Ethiopian healthcare sector.
- To measure patients' perception of the quality offered in the Ethiopian healthcare sector, specifically at Case Healthcare.
- To develop a waiting times prediction model that improves patient satisfaction at Case Healthcare.
- To develop a conceptual framework that attracts medical tourism by enhancing patient satisfaction.

1.5. Significance of the Study

The study has focused on theoretical and empirical method. It is significant in exploring and understanding the opportunities and the chronic problems that hindered the healthcare service quality improvement using both local and global contexts in a systematic approach. The lean service quality improvement addresses research gaps within a research area. The systematic understanding and analysis of the sector enables to offer a better insight into the best lean service quality practices in the healthcare sector to ensure better patient satisfaction, medical tourism and economic growth. Conducting evaluation of the literature in depth, identifying research gaps, and formulating research questions can provide a basis for further investigation to develop a theoretical framework. Lean service quality gap identification assists the knowledge base. It provides a foundation for future work to deepen the researcher's understanding of the subject matter, expertise within the field, and professional growth and development. Finally, it helps to add theoretical and empirical contributions to the body of knowledge and be the basis for future investigators to improve service quality. Theoretically, it contributes by adding a body of knowledge to the lean service quality concepts to create awareness in healthcare services. Practically, the application of lean service quality and the framework for the assessment of patient happiness and the quality of healthcare services in the Ministry of Health in Ethiopia and Addis Ababa in particular. Therefore, the study directly benefits the healthcare sector, policymakers, the Ministry of Healthcare, and the government as the policy input.

1.6. Scope of the Study

In Ethiopia, many healthcare systems are poorly managed and suffer from low service quality. However, it is challenging to address all healthcares at once. Therefore, this study focused on investigating the fundamental problems of the healthcare sector in Addis Ababa, specifically aiming to develop a healthcare service quality improvement model. Lean thinking and service quality provision were studied in detail to identify the primary issues within the healthcare sector at the Case Healthcare, as well as selected public healthcare facilities. This was achieved by examining existing models of lean thinking and service quality improvement, along with current service quality dimensions, to enhance patient satisfaction, retain medical travellers, and promote medical tourism.

1.7. Limitation of the study

Although the study has extensively reviewed the existing literature in line with its theoretical background, there are other areas of literature that could add depth and content to the subject. However, the limitation set on the scope of the study is commendable. Most of the existing literature focuses on healthcare service quality improvement in developed countries. The significant limitations of the study included challenges in gathering relevant data, specifically issues related to the sample area across the country and financial constraints.

Another restriction on the research was the lack of data collection due to patients experiencing high levels of pain, which hindered their ability to provide information. This made it difficult to access large datasets and raised issues related to data confidentiality. However, utilizing the required sample size from the case company, based on established sample size determination standards, mitigated this limitation, ensuring that the sample size met the necessary criteria. This study focuses on the healthcare sector in Addis Ababa, which may limit the generalizability of its findings. Additionally, it is important to note that this research is cross-sectional in nature. Future longitudinal studies could enhance our understanding of the subject matter more comprehensively.

1.8. Organization of the study

The study is divided into seven chapters to achieve its goals. Chapter One introduces the background and justification for the study. It covers concepts related to the healthcare sector, including service quality, lean thinking, patient satisfaction, Six Sigma, and lean service quality. This chapter also outlines the study's aims and research questions. Chapter Two reviews the literature on healthcare lean service quality, focusing on the current situation in Ethiopia and narrowing the discussion from a global healthcare context. It describes the theoretical foundations and historical progression of lean service quality, addressing the nature of service quality, lean thinking, patient satisfaction, medical tourism, Six Sigma, and relevant service quality measurement dimensions. Chapter Three covers the research methodology and data collection issues, detailing the methods used to collect data, sample size, and ethical implications. This chapter also presents the research design and data analysis tools. Chapter Four presents data analysis uses DMAIC, Cause-and-effect diagrams, QFD, and machine learning tools to predict waiting time. Chapter Five discusses the enablers of service quality improvement model, the SEM model and its relationships, hypothesis testing, SEMANN,

medical tourism attraction prediction, sensitivity analysis and discusses the findings of lean service quality improvement model and the study contribution and its implication. The final chapter concludes the study by summarizing the findings and outlining future research directions.

Chapter Two

Literature Review

2.1. Introduction

This chapter covers the theory and results of earlier research on lean thinking, Six Sigma, lean service quality, patient satisfaction, medical tourism in Ethiopia and worldwide, service quality dimensions, healthcare service quality, and lean Six Sigma. It identifies, organizes, and summarizes the existing state-of-the-art literature in the subject area. The review intends to review the earlier and the current state of the art and identify the area that needs further investigation to the body knowledge that could exist in service quality and lean thinking within the healthcare sector. This chapter discusses relevant topics in line with the study area to find the basic theoretical and experimental information to strengthen the findings.

2.2. Review Methodology

The review methodology indicates how the fundamental analysis of the review process was conducted. Different terminologies that have a relationship with the study have been defined based on the keywords. The scientific concepts and foundation of service quality dimensions and their evolution, the link between service quality and lean thinking, the relationship between lean thinking and Six Sigma, and lean service quality application in healthcare have been discussed extensively. Subsequently, the conceptual framework was developed, and literature gaps were identified for the current state of the arts. Finally, the review made a sound contribution to healthcare service quality improvements where the most significant number of patients flows daily.

The literature review for this dissertation has been conducted as a systematic review of lean service quality using systematic procedures until the required results are obtained. After the current state of the arts is discussed based on the global scenario, specific literature related to the healthcare sector in Africa, particularly in Ethiopia, using a narrative approach is conducted. This is because the systematic literature review in the Ethiopian case-related service quality and lean thinking literature is applied.

A systematic review methodology originated in clinical research to investigate science genuinely and conduct evidence-based management research (Heppell, 2017). It may ensure a clear logic and sequence that can be traced and replicate the investigation of subject matter in

the published research to ensure the completeness, fidelity, and rigorous character of the literature review compared to the traditional method (Prado-Prado et al., 2020). In this study, different databases such as Emerald, Science Direct, Taylor & Francis, Google Scholar, and Scopus were the main sources of the literature, in addition to dissertations, books, conference papers, magazines, and lecture materials from well-known scholars.

2.2.1. Literature Review Protocols

The paper search was conducted from June 2022 to February 30/2024 on Scopus, Google Scholar, Taylor and Francis, and Research Gate databases. During the material selection from Scopus, the selection criteria of the topic (Title, Author Keywords, and Abstract) were used. The document search was conducted using the keywords "Lean thinking", "healthcare service quality", "lean service", "lean management", "Medical Tourism", "Healthcare lean practice", "Healthcare process improvement", “Lean healthcare service quality", "Healthcare service quality", "Health system", " Medical tourism", "Medical travel".

The study screened the papers based on language, i.e., English, year of publication, published article, title, and abstracts, excluding books, duplicates, reports, and proceedings literature. The study extracted the data based on the title, year of publication, author(s), abstract, journal details, paper clustering (empirical and theoretical), and country, method, and outcome data. From the literature search, 162 journal articles published in the English language were identified for detailed review. The collected data from the databases were tabulated using MS Excel, and further analysis was made by using a bar graph based on publication year, courtiers/region, methodologies employed, and so on.

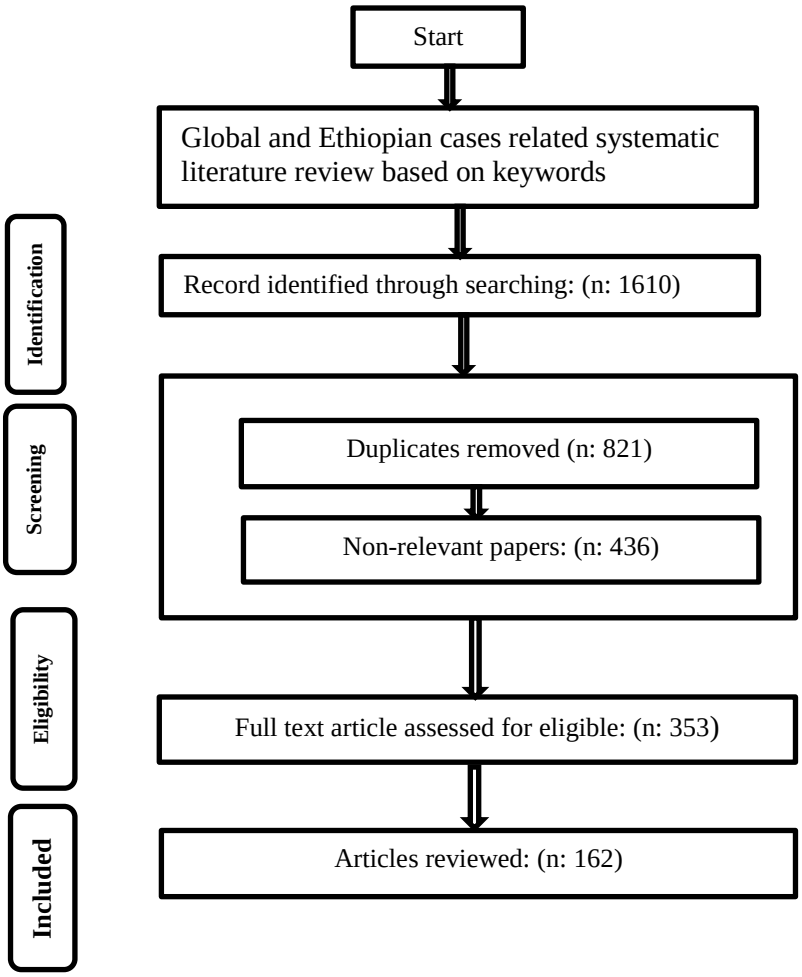


Figure 2.1: Systematic literature search and article selection

2.3. Systematic Review of Service Quality

Service is a continuous process with consistent changes that create, provide, and withdraw customers (Aljazzazen, 2021; N. Kim et al., 2021). Service concept and quality control were initially started in manufacturing sectors for discrete-continuous production units (A. Singh et al., 2020). The manufacturing industry quantifies product and service quality to reduce cost and waste and deliver product demand quickly (Al-hasson, 2021) to exceed patient expectations. Then after, service quality is applied significantly in the healthcare sector for improvement initiatives and to minimize confronting problems (Lindholm et al., 2018) to improve operating room throughput and emergency throughput, reducing medication errors and waiting times (Rabab et al., 2020).

Different practitioners defined healthcare service quality as the extent to which service comes across the patient`s expectations (Lewis & Mitchell, 1990; Dotchin & Oakland, 2006; Abugabah, 2017), providing high-quality service (Abugabah, 2017; Ampaw et al., 2020), and

a measure of the variation service quality delivered and the customer's expectations (Motamarri et al., 2014, Berry et al., 1988). Service quality, according to Parasuraman et al. (1985b), is the total assessment or mindset of service excellence. The World Health Organisation (WHO) defines service quality as optimum health, equitable medical costs, and assessment that takes into account aspects of customers' perceptions including reliability, responsiveness, assurance, empathy, and tangibles (Evans et al., 2001). Patient treatment (Alolayyan et al., 2018), information quality, accessibility, and continuity of services (Ampaw et al., 2020) are the interrelated factors of service quality. Furthermore, responsiveness, empathy, assurance, reliability, and tangibility strongly connect with fulfilling patient expectations (Adil, 2013) by reducing waiting time and length of stay and enhancing healthcare performance improvement.

Service quality needs experienced and skilled staff, infrastructure, and operational management (R. Aydin et al., 2020). It is expected to enhance patient satisfaction and medical tourism by providing significant feedback to medical staff (R. Aydin et al., 2020; Verma et al., 2022). In this sector, there are different challenges, such as increasing patient expectations (Verma et al., 2020, 2022), medical equipment changes and continuously changing technologies, medical errors, and access to healthcare information (Batra & Taneja, 2021; Brandmaier & Jacobucci, 2023). Service quality is based on the relationship between patients, service providers, and the service delivery process (Endeshaw, 2021). The healthcare sector provides the patients it serves with the proper service quality treatment (Fiakpa et al., 2022), which results in improved patient support and a sustained competitive advantage (Fu et al., 2021). Patient well-being and healthcare service quality are primarily measured to enhance patient satisfaction.

2.4. Healthcare Service Quality

The healthcare sector is the most complex at all levels and worldwide (Al Khamisi et al., 2019). According to Al Khamisi et al. (2019), the sector is very slow in accepting new quality improvement practices compared to the manufacturing sector. Different practitioners and healthcare research and quality agencies defined healthcare quality as “doing the right thing for the right patient, at the right time, in the right way to achieve the best possible results”. According to (Abugabah, 2017 and Ampaw et al., 2020), the essential component of service delivery is the quality of healthcare services. It is the extent to which the patient's expectations are met by the service (Dotchin & Oakland, 2006; Abugabah, 2017; Zhao et al., 2020). The inter-related factors such as patient treatment (Alolayyan et al., 2018), service scope (A. Singh & Prasher, 2019), service access, and resource availability (Ampaw et al., 2020) are the

significant factors in service quality improvement because more than 50% of patients are unable to get basic healthcare services (Tessema et al., 2022). This problem is significantly wide in Africa, where there is extensive discrepancy in accessibility and availability, particularly in Sub-Saharan Africa and in Southern Asia (Tessema et al., 2022). Accessibility, affordability, availability and acceptability of healthcare indicate the best quality of healthcare service outcome. According to Tessema et al. (2022), women suffer more due to service quality, access, and other healthcare inequalities, especially during service delivery.

Delivering high-quality services is dependent on meeting patients' functional and technical requirements in order to establish a solid rapport with meeting patient expectations (Boulding et al., 1993; Johns et al., 2004; Kara et al., 2005). The patient's voice is used to determine the functional and technical needs that contribute to the enhancement of healthcare service quality. It is carried out by the deployment of quality functions. To investigate and record the perceived service quality, healthcare service quality should also be patient-centric. Sekaran et al. (2018) also defined healthcare service quality in three components: effectiveness of the treatment, care provided to patients, and experience patients have with treatment. The healthcare sector is under various pressures to realize patient expectations (Getele & Jean, 2020) which are controlling swiftly increasing healthcare costs due to the ageing of the population and technological advancement (Al-Mhasnah et al., 2018), ensuring high service quality and access to medication (Al Khamisi et al., 2019).

Afsar-manesh et al. (2017) discussed healthcare service quality by analyzing the relationship between patients' expectations and their perceptions. An expectation is the desire of the patient, while perception refers to the patient's service evaluation. In this regard, their findings stated that healthcare management is responsible for improving overall patient service. Bartel et al. (2020) mentioned that hospital facilities affect patient satisfaction. Some of the challenges in the sector are interpersonal aspects, patient education, technical aspects, service outcomes, waiting time, amenities, and social support. Patient trust, favourable word of mouth (Parasuraman et al., 1991), costs (Boulding et al., 1993), waiting times, and length of stay (Berry et al., 1988) have a strong relationship with healthcare service quality for performance improvement.

According to Bekker et al. (2020); Dyck (1996), Roses et al. (2009), the principles, ideas, and conclusions from a service quality study that started in 1983 are integrated into the healthcare service quality gap analysis methodologies. The study, which was funded by the Cambridge,

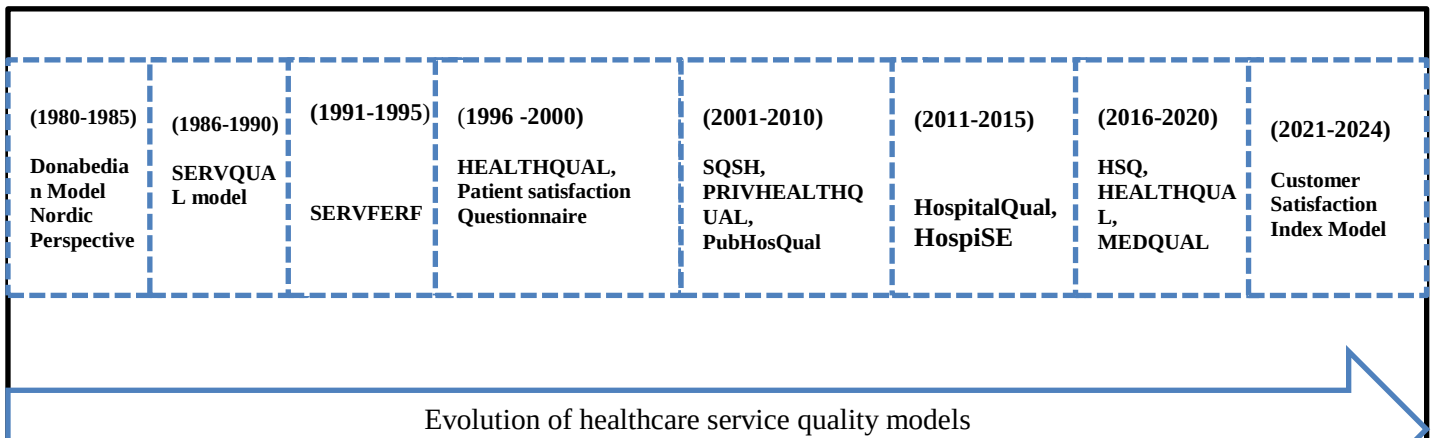
Massachusetts-based Marketing Science Institute (Ariffin et al., 2022; Zeithaml et al., 1988) produced theoretical models of service quality as well as the gap analysis methodology to measure patient perceptions. Evaluations of high and bad service quality are based on how customers view the actual service performance in relation to their expectations, if meeting or exceeding customer expectations is the secret to providing excellent service (Afthanorhan et al., 2019). The service quality and patient perceptions change when there are gaps between: the expectations of the patient and how the healthcare professional interprets them (Gap 1: management perception); the healthcare service provider's perception of patient expectations under which the services are delivered (Ho & Yi, 2014); (Gap 2: Service quality specifications); service quality specification and the actual service that is delivered (Al-Mhasnah et al., 2018); (Gap 3: service delivery); actual service delivered and what the healthcare sector communicates to the patient about service (Afthanorhan et al., 2019); (Gap 4: external communication), and patient expectation and perception level of the service they received (Ho & Yi, 2014); (Gap 5: Patient expectation/perception gap) (Afthanorhan et al., 2019; Hampton, 1993; Ho & Yi, 2014).

2.5. Service Quality Measurement

Different authors used different service quality dimensions in different countries based on customer needs and practitioners' empirical attainment. Donabedian was the first practitioner to study quality in healthcare, particularly service quality. Donabedian (1983) developed the Donabedian Model, which measured healthcare service quality by emphasizing "process, structure, and outcome" to give attention to effective and efficient healthcare service delivery. Later on, the SERVQUAL model was developed, which is commonly applied in healthcare services for measuring service quality.

According to (Dalmasso et al., 2021), service quality concepts is divided into two broad schools of thought. **Thought one** focuses on the technical and functional elements of basic service quality (Christian, 1984). This thought was derived from manufacturing system quality control, where technical quality focuses on service quality benefit, service delivery, and appropriateness, while functional quality focuses on how service quality is delivered.
Thought two focuses on patient perceptions of service delivery aspects (A. Parasuraman et al., 1985b), and based on this work, responsiveness, tangibles, assurance, reliability, and empathy were derived from 22 different dimensions.

Practitioners defined quality services as the gap between the patient`s expectations and perceptions (A. Parasuraman et al., 1985b; Zeithaml et al., 1988). According to Chen et al. (2013), the degree to which patients' expectations and perceptions of service providers align is another indicator of service quality. Service quality is patient perceptions of service performance (Cronin & Taylor, 1992; Brady et al., 2002; Ramori et al., 2021). Similarly, other prominent practitioners stated service quality as functional quality (how service is offered) and technical quality (what service is delivered to patients) components (Gronroos, 1984). In this regard, service quality is developed based on different dimensions, and SERVQUAL is one of the models based on different modifications (Berry et al., 1988; A. A. Parasuraman et al., 1991). The models and scales such as SERVQUAL (Zeithaml et al., 1988), SERVPERF (Cronin & Taylor, 1992), PUBHOSQUAL (Jayesh P & Renuka, 2010), HSQ Model (Sumaedi et al., 2016), HEALTHQUAL (E. Lee et al., 2017) and MEDQUAL (Kitsios et al., 2019) were developed to measure healthcare service quality. Sun et al. (2017) reviewed SERVQUAL usability and its appropriateness to evaluate service quality, however it lack service quality coverage in different aspects of service setting. Yang et al. (2020) conducted a qualitative study to develop dimensions such as health escape, hospital image, trustworthiness, personnel, clinical process, relationship, communication, personalization and administrative process to build healthcare service quality framework. Endeshaw (2021) also reviewed healthcare service quality measurement models such as SERVQUAL, SERVPERF, HEALTHQUAL, PubHosQual and HospitalQual. Based on these models, every country or healthcare service can have a model to measure their service quality because the patients' behaviour varies from place to place based on economic, political, and social background. The developed models are not adequate because SERVQUAL and modified SERVQUAL are not adequate for addressing all the comprehensive patient characteristics. These models are developed in industrialized countries; however, testing them in developing countries and modifying them based on the social background of the country and healthcare as well is very important.



Evolution of healthcare service quality models

Figure 2.2 Service quality models

Parasuraman et al. (1991) identified 22 service quality improvement dimensions to assess patient perception and expectation. After further testing and refinement, it was reduced from ten to five dimensions (Parasuraman et al., 1991). Tangibility (appealing physical facilities, buildings, up-to-date equipment, and personnel) (Al-Neyadi et al., 2018), assurance (the knowledge of service providers and their expertise, politeness, trust, and confidence in the patients), reliability (the service providers ability to perform the promised service) (Ahmend & Llyas, 2018), responsiveness (prompt service delivery and preparedness to help customers) (Pekkaya et al., 2019), and empathy (caring, closeness, and friendlessness to patients) are the core models that indispensably improve service quality (Berry et al., 1988; Parasuraman et al., 1985; Parasuraman et al., 1991; RiyazhKhan & Haq, 2019). Cronin & Taylor (1992) then developed the SERVPERF model to fill the criticisms of the SERVQUAL model and place a strong emphasis on performance quality in terms of meeting patient expectations and future service utilization. The HEALTHQUAL model was developed specifically for the healthcare sector, whereas the SERVQUAL model applied to most service industries (A. Parasuraman et al., 1991). The Donabedian and HEALTHQUAL models provide valuable awareness about in the healthcare sector about service quality standards. The HEALTHQUAL model was a version and amalgamation of the works of Donabedian and the SERVQUAL model (A. Parasuraman et al., 1985b), incorporating professional aspects of service quality. The HospitalQual model is another quality service improvement model for managers to monitor, control, and improve inpatient service quality in the public healthcare sector. Based on the SERVQUAL model, a prominent model called the LibQual conceptual framework was developed (Al-Mhasnah et al., 2018). The SERVQUAL model is thoroughly researched to identify (Sekaran et al., 2018) service quality based on waiting time, guidance, and technical facilities. The SERVQUAL dimensions briefly explained as below.

A. **Responsiveness:** Responsiveness was described as the medical staff`s promptness and preparedness in attending to the needs and desires of the patients. Stiglic et al. (2020) stressed that willing employees should be responsive by giving patients advance notice

of completion dates, giving them their full attention, promoting services, and attending to their needs. According to Medhekar et al. (2020), responsiveness is the capacity to provide assistance in accordance with the needs, wishes, and issues of patients. This dimension focuses on how quickly medical staff responds to patients` concerns. Consistently reviewing the service delivery process to keep patients informed can lead to improvement. Prompt service, willingness, and readiness to respond to patient requests are the measurement items.

B. **Reliability:** Reliability is the primary determinant of the patient`s perception of service quality (Akkawuttiwanich & Yenradee, 2018). The capacity of the healthcare and medical staff to carry out and complete the promised service with accuracy and dependability within the given set of standards is referred to as the reliability dimension (Lucca et al., 2022). The capacity of medical staff to perform the promised service consistently, precisely, on schedule, and without error is known as reliability (Sekaran et al., 2018; Tuzkaya et al., 2019; Yaduvanshi & Sharma, 2017). Healthcare performance flexibility, dependability, and reliability include things like accurate record-keeping and billing, as well as on-time service delivery (Medhekar et al., 2020). This dimension is very significant in reducing patient complaints by using well-trained and committed medical staff.

C. **Tangibles:** The structure's appearance, physical amenities, personnel, communication materials, and equipment that aligns with building functions are all considered tangibles (Khalili et al., 2018). Patients can evaluate the level of service quality by contrasting the observable components of these systems, such as the buildings, tools, staff, and materials (S. Ahmed et al., 2018b; Hussain et al., 2019; Smeda et al., 2018). Modern-looking tools, equipment, visually appealing facilities, and materials related to service are the measurements used in the tangibility dimension.

D. **Assurance:** The ability of an employee to be kind, discreet, courteous, trustworthy, confident, and competent in handling the patient's situation is known as assurance (Al Raoush et al., 2020; Lucca et al., 2022). Sekaran et al. (2018) assert that courteous and knowledgeable staff members have the ability to instil confidence and trust in patients. The employee must possess the necessary medical knowledge, abilities, expertise, and patient management skills. When operating a high-rise medical service, the safety of the medical service patients is paramount (Nur et al., 2021). Instilling confidence in

patients, making patients feel safe, consistently courteous employees, and employees` knowledge to answer patients` questions are the measurements of the dimension of assurance.

E. **Empathy:** Empathy, according to Tuzkaya et al. (2019), is the level of individualised and empathetic care provided. The capacity to recognise the wants and requirements of patients and provide prioritised or individualised service that makes them feel special and unique is known as empathy in healthcare (Ariffin et al., 2022; Hussain et al., 2019). Sekaran et al. (2018) identify three empathy components: patient knowledge, patient communication, and physical and service accessibility. According to Jing & Lim's (2020) research, medical staff should prioritise delivering prompt, polite, one-on-one attention to each patient above making physical environment improvements in an effort to increase patient satisfaction. Giving attention to patients, providing convenient service delivery/operating time, the caring fashion of employees for patients, understanding patient needs, and giving patients` best interests at heart are the measurements of empathy.

Different generic models in different countries were developed by different authors to improve service quality. This indicated that each country might have its service quality dimension to satisfy their customer based on their economic status and social and cultural background.

2.6. Service Design Thinking

Service design thinking is an approach that focuses on creating or improving services by understanding the needs and experiences of patients (Verma et al., 2022). It combines principles from design thinking (Ciasullo et al., 2024; Ulhassan et al., 2013), service management, and user experience to enhance service delivery (N. Kim et al., 2021).

To understand patient need within a larger ecosystem and to include patients in the development and improvement of the service, service design thinking is a comprehensive, patient-centered (user centricity) (J. Xu et al., 2022), co-creation (involving stakeholders such as users, employees, partnership and collaboration), visual thinking, and holistic approach (Srivastava & Prakash, 2019). Through patient visualisation, rapid learning, collaboration, and observation, service design thinking is a methodical approach to problem-solving that focusses on identifying and understanding both explicit and implicit patient demands. It supports the development of novel technology and service approaches to satisfy patient needs in the context

of healthcare constraints (Parasuraman et al., 1991; RiyazhKhan & Haq, 2019). Therefore, quality function deployment is employed to enhance service design by collecting the patient voice and translating it into appropriate requirements.

2.6.1. Quality Function Deployment (QFD)

By gathering patient opinions from the start of service delivery and applying it across the healthcare (Pramanik et al., 2017), QFD is the method that converts patient needs into suitable healthcare requirements (Akram et al., 2018). The information gathered identifies patient expectations and service quality demands (X. G. Xu et al., 2022). By bringing the patient's voice into line with healthcare resources through QFD (Bottani & Rizzi, 2006; Sekaran et al., 2018), patient satisfaction is increased and healthcare growth is facilitated by attracting patients and improving service quality.

Understanding patient satisfaction is crucial in the healthcare setting (González et al., 2005). It is imperative to ascertain not only the level of patient satisfaction but also the level of patient happiness of its rivals (González et al., 2005). Patient satisfaction level with the current healthcare service is the patient perception, indicating how well the service meets the patient`s requirements. According to Barutçu (2019), patient satisfaction is among the most important success criteria. QFD enables the possibility of identifying substantial healthcare improvement areas. Cross-functional teams use QFD as a systematic approach to enhance the healthcare sector by identifying and resolving problems related to providing services, procedures, and patient-satisfying tactics (Barutçu, 2019). QFD is a technique that creates high-quality services to meet patient needs, converting those needs into design goals and key quality assurance areas used during service deliveries.

QFD is driven by patients and helps to understand patient requirements before service delivery based on data collection from the healthcare sector. It provides the framework to indicate patient desires by converting spoken and unspoken patient requirements into the internal language of healthcare (Barutçu, 2019). He built a framework that seeks spoken and unspoken patient needs, reveals true patient needs, and interprets these into design requirements to deliver service quality towards achieving patient satisfaction. Pramanik et al. (2017) also defined QFD as an approach that increases patient satisfaction and service delivery by translating patient needs into design requirements.

Unspoken information that patients may not provide during QFD data collection should be included in voice data collection in order to determine all patient requirements (Barutçu, 2019). Both individuals and healthcare professionals consistently ignore these silent and concealed patient characteristics. In order to provide high-quality healthcare services and satisfy patients, it must meet all fundamental needs (Hasibuan et al., 2019). Furthermore, QFD needs to start healthcare in a way that goes beyond identifying patient needs and collecting data (Barutçu, 2019). By analysing service quality levels and patient expectations, the service quality management team ascertains both the explicit and implicit needs of the patients. In this regard, the data applied to QFD aims to decrease patients' service waiting time and achieve patient satisfaction by defining and incorporating their careful requirements into service design for future improvements. QFD is used in strategic planning procedures to prioritise patient voice in order to fulfil healthcare objectives and aspirations.

The initial stage in organising the QFD improvement process is the house of quality (HoQ). The HoQ is a methodical, graphical approach that shows the elements of the design arranged in a matrix, including rooms, a roof, and a basement. The HoQ matrix provides a summary of the service data to illustrate how an issue could impact patients' access to healthcare. The information acquired has to be pertinent to the patients' needs and the state of healthcare. Patients' needs, importance weights, technical attributes, a matrix of correlation ratings, patient satisfaction scores, and the aim for healthcare services make up the HoQ.

Patient's requirements: the first stage in implementing the QFD is to identify the patient's requirements, which involve describing, elucidating, and recognising the patient's requests. The HoQ model is driven by the requirements of the patient and ensures that the process design is based on information received about the patient's demands. Data gathering takes into account patient handling, medication errors, clean rooms and facilities, follow-up services, professional communication between medical staff and patients, and responsiveness and assistance (Prior & Akao, 1967).

Technical Requirements: the second phase in developing the HOD based on patient requirements and needs is to identify the technical requirements. Technical criteria include proper medicine administration, patient treatment with dignity, clean rooms and amenities, follow-up procedures by medical professionals, and frequent visits (Prior & Akao, 1967).

Relationship Matrix: the third phase in the house of quality is the relationship matrix. It serves to illustrate how closely and how strongly the needs of the patients and the technical requirements relate to one another. With a given value of (9, 3, and 1), the relationship between

them will be represented by symbols that depict strong, moderate, and weak relationships. This tactical move aims to enhance the offering in order to meet patient needs. The healthcare strengths and weaknesses were revealed in identifying the areas in which the chosen healthcare needs to make adjustments. At least one patient requirement must match one of the technical criteria in the relationship matrix (Prior & Akao, 1967).

Based on design standards, the QFD lowers costs, reduces rework and design change, reduces irrelevant and high-risk processes, reduces cycle time and waiting time (Prior & Akao, 1967; Taqdees et al., 2017), enhances service quality to meet patient expectations, standardises functional requirements, and increases throughput (Andronikidis et al., 2009). Evaluating the connections between every patient need and service feature and the links between the numerous service characteristics, is difficult and time-consuming (J. S. L. Lam & Bai, 2016).
However, QFD is long, difficult, and cumbersome due to the large data collected from patients for decision-making. Sometimes, relationships can be elusive and contingent on the subjectivities and viewpoints of the decision-makers, and bias is introduced (J. S. L. Lam & Bai, 2016). Moreover, it is also crucial to remember that QFD should be carried out continuously and that data and information saturation must be reached to provide the best outcomes and conclusions. To be more precise, QFD simplifies reality by assuming that patient requirements and service attributes have linear correlations (E. Karsak et al., 2003; E. E. Karsak, 2004).

Usually, QFD is utilized as a tool for design. However, it can be applied at any point when identifying consumer wants is necessary to ascertain technical requirements to establish priorities and goals. When it comes to quality-related operations, QFD can be a very useful tool. However, a major factor in the limited utilisation of QFD in this context is the absence of a framework and recommendations for adopting it to improve the quality of an already-existing product or process. The following sections outline a method for using QFD as a tool for quality improvement.

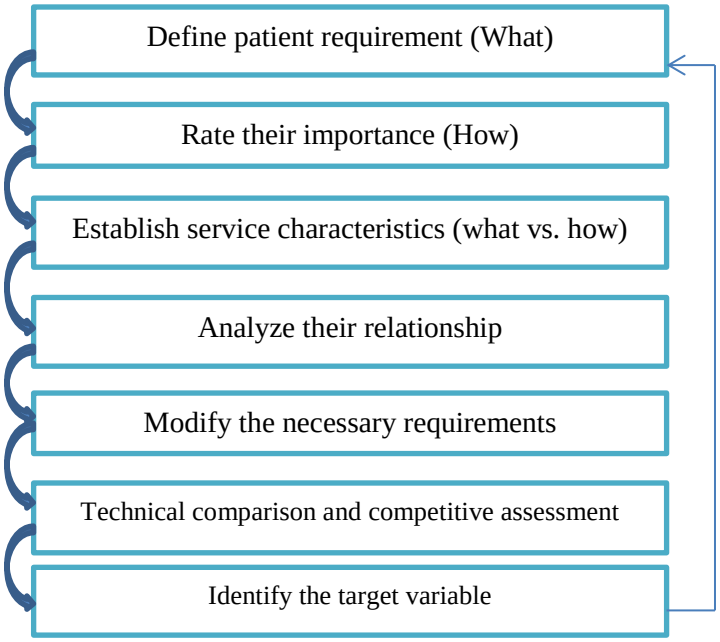


Figure 2.3: QFD analysis method: Source (Dehe & Bamford (2017).

2.7. Lean Thinking

Japanese manufacturing introduced the concept of lean production to improve Toyota Motor Company`s shop floor (Kollberg et al., 2006). The lean thinking idea was born in the 1950s, but it was disseminated to readers in 1990 (Hines et al., 2004). Toyota Motor used JIT, the Kanban method, and a high worker problem-solving level through lean management (Kollberg et al., 2006). The focus of lean thinking is reducing healthcare waste and suggesting alternative methods for the conventional process (S. Ahmed, 2019). It was introduced to the manufacturing of the Western through the Womack et al. book entitled "The Machine that Changed the World," which described lean production using lean product development, lean manufacturing, and lean enterprise management. The book was written to fill the gaps in activities among Western carmakers and Toyota through mass production systems to explore lean production support practices and infrastructure to enable changes in non-Japanese and non-automotive industries (Kollberg et al., 2006). The fundamental purpose of focusing on lean manufacturing is because of its impact on shop-floor work and manufacturers` interest in the approaches (Hines et al., 2004).

Lean thinking works on reducing the total healthcare waste (Peng et al., 2023). Hines et al. (2004) summarized the evolution of the lean thinking aspects such as customer value identification, value stream management, production flow development, pull system, and

motivation to perfection. Lean thinking is a method for improving the quality of healthcare services by reducing waste (Zepeda-Lugo et al., 2020). By enhancing service quality, this operating philosophy optimises responsiveness, operational efficiency, and patient happiness (Fu et al., 2021). Its intervention improves patient safety, patient happiness, patient flow, and service delivery while drastically lowering healthcare waste, waiting times, expenses, and patient congestion (Zepeda-Lugo et al., 2020). To cut down on waiting periods, waste, and needless movement in the healthcare industry, many writers employed value stream mapping, kaizen, and 5S as methods for improving the quality of healthcare services.

Patients do not gain from healthcare waste in terms of pain relief (Aburayya, 2020). The most prevalent wastes in the healthcare industry that do not benefit patients include motion, movement, waiting periods, inventory, especially medications, and medical mistakes (Shrafat & Ismail, 2019). The ultimate goal of waste reduction is to improve patient safety, efficiency, service quality, and satisfaction by streamlining the process and offering patient-responsive care.

To improve service quality in inpatient and outpatient departments, lean thinking engages decision-makers, upper management, patients, and medical personnel at all levels (Hamdan et al., 2019). Additionally, it improves value-added medical procedures including examinations and various expert assessments (Akdag et al., 2014; Hamdan et al., 2019). By meeting significant patient needs, these value-added activities immediately raise the quality of services. The enhancement raises the standard of healthcare services.

2.7.1. Need for Lean Thinking

Lean thinking is defined by Womack, J. P., & Jones (2003) as focusing on aspects like labor force, manufacturing/service space, tools, waiting times, and inventories to decrease non-value-added tasks, improve high service quality, and decrease errors in healthcare systems. The need for lean thinking is now commonly acknowledged, and healthcare must be improved in terms of waste, care, service speed, crowding, and patient safety (Holden, 2011). In an attempt to achieve broad improvement, the healthcare sector worldwide is increasingly adopting an approach called Lean thinking (Holden, 2011).

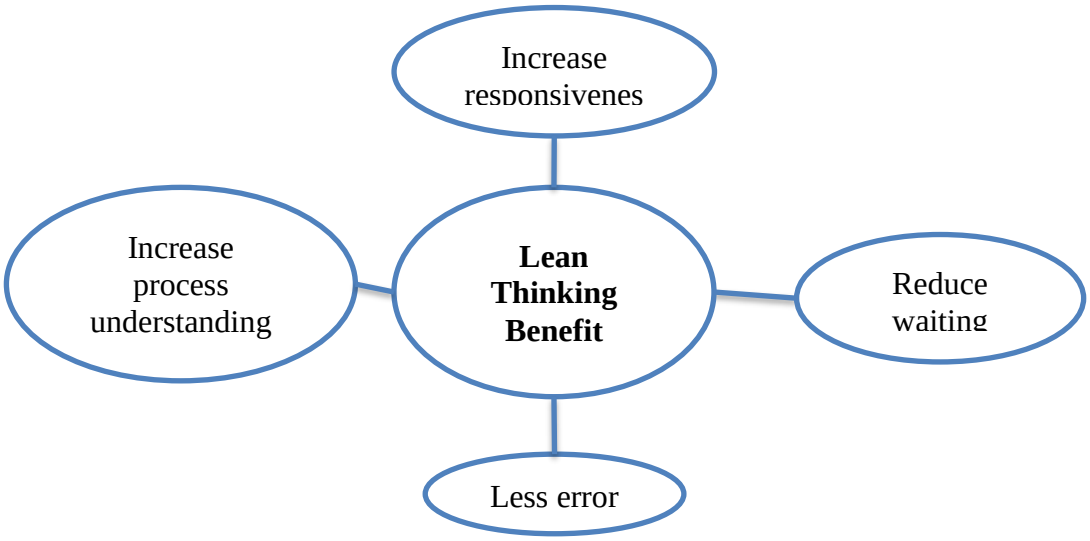


Figure 2.4: Lean thinking benefit: (Melton (2005)

2.7.2. Lean thinking application in healthcare

The origin of lean thinking was in the manufacturing firms, and different authors argued on the fundamental advantages of the healthcare sector from the lean thinking philosophy. Nevertheless, Womack promotes lean thinking application in the healthcare system, especially related with on-time service delivery and enhancing patient comfort; the author proposed lean thinking. In addition, Kollberg et al. (2006) corroborated the presence of multi-skilled medical staff and active patient involvement as the significant variables in lean thinking. The concept of zero defect and continuous improvement application in the healthcare sector is the fundamental lean thinking approach (S. Ahmed, 2019; Kollberg et al., 2006). According to Rosen et al. (2015), healthcare lean thinking focuses on delay, errors, and inappropriate procedure elimination. After further argument, the researchers consider the customer focus establishment on both healthcare and other manufacturing industries. Lean healthcare standardizes the work processes to increase the visibility of critical problems (Batra & Taneja, 2021) and thinking capability so that it enables solving problems and improving service quality (Amos et al., 2022).

Healthcare stakeholders have different perceptions regarding service quality due to its complex nature (R. Aydin et al., 2020). However, they share the pressure of optimizing healthcare service quality processes by simplifying, designing, and implementing improved service pathways (Crema & Verbano, 2017). They also aim to create substantial healthcare value (Ulhassan et al., 2013), service quality, and better patient and employee satisfaction

(Flynn et al., 2019) by developing approaches, tools, and techniques to upgrade quality infrastructures.

2.7.3. Healthcare waiting time

Waiting time is defined as the amount of time a patient must wait before being seen by a member of the medical staff or service provider (W. Hu & Li, 2022). It is one of the basic metrics to measure healthcare efficiency in managing resources to predict patient flow (Clancy et al., 2023). The amount of time a patient must wait before seeing a doctor is one of the key indicators of patient satisfaction in the healthcare sector (Jordon et al., 2020). The amount of time spent waiting is highly significant in terms of improving productivity and patient investment, as long waiting times have an impact on economic growth.

One of the main healthcare waste that has to be reduced in order to improve patient value is waiting times (Jordon et al., 2019). Because of its detrimental and dangerous effects, including congestion, patient discontent, safety, registration, and protracted suffering, it needs careful attention. It mostly takes place in emergency rooms, outpatient investigations, labs, and drug services, including the period of time between a patient's prescription submission and drug delivery (Kuo et al., 2020). Long wait times for medical care have a detrimental effect on a patient's perspective, degree of satisfaction, and sense of sickness (Hamdan et al., 2019). Medical staff stress, job overload, exhaustion, poor physical condition, boredom, increasing demand and overcrowding, limited resource allocation, and decreased productivity at the individual and national levels are some of the medical problems that come from this (Naidoo & Fields, 2019; Naidoo & Mahomed, 2016). Long wait times and patient discontent are common topics of debate across nations that impact patient expenses, safety (Mousavi Isfahani et al., 2019), comfort, mental health, psychological stress, and productivity (Costa & Godinho Filho, 2016). Thus, one of the most important factors influencing patient satisfaction in healthcare is waiting time.

Long wait times and an excessive patient flow are the main causes of healthcare strain (Lin et al., 2006). Patients who wish to attend the healthcare facility for emergency or other medical services should be provided with waiting time information via various applications. Therefore, there is pressure to lower these important elements in order to improve service quality by lowering costs and increasing healthcare efficiency (Andrawis et al., 2020). However, to improve service quality, patient flow is being streamlined by machine learning applications and medical equipment advancements (Curtis et al., 2017).

2.7.4. Lean thinking dimensions

Leadership: is the lean thinking philosophy that addresses management participation, willingness to apply new ideas, process change, direction indication, controlling challenges (Awang et al., 2022), and problem-solving to sustain the best practices (Dombrowski & Mielke, 2014). It changes the healthcare cultures through continuous improvement, effective communication, high-level insights, and an understanding of service quality (Honda et al., 2018). It also involves the top management commitment to determine the extent of healthcare service quality performance through internal and external integration (Mathur et al., 2018), visits, reports (Vaishnavi & Suresh, 2020), willingness for changes (Parkhi, 2019), and worker integration (Jagdish et al., 2014; Trenkner, 2016).

Training: The most fundamental factor for the achievement of lean thinking, execution, and healthcare service quality improvement is training and skill provision (Vaishnavi & Suresh, 2020). It is the success behind lean practices (Demirkesen, 2020). Lean practice is achieved when training is effective and delivers fundamental knowledge to improve performance and skills for practitioners to reduce embedded waste (Jagdish et al., 2014). It provides a detailed understanding of healthcare resources for continuous service quality improvement (Jain & Ajmera, 2019a). It supports the staff in becoming familiar with new technologies, tools, techniques, and emerging concepts about the entire system (S. Ahmed, 2019).

Healthcare lean culture: adopts a healthcare working culture, which is the fundamental tool for developing respect among individuals and teamwork (Awang et al., 2022) to improve critical lean practices (Demirkesen, 2020). It works on employee attitudes to create a good lean environment (Jain & Ajmera, 2019b). The lack of a healthcare lean culture hinders the success of lean practices, particularly in process management, process efficiency, and common understanding (Sarhan & Fox, 2013).

Teamwork: is a fundamental component for both lean thinking and service quality across the entire organization (Vaishnavi & Suresh, 2020). It is the critical collective practices of lean thinking that encourage employee engagement, skill training, responsibility, and deploying an effective organizational culture (Demirkesen, 2020). It encourages creative thinking through teamwork and worker empowerment to bring a new paradigm of organizational cultures and problem-solving capacity that enhance service quality improvement (Paez et al., 2005).

Employee involvement: Lean thinking certifies employees' engagement in service quality improvement, decision-making, worker morale, efficiency, patient happiness, and better lean approaches to improve patient satisfaction (Jain & Ajmera, 2019b).

Defect: According to Klein et al. (2021), healthcare defects occur due to misunderstandings and communication inconveniences between patients and medical staff, medication errors, wrong data registration, and incomplete documents.

Waiting time: The large waiting time in the healthcare sector is one of the key indicators of patient dissatisfaction that occurs due to long queue length, inefficient scheduling, and shortages of resources and access (Klein et al., 2021). Patient, employee, or equipment idle time in healthcare is a waiting which has an impact on patient safety (Abdallah, 2020).

Customer focus: The service begins and ends with customers (Awang et al., 2022). The healthcare sector requires studying the requirements of patients and their values. The awareness of patients' needs and variations and increasing patient expectations create a big challenge for the healthcare sector (Vaishnavi & Suresh, 2020). Patient preference, emotional support, responsiveness, reliable service, communication, educational level, empathy during care, and service comforts are some of the factors that influence patient satisfaction (S. Ahmed et al., 2013, 2018a). Meeting the patient's needs and wants in the healthcare service is vital (Al-Neyadi et al., 2018) because patient satisfaction is their holistic and fundamental objective. Patient service experience, population health, and healthcare cost reduction are the triple advantages by which patient satisfaction and customer focus are achieved (Pavão et al., 2018).

Responsiveness:- both service quality and lean thinking use responsiveness and waiting time metrics as key indicators to measure service quality level and waste reduction (Layik, 2021). Responsiveness in the healthcare process uses cycle times, waiting time, length of stay, and the ability to respond to changing patient needs as a measurement (Grass et al., 2020). It indicates the amount of work medical staff can serve during a sprint. Lean thinking tracks the duration of patients' service.

Perfection: The lean thinking final goal is perfection (Womack and Jones, 2003). The healthcare service quality provision failure may cause a medical error. This failure is derived from a lack of attention, a lack of resources, electric fluctuation, and knowledge (Reed et al., 1993). Perfection is changing workers' and patients' attitudes to bring breakthrough changes and knowledge diagnosis in healthcare zero defect, which is lean thinking habits (Adil, 2013). Perfection is not only about medical errors, changes in delay, waiting times, time for

registration, lead times, and referral management are also significant factors that need to be solved.

Generally, as various types of literature emphasize, patients are often seen as passive players in lean thinking, as healthcare focuses on eliminating waste without considering the patient's perspective. It is within the boundaries of the healthcare sector that inefficiencies are created. In contrast, patient involvement is fundamentally concerned with enhancing service quality and production time to save resources such as time, effort in healthcare, and individual and collective productivity. Hence, the patient is active in service quality. Therefore, it is beyond healthcare boundaries. Many studies have focused on lean implementation, approaches, tools, and techniques in manufacturing, service, and healthcare in particular. Patient requirement and planned service to smooth patient flow problems augment the stress and pressure on both medical staff and patients. Therefore, predicting embedded healthcare waste, patient expectations and patient requirements is the literature gap identified.

2.7.5. Lean Thinking Tools

2.7.5.1. Six-Sigma

By decreasing process variance, Six Sigma, a continuous process improvement methodology, is used to improve service quality (Shanmugaraja & Nataraj, 2012). According to Sunder M et al. (2020) it is among the best quality management strategies that allow for significant improvements in lowering medical errors, blunders, and defects while optimising patient happiness. By lowering expenses and waste and raising patient satisfaction, it increases healthcare productivity (Lokesh et al., 2020). A new approach to service quality management called Six Sigma pushes waste to go above and above for patients. As a breakthrough in healthcare waste reduction, it is a management approach and innovative problem-solving tool that improves service quality, patient happiness, and productivity (Niñerola et al., 2020). By providing the quickest response to patients, ensuring patient satisfaction, cutting costs, and streamlining the healthcare process, it optimises the quality of healthcare services through the integration of lean thinking.

The Six Sigma fundamental goal is total waste elimination through waste definition, source of waste identification, waste elimination planning, and waste occurrence control (Mancosu et al., 2018). The components of waste considered to be eliminated in the healthcare sector include medication error, shelf life, movement, inventory, LOS, and waiting time (S. Ahmed et al., 2018b).

2.7.5.2. Lean Six-Sigma

The healthcare sector is a powerful enabler of economic growth because of demographic shifts, reduction of productive time, greater wealth, and fulfilment of patients' expectations (Kaouthar, 2020). The sector seeks to identify healthcare initiatives and opportunities to develop healthcare service quality in a more organized and coherent manner (Parkhi, 2019). Lean thinking is a robust approach adapted to the healthcare service sector due to the high embedded volume of waste to create value, service quality, safety, and efficiency to reduce waste from patient pathways (Peimbert-García et al., 2019). At the same time, Six Sigma is a systematic and organized method that minimizes variability and deviation to enhance service quality (Valdez et al., 2018). It is a well-disciplined and structured approach for enhancing service quality (S. Ahmed et al., 2018b), streamlining operations (Kaouthar, 2020), productivity improvement, and innovation (Ferng & Price, 2005). The Six Sigma ties quality, cost, process, people, and accountability, relying on the statistical method (Drăghici, 2019). It is sector-wide quality improvement that reduces process variation that affects service quality (Parkhi, 2019). It emphasizes factors such as waste reduction potential (Ahmed et al., 2018b), increasing customer-centricity (Parkhi, 2019), improvement in workflows (Ferng & Price, 2005), user complaint reduction potential (Dellifraine et al., 2013), the scope for cycle time reduction and method simplification (Inal et al., 2018), the availability of innovative and qualified people (Haenke & Stichler, 2015), clear identification of critical-to-quality characteristics (Godley & Jenkins, 2019), and the Presence of top management commitment (Improta et al., 2019).

The combination of lean thinking and Six Sigma has become a strong technique to increase the speed of service delivery, cut costs, and increase customer satisfaction (Laureani et al., 2013). This integrated approach is fundamentally applied in healthcare (Peimbert-García et al., 2019) to decrease waiting times, LOS, medication errors, and productivity (S. Ahmed, 2019). According to (S. Ahmed, 2019; S. Ahmed et al., 2018a; Peimbert-García et al., 2019), the lean Six Sigma enabling factors in healthcare service quality are identified as efficiency, service quality, cost, patient satisfaction, staff active participation, and experience. This specifies value and integrates value-added activities, innovation, and value creation by avoiding interruption whenever requested (Al Khamisi et al., 2019).

The lean Six Sigma (LSS) level of adoption and its usability in healthcare are found at the infant stage in different countries (Jorma et al., 2016; Kaltenbrunner et al., 2019) rather than

accepting the techniques. As H. J. Harrington et al. (2012) stated, healthcare service quality improvement using LSS involves different significant components, which include healthcare problem insights and clarification, sustaining working culture and patient safety, continuous improvement and performance reporting, controlling and testing change strategies, and healthcare stakeholder involvement (L. Harrington, 2007). Six Sigma does not optimize the process flow but reduces the defect by identifying the problem that is 'hard to find but easy to fix, while the problems that are 'easy to find but hard to fix' are solved by lean thinking (Wetzel et al., 2014). It was combined and formed Lean Six Sigma, which is "making work better (by Six Sigma) and making work faster (by Lean principles)." The combined effect of both concepts maximizes healthcare operations and working processes while removing waste and improving quality, safety, and the environment (Lindberg et al., 2020). This approach significantly benefits the healthcare sector in terms of operational efficiency, cost-effectiveness, higher service quality, and patient satisfaction (Aburayya, 2020). It relies on the idea of continuous improvement to produce the best while using the least. Moreover, it has a significant impact on clinical zones such as infection control and medication sections (S. Ahmed et al., 2018b).

Using the DMAIC (Define, Measure, Analyse, Improve, and Control) approach, Six Sigma focusses on healthcare issues and process variation, while Lean thinking primarily focusses on non-value-added activity classification and process flow responsiveness (Niñerola et al., 2020). LSS is a management approach that identifies and eliminates medical errors, defects, and failure-causing factors in the healthcare process. In healthcare service quality, the combination of Lean and Six Sigma aims to reduce waiting times, total length of stay, medication error reduction, throughput efficiency improvement, and motion reduction (Lokesh et al., 2020). Several researchers have stated that LSS is a healthcare process improvement technique that fulfils the critical shortcomings of Six Sigma and Lean and builds synergies (Antony et al., 2019; Sunder M & Prashar, 2020). The prolonged flow of patients affects medication, service quality, patient satisfaction, and employee satisfaction (Lokesh et al., 2020). LSS reduces unnecessary waiting time due to machine breakdowns and long cycle times, thereby increasing patient satisfaction.

2.8. Lean Service Quality

Healthcare service quality is achieved when it exceeds patient expectations (A. Parasuraman et al., 1985a). It is continually assessed based on patient impressions, which are influenced by their perceived inferiority or superiority (Meuter et al., 2000). Service quality and lean thinking are interconnected concepts, as both reflect potential patient outcomes, with their levels determined by overall patient expectations and perceptions (Aljazzazen, 2021). However, literature reviews on lean thinking and service quality are scarce (Vanichchinchai, 2022), and there is insufficient research on the relationship between lean thinking and service quality, particularly in public healthcare (Marques & Ferreira, 2020).

In the study by Vanichchinchai (2022), it was noted that an emphasis on healthcare performance through lean thinking can negatively affect service quality. Nonetheless, lean thinking and service quality are viewed as avenues to enhance service quality for healthcare professionals, improve medical tourism, and boost productivity for healthcare managers (Vanichchinchai, 2022). Research by Kaltenbrunner et al. (2019) found a positive impact of lean thinking on patient satisfaction. Therefore, service quality is integrated with lean thinking in the healthcare sector to enhance patient satisfaction to reduce waiting time (Peng et al., 2023) and increasing patient safety and working conditions (Fiakpa et al., 2022).

The goal of integrating service quality with lean thinking is to reduce medical errors, length of stay (LOS), and waiting times while simultaneously enhancing service quality, corporate image, patient satisfaction, and medical tourism attraction. In healthcare, the primary benefits of combining lean service quality with patient satisfaction include improved patient safety, increased patient happiness, enhanced employee morale, and better teamwork dynamics.

Table 2.1: Service quality and lean thinking dimensions selection in prior studies

Number	Author	Service quality dimensions												Lean Thinking Dimensions												Author
		1. Tangibility, 2. Reliability, 3.assurance, 4.empathy, 5.responsiveness, 6.safety, 7. Efficiency, 8.Acessibility&Caring, 9.waiting time, 10.Employee involvement, 11.Org. Perfor. & colla. 12. Competency.												1. Training, 2.Cycle-time, 3 Defect, 4.employee involvement, 5.Responsiveness and perfection, 6.Waiting time, 7.Safety, 8.Cont. impr. 9. Leadership 10. Process mgt 11. Teamwork 12.Culture. 13. Customer focus/Patient satisfaction.												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	
1	(Anderson, 1995)	X	X	X	X	X										X		X	X				X				(Van den Heuvel et al., 2006)
2	(S. S. K. Lam, 1997)	X	X	X	X	X								X			X	X	X		X		X			X	(Vinodh & Joy, 2012)
3	(Sower et al., 2001)	X		X	X	X								X		X	X		X			X		X	X	X	(S. Ahmed et al., 2013)
4	(Sadiq Sohail, 2003)	X	X	X	X	X								X								X	X		X	X	(Sadikoglu & Olcay, 2014)
5	(Douglas & Connor, 2003)	X	X	X	X	X								X			X				X		X	X	X	X	(Arumugam et al., 2014)
6	(Johns et al., 2004)		X	X	X	X								X			X				X	X	X		X	X	(Sabry, 2014)

Number	Author	Service quality dimensions												Lean Thinking Dimensions												Author
		1. Tangibility, 2. Reliability, 3.assurance, 4.empathy, 5.responsiveness, 6.safety, 7. Efficiency, 8.Acessibility&Caring, 9.waiting time, 10.Employee involvement, 11.Org. Perfor. & colla. 12. Competency.												1. Training, 2.Cycle-time, 3 Defect, 4.employee involvement, 5.Responsiveness and perfection, 6.Waiting time, 7.Safety, 8.Cont. impr. 9. Leadership 10. Process mgt 11. Teamwork 12.Culture. 13. Customer focus/Patient satisfaction.													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	
7	(Kara et al., 2005)	X	X	X	X	X								X	X		X	X	X			X	X	X		X	(Noori, 2015)
8	(Tohidi & Jabbari, 2012)	X	X	X	X				X						X	X	X	X	X	X		X			X	X	(Amaratunga & Dobranowski, 2016)
9	(Hou, 2013)	X	X	X	X	X								X	X	X	X	X	X					X		X	(Alcaide-Muñoz & Gutierrez-Gutierrez, 2017)
10	(Punnakitikasem et al., 2012)	X	X	X	X	X										X			X		X		X		X	X	(Chaurasia et al., 2017)
11	(Punnakitikasem et al., 2012)	X	X	X	X	X									X					X	X	X	X	X			(S. Ahmed et al., 2018a)

Number	Author	Service quality dimensions												Lean Thinking Dimensions												Author
		1. Tangibility, 2. Reliability, 3.assurance, 4.empathy, 5.responsiveness, 6.safety, 7. Efficiency, 8.Acessibility&Caring, 9.waiting time, 10.Employee involvement, 11.Org. Perfor. & colla. 12. Competency.												1. Training, 2.Cycle-time, 3 Defect, 4.employee involvement, 5.Responsiveness and perfection, 6.Waiting time, 7.Safety, 8.Cont. impr. 9. Leadership 10. Process mgt 11. Teamwork 12.Culture. 13. Customer focus/Patient satisfaction.												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	
12	(Govender et al., 2014)	X	X	X	X	X										X	X	X	X		X		X			X	(Khalili et al., 2018)
13		X	X	X	X	X								X		X	X			X	X	X		X	X	X	(Al Khamisi et al., 2019)
14	(Kafetzopoulos et al., 2015)	X	X				X							X		X				X	X	X	X		X	X	(S. Ahmed et al., 2018b)
15	(Danlami Sarkindaji et al., 2015)					X							X					X		X				X			(Al-Qatawneh et al., 2019)
16	(D'cunha & Suresh, 2015)		X	X	X	X						X	X		X	X		X			X			X	X		(Çavmak, 2019)
17	(Habidin et al., 2015)	X	X	X	X	X						X		X		X			X		X			X		X	(Improta et al., 2019)

Number	Author	Service quality dimensions												Lean Thinking Dimensions												Author
		1. Tangibility, 2. Reliability, 3.assurance, 4.empathy, 5.responsiveness, 6.safety, 7. Efficiency, 8.Acessibility&Caring, 9.waiting time, 10.Employee involvement, 11.Org. Perfor. & colla. 12. Competency.												1. Training, 2.Cycle-time, 3 Defect, 4.employee involvement, 5.Responsiveness and perfection, 6.Waiting time, 7.Safety, 8.Cont. impr. 9. Leadership 10. Process mgt 11. Teamwork 12.Culture. 13. Customer focus/Patient satisfaction.												
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	
18	(Mohebifar et al., 2016)	X	X	X	X	X	X									X		X			X					X	(Shrafat & Ismail, 2019)
19	(Al-Neyadi et al., 2018)	X	X	X	X	X								X	X		X		X		X	X		X	X	X	(Vaishnavi & Suresh, 2020)
20	(Shafiq et al., 2017)	X	X	X	X	X	N							X	X		X					X			X	X	(Abdallah, 2020)
21	(D. Lee & Kim, 2017)	X			X		X	X						X	X		X	X	X			X					(Bhat et al., 2020)
22	(Owusu Kwateng et al., 2019)	X	X	X	X	X								X				X	X	X		X				X	(Prasad et al., 2020)
23	(Zun et al., 2018)	X	X	X	X	X								X	X	X	X		X					X	X	X	(Adeodu et al., 2021)

Number	Author	Service quality dimensions												Lean Thinking Dimensions												Author
		1. Tangibility, 2. Reliability, 3.assurance, 4.empathy, 5.responsiveness, 6.safety, 7. Efficiency, 8.Acessibility&Caring, 9.waiting time, 10.Employee involvement, 11.Org. Perfor. & colla. 12. Competency.												1. Training, 2.Cycle-time, 3 Defect, 4.employee involvement, 5.Responsiveness and perfection, 6.Waiting time, 7.Safety, 8.Cont. impr. 9. Leadership 10. Process mgt 11. Teamwork 12.Culture. 13. Customer focus/Patient satisfaction.													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	
24	(Schmalbach & Maza Avila, 2018)	X							X					X		X	X	X	X			X		X	X	X	(Jain & Ajmera, 2019b)
25	(Al-Damen, 2017)	X	X	X	X	X								X	X	X	X			X			X		X	X	(R et al., 2020)
26	(Pekkaya et al., 2019)	X	X	X	X	X								X	X	X	X	X	X	X	X	X	X	X	X	X	(Mazur et al., 2019)
27	(M. Ali, 2018)	X	X	X	X	X								X						X		X		X	X	X	(Demirkesen, 2020)
28	(Raina et al., 2018)	X		X	X	X		X								X	X	X	X		X	X				X	(Alsmadi et al., 2012)
29	(Swain & Kar, 2018)	X		X	X		X		X	X	X		X	X			X	X				X		X		X	(Bowen & Youngdahl, 1998)

Number	Author	Service quality dimensions												Lean Thinking Dimensions												Author
		1. Tangibility, 2. Reliability, 3.assurance, 4.empathy, 5.responsiveness, 6.safety, 7. Efficiency, 8.Acessibility&Caring, 9.waiting time, 10.Employee involvement, 11.Org. Perfor. & colla. 12. Competency.												1. Training, 2.Cycle-time, 3 Defect, 4.employee involvement, 5.Responsiveness and perfection, 6.Waiting time, 7.Safety, 8.Cont. impr. 9. Leadership 10. Process mgt 11. Teamwork 12.Culture. 13. Customer focus/Patient satisfaction.													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	
30	(Rezaei et al., 2018)	X	X	X	X	X			X						X	X	X	X	X			X		X	X	X	(Wahab et al., 2013)
31	(Abbasi-Moghaddam M et al., 2019)			X			X	X	X		X	X	X	X		X		X	X							X	(Baashar et al., 2020)
32	(Kottala, 2019)	X	X	X	X	X								X			X	X	X			X		X		X	(Habidin et al., 2015)
33	(Abbasi-Moghaddam M et al., 2019)	X			X				X	X						X		X				X	X		X	X	(de Koeijer et al., 2014)
34	(Shuv-Ami & Shalom, 2020)	X							X		X											X					

Number	Author	Service quality dimensions												Lean Thinking Dimensions													Author
		1. Tangibility, 2. Reliability, 3.assurance, 4.empathy, 5.responsiveness, 6.safety, 7. Efficiency, 8.Acessibility&Caring, 9.waiting time, 10.Employee involvement, 11.Org. Perfor. & colla. 12. Competency.												1. Training, 2.Cycle-time, 3 Defect, 4.employee involvement, 5.Responsiveness and perfection, 6.Waiting time, 7.Safety, 8.Cont. impr. 9. Leadership 10. Process mgt 11. Teamwork 12.Culture. 13. Customer focus/Patient satisfaction.													
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	
35	(M. S. Ibrahim, 2020)	X	X	X	X	X								X		X	X	X			X	X		X		X	(Barcia et al., 2022)
36	(Došen et al., 2020)	X	X	X	X	X																					
37	(Shuv-Ami & Shalom, 2020)	X		X					X																		
38	(Alomari, 2020)	X	X	X	X	X																					
39	(Naveen & Gurtoo, 2020)	X	X	X	X	X				X	X																
40	(Barrios-Ipenza et al., 2021)	X			X			X				X															

Based on the systematic literature analysis of Table 2.1, the dimensions mostly used in the service quality improvement studies were Tangibility (90%), Reliability (72.5%), Assurance (82.5%), Empathy (85%), Responsiveness (75%), and Service quality (97.5%). These dimensions and their number of occurrences are presented using the bar graph in Figure 2.5.

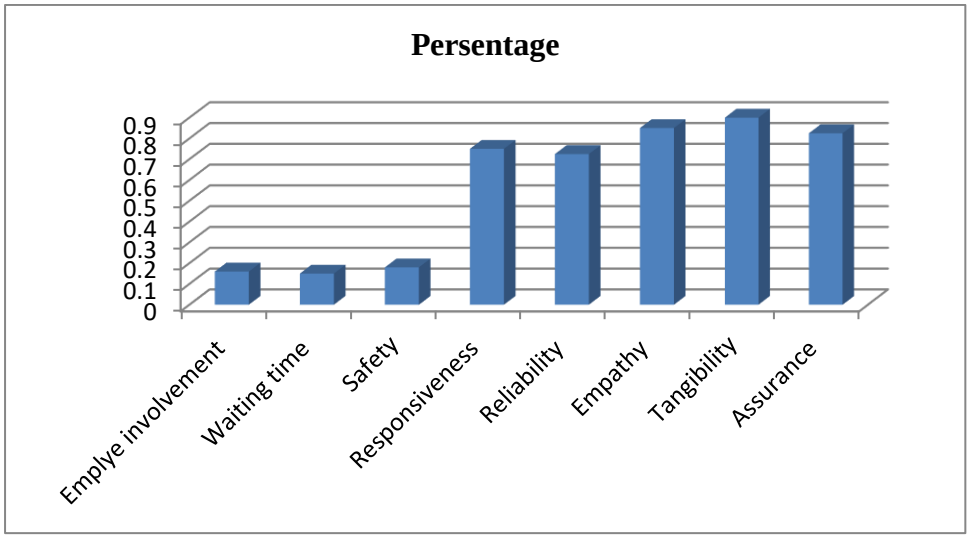


Figure 2.5: Dimensions of service quality improvement as represented in the selected literature

The study analysis based on Table 2.1 of lean thinking studies indicated patient satisfaction (82.8%), leadership (71%), Training (65.7), employee involvement (60%), responsiveness and perfection (57%), waiting for time/LOS (57%), Teamwork (54.3%), defect (54.3%), continuous improvement (40%) as the most number of dimensions and it is shown using the Figure 2.6 bar graph.

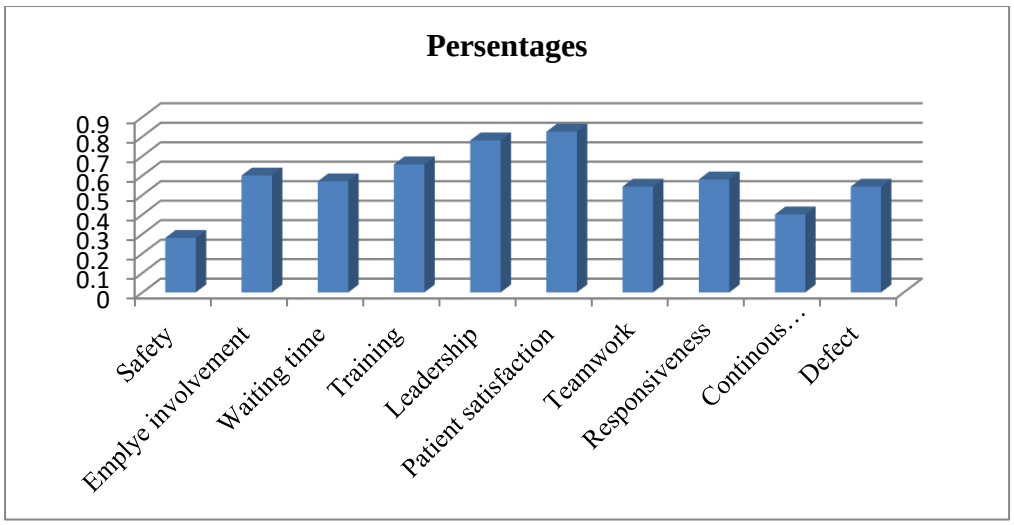


Figure 2.6: Dimensions of lean thinking as represented in the selected literature

From the above literature review analysis derived from Figures 2.5 and 2.6 or Table 2.1, the study collected service quality improvement and lean thinking dimensions to identify the most number of dimensions used in the study and common metrics among service quality improvement and healthcare lean thinking. **Responsiveness**, **safety**, **employee engagement**, and **waiting time** are the common dimensions of both healthcare service quality improvement and lean thinking of the study selected.

The systematic analysis indicates that the literature review accounted for 25.5% of the total papers analyzed, followed by the exploratory and confirmatory factor analysis methods. The most frequently used and cited methods in the systematic analysis are EFA and CFA, DMAIC, VSM, and 5S, with 11, 7, 5, and 2 citations, respectively. The DMAIC approach is utilized for improving and reorganizing healthcare service quality processes. Figure 5 illustrates the methods employed in the selected literature.

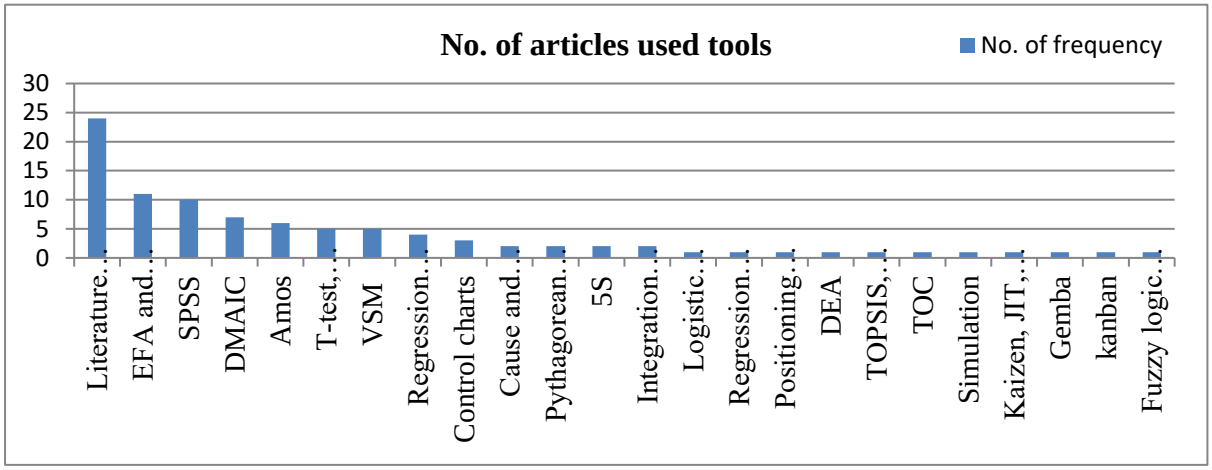


Figure 2.7: Bar graph depicting the number of publications made against methodologies

2.9. Patient Satisfaction

The primary outcome of improving service quality is patient happiness (Salem & Memari, 2016). It is a multidimensional feeling, appraisal, and the extent of patient expectations and preferences met by service providers (Al-Damen, 2017). It is all about matching patient needs, feelings, expectations, and perceptions based on service experience (RiyazhKhan & Haq, 2019). It is a fundamental driver of patient retention that results in effective and robust quality of service. Service excellence and empowered healthcare professionals lead to sustainable patient satisfaction in the healthcare system. Although improving patient flow in an outpatient setting benefits patients, healthcare providers, and the facility, it may be extremely difficult

(Kabba et al., 2020). It necessitates pertinent standardisation, which is common in many healthcare domains (N. Kim et al., 2021). Lean service quality applications should standardise key performance metrics for several aspects of service quality improvement, including length of stay (LOS), waiting time, patient education level, facilities, and readmission (Ahani et al., 2021). These elements provide a strong strategy for improving the quality of healthcare services by lowering waiting times, NVA, and medical expenses, which might lead to an improvement in patient satisfaction.

Patient satisfaction is evaluated by service availability and accessibility, service quality, patient technical and interpersonal care, and collaboration among different stakeholders measurements (Naidu, 2009). It is a higher-order dimension to change the corporate image of the sector (Izadi et al., 2013). In corporate image building, employees and stakeholder participation plays a crucial role. A satisfied patient has a good image and returns to get service with positive recommendations. According to Deb & Ali Ahmed (2018), patient`s expectations and perceptions match private healthcare more than public healthcare. This is due to waiting time, service orientation, overall experience, access to resources, patient handling, patient trust, and treatment and experience level (Deb & Ali Ahmed, 2018). Patients need preventive and curative quality service. The patient`s attitude toward service quality, service effectiveness, staff emotions, resource usefulness, and staff feelings for the patient are very important in enhancing patient satisfaction (Al-Damen, 2017). Patient satisfaction encompasses measurement indicators such as expectation, disconfirmation, performance, and willingness to recommend their satisfaction to others, which are the patient`s satisfaction (C. E. Kim et al., 2017). The satisfied patients maintain their association with medical staff, chase the prescribed treatment, and recommend good images about the sector to others.

Patient satisfaction is a crucial factor in evaluating healthcare service quality and gaining a competitive advantage for hospitals (Khansari et al., 2022), as it measures the effectiveness of healthcare systems (Khansari et al., 2022). It revolves around aligning patient needs, feelings, expectations, and perceptions based on their service experience (RiyazhKhan & Haq, 2019). This satisfaction serves as a fundamental driver of patient retention, leading to effective and high-quality service. It determines dimensions of service quality, medical tourism, and corporate image (Naidu, 2009) and acts as a higher-order factor that can transform the corporate image of the healthcare sector (Izadi et al., 2013).

In attracting a medical tourism, the participation of employees, stakeholders, and public-private partnership is crucial. A satisfied patient contributes to a positive image and is likely to return

for services while providing positive recommendations. According to Deb & Ali Ahmed (2018), patient expectations and perceptions align more closely in private healthcare than in public healthcare. This difference can be attributed to factors such as waiting time, service orientation, overall experience, access to resources, patient handling, trust, and the level of treatment and care provided (Deb & Ali Ahmed, 2018).

Patients seek both preventive and curative services of high quality. Factors such as attitudes toward service quality, service effectiveness, staff emotions, resource utility, and staff empathy are critical for enhancing patient satisfaction (Al-Damen, 2017). Indicators of patient satisfaction, including retention rates, compliance levels, and willingness to recommend services to others, provide valuable insights into the quality of healthcare received (C. E. Kim et al., 2017). Satisfied patients tend to maintain their relationships with medical staff, adhere to prescribed treatments, and promote a positive image of the healthcare sector to others. The factors related to service quality that affect patient satisfaction are:

- Patient demographic characteristics
- Perception of healthcare service quality characteristics (Batbaatar et al., 2017).
- **Technical care** (the competence, experience, and abilities of healthcare professionals) is one of the most important factors confirmed to affect patient satisfaction (Hemadeh et al., 2019).
- **Interpersonal care** (including physicians, nurses, and personnel) involves interpersonal communication, politeness, attention, empathy, responsiveness, friendliness, kindness, humaneness, emotional support, and respect for patient preferences (Batbaatar et al., 2017).
- **The physical environment** (including the cleanliness of the hospital, silence in patient rooms, illuminance, lighting design, and light distribution) is another factor affecting patient satisfaction (Cui et al., 2018).
- **Organizational characteristics** (including hospital reputation, patient safety, communication openness, feedback regarding errors, and teamwork across units)(Cui et al., 2018)
- **Access to variables** that includes three dimensions:
  - **a. Accessibility** (including shorter waiting times and simpler admission and discharge processes) (Batbaatar et al., 2017).
  - **b. Availability** (adequate numbers of nurses, physicians, and equipment) (Batbaatar et al., 2017).

c. **Affordability** (including insurance coverage and treatment costs) (Batbaatar et al., 2017).

- **Collaboration**: Governments are crucial to the delivery and control of high-quality healthcare services. The inability of governments to provide adequate services to fulfil patient expectations and attain universal healthcare is becoming more widely acknowledged. Therefore, in order to provide universal health coverage, high-quality services, and access to all services, all parties participating in the healthcare industry including the private sector must be present. Working arrangements based on a shared commitment (beyond what is suggested in a contract) between a public sector organisation and any non-public sector organisation are known as Public private partnerships (PPPs) (Pomey et al., 2015; Youssef et al., 1996). In order to improve healthcare service quality, PPPs carry out a number of tasks, including policy design, policy evaluation and monitoring, implementation, capacity building, activism, and resource mobilisation (M. Ali, 2018; Karlsson, 2022; Youssef et al., 1996). These operations address market deficiencies by offering cutting-edge technologies for inclusive development. Additionally, PPPs link businesses to government health organisations, support research, the need for complex and scientific emerging technologies, improve accessibility to the present service, and spur inclusive innovations (Karlsson, 2022). These technologies represent the cutting edge of knowledge, and their development requires information sharing across several industries (Ferreira & Marques, 2021). Additionally, PPPs increase R&D economies of scale, pool talent and scientific experts from various sectors, academia, and non-profits organizations to help managers improve service quality, patient satisfaction, and medical tourism with the aim of meeting or surpassing patient expectations (Ferreira & Marques, 2021). Independent organisations, on the other hand, can lack the staff and funding necessary to oversee, assess, and carry out several highly technical initiatives (Carvalho & Rodrigues, 2022).

2.10. Medical tourism

Medical tourism is a travel-related activities that involve visiting foreign countries primarily to seek medical care (Mohammed Abubakar, 2016) and it combines medical care with recreational activities, depending on each person's health situation (Gül et al., 2022). Due to increased global connection, information availability, the popularity of social networking sites, and the ease of access to state-of-the-art medical facilities, the graph of travel for medical

services worldwide is increasing (Cham, Lim, et al., 2021; Mohammed Abubakar, 2016; A. Zarei & Maleki, 2019).

Global population trends are undergoing significant change in healthcare service quality improvement, healthcare medical tourism and national economic growth. Patients are flowing from advanced industrialised countries such as USA, UK, Europe, and Australia to developing countries such as India, Thailand, Singapore, and Poland for the complex medical procedures and taking advantage of the reduced healthcare service (Antony et al., 2021; Douglas & Connor, 2003; Ferdinandus, 2020; Lai et al., 2020; Zhan, 2018). Asian Medical Tourism Association (2009) indicated that around 750,000 American patients travelled abroad for healthcare treatment, and that number is expected to increase to 6,000,000 by the end of 2012 (Rahi et al., 2021). This travel has a significant economic impact, particularly in developing countries (Pheng & Rui, 2016). According to several studies report, the global healthcare medical tourism sector was worth US $20 Billion in (Rahi et al., 2021). Based on this report, Thailand, India, Singapore, and Malaysia collected US$915 million from 1000,000, US$333 million from 180,000, US$915 million from 350,000, and 40 million from 400,000 medical tourists, respectively. These countries used different healthcare service quality improvement models, which are unique and complex (Abbasi-Moghaddam M et al., 2019; Brady et al., 2002; Tuzkaya et al., 2019). Hence, medical tourism is becoming a source of income globally through service quality improvement.

In the developed countries, the healthcare sector makes a substantial impact, particularly in economic contribution (Yeganeh, 2019). It is a robust and rapidly expanding sector, with global estimates of $9 trillion, compared to roughly $3.2 trillion in the United States (Hasle et al., 2021). The sector continues to be very dynamic and fast evolving in a world characterised by influences such as globalisation, demographic shifts, social upheaval, economic uncertainty, technological innovation, and patient expectation (Hasle et al., 2021). According to the Cham et al. (2021) report, about 3 USD trillion is projected for medical tourism globally by 2025, a 25% growth rate per year. In the twenty-first century, there has been a complete reversal of the trend in which patients moved from developing or underdeveloped countries to developed or wealthy nations (Adams et al., 2015; Fetscherin & Stephano, 2016; Khan et al., 2016; Mohammed Abubakar, 2016; A. Zarei & Maleki, 2019). Some of the main reasons patients choose medical tourism include relatively low costs for world-class medical care, relief from personal health risks, and avoidance of long waiting lists (Gül et al., 2022; Mahmud, Lima, et al., 2021; Sadeh & Garkaz, 2019). Among the nations that have dominated the medical tourism sector in recent decades are South Africa,

Venezuela, Mexico, India, Thailand, Malaysia, South Korea, and Singapore (Dash, 2020; Mahmud, Lima, et al., 2021; Mahmud, Rahman, et al., 2021).

Various factors such as medical treatment variety, low costs, favourable exchange rate of the economy, low waiting time, and other factors are significantly work on to attract medical tourism by the countries such as Taiwan, Malaysia, Thailand, Singapore, Costa Rica, Mexico, India, and Turkey. Medical tourism and healthcare corporate image are affected by medical staff knowledge, skill, and experience (Coutinho et al., 2019), security and safety (Cham, Lim, et al., 2021), accessibility, cost reasonableness, social aspects (word of mouth), and social media communication (Nikbin et al., 2019). Healthcare corporate/brand image is a significant factor that improves medical tourism using design, fame, and symbolism (Cham, Lim, et al., 2021) to attract worldwide travellers for services. Corporate/brand image influences the patient`s overall perceptions of the service.

Over the past few decades, Bangladesh has experienced consistent economic growth, establishing itself as one of the developing countries in South Asia (Mahmud, Lima, et al., 2021). In Bangladesh, there are two types of healthcare services: public and private. Public healthcare is heavily subsidized (Joarder et al., 2019). Despite some impressive advancements in Bangladesh's healthcare system, such as lower rates of infant and maternal mortality, patients continue to encounter poor experiences with the quality of (M. M. Ali & Medhekar, 2018; Andaleeb et al., 2007). The public healthcare system has not reached its full potential despite economic growth (M. M. Ali & Medhekar, 2018).

The public healthcare system is overburdened, facing issues such as a lack of funding, a scarcity of qualified medical personnel, profit-driven and irrational diagnoses by doctors, out-dated medical equipment, corruption, and low levels of public confidence. These factors contribute to the shortcomings of the general healthcare system in Bangladesh (M. M. Ali & Medhekar, 2018). As a result, a significant number of Bangladeshi patients travel to neighbouring countries in search of better medical treatment to alleviate these issues (M. M. Ali & Medhekar, 2018; Andaleeb et al., 2007).

While Bangladeshi medical tourists frequently visit Thailand, India, Malaysia, and Singapore, India attracts the largest share of these visitors (M. M. Ali & Medhekar, 2018). In recent years, patients from Bangladesh have made India the world's most popular destination for medical tourism; these patients have generated over 50% of India's total income from medical and health tourism in recent years (Mahmud, Lima, et al., 2021). India continues to attract neighbouring patients by providing higher-quality healthcare with modern medical facilities,

and the number of patients from Bangladesh is increasing annually (Ahmed & (Z. Ahmed & Yeasmeen, 2016).

Healthcare quality improvement is crucial for economic growth and patient satisfaction (Abbasi-Moghaddam M et al., 2019; M. Zarei et al., 2011). Competition, high patient expectations, and unique patient demands attract foreign patients (Sekaran et al., 2018). High stress levels and low service quality can lead to medical tourism. Healthcare beliefs, attitudes, and access to information influence service quality and national economic impact (Berry et al., 1988; RiyazhKhan & Haq, 2019). Countries like Thailand, Malaysia, Singapore, and India are becoming medical tourist destinations. Practitioners are focusing on service quality improvement due to longer healthcare stays, wait times, resource waste, and prescription errors (Oraedu, 2019). Key pillars include medical staff, technology integration (Srivastava & Prakash, 2019), stakeholder engagement, management commitments, and medical travel (Itumalla, 2012). Improved service quality promotes health, medical tourism, and national economic and social development, requiring skilled professionals for optimal clinical results.

Medical tourism, driven by patient expectations and perceptions, is transforming emerging nations like Malaysia, Indonesia, Thailand, and India (M. K. Rahman, 2019). These countries are promoting their medical facilities, skilled medical professionals, and high-quality treatment to attract foreign medical tourists, thereby boosting economic growth and healthcare image (M. K. Rahman, 2019). Healthcare service quality and medical tourism generate economic benefits, with Asian countries developing infrastructure to capitalize on international medical tourism (Nikbin et al., 2019). Governments must improve service quality, infrastructure, and tourism linkage activities to boost corporate image and attract skilled medical staff. Globalization connects patients (Coutinho et al., 2019), potentially building economic ecosystems in technologically advanced countries.

The Ethiopian public healthcare sector faces challenges such as a lack of funding, modern technologies, a scarcity of well-qualified medical staff, and low levels of public confidence in service delivery. As a result, many Ethiopian patients travel to neighbouring countries for better medical treatment. However, improving lean service quality in healthcare significantly enhances patient satisfaction, retention, and the attraction of medical tourism. Therefore, intensifying efforts to attract medical tourism and retain patients is a crucial element of healthcare reforms. This enhancement can boost the region’s appeal for medical travel. Consequently, the Ethiopian healthcare sector should develop an approach that improves current service quality and attracts medical tourism to foster economic growth.

2.10.1. Corporate Image

Corporate image building is the healthcare hallmark, mostly in medical service travel. In this regard, healthcare service medical tourism is a rapidly growing practice across international borders as a national industry due to efficient staff, low cost, and medical facilities (Fatehi Rad et al., 2010). Corporate image is the overall impression of knowledge, feeling, belief, or patient perception about healthcare service quality based on past experience and the current approach (S. Aydin et al., 2005). Medical staff quality, infrastructure/facility, medical care, management procedures, patient safety, and healthcare reliability are the factors that build a good image of the patient (Padma et al., 2010). Corporate image is a measure of patient perception of the degree of service quality level, employee performance, correlation, and attitude of patients toward the service delivered (Wetzel et al., 2014). A well-managed healthcare corporate image building is a promising strategy to improve service quality and patient satisfaction (Ghazali et al., 2017). It involves intangible images (high-standard treatment, reputation, good care, and kind employees) and tangible images (modern and better infrastructure, modern technology, supportive service, and parking facilities (Lemmink et al., 2003). Competent management, patient focus, reputation, and amenities are the significant dimensions that can change this patient`s image through day-to-day interaction.

High corporate image and better service quality improvement trigger medical tourism, which is dependent on healthcare providers, governments, and patient satisfaction (Abbasi-Moghaddam M et al., 2019; M. Zarei et al., 2011). Healthcare service quality deliveries are exposed to significant market competition due to increasing patient requirements to survive, high patient expectations, service market, price competition, and unique demands of the patients (Sekaran et al., 2018). Patients and healthcare service providers are exposed to high levels of stress due to a single error that costs loss of life and failure to fulfill patient requirements. Lack of healthcare service quality and patient satisfaction increases patients` discomfort ability and medical travel. Patient and service providers' beliefs, attitudes, and word of mouth ((Berry et al., 1988; RiyazhKhan & Haq, 2019), access to information, and norms may affect the service quality, corporate image, and service marketing. As a result, medical tourism is increasing from time to time to find medical service marketing.

Corporate image is critical for both corporate reputation and medical tourism. It serves as a key indicator of patient impressions, measuring and maintaining service quality to enhance patient satisfaction and promote medical tourism (Fiakpa et al., 2022; Preethy et al., 2013). The

corporate image comprises two components: a functional component, which relates to tangible features that can be measured, and an emotional component, which encompasses psychological aspects reflected in patient attitudes and feelings towards the service (Nguyen & Leblanc, 2001). Both components are shaped by the experiences of medical staff and patients.

2.10.2. Healthcare service accessibility

Accessibility is a multifaceted factor that is central to measuring healthcare medical tourism services (A. Singh et al., 2020). It refers to the ease with which a patient can obtain necessary medical care within an appropriate timeframe relative to the urgency of their needs (Dabaghi et al., 2022). Accessibility encompasses how medical care resources are organized to accommodate a diverse range of patients' abilities to contact providers, whether by telephone, during walk-in hours, or through flexible appointment systems.

Healthcare providers must adhere to customer service standards and be committed to offering accessible medical treatment that respects patients' independence and dignity. Medical tourists, in particular, have a right to receive care that is integrated into the healthcare industry, which includes access to the internet, websites, information, communication, and medical staff (Rydback, 2021). The development of the internet has significantly enhanced hospital accessibility for patients even before their arrival (George, 2021). It enables hospitals to provide information about their amenities, personnel, and services prior to a patient's discharge.

2.10.3. Medical costs reasonableness

Medical care costs play a significant role in the travel and tourism sector. Understanding whether patients perceive cost increases as appropriate or excessive is crucial for the hospitality and tourism industry (Cham, Lim, et al., 2021). Patients' concerns about pricing fairness influence their choice of services (G. Aydin & Karamehmet, 2017). The perceived reasonableness of medical prices refers to the amount patients feel they should pay to healthcare providers for medical services. This perception can significantly impact the satisfaction of prospective medical tourists and their families. Nakhaeinejad et al. (2022) found a strong correlation between perceived service quality in medical clinics and the perceived fairness of service charges. The overall cost of healthcare medical tourism includes expenses for various room sizes, food and drink, and concierge services.

2.10.4. Healthcare technicality

Technicality is a process that requires specialized methods, knowledge, abilities, and skills. In healthcare, technicality refers to the application of structured knowledge and skills through tools, processes, and systems designed to address specific healthcare issues (Woodhead, 2013). In this study, technicality pertains to the quality of healthcare services, emphasizing the technological level of communication that ensures system availability, privacy, efficiency, and reliability of high-quality equipment. According to Ahani et al. (2021), technical quality involves the accuracy and methods of medical treatment utilizing advanced mechanical equipment.

2.10.5. Interpersonal behaviour

The term "interpersonal behavior" refers to how medical staff treats patients or medical tourists with consideration and respect. According to H. Wang et al. (2023), it encompasses aspects such as perception, knowledge, communication skills, relationships, perceived service quality, and motivation. Physicians' attitudes and their interactions with patients demonstrating respect, care, friendliness, and civility reflect their interpersonal behavior, which consistently inspires confidence in patients (Vovk et al., 2021). Additionally, there is a significant correlation between patient satisfaction and medical tourism, which enhances interest in visiting medical tourism destinations (Mathijsen & Mathijsen, 2020).

2.11. Lean thinking, Service quality, and Patient Satisfaction Impact on Medical Tourism

Healthcare quality improvement is very important, especially in medical services, in order to contribute to the economic impact on individual and national growth through medical travel and service marketing. Better service quality will satisfy patients and trigger medical tourism (Abbasi-Moghaddam M et al., 2019; M. Zarei et al., 2011), significant market competition, increasing patient requirements and expectations, price competition, and unique demands of the patients (Sekaran et al., 2018). Patients and healthcare service providers are exposed to high levels of stress due to a single error that costs life and results in medical travel for better service. Service providers' beliefs, attitudes, and word of mouth (Berry et al., 1988; RiyazhKhan & Haq, 2019), access to information, and norms are the factors that build corporate image and attract medical tourists. As a result, medical tourism is increasing from time to time to find medical services abroad. Many countries like Thailand, Malaysia, Singapore, and India are

becoming medical tourist destinations to increase service marketing, foreign currency, and national economic growth.

The healthcare industry may cut down on waste from mistakes and improve procedures that benefit patients by implementing lean thinking (Kabba et al., 2020). Additionally, it raises patient satisfaction rates for service quality improvement, medical staff productivity, and healthcare productivity rates (Elboq et al., 2021). By lowering excessive expenses and waste in the healthcare process, such length of stay and waiting time, the combination of lean thinking with service quality improves patient satisfaction (S. Ahmed et al., 2018b). Lean thinking is a complementary technique that increases patient satisfaction and service quality, saves waiting time, and reduces high patient and healthcare costs to deliver distinguished services. Various studies identified the most fundamental obstacles facing the healthcare sector as long waiting times, length of stay, patients' safety, system complexities, and quality issues (Aburayya, 2020). Lim & Tang (2000) describe the healthcare sector as "Data Rich, but Information Poor."

Healthcare service medical tourism is rapidly growing across international borders as a national industry due to its efficient staff, low cost, and medical facilities (Fatehi Rad et al., 2010). Malaysia welcomed 230,000 foreign patients into the country for healthcare and medical tourism, generating about 151 million in revenues with an annual growth rate of US$40 billion to US$100 billion. As a result, Malaysia’s government updates its service quality occasionally to maintain and increase patient numbers. Malaysia is now working to diversify its economy to a service-based economy to generate well-paying employment and become a developed nation because the healthcare sector is recognized as a potential source of sustainable economic growth as it is acknowledged globally as one with an enormous industry. Different countries are striving and in competition to establish the hub of medical tourists by emphasizing quality, safety, cost, medical staff efficiency, and time to create economic growth opportunity by bringing foreign currency.

2.12. Literature Gaps

A. Service Quality and Lean Thinking Integration

Several studies have been conducted on the quality of service, patient satisfaction, and lean thinking. However, the combined research of service quality and lean thinking concepts and their effect on patient satisfaction is rare. Hence, the study attempts to integrate the two ideas and develop lean service quality to examine the effect of the dimension on patient satisfaction

and medical tourism attraction. Therefore, the study examines the impact of service quality, lean thinking, lean service quality, and patient satisfaction on medical tourism attraction.

Patient involvement is fundamentally concerned with enhancing service quality and productivity to save resources such as time, medical travel and effort in healthcare. Hence, the patient is active in service quality. In contrast, as different kinds of literature emphasize, patient is mostly a passive player in lean thinking because lean thinking focuses on eliminating waste to deliver value in isolation from the patient (Valenzuela, Estocalenko, et al., 2020). Hence, integrating service quality and lean thinking is essential to create active patient involvement. This link (i.e. service quality and lean thinking) can assist as the starting point for working on lean service quality approach. It redesigns the waste-free service process with a patient centred viewpoint to realize efficient processes and productivity. Lean thinking in the healthcare service quality improvement enhances patient satisfaction when managers understand patients' operational processes to improve healthcare productivity. Patient awareness creation enhances value creation to improve service productivity (Payne et al., 2008). Hence, lean thinking is a valuable philosophy for the healthcare system to enhance the quality of service and better understand service productivity improvement (Carlborg et al., 2013).

B. Service Design Thinking

Service design thinking addresses the gap in service quality improvement. It is an approach that incorporates both the spoken and unspoken thoughts of patients by collecting their voices. It is an all-encompassing, patient-centred (user centricity), co-creation (involving stakeholders such as users, employees, partnership and collaboration), visual thinking, and holistic approach that applies design thinking techniques to understand patient behaviour within a larger ecosystem and incorporates patients in developing and enhancing the service. Service design thinking is a systematic approach to problem-solving that centres on recognizing and comprehending both stated and unspoken patient needs through patient visualization, quick learning, teamwork, and observation. In light of healthcare restrictions, it aids in innovating new technology and service methods to meet patient requirements (Parasuraman et al., 1991; RiyazhKhan & Haq, 2019).

C. Service Quality Improvement Dimensions

Different countries use different healthcare service quality improvement models that are unique and complex in nature to balance patient expectations and perceptions (Abbasi-Moghaddam M

et al., 2019; Berry et al., 1988; Brady et al., 2002; A. Parasuraman et al., 1985a; Tuzkaya et al., 2019). Several researchers identified service quality measurement models such as Donabedian, SERVQUAL, SERVPERF, HEALTHQUAL, PubHosQual, and HospitalQual models (Endeshaw, 2021). These models have wide applications but are still debatable and controversial when measuring healthcare service quality holistically. These models are developed in industrialised countries; however, testing and modifying them in developing countries based on the social, economic, and political background of the countries as well is very important. In addition, it lacks service design, waste generated prediction to enhance patient satisfaction and medical tourism attraction.

D. Methodology Based Literature Gaps

Structural Equation Modelling (SEM)

SEM was introduced in 1970 to differentiate, represent, and analyze hypothetical and conceptual models that have structural correlations between different factors (Berhan, 2020; Hair et al., 2012). It is a multivariate regression method that examines a complex theoretical model to investigate several dependent relationships among variables and hypothesis testing (Ekinci et al., 2014). The SEM is described by a structural model (the relationship and dependencies among the latent variables) and a measurement model (determines the relationship between the latent and observed variables through a CFA) (L. T. Hu & Bentler, 1999). It contains the latent variables that represent the theoretical dimension. It provides an easy, simple, and appropriate model to build a conceptual framework and data analysis (Hair et al., 2012). Factor analysis comprises confirmatory and exploratory factor analysis. It also includes SEM and measurement models to demonstrate the relationship between latent variables and observed variables. SEM determines the influence of service quality, lean thinking, and lean service quality (Valmohammadi & Roshanzamir, 2015), the relationship between quality management and innovation (Aydin et al., 2020), and the correlation between soft and hard dimensions of the conceptual framework (Al-Mhasnah et al., 2018). SEM is the statistical test that uses CFA to determine the significance of the statistical analysis in order to decide if the data fits the model (confirm the existing correlation) (Jain & Ajmera, 2019a) and EFA explore the potential correlation and predict the path model from facts (Berhan, 2020; Hair et al., 2012). Berhan (2020); Hair et al. (2012) suggested SEM for measuring and evaluating the tools that assess risk in service sector. The SEM is known in management (Hair et al., 2012), marketing (Awang et al., 2022), tourism, healthcare and business research (Al-

Mhasnah et al., 2018). In this case, independent variables are exogenous variables that other variables cannot predict, whereas dependent variables are endogenous variables that are predicted by other variables.

This study develops the model using service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism. It uses SEM to identify linear relationships among dimensions, verify hypotheses, and measure these dimensions, but SEM lacks non-linear relationships and non-parametric models (Islam et al., 2023). The study introduces a hybrid approach (SEM-ANN) to address these limitations (Islam et al., 2023; Muñoz-Leiva et al., 2017). ANN is used to estimate factor loadings, establish regression relationships, and facilitate classification and prediction in SEM construction. This approach helps understand factors affecting medical tourism and the adequacy of healthcare service quality.

Machine Learning

When computer science improved to solve complicated computational models in the 1960s, the idea of machine learning was established (Jordon et al., 2019). To tackle a difficult multiparameter and multidimensional dataset, the idea was enhanced by several computational approaches (Jordon et al., 2020). Machine learning was able to uncover the dataset's hidden pattern by using the training dataset (Kuo et al., 2020).

In machine learning algorithms, a neural network is made up of neurones that process complex relationships between inputs and outputs; this complex network includes a hidden input layer, an output layer, an error function, and connections between neurones. Machine learning approaches are effective tools for modelling datasets, allowing the identification of trends that are difficult to capture using traditional regression methods (Vargas-Calderón et al., 2021). They also make it easier to create models that improve the precision and accuracy of waiting time predictions, thereby improving service quality.

Model accuracy is assessed by comparing the model's predictions with actual data, allowing for an evaluation of its efficiency. To effectively forecast waiting times, some writers have used machine learning approaches such support vector machines, neural networks, random forests, and linear regression (Wuest et al., 2016). Linear regression is often used as a baseline for comparison with other proposed methods (Y. Sun et al., 2011). According to Harford et al. (2022), there is a trend toward utilizing large datasets to train predictive models, alongside the application of lean thinking concepts for waiting time prediction.

In order to improve patient happiness and service quality, waiting time prediction is essential in the healthcare industry. Machine learning can forecast delays and enhance service quality by using patient perception, flow rates, and line size. Neural networks use repetition to learn, much like people do. One popular method for continuous improvement in lean healthcare is machine learning (Curtis et al., 2017). It is employed to forecast patient wait periods (Kuo et al., 2020), which are complicated by variables such as treatment length (Jordon et al., 2020), arrival time, and diagnostic test results (Clancy et al., 2023; Yuliati & Andriani, 2021). To rank patients according to urgency, many queueing models are employed, especially in emergency rooms (Nur et al., 2021).

The study's primary goals were to create a model that can approximate patient wait times and anticipate medical tourism attractions. According to Kuo et al. (2020), the machine learning system predicted patient waiting times based on recent data. The purpose of the study was to determine if machine learning could accurately anticipate waiting times using operational history data from the healthcare industry and whether the lean thinking concept might improve the performance of machine learning algorithms.

Artificial Neural Networks (ANN)

ANN is a data-driven model that can learn from data and identifies complex non-linear relationships to more provide accurate predictions than linear models (Chong, 2013; Uluskan, 2020). An ANN has a neural tendency to store experimental knowledge to deal with linear and non-linear relationships but is not suitable for testing hypotheses (Uluskan, 2020). It also has the ability to measure non-compensatory processes and offer higher prediction accuracy than linear models (Chong, 2013). It is applied to complement, analyze, measure, and verify the effectiveness of SEM constructs.

The fundamental goal of integrating SEM with machine learning is the combination of explanation and prediction to complement each other in exploring intentional and unintentional factors that impact healthcare patient satisfaction to mitigate patient risks (Shmueli, 2010). This fusion is due to the difficulties of SEM in justifying the non-explanatory domain and expected value prediction (Rigdon, 2016; Shmueli, 2010). ANN is used to improve SEM performance, explanatory model, and non-parametric approach to find non-linear effects. SEM captures linear relationships and validates the causal relationship between hypotheses, which is inadequate to model complex systems (Muñoz-Leiva et al., 2017). Due to this, ANN is recommended for insightful findings. particularly in this non-linear relationship (X. Li et al.,

2021). Therefore, the SEMANN approach is utilized to assess and evaluate of healthcare service quality.

Table 2.2: SEMANN comparison

S/N	Criteria	SEM	ANN
1	Goal	Theory building, hypothesis testing, model fitness maximization (Leong et al., 2019)	Prediction and error reduction (V. H. Lee et al., 2020)
2	Theory dependency	Strong (T. S. Hew et al., 2016)	Week (T. S. Hew et al., 2016)
3	Algorithm	Variance and co-variance based	Artificial intelligence (J. J. Hew et al., 2018)
4	Measurement	Variance	Model accuracy (G. W. H. Tan et al., 2014)
5	Linearity	Required	Optional (Leong et al., 2019; G. W. H. Tan et al., 2014)

This hybrid (SEMANN) approach provides new perspectives on the healthcare service quality assessment and patient satisfaction. In this regard, ANN was selected to estimate factor loading/regression relation, classification, and prediction in the SEM building. SEMANN was applied by a few researchers in banking, mobile commerce, and mobile payment services (Islam et al., 2023; Muñoz-Leiva et al., 2017). Hence, the SEMANN approach is used in the healthcare lean service quality and patient satisfaction to enable an in-depth understanding of healthcare service quality, lean thinking, lean service quality, corporate image, and patient satisfaction. It also determines the factors that have a substantial impact on patient satisfaction and adequacy of healthcare service quality.

2.13. Lean Service Quality Conceptual Framework

Different lean tools and approaches are combined with other philosophies to enhance further healthcare service quality performance (Bhamu & Sangwan, 2014). Since lean thinking can provide patient value in line with service quality, patient satisfaction can be enhanced by their integration. Boyle et al. (2012) integrated lean thinking and a production sustainability system to increase furniture manufacturing, service quality, and financial success and make a positive impact on the environment. The adopted lean service quality provides a robust technique to

improve service quality that increases patient satisfaction (Laureani et al., 2013; Peimbert-García et al., 2019). It solves the waste related to healthcare performance improvement initiatives such as decreasing emergency department walkouts, non-value-added activities, process variation (Zepeda-Lugo et al., 2020), inpatient LOS, and increasing patient waiting time (Zepeda-Lugo et al., 2020). It is enhanced by responsiveness, accessibility, reliability, empathy, and assurance (Kollberg et al., 2006). Kollberg et al. (2006) also stated employee involvement, tangibility, accessibility, delay, and process mapping as the critical factors for service quality and lean thinking. Lean service quality focuses on waste reduction to improve healthcare effectiveness and performance levels by reducing waste and processes that do not add value (Fiakpa et al., 2022). Lean thinking and service quality fundamentally influence service delivery speed, delivery reliability, cost, medication error (Aij & Rapsaniotis, 2017), and patient expectation and they are mutually supportive of the system.

This study has been conducted to explore the concepts of healthcare service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism. These dimensions are identified to measure healthcare lean service quality and patient satisfaction in the Ethiopian context through SEM. SEM is a well-known method introduced to determine the linear relationship among the dimensions, hypothesis verification, and its impact on endogenous variables (Islam et al., 2023). However, SEM ignores non-linear relationships and non-parametric complex models. Hence, the study introduced machine learning models into SEM to solve the SEM drawback to include non-linear relationships, model prediction accuracy, and causal analysis.

Hence, the SERVQUAL model serves as the foundation for the theoretical framework for lean service quality improvement (A. Parasuraman et al., 1991) and lean Six Sigma (Womack, J. P., & Jones, 2003) as the foundational roadmap guideline. The developed framework integrates service quality, lean thinking, and Six Sigma with machine learning techniques to support medical staff and management in addressing significant issues such as medical error and waiting time reduction to increase medical staff productivity, service quality, and patient satisfaction.

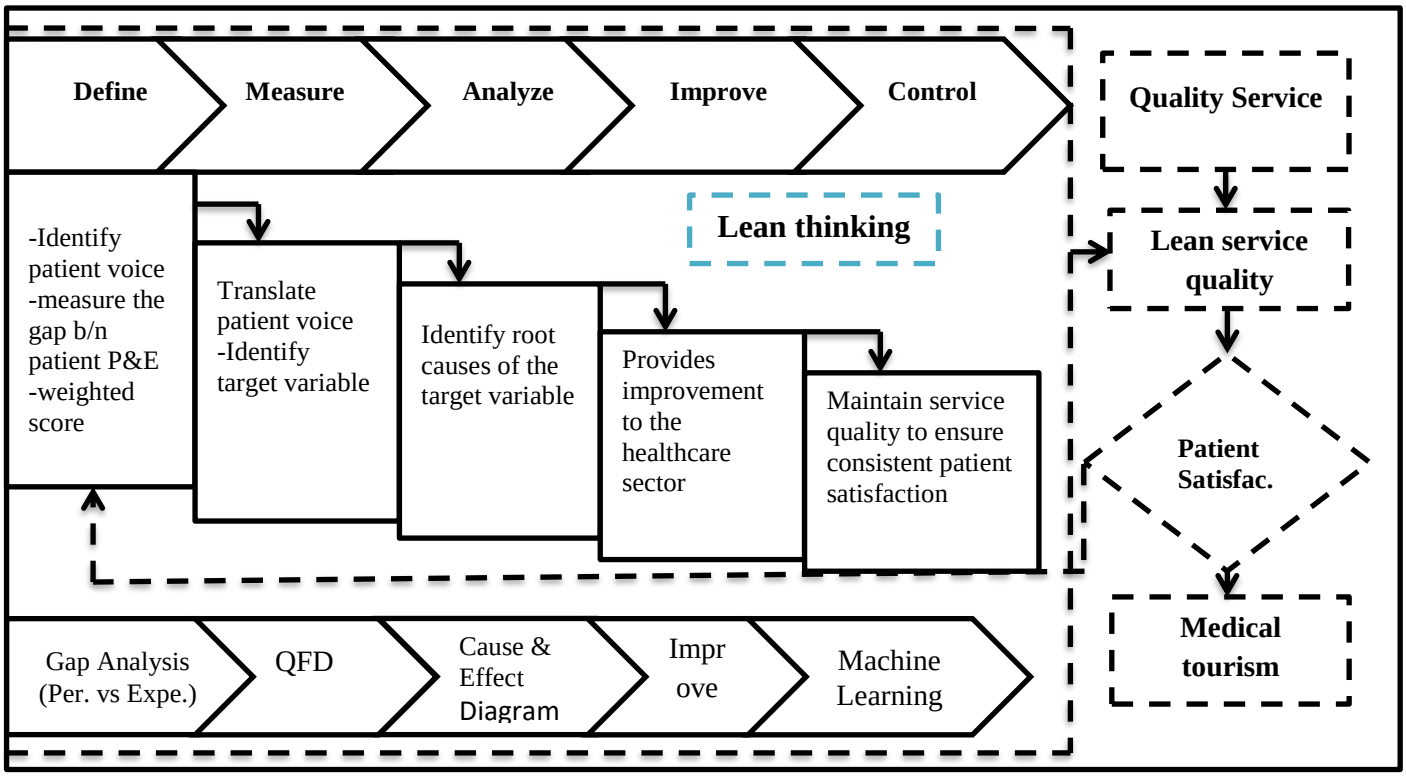


Figure 2.8: Lean service quality framework, (source from the researcher)

The goal of integrating service quality and lean thinking as indicated in Figure 2.8 is to decrease medical errors, delays, and waiting times while increasing service quality, patient satisfaction, and productivity and removing other barriers to better service quality. In healthcare, improving patient safety, patient happiness, employee morale, and teamwork dynamics are the main advantages of lean service quality.

2.14. Chapter Summary

The literature review has delivered significant insights into service quality, lean thinking, lean service quality, and patient satisfaction to enhance medical tourism and economic growth. Improving healthcare service quality is an essential issue for healthcare professionals, patients, and healthcare policy-makers, medical tourism attraction, and national economic growth. It addresses service quality landscapes, including healthcare service quality, service quality measurements, service quality dimensions, QFD, lean thinking, lean service quality, patient satisfaction, and medical tourism. An extensive literature review has been conducted to develop theories of service quality from the literature gaps and identify service quality improvement dimensions. The study develops a conceptual framework to improve healthcare service quality to satisfy patients and attract medical tourism. This aimed to analyze the existing literature on healthcare service quality and lean thinking to offer a better understanding of lean service

quality in Ethiopia. It was conducted to show how lean thinking and service quality overlap to enhance low waiting time, high responsiveness, employee involvement, and safety towards improving service quality (Aij & Rapsaniotis, 2017). Lean thinking dimensions are the tools that enhance healthcare service quality through waste reduction to enhance patient satisfaction and medical tourism.

The integration of service quality and lean thinking dimensions from healthcare case studies indicated a reduction in medication error, delay/ waiting time, and other factors that hinder service quality enhancement, as (Trakulsunti & Antony, 2018) also identified the impacts and recognizes the adoption of lean thinking to improve service quality. Its prime benefit in healthcare is enhancing patient safety, patient satisfaction, employee morale, and teamwork dynamics (Swarnakar et al., 2021). Different kinds of literature recommend a lean thinking benefit in the healthcare sector, even though unknown gaps are still there to recommend the adoption (Jordon et al., 2020; Phieffer et al., 2017).

In lean service quality adoption, lean thinking and service quality dimensions are flexible enough in a wide range of service quality issues (Vanichchinchai, 2021). It is used in financial service improvement, patient flow, healthcare admission and discharge, bed management, and quality improvement (Glasgow et al., 2010). It also enhances the success of service quality and the growth of medical staff in knowledge, skill, and experience through training when medical staff and top management in the sector are involved (Glasgow et al., 2010). Understanding lean thinking and service quality to address critical problems in the healthcare using a variety of dimensions leads to service quality improvements. Different reviewers have investigated the lean thinking dimensions such as leadership, employee involvement, training, responsiveness, continuous improvement, safety, and active patient participation (Aij & Rapsaniotis, 2017) to enhance healthcare service quality (Ahmend & Llyas, 2018). This is achieved by reducing unnecessary non-value-added variables such as medical errors, cycle time, waiting times, and costs (Aij & Rapsaniotis, 2017). This waste reduction in healthcare improves lean service quality. Lean service quality is about responding to change, where continuous improvement (i.e., lean thinking) is critical (Layik, 2021). It focuses on employees` and patients' needs and embraces change that drives continuous improvement (Dormann et al., 2020) to reduce waste within healthcare (Layik, 2021). From the selected existing literature, a lean service quality report in improving healthcare service quality is weak.

CHAPTER THREE

Research Methodology

3.1. Introduction

The systematic pursuit of new knowledge and information is the subject of research and an art of scientific inquiry. It consists of many systematic tasks, including problem definition, hypothesis creation, data collection, organisation, evaluation, interpretation, and conclusion. Prior to the actual execution, the study design and methodology must be pre-established. It aims to present the overall research design and the methodology that is used to attain the objectives of the study. It introduced the research design, identified relevant data collection (qualitative and quantitative data types), and represented the general framework of the research. The article selection was carried out using comprehensive databases Scopus, Google Scholar, Taylor and Francis, and Research Gate. Its primary purpose is to investigate the existing databases under the umbrella of service quality and lean thinking to identify possible research gaps. In this sense, waiting time prediction helps to improve the quality of lean services, especially for low-acuity patients, who require prompt treatment. Low-acuity patients in Ethiopia do not utilise precise waiting time prediction when deciding whether to seek medical attention.

3.2.Research Design

The research method was used to present the procedures and techniques for research analysis and model development to examine the research problem. In order to achieve the ultimate research objectives, the study used a mixed-methods approach, utilising both qualitative and quantitative methods aligned with primary and secondary data sources. The study's objectives were to investigate healthcare service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism. The qualitative approach aimed to validate and triangulate the quantitative data and further information that helps to improve healthcare service quality, patient satisfaction, and medical tourism. It involves a preliminary survey, preliminary literature review, problem identification, objective formulation, comprehensive literature review, questionnaire development, interview question preparation, data analysis and presentation, model development, conclusion, and recommendation.

In this dissertation, the assessment is made in the case of St. Paul`s Hospital Millennium Medical College and some selected healthcare institutions regarding service quality, lean thinking, lean service quality, waiting time, patient satisfaction, and its effect on medical tourism to point out the solution. Moreover, the study aimed to integrate service quality and lean thinking to improve healthcare service quality that enhances patient satisfaction and medical tourism. Due to preliminary assessment and the presence of problems in the area, the case study was chosen specifically for outpatient departments. To address the quality problems in healthcare services caused by long waiting times, patient flow issues, and non-value-added activities, the study employed both qualitative and quantitative methods to investigate the current healthcare situation.

The research design was intended to arrange ideas, concepts and provide appropriate research frameworks. Jang et al. (2016) defines research design as a plan for the study, providing the overall framework for understanding the research work. Ibrahim et al. (2021) also stated it as a plan for selecting subjects, literature review, data collection and analysis, and model development to answer the research question(s). The first phase is used to identify preliminary research gaps, problem statements, and objective formulation. The second phase reviews the existing literature, identifies research gaps, and proposes a conceptual framework. The third phase deals with data collection and analysis. The fourth phase works on healthcare lean service quality model development, and the last phase states the research conclusion and future work direction.

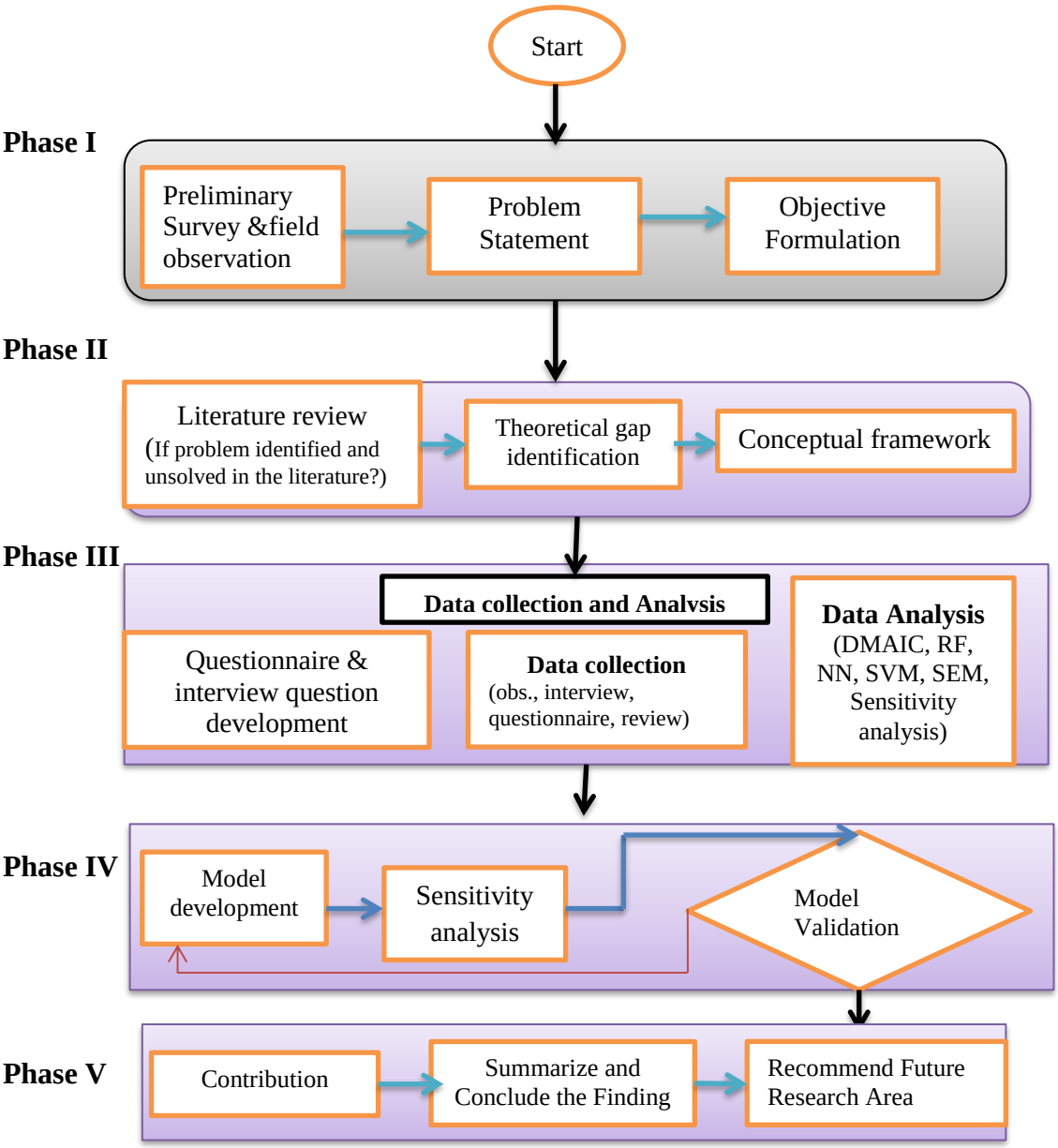


Figure 3.1: Research design framework (source: developed by author)

The study formulated the problem statement based on the healthcare sector`s inherent problem and lean service quality practices and service delivery. The study`s objectives was also framed to answer the research problem incorporating research question.

The study used explanatory data analysis to explain causal relationships between service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism. It also identifies if service quality and lean thinking improvement enhances medical tourism. Hence, the study investigated the lean thinking and service quality concept, improvement methods, and its

contribution for patient satisfaction and medical tourism in line with the current practice and challenges of healthcare service quality improvement from global to regional perspectives to the state of the art and knowledge gap. The study used systematic literature review to perform a generic review of service quality and lean thinking in the healthcare sector until results are obtained. The study used Google scholar, Elsevier, Emerald, Inderscience, Science Direct, and Taylor and Francis.

3.3.Data collection and analysis method

3.3.1. Data collection method

The goal of the study was to find healthcare waste in order to enhance the quality of healthcare services. Based on the identification of the dimensions, a conceptual model was developed. To collect data on healthcare service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism attraction, 31 measurements were prepared based on the SERVQUAL model and lean thinking principles, using a 5-point Likert scale (where 1 indicates strong disagreement and 5 indicates strong agreement). From this data collection, five dimensions were formulated to create the structural equation model (SEM).

After undergoing pilot testing () and peer review, the questionnaire was modified as needed to remove repetition and increase clarity. Participants were selected based on their understanding of service quality, lean thinking, and medical tourism, with additional information provided as needed. The study collected the data over a period of one year, from January 2023 to August 2024. It takes around fifteen to twenty minutes to complete the questionnaire. The researchers distributed 280 questionnaires to achieve the required sample size. To ensure a diverse data set, the researchers circulated the questionnaires across various departments and maintained regular contact with respondents. As a result of intensive daily follow-ups, 234 questionnaires were returned. However, nine were excluded from analysis due to significant missing data, leaving a final count of 225 usable questionnaires and a response rate of 80 percent. To enhance understanding of the framed questions, the items were adapted from validated measurement scales used in similar research. This approach ensured appropriate dimensions coverage while benefiting from established reliability and validity.

A questionnaire, observation, stopwatch, and interview from St. Paul's Hospital were used to gather pertinent data. The data was collected from different medical staff, patients, and top management about waiting time, patient service time, arrival time, patient expectation, patient perception, accessibility, and patient flow. There has never been a publication of the primary data collected from outpatient patients. The exploratory research methodology was used to examine the dataset

and develop relationships between the variables in order to generate meaningful hypotheses. Exploratory research is useful when the goal of the study is to become familiar with a phenomenon or gain new insight into it in order to define a more precise problem or build a hypothesis, according to Rani (2016). Ulhassan et al. (2013) explain the kinds of problems that are worth investigating and testable hypotheses to frame in a way that they can be investigated using particular designs and procedures and develop appropriate means of collecting data. Through the use of machine learning techniques to anticipate healthcare waiting times and detect healthcare waste, the study aimed to enhance the quality of healthcare services.

Table 3.1: Data collection methods and data analysis tool

No.	Specific Objectives	Source of data	Data collection method	Data analysis tool
1	Assessing the current challenges of service quality in medical tourism at St. Paul's Hospital Millennium Medical College.	Case hospital and Literature review	Primary and Secondary data	Literature review
2	Identifying key factors affecting patient satisfaction in the context of medical tourism in the Ethiopian healthcare sector.	Case study, Literature review	Primary & secondary	Literature review
3	To measure patients' perception of the quality offered in the Ethiopian healthcare sector, specifically at St. Paul's Hospital	Case study	Primary & secondary	QFD, Gap analysis
4	Developing a healthcare waiting times prediction model that improves patient satisfaction of St. Paul's Hospital Millennium Medical College.	Case study	Questionnaire, stopwatch	DMAIC, QFD, Cause & effect diagram, Machine learning (RF, SVM & NN)
5	Developing a conceptual framework that attracts medical tourism by enhancing patient satisfaction.	Literature review, case study	Primary & secondary	SEMANN, sensitivity analysis

3.3.1.1.Primary Data Source

I. Preparation of Interview question

The study made a conversation with different selected key informants such as patients, medical staff, and top management to collect their opinions about the service quality, patient expectations, patient perceptions, healthcare waste, to reject irrelevant ideas that are included and relevant ideas that are missed. The study prepared simple questions for the interview that focused on patient waiting time, patient requirements, technical specifications, and other wastes in the sector.

II. Questionnaire development

The study developed the questionnaire based on the previously used accessible scales and checked to see if they were simple to interpret in Ethiopia`s healthcare context. The suitable measurements that tested in different countries were used to determine the significance of the five dimensions. The questionnaire was developed based on research purpose and target audience, concise and keeping the questionnaire as short as possible while still capturing the necessary information. Then, a modified format was created and distributed to patients, medical staff, and students. A structured questionnaire comprising demographic data and thirty-one measurements of lean service quality under five dimensions was employed in the study. The lean service quality metrics were derived from the SERVQUAL model and the literature on lean concepts. Every lean service quality item was adjusted in accordance with the SERVQUAL model, academics, professionals, and researchers' arrangements. A 5-point Likert scale was followed by an arrangement scale that went from 1 lowest to 5 highest. The study effectively covered most of the healthcare service quality dimensions by selecting five lean service quality dimensions: service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism.

III. Observation

Observation is one of the data collection methods that gather valuable information about the patient experience, technical requirements, interactions between patients and medical staff, and patient waiting times. The study collected data by observing patient service times and patient flow during the treatment period in the healthcare sector. The patient flow data includes waiting times, arrival times, time at the registration counter, and departure times, as well as the number of staff and doctors at each stage.

3.3.1.2.Secondary Data Source

The study utilized secondary data from statistical records, journals, medical magazines, and healthcare datasets. It reviewed various literatures to identify, evaluate, and interpret studies, aiming to recognize gaps in the existing literature. A comprehensive systematic literature review was conducted to gain insights into service quality, lean thinking, patient satisfaction, and medical tourism attraction.

I. Sample Size Determination

Sampling is an approach of selecting the representatives of the individual from the population to determine characteristics of the whole population. The study used purposive sampling, which is the most commonly used sampling method in clinical research (deliberate selection of patients, medical staff, and management personnel and data management staff). The sample is selected based on the purpose or selective sampling method to collect the data from the appropriate samples representing the population. Purposive sampling is the most commonly used in clinical research where patients who meet the inclusion criteria are recruited in the study. The sample that was used for this study is selected from the population of the study and the sample size was calculated. 924 patient data was used from OPD, inpatient, emergency, card room and laboratory for machine learning and 225 patient data was used for SEM.

II. Sampling Plan

Data sample size refers to the number of responses to be included in the study; sample size determination is very difficult because it involves several qualitative and quantitative reflections on the research study. The most basic part of research work is sample selection for data collection because it is not possible to cover all the public in the study; therefore, it is essential to draw out sample data that can represent the population. Purposive sampling is used to collect respondents' opinions on the subject of the study. During the sample size determination, some important qualitative dimensions that should be measured in formulating the data size include judgment, investigating the environment, number of items, nature of the analysis, and data size. For infinite population, when the standard deviation, sample, and population mean are not known, sample for proportion with maximum variability. The sample size determination for patients is determined using the following formula by Jha et al. (2016).

$N = (Z\text{-score})^2 * Std.\ Dev.* (1-Std.Dev.) / (margin\ of\ error)2$

The study assumes a 95% confidence level, with a Z value of 1.96 based on the normal distribution table, a standard deviation of 0.5, and a margin of error of ± 5%. As a result, we have computed N, the study assumed (Z-score = 1.96, Standard Deviation = 0.5, margin of error = ± 0.5).

$$N = \{(1.96)^2 \times .5(.5)\} / (.05)^2$$
$$= (3.8416 \times .25) / .0025$$
$$= 0.9604 / .0025$$
$$N = 384.16$$

Based on the previously described calculation, the minimum sample size need to be 384. With a 95% confidence level and standard error level maintained within 0.5 of the value, a 5-point Likert scale would enable the assessment and effect of customer perception of service quality in the context of private healthcare.

3.3.2. Methods of Data Analysis

The study used a confirmatory factor analysis (CFA) and SEM using AMOS 23 to test the relationships between measurements and measurement model.

I. DMAIC

DMAIC was used to analyze LSS problems specifically to reduce prolonged healthcare waiting time. It is adopted to bring sustainable service quality to enhance patient needs. The utilisation of the DMAIC approach in the study was extremely to reduce waiting time, service quality improvement, and patient satisfaction. The patient voice was collected to distinguish their functional and technical requirements through QFD. During the Define Phase, the patient perception and expectation were gathered, and the gap in service quality was measured, whereas, in the Measure Phase, the patient voice was utilized to evaluate the high-weighted score measurement. In addition, when applying the Analyze Phase, a cause-and-effect diagram was introduced to determine the potential underlying reasons of the issue. Finally, during the Improve and Control Phase, machine learning tools such as RF, NN, and SVM were employed. Moreover, models for predicting healthcare waiting times were constructed using a machine learning technique.

Quantitative data gathering was employed to evaluate the actual waiting times and related factors. Different machine learning algorithms was used to control the waiting times, and their performance using performance metrics. From the machine learning, the study used random forest, neural

network, and support vector machine based on data size and problem complexity to develop a model that predicts healthcare waiting time. These machine learning models used 924 datasets to differentiate strong relationships between the critical variables. During data collection, urgent, semi-urgent and non-urgent patients are considered for the study. The study collected actual waiting time and pursued the factors that increase patient waiting time to improve service delivery.

II. SEM and ANN (SEMANN)

The fundamental goal of this study is to assess healthcare lean service quality through the SEMANN approach. A SEM technique was used to measure causal connections between complex factors. The SEM checks model internal consistency between measurement and constructs, validity and relationship. In order to improve healthcare service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism dimensions are used in model development. In this data collection, five dimensions were developed to formulate SEM. In this regard, the hypotheses that were determined from the literature were tested using the dual approach of SEM. The study utilized an artificial neural network (ANN), specifically a multi-layer perceptron with input, hidden, and output layers (Leong et al., 2019). The developed SEM was verified and decomposed into three ANN models: ANN Model 1: The output variable is lean service quality, with lean thinking and service quality as input variables. ANN Model 2: The output variable is patient satisfaction, with lean thinking, service quality, and lean service quality as input variables. ANN Model 3: The output variable is medical tourism, with lean thinking, service quality, lean service quality, and patient satisfaction as input variables. The study applied the sigmoid function for non-linear activation using min-max normalization. SEMANN analyses were conducted using the 23 versions of IBM SPSS, AMOS Graphics, and Python software. Sensitivity analysis assessed the predictive power of SEMANN, determining how changes in the model's inputs affect the outputs, and identifying the inputs that significantly influence the model outputs. Table 3.2 offers the method employed for data analysis to attain the research objectives.

Table 3.2: Data analysis tools

No.	Methods	Description
	Literature Review	**Systematic Literature Review**
1	**DMAIC**	Six-Sigma is more about changing the mindset of people, making a shift from a traditional approach of problem-

		solving (i.e. fire fighting) to a proactive approach, based on facts and the correct analysis of healthcare data for decision-making purposes. The tools and techniques of Six Sigma are used for collecting, analyzing, and interpreting data to drive decisions. Six-Sigma is result-oriented and therefore places a clear focus on bottom-line business impact in hard dollar savings. It defines patient requirement and determine the baseline of the process and find clues to understand the root cause of the problem in the process. DMAIC is a systematic problem solving tool for healthcare process improvement to identify, analyze, improve and control process variation. It is a systematic problem solving tool for healthcare process improvement to identify, analyze, improve and control process variation
2	**QFD**	The QFD was introduced to design healthcare service by identifying patient requirements and translates it into specific technical requirements.
3	**Cause and Effect Diagram**	It was used to identify the potential causes of service quality problem and differentiate the root causes.
	SEM (SPSS, AMOS)	A comprehensive tool for building and analyzing a structural model involving causal relationships between complex factors. The SEM checks model internal consistency between measurement and
4	**Machine Learning:** It enables the system to acquire the knowledge, build incredibly complex models that predict patient expectation, waiting time, LOS, and medical	**Support Vector Machine**: is a robust efficiency and accuracy prediction than traditional method but low overfitting and missing data management
		Random Forest: it has the ability handle noisy data, classification accuracy and better estimation accuracy with limitation of low learning skill and missing data management. RF trained several decision trees

	diagnosis using RF, NN, and SVM to improve their performance through experience.	instantaneously to yield high accuracy single output by combining the outputs of all decision trees.
		Neural Network: Accurate prediction accuracy, flexibility, correlation and classification for nonlinear complex system. It can handle noisy data.
5	**Deep learning:** is a multiple hidden layers of artificial neural network that uses a large dataset to make accurate prediction	**Recurrent Neural Network:** data analysis and prior knowledge is not needed but has a problem of vanishing gradient and requires large dataset
		Convolutional Neural Network: predict nonlinear, multidimensional and complex system in accurate manner for feature extraction but requires large dataset for training
		LSTM: prior knowledge and assumptions are not required for accurate estimation but needs large dataset and expensive. It has a Capability of supervising a large amount of data

3.4.**Reliability Test**

The main goal of the reliability test is to determine whether the data is trustworthy. Reliability refers to the extent to which a set of variables in these case, measurements is consistent in what it is intended to measure. The internal consistency between measurements and dimensions are evaluated using a reliability test.

The model's internal consistency and validity were assessed through various tests, including discriminant, convergent, and goodness-of-fit statistics. This evaluation included reliability measures such as composite reliability (CR), average variance extracted (AVE), Cronbach's alpha coefficient, and standardized factor loadings. The study employed Cronbach’s alpha coefficient to test the internal reliability of the variables using the Statistical Package for the Social Sciences (SPSS). A 95% confidence interval was set as the threshold value for acceptable levels of data reliability. Additionally, a pilot test of the measurements was conducted in the study areas to identify unrelated, ambiguous, and redundant questions.

3.5.Ethics considerations

The study was discussed with the healthcare's top management and senior quality manager to obtain permission from the Case Hospital, affirming adherence to the ethical principles outlined in the 1964 Declaration of Helsinki and its subsequent revisions. The self-administered primary data collection utilized a convenience sampling method to select participants based on their discomfort levels, understanding of healthcare quality, and educational background. This approach ensured comprehension of the presented ideas while adhering to COVID-19 protocols. Participants provided verbal informed consent prior to completing the questionnaire. They were clearly informed that participation was voluntary, and that completing and submitting the questionnaire constituted their consent to participate. Comprehensive details about the study's objectives, the voluntary nature of participation, and assurances of confidentiality were communicated during the consent process.

3.6.Data pre-processing

To achieve appropriate performance in model accuracy, the machine learning model uses data pre-processing to enhance the quality of the data for training and testing. Before the model learns, it looks into duplicate, noisy, and missing data to improve data quality. Healthcare datasets may have high dimensions, and data dimension reduction is required in compressed form. This dimensionality reduction is useful for healthcare service quality improvement prediction by maintaining suitable features. However, it reduces machine learning model performance due to training process quality and learning model accuracy. In this regard, it creates a loss of some information. When the data size is big, data reduction techniques such feature extraction (i.e., new datasets with smaller data sizes than the original dataset) and selection (i.e., the best subset of features) are employed (Bolhasani et al., 2021). Data missing value prevention is very important to increase data quality and performance models because it reduces model performance. It is managed by removing the missing data and estimating the value missed. In order to improve the quality of the model, the other data management technique is noisy healthcare data prevention, which filters and eliminates the noisy data using expert knowledge. After the data has been cleaned, the model is constructed and assessed. Arrival time, waiting time, and the time the doctor saw the patient are all included in the cleaned data. The departments in the research were processed using a one-hot categorical encoder approach. The relationship between the arrival time, the time the doctor saw the patient, and the waiting time was examined using the Pearson correlation.

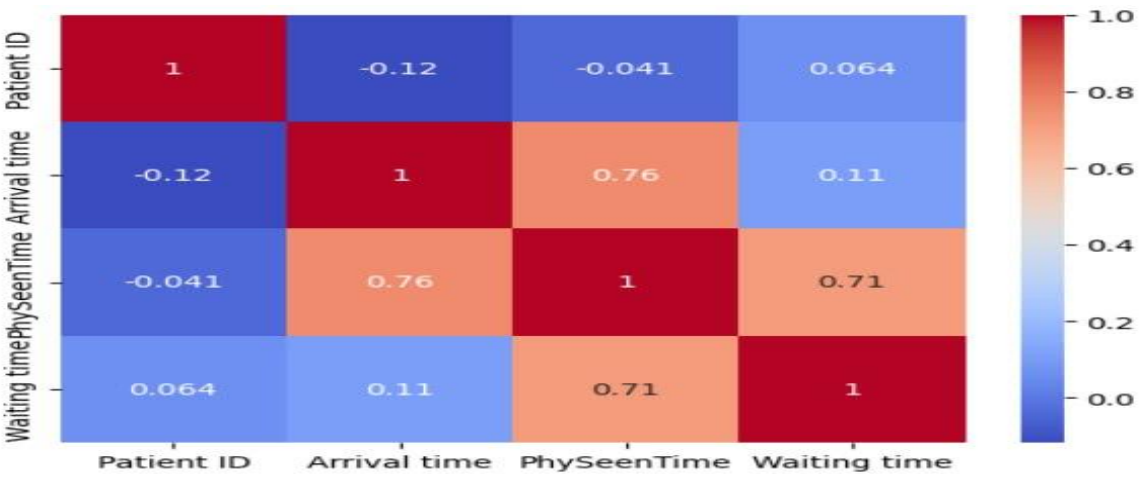


Figure 3.2: Pearson correlation

Waiting time, physician-seen time, and arrival time variables have strong correlation.

Chapter Four

Data Analysis

4.1.Introduction

Healthcare service quality is recognized as a vital aspect of socio-economic development (Somé et al., 2019). Indeed, different practitioners and policy circles concluded that healthcare service quality leads to substantial economic growth as it is the cause and consequence of economic gains by reducing healthcare waste and improving service quality (Somé et al., 2019). Therefore, there is a significant correlation between waste reduction, service quality improvement, healthcare outcomes, and economic growth.

This chapter presents the survey of selected healthcare sector investigation in the concepts of lean service quality practice. The factors that influence service quality of healthcare were investigated to realize the existing healthcare service delivery and to improve lean service quality. LSS, i.e., the DMAIC approach, is broadly applied in the healthcare sector. It is a structured problem-solving tool that realizes healthcare service quality improvement. The lean service quality & Six Sigma contribution to the healthcare sector improvement is assessed. Along with that, healthcare lean service quality improvements such as machine learning for prediction purposes were also identified.

Lean thinking capture the attention of different sectors to reduce waiting times, which significantly affects patient perception (Scala et al., 2021). The fundamental effect of lean thinking in healthcare regarding high waiting time is to enhance low patient safety, healthcare cost, low service quality, low patient satisfaction, low productivity, and national economic growth (Hamdan et al., 2019). Because they affect patient perception, lengthy wait times are one of the lean wastes that negatively impact service quality and patient happiness (Fiorillo, 2021). This waste is unavoidable, but making an accurate prediction and providing appropriate information to patients can improve patient satisfaction. The prime waiting time determinants are medical staff availability, medical staff pace to investigate patients, increase in patient flow, high workload, and limited resources (Naidoo & Mahomed, 2016). Since accurate waiting time estimation is difficult, machine learning algorithms are the best choice. It is an effective technique to predict the healthcare waiting time using a large dataset. It lacks the possible failure prevention of service quality and service design in improving service quality. Further investigation in the lean service quality, waiting time prediction, service design, service failure, and DMAIC and machine learning methodologies is to minimize healthcare embedded waste. Therefore, in order to improve service quality and patient happiness, the research

introduced healthcare service quality, lean thinking, and Six Sigma integration. Additionally, lean service quality uses machine learning to identify non-value-added activities and patient waiting times. Lean service quality integration with machine learning algorithms has a significant impact on improving healthcare service quality (Moyo et al., 2018). Therefore, in both inpatient and outpatient departments, decision-makers and medical staff all contribute significantly by offering accurate data that helps with prediction and reduces healthcare waste (El-Bouri et al., 2021). In the healthcare service design, QFD is applied by considering patients' requirements and transforming them into technical or engineering requirements to reduce prolonged patient waiting time, which in turn improves patient satisfaction.

4.2.Define, Measure, Analyze, Improve and Control (DMAIC)

One of the major objectives of carrying out this investigation was to reduce the hidden and unhidden waste to improve healthcare service quality through human and technical factor examination. Lokesh et al. (2020) scrutinized the DMAIC approach to reduce the process variation in the healthcare and the occurrence of medical service failures. Service quality improvement is the fundamental art of several business industries, such as the healthcare sector. This healthcare quality improvement is the potential factor that delights and delivers considerable advantages for patients. The patient`s prolonged waiting time, which is measured in hours, is the service quality improvement chosen in this case. After problem identification, healthcare process performance was measured in the measure phase. The healthcare environment`s complexities, in comparison with other sectors, are unique and challenging and need continuous improvement in application approaches such as lean, Six Sigma, and LSS. Six Sigma is a service quality measurement tool and data-driven approach that attempts to remove process defects and close to perfection. DMAIC is a LSS problem-solving technique used for waste reduction (Jordon et al., 2019). It has undergone constant modification to enhance the standard of sustainable healthcare. In order to improve patient happiness, it also lowers waiting times, medical expenses, and environmental factors.

4.2.1. Define Phase

The first phase of the DMAIC technique is "Define," which aims to define patient voice (VOC) (i.e., patient requirements). The Define phase is used to identify the critical healthcare service quality characteristics by creating a QFD structure to determine the relationship between the technical and functional requirements of the factors that affect patient satisfaction. It focuses on the

healthcare problem and understanding patient objectives (Clancy et al., 2023). The patients` demand requirement from entry to exit of the healthcare sector is studied. The patients' voices were collected to validate the healthcare problem area (Sunder M et al., 2020). It was to find the critical patient voice requirement affecting patient satisfaction, service quality, and patient waiting time (Lokesh et al., 2020).

In this analysis, lean Six Sigma should put a high focus on the QFD technique to listen to patient requirements and measure service processes such as processing and response time to understand their needs. The QFD emphasizes understanding and identifying what patients need and want to prioritize service. The patient voices were gathered using the Likert scale to establish clear patient needs and expectations. Based on patient requirements, technical requirements were determined to construct a relationship matrix following experts and literature viewpoints, keeping the improvement direction and importance ratings in mind. The higher weighted score rating implies the most important patient requirement that needs consideration and further improvement. It is calculated by multiplying the importance rating by the sum of the relationship in the matrix. Figure 4.1 illustrates the steps for analysing the DFD process.

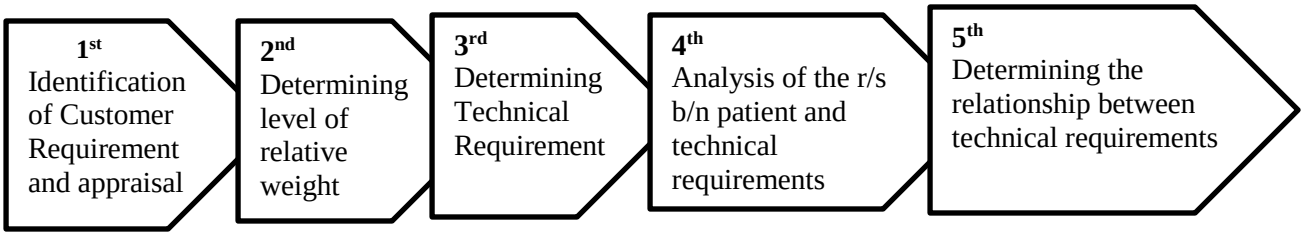


Figure 4.1: QFD Analysis Process (Source: Author)

The define phase identified the fundamental problems that affect the patient treatment process. Patient voice requirements were collected through questionnaires with patients and medical staff. A Likert scale was employed to determine the healthcare service quality patient expectation and perception level. 118 respondents responded out of 130 distributed questionnaires. Then after, the study analyzed the data collected through qualitative and quantitative methods to provide necessary information to increase service quality. The reliability test was measured using Cronbach's alpha coefficient to check the validity of the measurement (Kottala, 2019). From the Cronbach alpha analysis, 0.947 for patient expectation and 0.984 for patient perception were scored. Thus, the reliability test of the collected data indicated reliable internal consistency for the service quality improvement level (Xing et al., 2020). Table 4.1 indicates the average patient perception, average

patient expectation, the gap between patient perception and expectation, importance weight, and weighted scores.

Table 4.1: Patient perception and expectation measurement

Measurement	**Perception (P)**	**Expectation (E)**	**(P-E)**	**Importance weight**	**Weighted score**
Measurement 1	2.83	4.02	-1.19	8	9.52
Measurement 2	1.74	2.91	-1.17	6	7.02
Measurement 3	3.79	2.23	1.56	6	9.36
Measurement 4	2.78	3.44	-0.66	6	4.62
Measurement 5	2.56	3.89	-1.33	7	9.31
Measurement 6	1.93	3.46	-1.53	7	10.71
Measurement 7	2.37	4.74	-2.37	8	18.96
Measurement 8	2.89	2.85	0.04	8	0.32
Measurement 9	4.36	2.53	1.83	7	12.81
Measurement 10	2.19	3.86	-1.67	7	13.36
Measurement 11	4.26	2.84	1.42	8	11.36
Measurement 12	1.95	3.68	-1.73	6	10.38
Measurement 13	2.46	3.63	-1.17	8	9.36
Measurement 14	2.58	4.19	-1.61	8	12.88

4.2.2. Measure

The second phase of the lean six-sigma methodology is the measure phase. It is one of the patient requirement information measurement mechanisms to differentiate the most weighted score based on patient needs (Clancy et al., 2023). It is fundamentally important to measure the healthcare process that causes patient dissatisfaction. In the healthcare process patient time and money are wasted due to non-value-added processes in the sector. It also measures the data quality problems and prepares all steps to build the model based on the raw data (Clancy et al., 2023).

When there is no correlation between patient expectations and technical requirements, the correlation matrix is empty to save space. The study used 1, 3, and 9 symbols to represent weak, moderate, and strong relations respectively. These symbols are represented by shaded circles, circles, and upward triangles, respectively. The shaded circle indicates a strong patient requirement

relationship, whereas the circle indicates a moderate patient requirement. The relationship is represented with an upward triangle when the improvement is weak.

There is a correlation among each technical requirement that may affect one another positively or negatively. These correlations are described through a correlation matrix called a house of quality. The correlation matrix used (+) for positive correlation and (-) for negative correlation and X when there is no relationship between them. The correlation matrix shows the technical requirement if they had a negative or positive correlation with each other. According to Figure 4.2, the healthcare service quality and lean thinking measurement indicated a high score regarding patient waiting time followed by responsiveness of service during the medication. A weighted score of the patient requirement identification is very important for QFD analysis. QFD explored patients` needs and aligned them with standardized process specifications to meet the healthcare service quality process. It is a patient-driven approach that designs healthcare processes to increase service responsiveness. Different brainstorming sessions were held with patients, medical staff, and management to identify the ‘what`s and ‘how of the service quality and waiting time problem.

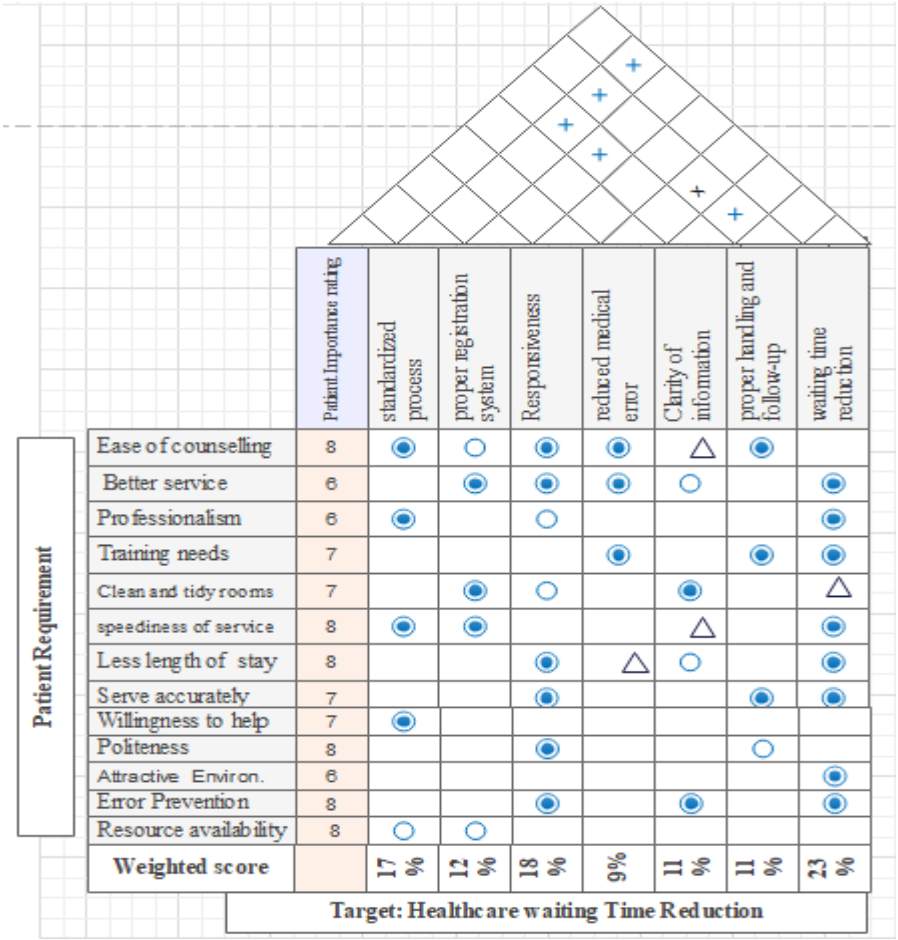


Figure 4.2: House of quality (Source: Author)

4.2.3. Analyze

This phase analyses different healthcare waiting time root causes that create prolonged healthcare waiting times (Clancy et al., 2023). The analysis phase identifies bottlenecks, process inefficiencies, and non-value-added activities to differentiate the potential causes of healthcare waiting time (Gijo & Antony, 2014). Responsible factors for poor patient satisfaction regarding long waiting times and length of stay, are identified using a cause-and effect diagram. A cause and effect diagram is drawn based on the healthcare observations and discussions with medical staff and patients. In developing and analyzing cause and effect diagrams, six categories, such as patient, materials, medical staff, process, machine, and management, are created. The 27 causes under each category are overcrowding, diagnostic test delay, facilities, access, shortage of manpower and drugs, patient service priority, admission capacity, searching patients, excessive laboratory tests, and other medical records. Data preparation, data cleaning, and integration of the data from different departments are also analyzed to predict the healthcare waiting time. The root cause of the problem related to healthcare service quality improvement is illustrated in Figure 4.3.

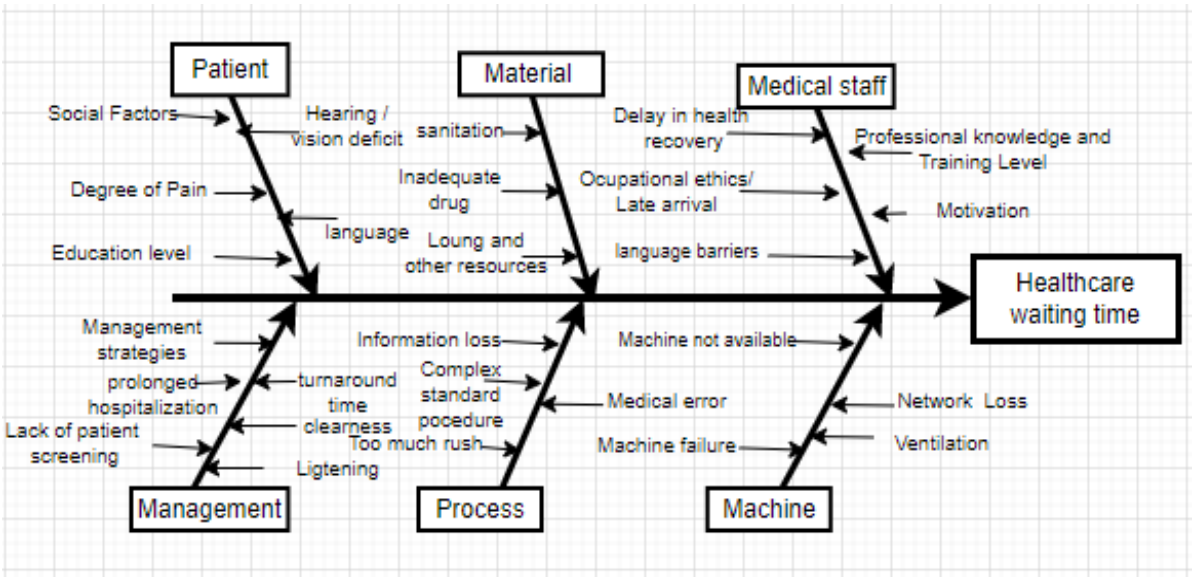


Figure 4.3: Cause and Effect Diagram of prolonged healthcare waiting time

4.2.4. Improve

Healthcare service quality improvement is made by enhancing service quality performance and predicting the healthcare wastes in order to increase patient satisfaction. The improve phase employs the insights resulting from the analyses to provide improvements to the healthcare. It is the deployment task that involves the evaluation results in the analysis phase.

It determines the waiting time and patient flow smoothing for service quality improvement. This improvement is made by identifying registration waiting time, waiting time for consultation, and treatment time.

Table 4.2: Causes and corrective measures to reduce patient waiting time.

S/N	Causes	Descriptions	Solution
1	**Input (**patient. Medical staff, management**)**	Slow registration, incomplete information, leaving the office for refreshment, taking a long time over the phone, sensitivity to patient issue	Print out paper prescriptions, working for international healthcare standards, training, patient friendliness, medical staff professionalism, complaint handling, and knowledge.
		Too much rush, inability to read and low level of education, Poor patient communication, lack of information, and aging of the population	Patient scheduling, printout paper prescriptions, spending more time with patients, patient scheduling through calls and emails and the information desk
2	**Resource (**machine and material)	Shortages of resources and staff commitment	Real-time updating application for drug and inventory management, training, and adoption of outsourcing strategy.
		Limited staff, access, late arrival	Increasing access, medical staff, and working time and patient scheduling
3	**Method (**process**)**	Limited working hours and medical error	Beginning three shifts per day, training and medical error prediction
		Long waiting time	Increasing access, medical staff and working time, patient scheduling, patient rerouting in addition to normal root, and waiting time prediction

Source: (adopted from American Society for Engineering Management, 2018)

4.2.5. Control

This phase is the final stage that concentrates on maintaining the quality of healthcare service to ensure consistent patient satisfaction. Machine learning prediction enables the medical staff to

analyze and control the healthcare service process proactively to exceed patient expectations (Clancy et al., 2023). Controlling the healthcare service quality and wastes related to waiting time through prediction is very critical to controlling healthcare process variation (Site et al., 2021). Machine learning techniques such as neural network, supported vector machine and random forest are applied to predict the patient waiting time and speed up patient service responsiveness by eliminating healthcare process wastes. The study chose the healthcare sector to apply the machine learning model in lean thinking to raise service quality and patient satisfaction.

4.2.5.1.Waiting Time Prediction Method

The study focuses on predicting healthcare waiting times, which is especially useful for low-acuity patients because high-acuity patients are treated in the emergency department. An accurate healthcare waiting time prediction may reduce a low-acuity patient's concern while waiting, while high-acuity patients are relatively rare (10% of patient visits) (Bayraktar, 2016). The fundamental concern of this technique is to reduce the time patient spends on service. It focuses on addressing healthcare lean service quality improvement by combining the fields with machine learning to predict prolonged healthcare waiting time in the treatment process. This prolonged waiting time is based on different factors such as service type, arrival rate, service rate, and service efficiency. Hence, the machine learning technique is applied to enhance healthcare service quality through study, training, observation, and using historical time series data to develop models by investigating complex datasets. Patient visit records in the healthcare service delivery are filtered for waiting time prediction. In this regard, medical staff is involved as professional experts. When patients are seen in a timely manner, waiting time prediction model development might not be significant. This waiting time prediction is visually visited and compared to differentiate the better prediction model. Therefore, machine learning actual prediction model visualization is fundamentally important to evaluate the prediction quality in addition to checking statistical performance comparison metrics such as RMSE, MAE, or R^2 (Curtis et al., 2017). In this regard, the study considers data size, data type, and training time of the learning model to determine model learning complexity to avoid underfitting and overfitting. The learning model creates accurate results with several parameters, and it may require a long time for training. The model development evaluation highly depends on data, and its possible error may affect the model performance. Lack of adequate testing may increase model error (Rahmani et al., 2021).

To achieve this goal, three machine learning algorithms, such as SVM, RF, and NN, were used. The results of these models demonstrate patient waiting time to accurately predict and take corrective

action to accelerate the patient treatment process. This predicted waiting time supports the decision-making process to take action in regards to the critical factors that affect healthcare service quality, such as prolonged waiting time reduction, leveraging insight, bed availability, patient outcome improvement, and resource allocation. Furthermore, the predicted waiting time accuracy is improved by updating recent data and retraining patient datasets. Ultimately, the result of this study indicates that machine learning-based healthcare lean service quality holds substantial promise to improve treatment processes and patient satisfaction.

A. Support Vector Machine

The waiting time prediction line indicates an observation in the test set. The support vector machine categories are represented by red and blue lines. The graphic shows a red line for the actual wait time and a blue line for the expected wait time. The model shows that the actual and expected waiting times overlap, indicating that the predicted and actual waiting times is comparable.

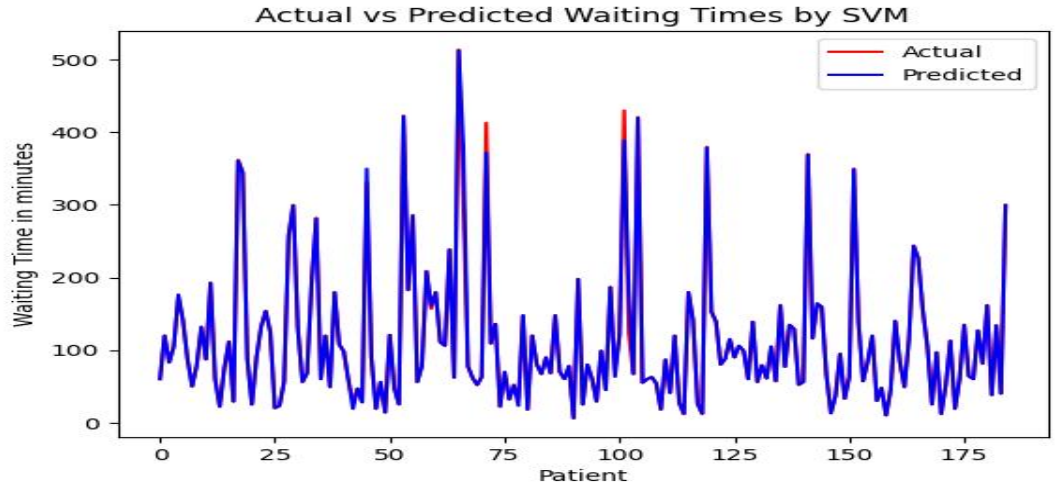


Figure 4.4: Actual vs predicted healthcare waiting time by SVM

B. Random Forest

The waiting time prediction line indicates an observation in the test set. The random forest categories are represented by red and green lines. The graphic shows a red line for the actual wait time and a green line for the predicted wait time. The model shows that the actual and expected waiting times overlap, indicating that the predicted and actual waiting times is comparable.

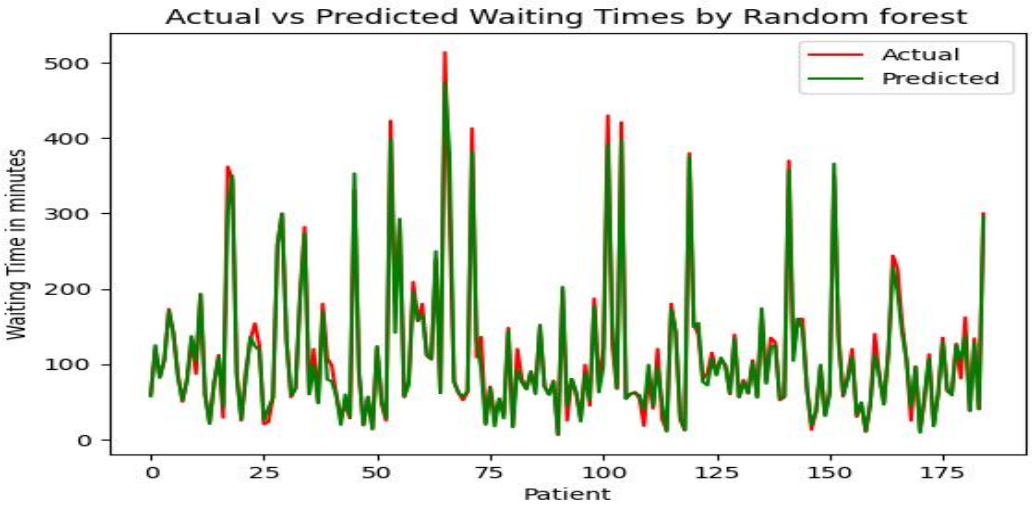


Figure 4.5: Actual vs predicted healthcare waiting time by random forest

C. Neural Network

The waiting time prediction line indicates an observation in the test set. Red and grey lines signify the Neural Network categories. A red line indicates the actual wait time and a grey line indicates the predicted wait time. The model indicates that the actual and predicted waiting times overlap, suggesting that the two is equal.

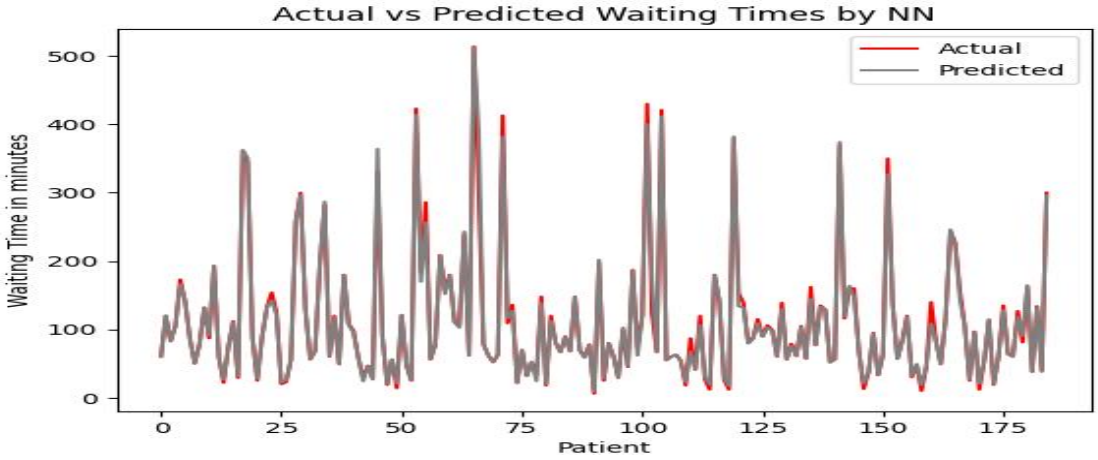


Figure 4.6: Actual vs predicted healthcare waiting time by NN model

The support vector machine model's prediction performance accuracy is much better than that of the neural and random forest models for predicting the actual data.

D. Model Evaluation and Comparison

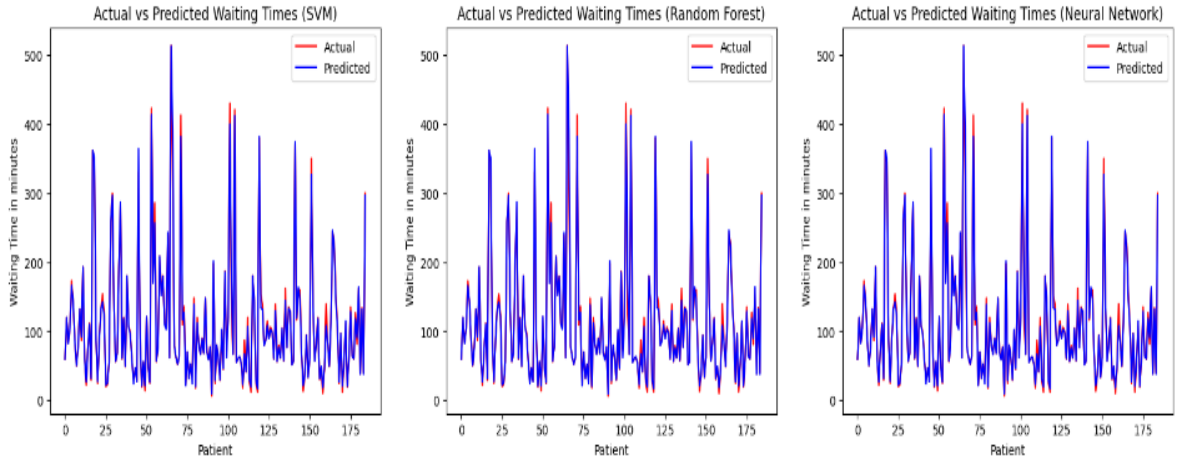


Figure 4.7: healthcare waiting time prediction comparison model

The waiting time model performance was compared and contrasted by evaluating the prediction test errors. The Mean Absolute Error (MAE) and Root-Mean-Square Error (RMSE) were computed for each model to compare the performance accuracy. Finally, the waiting times predicted were plotted against actual values for each model to illustrate differences across models and feature sets.

Table 4.3: waiting time prediction performance comparison metrics

Error	**NN**	**RF**	**SVM**
MAE	4.42	8.17	1.73
R^2	0.988	0.979	0.992
RMSE	10.2	13.7	8.65

The performance prediction accuracy across the developed models is different among techniques. The prediction accuracy R^2 of SVM is the most accurate prediction model for healthcare waiting time. The support vector machine imitates waiting time performance in a very impressive way compared to other models to improve service quality. The developed model announces the healthcare waiting time to enhance patient satisfaction, as (Jordon et al., 2019, 2020) corroborated.

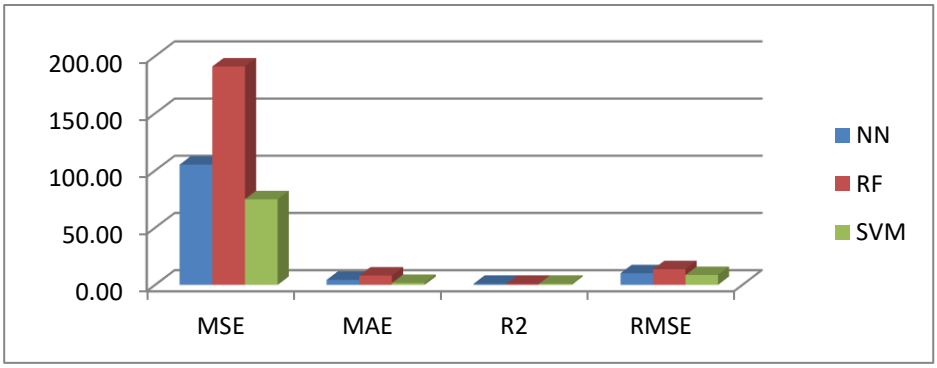


Figure 4.8: Performance Comparison Metrics

4.3.Chapter Summary

The study used the DMAIC method to determine the potential factors that affect healthcare service quality to enhance patient satisfaction. Out of the 130 surveys provided, 118 respondents responded. The measurement validity of the reliability test was examined using Cronbach's alpha coefficient (Kottala, 2019). Cronbach alpha analysis yielded scores of 0.947 for patient expectation and 0.984 for patient perception. Patient requirement information was collected to differentiate the most weighted score based on patient needs, as (Clancy et al., 2023) also corroborated. This weighted score is the target variable that is determined by functional requirements and technical specifications through QFD. The target variable components were divided into six categories using the cause and effect diagram, including patient, materials, medical personnel, process, machine, and management. In addition, 27 causes under each category were identified to differentiate the cause for prolonged healthcare waiting time. It developed an accurate healthcare waiting time prediction model that improves service quality, as (Hijry & Olawoyin, 2021) also discussed. The model is compared with other service quality and waiting time prediction models based on variables such as arrival time, waiting time, etc. It used 924 patient data to predict healthcare waiting time using machine learning techniques such as random forest, support vector machine, and neural network to control the DMAIC method.

It allocated 20% of the dataset for the testing set and 80% for training purposes. It showed the importance of the training data quantity importance to predict the waiting time in the machine learning model development, as (Kuo et al., 2020) also verified. Several studies have outperformed sophisticated machine learning models of linear regression that solve complex problems (El-Bouri et al., 2021). NN, SVM, and RF outperformed linear regression with significant differences in performance between the three. The performance comparisons metrics such as RMSE, MAE, and R^2 were accessed to identify predictive regression model accuracy, as different researchers also used

them as comparison factors (Jordon et al., 2020). From the identified machine learning techniques, the support vector machine imitates better waiting time prediction models than other models to improve service quality. The developed model can help to reduce the healthcare waiting time to enhance patient satisfaction, as (Jordon et al., 2019) also confirmed. The SVM technique indicated significant performance over NN and RF models to announce waiting time in all departments. Its main focus is to determine the accurate waiting time to increase service delivery and patient satisfaction, as (Huang et al., 2016) also stated. Moreover, the application of machine learning techniques in service quality improvement and LSS can reduce the waiting time based on the model prediction results. This improvement mechanism can increase responsiveness, patient flow smoothing, and service quality management by adopting LSS and machine learning approaches. The waiting time, arrival time, and the time the patient is seen by physicians are the waiting time predictors for healthcare service quality. Based on these models, healthcare service quality improvement could be made by medical staff for treatment, number of beds, and number of rooms for medical investigation/treatment, particularly for outpatient cases, in order to reduce waiting time. Lean thinking can also assist in reducing unnecessary long-distance movement, prolonged waiting time, and other related waste. Lean waste prediction`s main purpose is to improve healthcare service quality by reducing non-value-added activities. It tends to improve service waiting time, bottlenecks, and other healthcare embedded waste to attain flexible and quicker patient service responsiveness. Generally, waiting time, shortage of beds, overcrowding, length of stay, and other non-value-added activities are the most common lean wastes that need further attention in the sector. The models were compared using performance matrices such as R2, RMSE, and MAE, which were also by (H. Ibrahim et al., 2021) for model accuracy comparison. The dependent variable's degree of variation that the independent variable could account for was assessed by the R^2 coefficient, which performs better as it approaches 1, as (X. Li et al., 2023) also proposed. The MAE, which is the average of the actual and predicted patient waiting times, is to indicate whether the anticipated wait time is too long or too short and to benefit as the estimated waiting time is more in line with the actual time.

Chapter Five

Proposed Model for Lean Service Quality Improvement

5.1.Introduction

The lean service quality attempted to reveal their integration of service quality and lean thinking in the services sector to enhance the work process, patient satisfaction, medical tourism, and economic growth. It minimizes healthcare waste, working culture change, and service quality failures to emphasize patient satisfaction. It also centred on employee training, awareness creation on waste reduction and service quality improvement mechanisms, team building etc., to ensure healthcare service quality.

Different numbers of dimensions that measure healthcare service quality have been used to attain service quality, patient satisfaction, medical tourism and economic growth according to patient requirements (Al-Mhasnah et al., 2018). SERVQUAL model was applied to measure the quality of healthcare service and enhance patient satisfaction. It consists of five generic dimensions (reliability, tangibility, responsiveness, reliability, assurance, and empathy) to measure service quality based on their expectation and perceptions (RiyazhKhan & Haq, 2019) that have been addressed in many types of research. In this regard, patients are always expecting accurate, reliable, and responsive services due to patient risk and suffering (Mosadeghrad, 2014a). These risks and medical errors require critical attention because they cause loss of life (Baashar et al., 2020). Due to this, patients always prefer services that they trust and that meet or exceed their expectations.

Donabedian, SERVQUAL, and PubHosQual models were also used by different practitioners using structural equation modelling (SEM) to measure service quality. SEM examines the relationship between lean service quality dimensions and latent variables. It is a set of statistical methods that perform confirmatory factor analysis, path analysis, and path modeling to find the relationships between variables. It states the consistency and explanation in a statistical method reflecting the actual scenario (R et al., 2020). It also uses two variables, such as exogenous and endogenous variables corresponding to independent and dependent category, respectively. SEM also comprises measurement and Structural models. The measurement model indicates how latent variables represent the specified theory, while the structural model describes the causal relationships between different dimensions. However, those above-stated models still contain controversial dimensions to improve healthcare service quality. This study has been conducted to explore the concepts of healthcare service quality, lean thinking, lean service quality, patient satisfaction, and medical

tourism. These dimensions are identified to measure healthcare lean service quality and patient satisfaction that enhance medical tourism in the Ethiopian context through SEM. SEM is a well-known method that is introduced to identify the linear relationship among the dimensions, hypothesis verification, and its impact on endogenous variables (Islam et al., 2023). However, SEM ignores non-linear relationships and non-parametric complex models. Hence, the study introduced machine learning models into SEM to solve the SEM drawback, including non-linear relationships, model prediction accuracy, and causal analysis. This hybrid (SEMANN) approach provides new perspectives on the healthcare service quality assessment and patient satisfaction. In this regard, ANN was selected to estimate factor loading/regression relation, classification, and prediction in the SEM building. The SEMANN approach is used in the healthcare lean service quality and patient satisfaction to enable an in-depth understanding of service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism. It also determines the factors that have a substantial impact on patient satisfaction and adequacy of healthcare service quality.

5.2.Factor analysis

Factor analysis is divided into Confirmatory Factor Analysis (CFA) and Exploratory Factor Analysis (EFA). The study aims to use both EFA and CFA to duplicate the observed variables and fewer latent variable relationships. Explorative factor analysis (EFA) is a data-driven method that considers no assumption at the beginning for latent factors among indicators common factors. There are model fit indexes that assess how well a statistical model corresponds to the observed data and evaluate the model's adequacy.

Goodness of Fit Index (GFI): is to differentiate the solution that replicates the observed relationship between the variables of the models. It is able to replicate these observed correlations equally (i.e., models with more factors). GFI result shows how well the model replicates the covariance matrix between the indicator variables. It expresses a direct and indirect fit statistic of the model to sample size. GFI values range from 0 to 1, as a value close to 1 indicates a better fit, and its threshold value is greater than 0.70 (Berhan, 2020).

Adjusted Goodness of Fit Index (AGFI): the GFI adjustment using a degree of freedom ratio tries to measure a complex model. It penalizes the complex models and favors models with a low number of free paths. In complicated models, its value is often lower than GFI values.

Normed Fit Index (NFI): is the original incremental fit index. It is the difference between the λ^2 value for the fitted model and a null model divided by the λ^2 value for the null model. Its value range is from 0 to 1, and a perfect fit model has a value close to 1.

Comparative Fit Index (CFI): This is an incremental fit index (Hair et al., 2012) that evaluates a user-specified solution model fit index. It is a null or independent baseline model where the covariances between input indicators are fixed to zero. In model fit evaluation against a relationship between the variables, CFI looks more favourable. The CFI value ranges from 0 to 1, with values closer to one implying good model fit.

Root Mean Square Error of Approximation (RMSEA) is a broadly recommended model-fit index in model fitness (Hair et al., 2012). It relies on a sample data index that depends on the non-central $\chi 2$ distribution. The RMSEA is an error of approximation index since it evaluates how well a model fits the population rather than determining whether it holds true perfectly in the population of $\chi 2$.

Eigenvalue >1 Rule**:** the "the Kaiser criterion," or "the eigenvalues > 1.0 rule") is very simple. The number of eigenvalues larger than 1.0 and the number of nontrivial latent dimensions in the input data are calculated from the input correlation matrix. Then, it proposes a latent structure that is unidimensional. The variation explained by a factor is less than the variance of a single indicator when the eigenvalue is less than 1.0. Researchers should be aware that EFA standardises both the latent and observable variables and that eigenvalues indicate variance. Reducing the number of latent variable factors that should be less than the number of input indicators is the primary objective of EFA. When an eigenvalue is less than 1.0, the equivalent factor accounts less variance than the indicator (whose variance equals 1.0).

Factor analysis is conducted using EFA to identify the dimensions of healthcare lean service quality improvement. After the EFA, CFA is conducted to confirm the dimension structure identified using EFA.

5.2.1. Exploratory factor analysis

EFA is used to evaluate the dimensions of healthcare service quality through multivariate structures. EFA helps to determine a minimum number of shared variables based on the correlation between them. Factor loading and relationship matrix are analyzed in order to determine the factor scores in EFA. EFA is used to identify number of dimensions that have low factor loading and dimension that are badly evaluated using normal distribution data.

5.2.2. Confirmatory factor analysis (CFA)

CFA is one of the statistical analysis approaches for SEM that focuses on differentiating latent components that explain the variation and covariation between collections of indicators. Every

component of the factor model, including the number of factors, the distribution of indicators, the factor loadings, and more, must be pre-specified in a CFA analysis. A strong conceptual or empirical basis is necessary to track the factor model's evaluation. Additionally, scale development and construct validation employ CFA. In contrast to EFA, where the number of factors can only be pre-specified by the researcher, CFA is significantly influenced by prior research study evidence, theory, and the researcher's test mean solution by determining a number of factors and factor loading. CFA is better in construct validation and test construction than EFA.

To assess the applicability of an analysis, most numerical methodologies demand the results of at least one statistical test. CFA used various statistical tests such as the Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Normed Fit Index (NFI), Comparative Fit Index (CFI), and Root Mean Square Error of Approximation (RMSEA) to identify the model fitness.

CFA is one of the theory-testing statistical analysis approaches for SEM that focuses on differentiating latent components that explain the variation and covariation between collections of indicators (Hair et al., 2012; Valmohammadi & Roshanzamir, 2015). CFA is a theory testing method, while EFA is a theory-generating method that verifies the structure of the dimension (Jain & Ajmera, 2019b). CFA is used to test the interaction between the observed and latent factors to determine the factor and its standardized estimate to confirm the predetermined hypothesis (Hair et al., 2012). CFA is affected by sample size, research hypothesis to be tested, multivariate normality distribution, measurements, parameters, and missing data (Jain & Ajmera, 2019b). CFA confirms the significance of statistical analysis in determining if the data fits the model.

5.3.Lean service quality framework and hypothesis development

This framework serves as the foundation for understanding the interplay between lean principles and service quality within the context of medical tourism. Lean thinking emphasizes the elimination of waste and the continuous improvement of processes, which directly influences service quality.

By integrating lean principles with service quality, healthcare sector can enhance patient satisfaction and operational efficiency, ultimately fostering a more favorable environment for medical tourism. The proposed relationships within the framework illustrate how lean service quality impacts key variables such as patient satisfaction and employee involvement. These interactions are vital for understanding how improvements in service quality can lead to enhanced medical tourism experiences.

In this context, the figure (5.1) visually represents these relationships, showcasing the interconnectedness of lean thinking, service quality, and medical tourism. It lays the groundwork for hypothesis development, which will further explore these dynamics. By discussing the framework first, the study set the stage for a deeper analysis of the hypotheses, ensuring that readers grasp the significance of each component before delving into the visual representation. This structured approach not only clarifies the theoretical underpinnings of the research but also highlights the practical implications of implementing a lean service quality model in the Ethiopian healthcare sector. The healthcare service quality improvement framework has been developed, as illustrated in Figure 5.1.

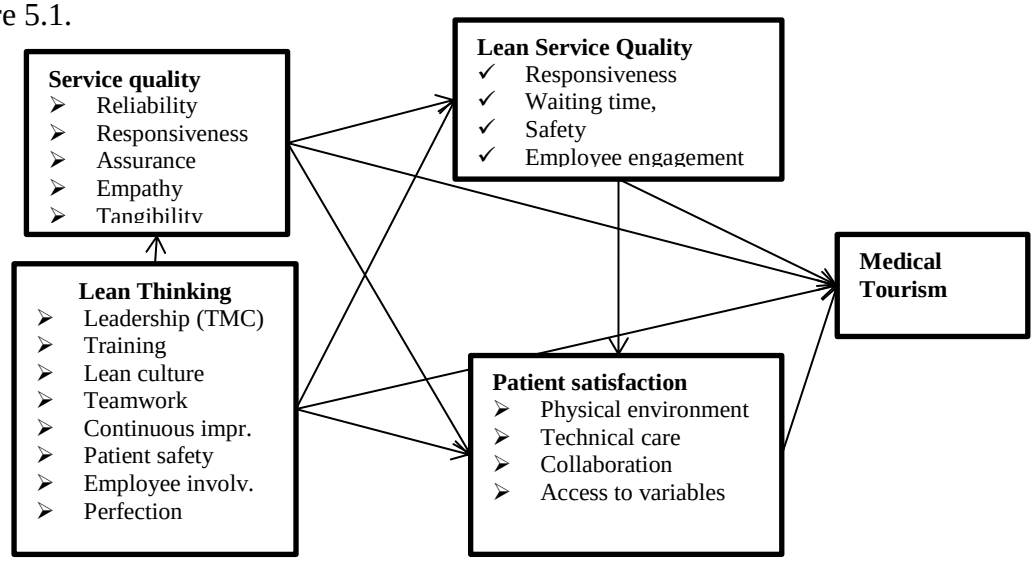


Figure 5.1: Lean service quality framework

5.3.1. Relationship between service quality, lean service quality, patient satisfaction, and medical tourism

Maintaining the highest standards for healthcare service quality involves doing the right thing, making constant improvements, achieving the best clinical outcomes, ensuring patient satisfaction, retaining talented medical professionals, and sustaining strong financial performance to support healthcare service providers (Mahmud, Lima, et al., 2021). Due to their value-driven nature, most of today's medical tourists (patients) evaluate their experiences against their expectations when receiving medical care (H. Y. Wang, 2012). The goal is to enhance the satisfaction of medical tourists (customers) by minimizing the gap between expectations and reality. Many researchers have identified several factors for maintaining quality standards, including tangibles, accessibility, adequacy, empathy, improvement of care quality, reliability, safety, cost, convenience,

effectiveness, efficiency, and continuity. These factors are essential for ensuring better service quality and patient (medical tourist) (Hampton, 1993; RiyazhKhan & Haq, 2019; Zeithaml et al., 1988). Another group of researchers expanded this dimension significantly by utilizing the SERVQUAL model (Mahmud, Lima, et al., 2021).

Service quality plays a significant role in enhancing lean service quality and patient satisfaction, which in turn attracts medical tourism in the healthcare sector. To improve service quality, patient satisfaction, and medical tourism appeal, the healthcare sector must reform its processes, medical staff, equipment, and other resources (Antino et al., 2020; Mahmud, Rahman, et al., 2021). By exchanging knowledge, recognizing requirements, communicating, offering information, offering emotional support, maintaining continuity of care, and coordinating, patients may improve patient satisfaction and medical tourism (Vaishnavi & Suresh, 2020, 2021). Enhancing the skills of medical staff at all service levels such as nursing care, physician care, mastering new technologies, and employee retention to improve patient satisfaction, and medication accuracy requires a focus on service quality (Ahmed et al., 2018b). In the context of this study, it is posited that service quality positively influences lean service quality and patient satisfaction. Therefore, these hypotheses are:

H1. Service quality has a significant positive effect on lean Service Quality

H2 Service quality has a significant positive direct effect on patient satisfaction.

H3. Service quality has a significant positive effect on medical tourism

5.3.2. **Relationship between lean thinking, lean service quality and patient satisfaction**

The healthcare sector is increasingly incorporating lean thinking into its service quality improvement to enhance patient satisfaction and attract medical tourism (Akhorshaideh et al., 2023). Lean thinking has a strong positive relationship with both lean service quality and patient satisfaction, as it focuses on the needs and experiences of patients (Ahmed et al., 2018b). According to Shrafat & Ismail (2019), the relationship between lean thinking and patient satisfaction is influenced by factors such as service quality, service access, cost, and flexibility. Lean thinking not only positively influences service quality and patient satisfaction but also enhances the attraction of medical tourism, thereby improving healthcare service quality (Barretiri et al., 2021). They found a significant positive relationship between lean thinking, service quality, and patient satisfaction. In the context of this study, it is posited that lean thinking influences lean service quality and patient satisfaction, contributing to the attraction of medical tourism. Thus, these hypotheses are:

H4. Lean thinking has a significant positive effect on lean Service Quality.

H5. Lean thinking has a significant positive direct effect on patient satisfaction

H6. Lean thinking has a significant positive direct effect on medical tourism

5.3.3. Relationship between lean service quality, patient satisfaction, and medical tourism

Lean service quality is applied in the healthcare sector to increase value-added activities and enhance service quality, thereby improving patient satisfaction and attracting medical tourism. It focuses on identifying waste and errors within healthcare processes to boost patient satisfaction (Gholizadeh et al., 2016). In addition to eliminating waste and errors, lean service quality can enhance responsiveness, patient safety, and overall effectiveness, contributing to greater patient satisfaction and medical tourism attraction (J. Ali et al., 2023). Patient satisfaction also plays a crucial role in enhancing medical tourism by guiding healthcare improvements and resource allocation. It fosters patient loyalty and attracts medical tourists. High levels of patient satisfaction contribute to medical tourism when policymakers, healthcare providers, and managers actively avoid adverse events, improve outcomes, and ensure error-free treatment (S. Ahmed, 2019; S. Ahmed et al., 2018a). In the context of this study, medical tourism is closely linked to strong and positive lean service quality and patient satisfaction. Hence, the hypotheses are as follows:

- ✓ H7. lean Service Quality has a significant positive direct effect on patient satisfaction
- ✓ H8. lean Service Quality has a significant positive effect on medical tourism
- ✓ H9. Patient satisfaction has a positive influence on medical tourism attraction.

5.4.Measurement model reliability and validity

The model test was measured through internal consistency or reliability and validity tests. The model dimensions internal consistency or dimension reliability is examined using CFA. CFA is used to determine the discriminant validity, convergent validity, and goodness of fit statistics. The model analyses the reliability model through CR, AVE, and Cronbach's alpha coefficient. The fundamental CFA of convergent validity identification tools is AVE, CR, Cronbach's alpha, and factor loadings (standardized estimates). Some of the model fit-criteria statistical tools are root mean square error of approximation (RMSEA), goodness-of-fit index (GFI), the normed fit index (NFI), Tucker Lewis index (TLI), Comparative fit index (CFI), Chi-Square mean (CMIN/DF), and the adjusted goodness-of-fit index (AGFI). Based on these criteria, the dimensions discussed above are assessed for CR and AVE using convergent and discriminant validity. Using the CR and AVE formulas provided by (Ariffin et al., 2022), CR and AVE are computed from model estimates while employing CFA. It was suggested by Lindberg et al. (2020) that CR and AVE should both equal or exceed 0.60 and

0.50, respectively. These evaluations showed that the measurements utilized in this study fell within acceptable ranges that supported the dimensions' dependability. Empirically, CFA is used to assess dimensions (for theory testing from goodness-of-fit indices) and convergent and divergent validity. Convergent validity indicates if the factors loading for measurements measure the same dimensions significantly (Vollmer et al., 2018). Measurements were developed to evaluate the dimension interconnection and determine the discriminant and convergent validity of the healthcare lean service quality. This healthcare lean service quality dimensions relationship and model evaluation assessment is conducted using validity and reliability analyses. Discriminant validity is the degree to which indicators or measurements that do not belong to a given dimension can be distinguished from that particular construct, whereas convergent validity is the relatedness of measures to their assigned dimensions (Berhan, 2020).

5.4.1. Convergent validity

According to Berhan (2020), the model measurement tested convergent validity to examine the extent to which different items are consistent and measure the same notion. Hair et al. (2012) also assessed convergent validity through standardized estimates, the average value extracted, and composite reliability. In this convergent validity test, all indicators, such as service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism, are processed, and most indicators have > 0.5 standardized estimates of loading factor value and are considered valid. In this study, Composite reliability, average variance extracted, and most standardized estimate of factor loading indicators are valid, and structural equation modeling fit-test can be commenced. During the model test in CFA, the reliability test indicates that a measuring technique can offer relatively similar results on the same model. Reliability is calculated using the AVE and CR formula. The greater reliability value shows that the variables are reliable in measuring the latent variable. The recommended CR threshold value is 0.7 or greater, while the AVE recommended threshold value is 0.5 or greater (Berhan, 2020). In the reliability test, all indicators such as service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism are processed using composite reliability 0.7 or greater and average variance extracted values of 0.5 or greater that show all indicators are reliable.

The dimension`s factor loadings (standardized estimates) range from 0.505 to 0.95, and it indicates significant CR, AVE, and p-values. The AVE between service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism are in the recommended criteria. The CR, which is the squared sum of the standardized estimates for each dimension and the error variance sum for

all dimensions, is also within the recommended criteria (Hair et al., 2012). According to Hair et al. (2012), a good AVE of 0.5 or higher recommends adequate convergence, and CR estimates are 0.5 or higher. The CFA results of CR, standardized estimates (Factor Loading), and AVE are all in the convergent validity. All the models fit the indices criteria for all dimension values of CFA, i.e., RMSEA, TLI, GFI, AGFI, and NFI, which are within the criteria recommended. In addition, Table 5.2 indicates that the dimensions reliability value of Cronbach's alpha is above the cut-off values.

Table 5.2: Observed and Latent variables used in CFA model

No	**codes**	**FL**	**AVE**	**CR**	**Mean**	**SD**	**α**	**RMSEA**	**GFI**	**TLI**	**CHIN/DF**
1	Service Quality1	0.61	0.69	0.95	3.08	0.72	0.95	0.058	0.94	0.98	1.7
2	Service Quality2	0.89									
3	Service Quality3	0.80									
4	Service Quality4	0.75									
5	Service Quality5	0.90									
6	Service Quality6	0.81									
7	Service Quality7	0.94									
8	Service Quality8	0.82									
9	Service Quality9	0.84									
10	Service Quality10	0.88									
11	Lean Thinking1	0.56	0.55	0.86	3.04	0.5	0.85	0.05	0.96	0.97	1.5
12	Lean Thinking2	0.6									
13	Lean Thinking3	0.60									
14	Lean Thinking4	0.76									
15	Lean Thinking5	0.58									

16	Lean Thinking6	0.77									
17	Lean Thinking7	0.84									
18	Lean Thinking8	0.83									
19	Lean Service Q.1	0.81	0.5	0.78	3.7	0.2	0.8	0.01	0.99	0.9	1
20	Lean Service Q.2	0.89									
21	Lean Service Q.3	0.87									
22	Lean Service Q.4	0.78									
23	Patient satisfaction1	0.67	0.7	0.9	3.71	0.2	0.9	0.01	0.99	0.99	1
24	Patient satisfaction2	0.58									
25	Patient satisfaction3	0.84									
26	Patient satisfaction4	0.65									
19	Medical Tourism 1	0.505	0.65	0.82	3.3	0.45	0.83	0.01	0.99	0.99	1
20	Medical Tourism 2	0.527									
21	Medical Tourism 3	0.907									
22	Medical Tourism 4	0.958									
23	Medical Tourism5	0.832									

Note: SD: standard deviation, AVE: average variance extracted; CR: composite reliability; GFI: goodness of fit index; TLI: Tucker Lewis index indicating the parameter value of 1 significant *p<.05, **p<.01, ***p<.001.

Table 5.2 above indicated that mean scores and the standard deviations (SD) for the lean service quality improvement and its SD found to be between 3.04 to 3.71, and 0.2 and 0.72, respectively.

The AVE value of 0.5 indicates a satisfactory degree of reliability, whereas the Composite Reliability (CR) value of 0.95 indicates an acceptable measure of convergent validity.

5.4.2. Discriminant Validity

The model-fit test of the CFA of the measurement model is also done through discriminant Validity. The discriminant validity is the extent to which measures of one dimensions differ from measures of other dimension in the same model (MacKinnon & Luecken, 2008). It is the fundamental criteria that share more variance with its component than it is shared with other dimensions in a developed model (Berhan, 2020). Model Validity is acceptable when the measurements determine what should be measured. Furthermore, it is measured by investigating the relationships among the measures of overlapping dimensions. When the square root of the average variance extracted for each dimension is 0.5 or greater, the model is valid (Berhan, 2020). According to Table 5.3, each dimension's average extracted variance square root is higher than the items that are off-diagonal in the associated row and column, demonstrating sufficient discriminant validity. The square root of the average variance extracted for dimensions, i.e., service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism, are within the recommended value for the discriminant validity.

Table 5.3: discriminant validity

Dimensions	Service quality	Lean thinking	Lean SQ	Patient Sati.	Medical T.
Service quality	.94				
Lean thinking	.456**	.96			
Lean SQ	.184**	.578**	.912		
Patient Sati.	.253**	.374**	.527**	.89	
Medical T.	.045	-.079	.081	.214**	.97

**. Correlation is significant at the 0.01 level (2-tailed).

5.5.Model-fit index

Generally, the overall CFA model fit test is conducted to check how well the model expresses the actual conditions. The CFA result exemplifies RMSEA < 0.048 (good fit), GFI 0.85 (good fit), NFI 0.94 ≥ 0.90 (good fit), RFI 0.92 ≥ 0.90 (good fit), IFI 0.96 ≥ 0.90 (good fit), AGFI value 0.82 > 0.8 (marginal fit), and the CFI value 0.96 ≥ 0.90 (good fit), which indicates the confirmatory factor analysis meets the complete model fit requirements which mean the confirmatory factor analysis in

the study matches with the data. GFI 0.856 > 0.80 (marginal fit), and AGFI value 0.82 > 0.8 (marginal fit), which indicates the confirmatory factor analysis model meets the incremental model fit requirements, which means that the overall confirmatory factor analysis model is comparatively fit based on the threshold value. Moreover, the overall confirmatory factor analysis of this model offers a good image of the research data.

Table 5.4: CFA Model-fit index

No.	**Model-Fit Criterion**	**Authors**	**Recommendation threshold value**	**Model result**	
1	CMIN/DF	Marsh & Hoever, 1985	< 5	1.5	Excellent
2	GFI	Chau, 1997	>0.7	0.856	Acceptable
3	CFI	Bentler,1990	>0.7	0.96	Excellent
4	RMSEA	Byrne, 2001	< 0.08	0.048	Excellent
5	TLI	Hair et al, 2009	>0.7	0.96	Excellent
6	RFI	Meyers et al 2005	>0.7	0.92	Excellent
7	IFI	Meyers et al 2005	>0.7	0.966	Excellent
8	AGFI	Chau, 1997	>0.7	0.82	Acceptable
9	NFI	Hair et al, 2009	>0.7	0.94	Excellent
10	CFI	Hair et al, 2009	>0.7	0.966	Excellent

As the result indicates in Table 5.4, the CFA shows that all model fit criteria, which is a goodness of fit index, are valid (fit). However, Hair et al. (2012) stated that an adequate or marginal model when the model fit index lies in the range of 0.80 to 0.90 regarding the value of GFI and AGFI. The overall model fit criteria of the goodness of Fit test results in Table 5.4 indicates a good model. In this study, the values of RMSEA, TLI, CFI, NFI, RFI, CMIN / DF, GFI, and AGFI have fulfilled the threshold values. Thus, the CFA model can be considered suitable for use. Therefore, the developed CFA model in Figure 5.2 is acceptable.

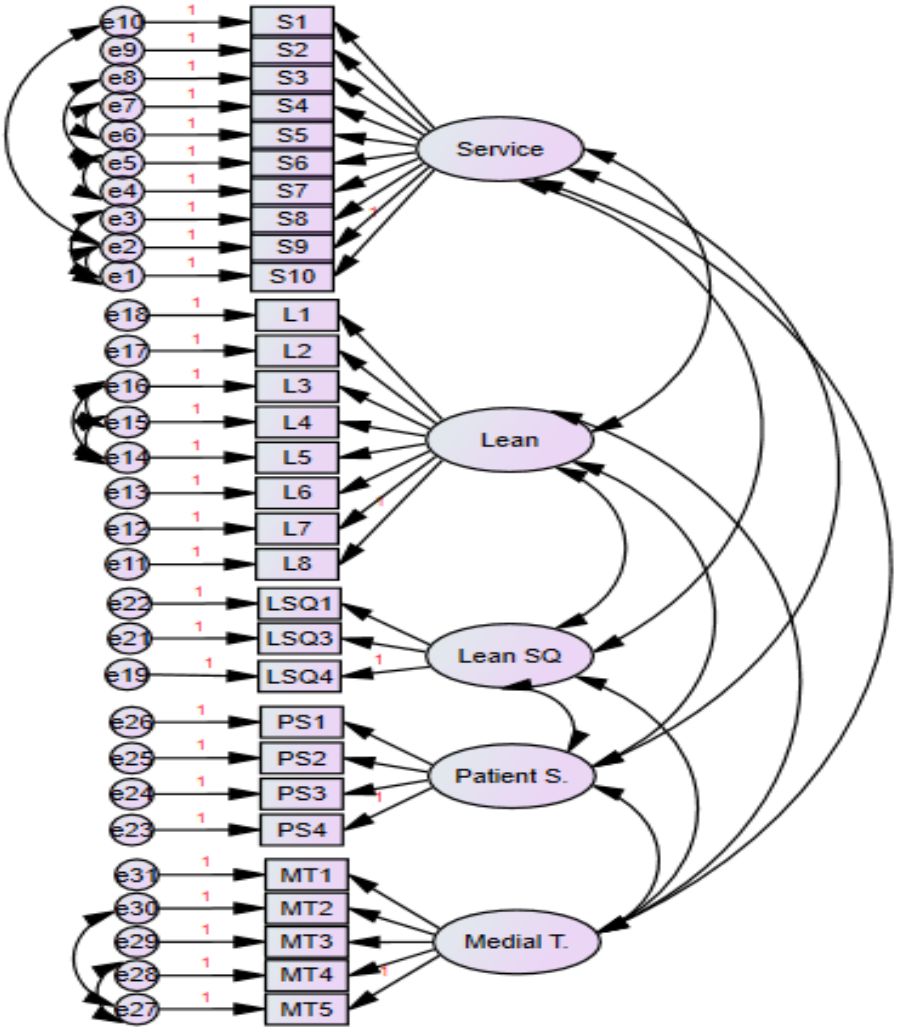


Figure 5.2: confirmatory factor analysis model

5.6.Structural Equation Modeling (SEM)

Having ensured that the dimensions included in the model of this study are valid and reliable, the analysis can proceed to estimate and evaluate the structural equation model representing the hypotheses developed. The SEM analysis is used to examine the effect of lean thinking, service quality, lean service quality, and patient satisfaction on medical tourism in the Healthcare sector. According to Hair et al. (2012) and Berhan (2020), the analysis of SEM has two categories: variance-based and covariance-based SEM. These two SEM categories can be distinguished by confirmatory and exploratory approaches. The goal of the exploratory approach is to explore the possible relationships in the SEM model to determine the path model developed during the absence of facts (Hair et al., 2012). On the other hand, the confirmatory method places more emphasis on

measuring the correlation between the measurement and dimensions in the model in order to test the organized path model across several domains (Hair et al., 2012).

SEM is used in different research fields such as economics, marketing researchers, educational researchers, healthcare professionals, and medical researchers. Its fundamental target is to scrutinize the relationship among independent variables and dependent variables to see whether the variables are statistically significant or not. SEM is used different dimensions such as service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism to build models and indicate the relationships between variables. Several theoretical hypotheses of models are tested in SEM to define dimensions and how these dimensions are related to each other in addition to providing a complete approach for the quantification and "testing of theories." The structural equation modeling fundamentally integrates path models and CFA. In addition, SEM models include latent and observed variables. Latent variables are not seen directly; it follows that they cannot be measured directly. The unobserved variable is the connected to observable variable where measurement is possible. The SEM estimates the structural coefficients to test with three exogenous variables (i.e., lean service quality, patient satisfaction, and medical tourism) and two endogenous variables (service quality and lean thinking). Thus, SEM assessment involves path loading estimation and it indicates the significant relationships among latent variables.

In order to assess the internal consistency of measurement dimensions, the CFA was assessed in the first phase. The study specified the model measurement based on lean service quality improvement dimensions (service quality, lean thinking, lean service quality, patient satisfaction, and Medical tourism). The structural equation (causal effect) from the main dimension is employed on each of the five dimensions, as depicted in Figure 5.3. After that, 1000 likelihood estimator (maximum) iterations were used to measure the SEM analysis in order to determine the estimates and model fit parameters for each dimension in a model. To examine the influence of service quality, lean thinking, lean service quality, and patient satisfaction on medical tourism, SEM was developed. The relationship among variables were analysed and compared, both direct and indirect relationships were also tested in the structured model.

Five components with significant factor loadings exceeding 0.50 have been identified. These components are service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism considerations. The results were further analyzed to assess the model's fit. Since there isn't a single metric accessible to determine model fit, many metrics must be used. The data match the

model, as indicated by the model analysis's Chi square CMIN/DF = 1.64. The good fit was further confirmed by other evidence. Given that a GFI of 1.0 denotes a perfect match, a Goodness-of-match Index (GFI) of 0.85 suggests that the model fits quite well. A decent model fit is implied by the root mean square error of approximation (RMSEA) value of 0.05, which is below the permissible limit of 0.08. At 0.82, the Adjusted Goodness of Fit Index (AGFI) score is nearly at its suggested level. Tucker-Lewis Index, or TLI, is 0.96; the Normed-Fit Index (NFI) is 0.92; and the Comparative Fit Index (CFI) is 0.97. Since the NFI, CFI, TLI, and IFI values are higher than the suggested value of 0.9, they indicate strong model fits. To ensure the SEM`s reliability and validity, CR, AVE, convergent, and discriminant validity were performed. Finally, the SEM was developed as Figure 5.3 depicts.

Table 5.5: SEM model fit index threshold value

No.	**Model-Fit Criterion**	**Authors**	**Recommendation Threshold Value**	**Model Result**	
1	CMIN/DF	Marsh & Hoever, 1985	< 5	1.64	Excellent
2	GFI	Chau, 1997	>0.7	0.85	Acceptable
3	CFI	Bentler,1990	>0.7	0.97	Excellent
4	RMSEA	Byrne, 2001	< 0.08	0.05	Excellent
5	TLI	Hair et al, 2009	>0.7	0.96	Excellent
6	RFI	Meyers et al 2005	>0.7	0.92	Excellent
7	IFI	Meyers et al 2005	>0.7	0.97	Excellent
8	AGFI	Chau, 1997	>0.7	0.82	Acceptable
9	NFI	Hair et al, 2009	>0.7	0.92	Excellent

As a result, the SEM calculation shows that all goodness of fit criteria in non-outlier data gave good index (fit), except the AGFI criterion, which gives a value less than 0.90. However, Altuntas et al. (2022) explains that the value of AGFI in the range of 0.80 to 0.90 is referred to as a perfect marginal fit to the data or adequate model. Thus, the model developed in this study was acceptable.

The aforementioned criteria all demonstrate the sufficiency of factor solutions. This study's main goal is to assess the variables that significantly affect the enhancement of service quality in order to please patients and draw in medical tourists. Therefore, the healthcare sector and governments may address these variables more effectively and efficiently if they have a sufficient and thorough understanding of their intensity. Because patient needs are always changing and because there have been significant advancements in contemporary healthcare services, the healthcare sector must contend with new threats and problems. Healthcare managers and experts may learn about the strengths of different organisations to fully comprehend the linkages, interdependencies, and relative importance in order to improve patient satisfaction, service quality, and medical tourisms.

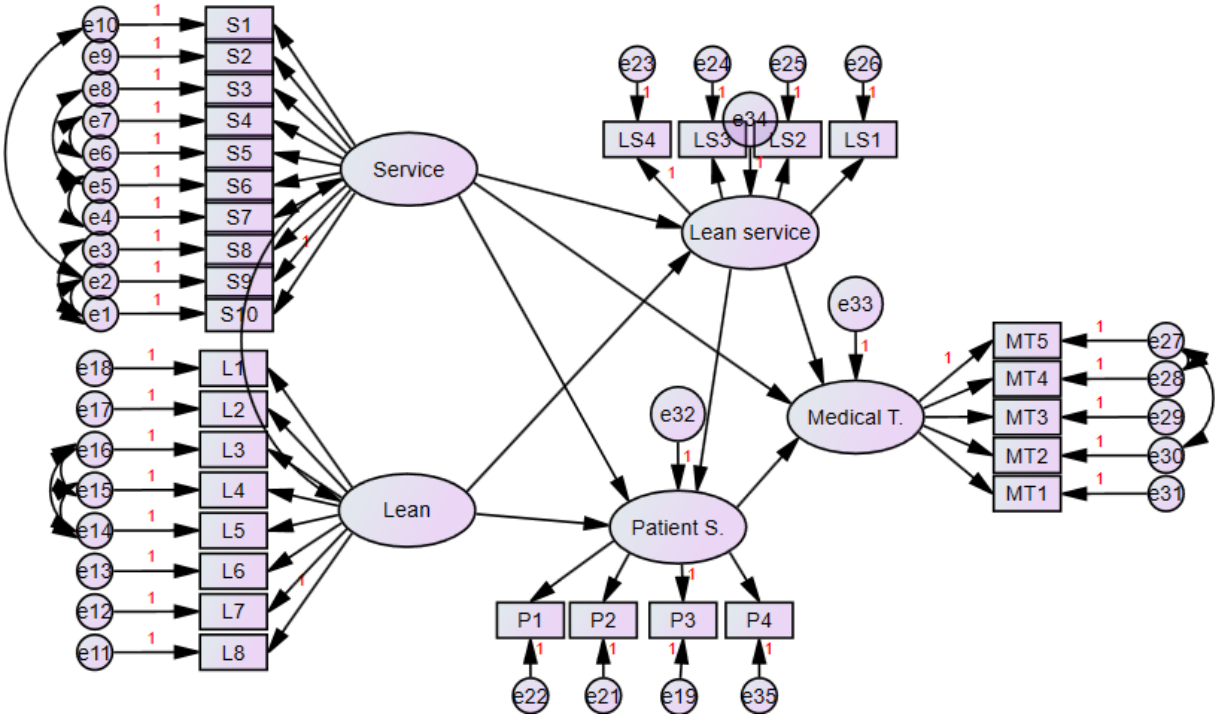


Figure 5.3: structural equation model for service quality improvement

Table 5.6: SEM hypotheses significance

Hypotheses	Estimate	S.E.	C.R.	P	Result
Lean Service Quality <-- Service quality	0.1335	0.03392	3.9358	***	Supported
Patient satisfaction <-- Service quality	0.17395	0.07479	2.3258	0.02	Supported
Medical tourism <--- Service quality	0.12358	0.03716	3.3256	***	Supported
Lean Service Quality <-- Lean thinking	0.03525	0.03716	0.8485	0.0428	Supported
Patient satisfaction <-- Lean thinking	0.05027	0.05036	0.9982	0.31	Not Supported
Medical tourism <-- Lean thinking	0.1358	0.03716	3.654	***	Supported
Patient satisfaction <-- Lean Service Q.	2.11906	0.55715	3.8033	***	Supported
Medical tourism <-- Lean Service Q.	0.13	0.05477	2.3734	0.017	Supported
Medical tourism <-- Patient satisfaction	0.10803	0.05237	2.0628	0.039	Supported

The study results showed a positive effect of service quality on healthcare medical tourisms and patient satisfaction, which is consistent with previous findings (Alkhaldi & Abdallah, 2022; Sánchez et al., 2018). Therefore, the service quality improvement is central to patient satisfaction and medical tourism attraction in healthcare sector. Medical tourism encourages healthcare providers to build strong relationships with the private sector, civil society, and medical and pharmaceutical suppliers. This collaboration ensures that necessary materials are provided quickly and in appropriate quantities through public-private partnerships. The lean service quality and patient satisfaction are significantly related to medical tourism dimension. These findings are in line with existing literature (Islam et al., 2023; Rotter et al., 2019; Sepp et al., 2021). The findings state that service quality and lean thinking are the basis for improving patient satisfaction and medical tourism.

Lean thinking has also a positive effect on lean service quality. However, the lean thinking did not show a significant effect on patient satisfactions**.** This result is inconsistent due to different patient needs with most previous findings (Cheng San, 2022; Chiarini & Vagnoni, 2017; Jaleel et al., 2021), which indicate that lean thinking should emphasize reducing prolonged waiting time, length of stay (LOS), capital loss and other non-value-added activities to enhance patient satisfaction. Moreover, lean thinking has a significant indirect relationship with patient satisfaction through the mediating effects of lean service quality, as indicated by the multiplication of the coefficients of the indirect paths (Hair et al., 2012).

The outcomes observed in the analysis may also be influenced by the distinct characteristics and practices between manufacturing and healthcare processes. While lean thinking and its principles

have proven effective in reducing waste in healthcare, variations and defects still occur. Continuous improvement efforts can significantly reduce waiting times, thereby enhancing patient satisfaction. However, the unique needs of each patient appear to limit the impact of lean thinking on patient satisfaction, although it does contribute to improvements in healthcare service quality. Moreover, the situation in the healthcare sector is different (S. Ahmed et al., 2018a; Alkhaldi & Abdallah, 2020). Improving patients' satisfaction and suitable healthcare requires understanding the unique needs of different patients to be responsive in providing appropriate healthcare services. Therefore, the insignificant effect of the lean thinking on patient satisfaction can also be justified by the lack of patient aspects in reducing waste in the healthcare sector (S. Ahmed et al., 2018a; Jain & Ajmera, 2018). It could also be attributed to the fact that lean thinking activities in the healthcare sector require frequent reworking and controls many times to verify and confirm the precision of medical equipment because it is linked with human lives, and with no errors. Engaging empowered, knowledgeable, skilled, and rewarded employees and stakeholders encourages the reduction of healthcare waste through lean thinking (Improta et al., 2018; Ramori et al., 2021). This approach aims to satisfy patients by understanding their needs, facilitating their access to services, and providing appropriate care.

Even though internal operations efficiency and reduced costs are important, patients don't seem to prioritize them first. The primary factors influencing patients' decision to choose private hospitals are service quality and reliability. In reality, despite their low costs, people typically avoid public hospitals. Patients become devoted and the reputation of the healthcare facility improves when they have trust in it. As a result, the healthcare gains market share and becomes more competitive, which enhances its appeal to medical tourists. Public-private partnerships are therefore promoted.

Public-private partnerships enable the involvement of empowered, informed, and trained staff to work effectively. They help staff understand patients' demands, pool new technologies, facilitate access to those technologies, and make informed decisions to enhance procedures and reduce operating costs. This will lead to minimized waste, reduced operational costs, greater accessibility to suitable healthcare services, increased patient satisfaction, and enhanced attraction for medical tourism. The results indicate that the implementation of public-private partnerships in healthcare facilitates the pooling of infrastructure, technologies, and skilled medical staff, ensures that biomedical equipment remains in good working order, prevents breakdowns and disruptions in medical treatment processes, and maintains readiness for use at all times.

5.7.Collaboration (Public private partnerships)

Public-private partnerships, or PPPs, are being considered by governments facing mounting budgetary strain as a means of extending access to better healthcare by utilising private sector cash, management expertise, and know-how that have been widely employed all over the world, especially in Europe and in the United States. Governments can work with the private sector to improve the quality of healthcare services by combining administrative and technical expertise and pooling resources through public-private partnerships (PPPs). Access to essential health services, risk sharing based on the level of capital committed, rapidly evolving and improving medical technologies, the initial infusion of capital by the private partners, and the rising costs of providing healthcare services as the population ages in both developed and developing countries are the main factors driving this increased interest in PPPs. Achieving universal health coverage, which includes financial risk protection, access to high-quality essential health care services, and universal access to safe, effective, and reasonably priced essential medications and vaccines, is one of the goals for the third Sustainable Development Goal, which aims to ensure healthy lives and promote well-being for all.

Strengthening healthcare service delivery is the most inclusive, effective, and efficient way to improve service quality, according to world leaders, who reaffirmed that everyone has the fundamental right to the best possible health. In order to create more robust and long-lasting service delivery, it also urged all parties involved to behave as partners and take coordinated action. Improving the quality of healthcare services necessitates the efficient collaboration and participation of all significant players, including patients, medical staff, the commercial sector, civil society, regional and global partners, and others.

In order to solve the drawbacks of existing initiatives to enhance our healthcare, PPPs have grown in importance as a means of funding and enhancing health. This is because, by acquiring supplies like equipment, medications, ambulances, and technical support, the private sector contributes significantly to the provision of healthcare and public health. The PPP improves clinical performance and service quality in the healthcare by utilising private-sector expertise. PPP is typically thought of as a private sector, for-profit business investing in the government to accomplish a certain objective. It addresses healthcare access, gaps, quality target, and system inefficiencies; deployment of private providers to fill staffing gaps; clinical expertise (renovate, operate, lease, and maintain equipment and train staff to run services for a fixed fee, saving public hospitals from spending time and resources)***;*** collaboration on quality assurance oversight (Rather

than conducting all regulation and monitoring in-house. The MOH should work with the partners on providing certification and standardized training for health services); contracting-out training with private in-service training institutions to improve the medical staff capacity; connected with large investments such as infrastructure for cooperation that commonly cannot be afforded by governments and shared risk, rewards, and roles between both public and private partners.

5.8.Mediation analysis

The study identified direct and indirect correlations between dimensions such as service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism. A direct effect is the effect of independent/exogenous variables on dependent/endogenous variables, whereas an indirect effect is the effect of an independent/ exogenous variable on an endogenous variable via a mediating variable (Berhan, 2020). Service quality exerts direct and indirect effects on medical tourism through patient satisfaction. The resulting assessment linked to lean service quality significantly determines patient satisfaction and medical tourism (Abdel Fattah et al., 2021), showing that patient dissatisfaction happens when the service deliveries are below patients` expectations. Though service quality and lean thinking have a significant effect on increasing patient satisfaction, (Abdel Fattah et al., 2021) determined that lean service quality and patient satisfaction mediate the relationship between service and medical tourism and lean thinking medical tourism. In healthcare service quality improvement, service quality and lean thinking are significant dimensions in sustaining patient satisfaction, and medical tourism (Abdel Fattah et al., 2021).

The success of healthcare service quality is recognized by strategies for sustaining quality services, patient satisfaction, and medical tourism. Lean service quality, and patient satisfaction have been recognized as contributing to medical tourism (Ahmed, 2019). Empirically, practitioners found indications that lean service quality and patient satisfaction mediate the relationship between service quality, lean thinking, and medical tourism. Lean service quality and patient satisfaction are attained by service quality and lean thinking, which in turn establish an excellent base of medical tourism and economic growth (Preethy et al., 2013).

The assessment of the indirect effects (mediation effects) of service quality and lean thinking on the relationship between patient satisfaction and medical tourism in the suggested SEM is based on SEM bootstrapping. A non-parametric resampling technique known as "bootstrapping" has been acknowledged as a more thorough and effective way to examine the mediating effects (Berhan, 2020; Hair et al., 2012). The findings pertaining to the direct impacts indicated that there was a noteworthy correlation between service quality, patient satisfaction, and medical tourism. Medical

tourism bias adjusted by the bootstrapping confidence interval of indirect effects (95%) shows that the mediation effects are statistically significant (Hair et al., 2012).

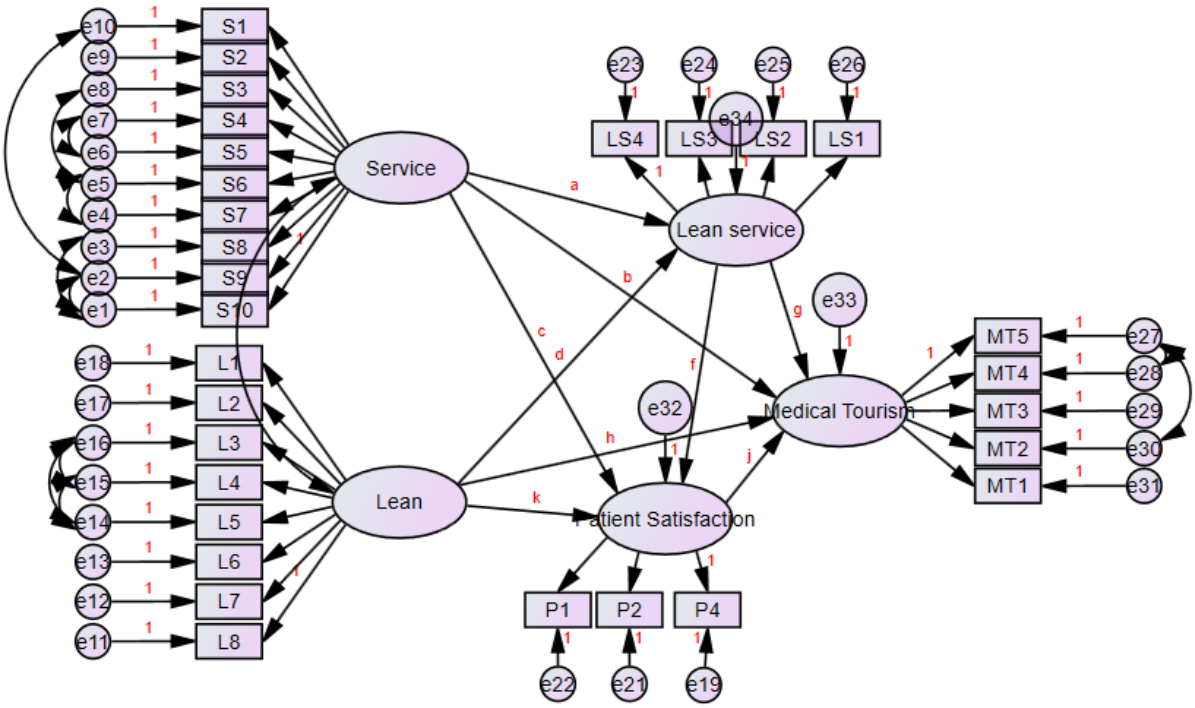


Figure 5.4: Mediation analysis model

The study considered the direct, indirect, and total effects of independent variables (i.e., service quality and lean thinking) on medical tourism via mediating variables (i.e., lean service quality and patient satisfaction). The findings of the study revealed that, in addition to their overall impact, service quality and lean thinking have a direct and indirect significant relationship with medical tourism via mediating variables. Service quality has an indirect relation with medical tourism. Service quality has both an indirect and direct significance relationship with medical tourism through lean service quality. The remaining constructs have a direct, indirect, or totally significant relationship with service quality.

Table 5.7: Direct and indirect mediation analysis

N/S	Variables Outcome	Direct effect		Indirect effect		Total effect	
1	Service quality to Patient satisfaction to medical tourism	0.000**	Sign.	0.06 ***	Sign.	0.06***	Sign.

2	Service quality to lean service to Patient satisfaction to medical tourism	0.000**	Sign.	0.03***	Sign	0.03	Sign.
3	Service quality to lean service to medical tourism	0.04	Sign.	0.012***	Sign	0.05***	Sign.
4	lean service quality to medical tourism	0.000****		0.000***	Sign.	0.000****	Sign.
5	Lean thinking to Patient satisfaction	0.31	Not Sign.	0.04	Sign.	0.35	Not Sign.
6	Lean service quality to Patient satisfaction to medical tourism	0000	Sign.	0.000**	Sign.	0.000***	Sign.

Obtained results indicate that service quality has both direct and indirect effect on patient satisfaction and medical tourism. Lean service quality has both direct and indirect effect on medical tourism. On the other hand, lean thinking has significant relationship by in indirect effect, but is not significant by direct effect on patient satisfaction.

5.9.Artificial Neural Networks (ANN) Analysis

SPSS-AMOS version 23 was used to develop SEM and analyse the relationship between service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism. Developing a complex model is inadequate (Chong & Chan, 2012) because it oversimplifies the complex system and examines only linear relationships (Naveen & Gurtoo, 2020; Tan et al., 2014). The conventional (SEM) multivariate analyses determine the causal relationship significance level, while ANN cannot determine it due to its interpretation and is unsuitable for hypotheses testing (Hew et al., 2018; V. Lee et al., 2020). Due to the nonlinear relationships in the model, it is helpful to involve a dual-stage analysis. Therefore, the study used an artificial neural network (ANN) to simulate the lean service quality improvement dataset. The integrated SEM and ANN produce a robust output using a multi-layer perceptron (input, hidden, and output). SEM simplifies the system complexities by examining the linear model using significant variables and causal relationships without considering the nonlinear model. The study addressed these drawbacks by integrating the ANN approach and SEM to handle linear and nonlinear relationships, avoid model overfitting, and reduce distribution assumptions (Hew et al., 2016). It outperforms more accurate patient satisfaction and expectation

prediction than regression techniques (Tan et al., 2014). The SEM is used as the input unit of the ANN model. SEM is very significant for theory validation, detecting linear relationships, and oversimplifying complex systems. At the same time, ANN can detect both nonlinear and linear relationships without robust speculative or theoretical bases (Leong et al., 2019). ANNs identify all linear, nonlinear, and non-compensatory relationships by avoiding assumptions in distribution and model development (Liébana-Cabanillas et al., 2018). It is a highly adaptable technique for accurate prediction and usually outperforms linear and multiple regression models (Tan et al., 2014). Hence, ANN is complemented by the SEM model to fill a nonlinear and non-compensatory model, which is a hybridized two-stage approach. SEM determines the hypothesis test and significant variables, while ANN uses significant variables as input to determine the variable's importance and predict patient satisfaction. The selection of ANN hidden layers is contingent upon the intricacy of the system and the problem that needs to be resolved. One hidden layer is sufficient for this investigation; the number of neurons depends on the size of the sample, activation function complexity, architecture of the neural network, training algorithms, and the number of hidden layers (Li et al., 2021).

ANN can obtain knowledge through its learning process, particularly in training nonlinear datasets, to enhance its performance (Hew et al., 2018). The SEMANN adoption in the lean service quality model is recommended by (Lee et al., 2020) to explore the relationship between the variables in the healthcare system. For the predictive scope of the research setting, weak theoretical, and other non-linear relationships, ANN is the appropriate choice because it is flexible and avoids multivariate assumptions (Leong et al., 2019). It is a processing unit like the human brain, where knowledge is gained through the learning process by storing knowledge (Leong et al., 2019).

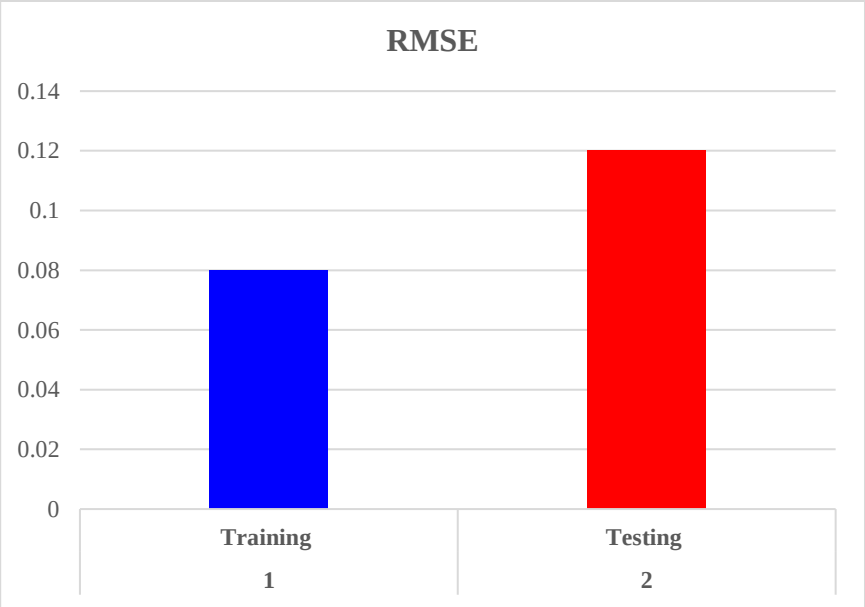


Figure 5.5: RMSE values of ANN

The RMSE values in the ANN model indicate good predictive accuracy (J. J. Hew et al., 2018). Moreover, based on the approach of Leong et al. (2019). A lower RMSE value ascertains model fitness and robust predictive accuracy (Lee et al., 2020). After the relevance of patient satisfaction prediction and prediction accuracy is determined, a sensitivity analysis is conducted to rank the dimension`s relative importance (Hew et al., 2016).

Table 5.8: Neural network sensitivity analysis

ANN	**Model 1**		**Model 2**			**Model 3**			
Output neurons	lean service quality		Patient satisfaction			Medical tourism			
	LT	SQ	LT	SQ	LSQ	LT	SQ	LSQ	PS
ANN1	0.44	0.56	0.163	0.397	0.44	0.293	0.312	0.366	0.029
ANN2	0.43	0.57	0.167	0.393	0.441	0.281	0.312	0.368	0.039
ANN3	0.4	0.60	0.168	0.387	0.441	0.267	0.312	0.371	0.05
ANN4	0.466	0.544	0.184	0.376	0.441	0.262	0.312	0.373	0.053
ANN5	0.439	0.561	0.21	0.35	0.44	0.263	0.312	0.374	0.051
ANN6	0.424	0.576	0.24	0.32	0.44	0.263	0.312	0.376	0.049
ANN7	0.42	0.58	0.23	0.33	0.44	0.267	0.312	0.377	0.044
ANN8	0.432	0.568	0.23	0.33	0.44	0.267	0.312	0.38	0.041
ANN9	0.44	0.56	0.22	0.34	0.44	0.27	0.312	0.383	0.035

ANN10	0.45	0.55	0.21	0.35	0.44	0.267	0.312	0.386	0.034
Average	**0.434**	**0.566**	**0.202**	**0.35**	**0.44**	**0.27**	**0.312**	**0.375**	**0.042**
Average	**93%**	**94.4%**	**84%**	**89.9%**	**99%**	**93%**	**100%**	**97%**	**83%**

To find further insights about medical tourism and dimensions` relative importance, three ANN models were identified for analysis using RMSE and sensitivity analysis. Based on the presented Table 5.8 of the ANN sensitivity analysis, the most significant predictor of lean service quality is service quality, followed by lean thinking. In the second model, the most significant predictor of patient satisfaction is lean service quality, followed by service quality and lean thinking. On the other hand, model three, which is medical tourism, contains service quality as the most significant predict, followed by lean service quality, lean thinking, and patient satisfaction. Based on this result, the study can realise that service quality, lean service quality, lean thinking, and patient satisfaction have an outstanding direct or indirect contribution to healthcare service quality improvement, which lays the foundation for overall medical tourism attraction through effective prediction.

Model One

As shown in Figure 5.5, the RMSE values for both the training and testing data are low, indicating higher predictive accuracy and better data fit. Table 5.8 presents the results of the sensitivity analysis, which assessed the predictive power of each input neuron. To obtain the normalized importance of these neurons as a percentage, the study divided their relative importance by the maximum importance. Service quality was identified as the key determinant in predicting lean service quality. In the first model, the order of importance for lean service quality, in descending order, is as follows: service quality, followed by lean thinking.

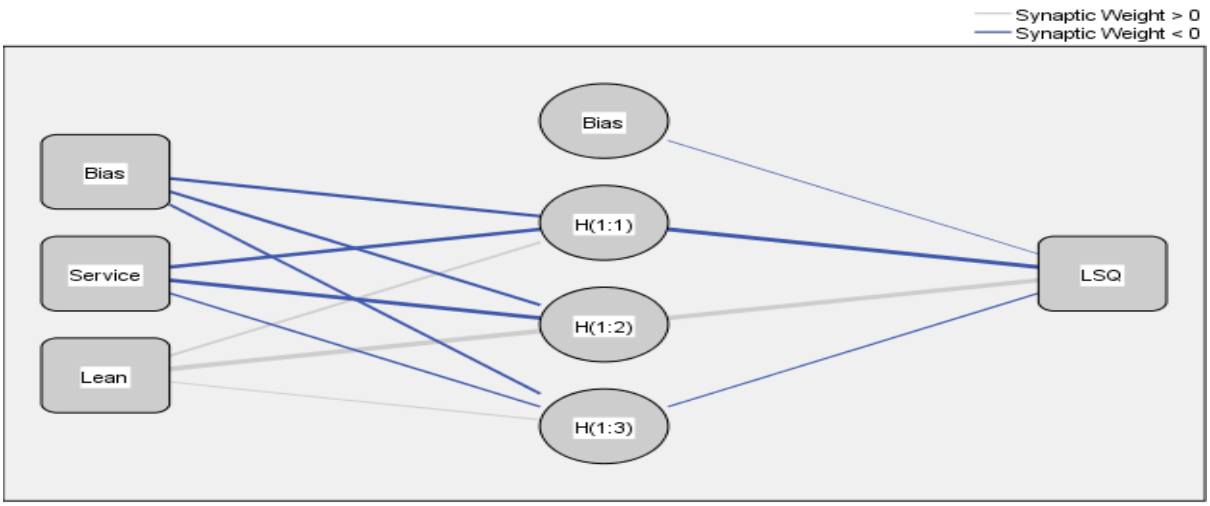


Figure 5.6: Neural Network between service quality, lean thinking, and lean service quality

Model Two

In Model 2, lean service quality is the most significant predictor of patient satisfaction, followed by service quality and, finally, lean thinking.

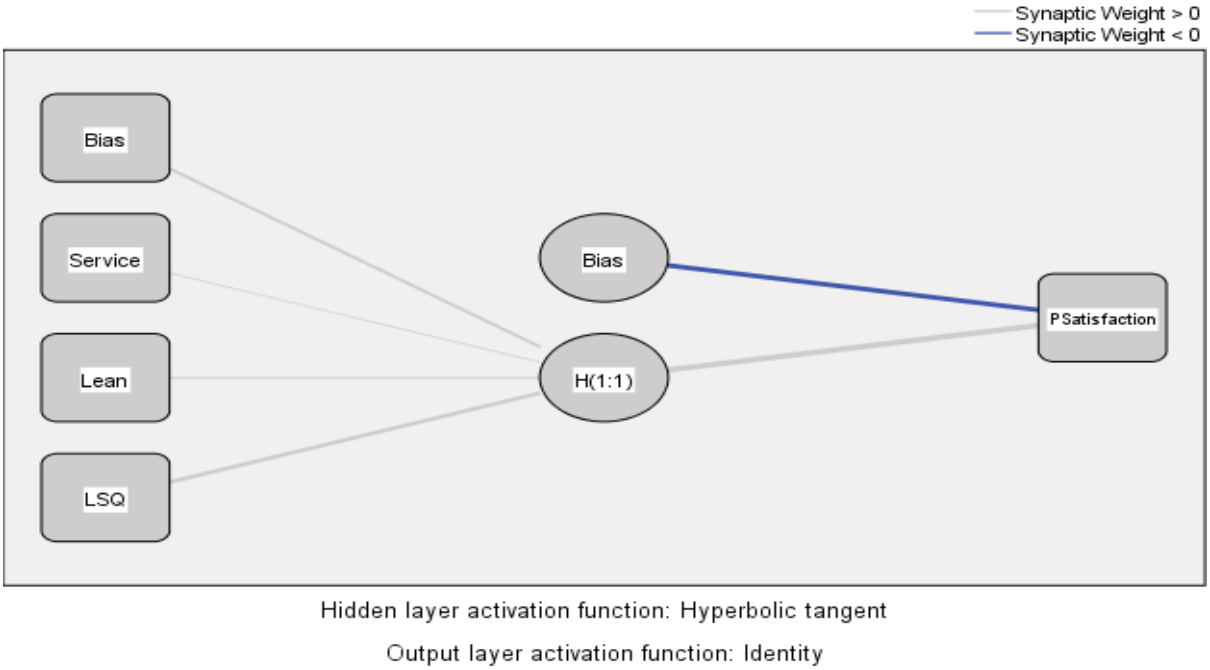


Figure 5.7: Neural Network between service quality, lean thinking, lean service quality, and patient satisfaction

Model Three

In Model 2, lean service quality is the most prominent predictor of patient satisfaction, followed by service quality and, finally, lean thinking. Furthermore, patient satisfaction emerged as the most effective predictor of medical tourism. Service quality is the leading predictor of medical tourism, followed by lean service quality, lean thinking, and, lastly, patient satisfaction. All dimensions in the ten ANNs for each model had at least one non-zero synaptic weight connected to the hidden neurons, which validates the relevance of these dimensions as variables, as shown in Figures 5.6, 5.7, and 5.8.

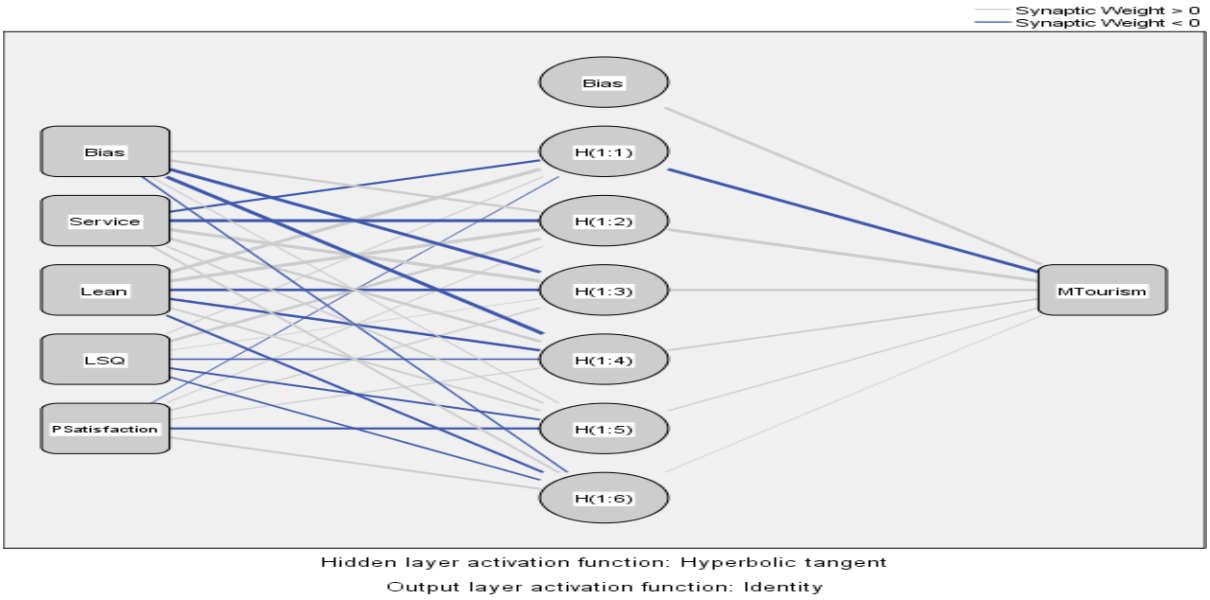


Figure 5.8: Artificial Neural Network between service quality, lean thinking, lean service quality, and patient satisfaction to medical tourism.

Considering the relevance of patient satisfaction prediction and robust predictive accuracy of ANN models, Table 5.9 indicates the sensitivity analysis that ranks the dimensions based on their relative importance of input neurons in each ANN model. A sensitivity analysis is conducted using Table 5.9 to rank the relative importance of each variable, while the medical tourism prediction model is illustrated in Figure 5.9.

In ANN Model 1, service quality indicates the highest relative importance for lean service quality, followed by lean thinking. In Model 2, service quality is again relatively more important than lean thinking.

Table 5.9: SEM and ANN analysis Comparison

	Dimension	SEM Path	Ranking (SEM)	Relative Importance (ANN)	Ranking (ANN)	Ranking Matched?
Model 1: LSQ	Service quality	0.38	1	94.4%	1	Yes
	Lean thinking	0.28	2	93%	2	Yes
Model 2: Patient satisfaction	Service quality	0.5	2	89.9%	2	Yes
	Lean thinking	0.39	3	84%	3	Yes
	Lean service qua.	0.8	1	99%	1	Yes
Model 3: Medical tourism	Service quality	0.89	1	100%	1	yes
	Lean thinking	0.48	3	93%	3	ye
	Lean service qua.	0.8	2	97%	2	yes
	Patient satisfaction	0.42	4	83%	4	Yes

Regarding the dimension of healthcare lean service quality improvement, there is no weak effect in the verified model of the ANN. The normalized importance levels for all dimensions are greater than 80%, which is very high. It showed a significant relationship with both SEM and ANN model analysis. Hence, the dimensions in model 1, 2, and 3 indicated a significant relationship with each other. Medical tourism attractions predictions are very substantial to increase healthcare service quality by reducing the factors that affect patient satisfaction, such as waiting time, LOS, medical error, shortage number of beds, etc.

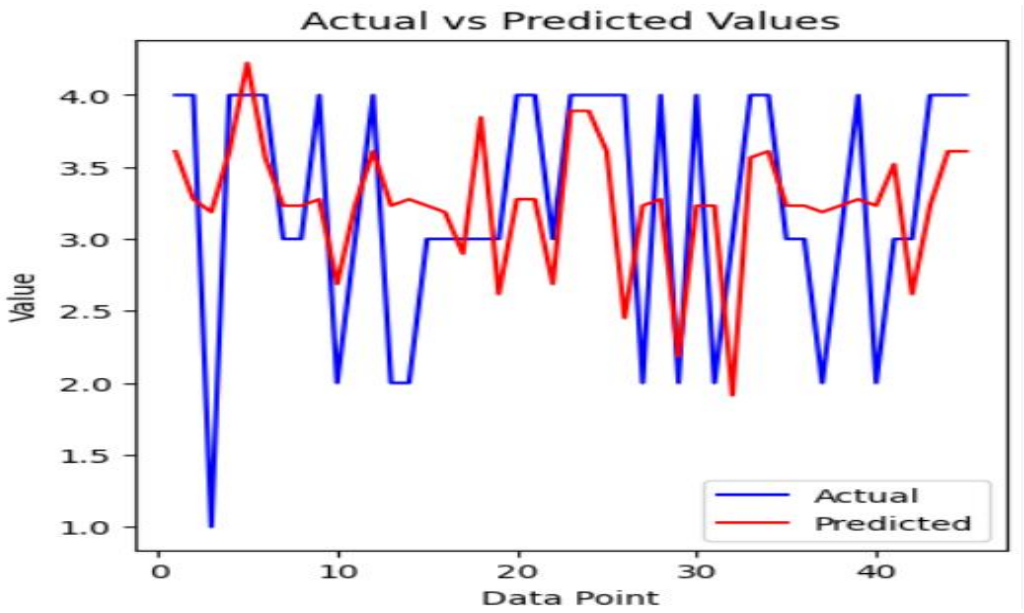


Figure 5.9: Medical tourism attraction prediction model

The healthcare service quality improvement is fundamentally significant for service delivery, patient satisfaction, medical tourism, and national economic growth, as the finding of Ampaw et al. (2020) also revealed. The study measured the healthcare service quality using the dimensions such as service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism (Ampaw et al., 2020; Donabedian, 1988; RiyazhKhan & Haq, 2019). The model finding revealed that service quality, lean service quality, and patient satisfaction have a positive significant relationship with medical tourism, as (Itumalla, 2012) also indicated. The findings of Zhang et al. (2020) suggest that increasing patient satisfaction in healthcare supports the positive outcomes of medical tourism, as Rosemarin et al. (2019) also discovered related findings between service quality (tangibility, responsiveness, reliability, assurance, empathy) and lean service quality. The positive relationship between service quality and patient satisfaction significantly affects waiting time, lower customer trust in the sector, and other factors.

Chapter Six

Discussion and Implication of the study

6.1.Discussion

The study used 23 versions of IBM SPSS, AMOS Graphics, and ANN to analyse the collected data. Among the 225 respondents who took part, 116 (51.56%) were female, and 109 (48.44%) were male, representing a range of healthcare sectors. The study attempts to provide empirical evidence and supports the SEM. The mean and standard deviation of lean service quality parameters were determined using descriptive and multivariate statistical analyses. Medical staff, patients, and graduating class students of Addis Ababa hospitals and healthcare centres were used as demographic variables. The average mean values for the dimensions are greater than the scale's midpoint (i.e., 3.35 on a five-point scale), which is considered high. The descriptive statistics indicated that patient satisfaction has the greater mean (i.e., 3.71), which shows a high rating by respondents (Berhan, 2020), while lean service quality and patient satisfaction (i.e., 0.2) have a low standard deviation, which implies low variability among the respondents. The low mean is identified in lean thinking (i.e., 3.04), while a high standard deviation occurs in service quality (i.e., 0.72). Moreover, the high SD showed a high rating and high variability among the respondents (Berhan, 2020).

The model fitness measurement indices are GFI, $\chi 2/df$, RMSEA, AGFI, NFI, CFI, and TLI, which come out to be 0.85, 1.64, 0.05, 0.82, 0.92, 0.97, and 0.96, respectively, and show good fit as (Srivastava & Prakash, 2019) also corroborated. All these model fit values are aligned with the cut-off criteria and recommendation norms (Berhan, 2020, Hair et al., 2013). The study evaluates various path coefficients hypothesized relationships by revealing that the critical ratio (CR) is greater than the absolute value of 1.96, which is statistically significant (Berhan, 2020). The service quality dimension indicated a significant positive relationship with lean service quality, patient satisfaction, and medical tourism. Service quality dimension was measured using tangibility, reliability, responsiveness, assurance, and empathy, as (Ampaw et al., 2020; Donabedian, 1988; RiyazhKhan & Haq, 2019) also used in their studies. The model finding revealed that service quality, lean service quality, and patient satisfaction have a significant positive relationship with medical tourism, as (Itumalla, 2012) also indicated. The findings of Zhang et al. (2020) suggest that increasing patient satisfaction in healthcare supports the positive outcomes of medical tourism. Rosemarin et al. (2019) also discovered related findings between service quality (tangibility, responsiveness, reliability, assurance, and empathy) and lean service quality.

6.1.1. Service Quality

In this study, the lean service quality improvement model comprises two independent and three dependent dimensions, including service quality, lean thinking, lean service quality, patient satisfaction, and medical tourism. Ten measurements were used to measure service quality. The overall finding of the CFA shows that the measurement indicates the CMIN/DF = 3.563, the GFI = 0.703, the CFI = 0.843, and the RMSEA = 0.058. From the ten measurements, no items have measurements that are unacceptably high and need the decision to be removed. Hence, the results show that the model fits the data adequately.

The study revealed a positive and significant relationship between service quality and lean service quality, as well as between service quality and patient satisfaction. These factors directly impact medical tourism. The effect of service quality on enhanced patient satisfaction and medical tourism is supported by research conducted by (Gholizadeh et al., 2016; Toni et al., 2023) which aligns with the current study's findings. The results emphasize the influence of service quality on improving lean service quality, patient satisfaction, and medical tourism, demonstrating significant relationships. Furthermore, Jaleel et al. (2021) highlighted the importance of service quality and lean thinking in enhancing healthcare service quality and patient satisfaction and its role in attracting medical travellers. They concluded that increasing service quality and patient satisfaction positively affects both medical tourism and the relationship between these variables. From a medical perspective, the dimension of service quality involves doing the right thing at the right time, in the right way, for the right patient, and achieving the best possible medical outcome, as consistent with the studies by Puri* et al. (2019) and Sharma et al. (2017).

6.1.2. Lean thinking

Eight items were used to measure lean thinking. The overall results of the CFA indicate that the initial measurement model did not need to be re-specified, so none of the items were deleted. The chi-square/df was significant (CMIN/DF = 1.5). The GFI is 0.957, the CFI is 0.972, and the RMSEA are 0.05. The Lean thinking pays a special attention to teamwork or collaborations through public private partnership, which have multidisciplinary effect for healthcare sector development, patient satisfaction and medical tourism attraction. Working as an effective and cohesive collaboration is frequently reported to reduce medical errors, waiting time, and other related waste to ensure high service quality, patient satisfaction, and medical tourism attraction. A lean service quality improvement approach in the healthcare sector needs to cope with the efforts towards promoting

collaboration and multidisciplinary teams (including private healthcare sector, civil societies, and other stakeholders for improving the quality of healthcare services, and for developing a safe environment for patients.

The findings indicated a significant positive relationship between lean thinking and lean service quality and medical tourism. Stadnicka and Litwin (2019) emphasized the role of lean thinking in the healthcare improvement process, which reduces waste and enhances service quality, patient satisfaction, and medical tourism. Lean thinking is a crucial dimension that requires comprehensive understanding, strong commitment, and thorough analysis to improve service quality, reduce waiting times, provide faster service, and enhance patient satisfaction, as also (Gholizadeh et al., 2016) corroborated.

However, the study found that lean thinking does not significantly correlate with patient satisfaction, which is inconsistent with previous research (Cheng San, 2022; Chiarini & Vagnoni, 2017; Jaleel et al., 2021). These studies indicate that lean thinking should focus on minimizing prolonged waiting times, length of stay (LOS), capital loss, and other non-value-added activities to improve patient satisfaction. Successful implementation of lean thinking is contingent upon the presence of committed healthcare managers, active participation from all medical staff, modern technologies, effective healthcare structures, and collaboration among stakeholders and patients (Sakthivelmurugan et al., 2021). Lean thinking aims to identify the root problems in healthcare to prevent their recurrence.

6.1.3. Lean service quality

Four measurements were used to measure the lean service quality. The CFA overall results indicate that all items have acceptable values (CMIN/DF = 1, GFI = 0.815, CFI = 0.886, and RMSEA = 0.01). This dimension has a significant positive relationship with patient satisfaction and medical tourism, which is consistent with the findings of Voehl & Elshennawy (2021). Therefore, it helps reduce waste in time, money, and supplies, while also enhancing patient goodwill. By accelerating service delivery, lean service quality enhances patient happiness, lowers costs, and streamlines healthcare processes (Voehl & Elshennawy, 2021). Healthcare can benefit from lean service quality to improve systemic activities and procedures (Voehl & Elshennawy, 2021).

6.1.4. Patient Satisfaction

Service quality and lean service quality dimensions are strongly correlated with patient satisfaction dimension. This indicates that there is a high association between service quality, lean service quality, and patient satisfaction, which is defined by patient expectations and perceptions. Four measurements were used to measure the patient satisfaction. The CFA overall results indicate that all items have acceptable values (CMIN/DF = 1, GFI = 0.815, CFI= 0.886, and RMSEA = 0.0104). Patients are more satisfied with their medical demands when the quality of the services is greater. The study's findings are consistent with those of with Cham et al. (2021), who found that patient satisfaction is positively and significantly impacted by service quality. Providing a comfortable waiting area, prompt doctor examinations and consultations, courteous service from medical staff that is willing to help patients and patience in delivering services are all ways to improve patient satisfaction through service quality and lean thinking. The degree of patient satisfaction increases with the quality of amenities.

6.1.5. Medical Tourism

Five measurements were used to measure the medical tourism. The CFA results indicate (CMIN/DF = 1, GFI = 0.815, CFI = 0.886, and RMSEA = 0.01). Results indicate that all items have acceptable values. The result confirmed that service quality, lean thinking, lean service quality, and patient satisfaction significantly and positively affected medical tourism, and the results coincided with Salamah et al. (2022). Service quality is reflected in delivering responsive and reliable responses to the patient`s requirements to provide quality services (RiyazhKhan & Haq, 2019). The analysis indicates that healthcare lean service quality improvement improves patients' satisfaction through service quality (responsiveness, reliability, tangibility, assurance, and empathy), lean thinking, and lean service quality, (Baashar et al., 2020; Fenner & Netland, 2023; Medhekar et al., 2020).

Healthcare lean service quality needs cooperation between the healthcare provider, patient, government, and other stakeholders (Medhekar et al., 2020) to enhance patient satisfaction and medical tourism. In service quality improvement, service quality (i.e., tangibility, responsiveness, reliability, assurance, and empathy), lean thinking, lean service quality and patient satisfaction, have a significant influence on medical tourism and economic growth (Baashar et al., 2020). Chang et al. (2006) studied the influence of service quality on patient satisfaction in the context of reliability, responsiveness, assurance, tangibility, and empathy. The five dimensions form overall patient satisfaction, and they are highly correlated. The statistical significance test between service quality

and patient satisfaction, service quality and medical tourism, service quality and lean service quality was conducted.

The study investigated the impacts of service quality, lean thinking, and lean service quality on patient satisfaction and medical tourism in the healthcare sector. All the variables' correlation coefficients indicated a positive relationship, indicating that service quality improvement has a significant effect on patient satisfaction and medical tourism, as (Naveen & Gurtoo, 2020) explained. The result is consistent with the finding of (Baashar et al., 2020) and it indicated a substantial influence on patients' satisfaction. The study's lean thinking result is also consistent with the result of Abbasi-Moghaddam M et al. (2019), in which lean thinking has a significant impact on medical tourism. The patient satisfaction significance impact is also consistent with Zhang`s et al. (2020) and Sekaran`s et al. (2018) result. Similarly, lean service quality significantly influences patient satisfaction, medical tourism, and it is consistent with the findings of Sekaran`s et al. (2018) and (Chong & Chan, 2012). However, the lean thinking doesn't indicate a significant relationship with patient satisfaction.

The model predictive accuracy was significantly assessed using RMSE, as (Hair et al., 2012) also used. It shows the independent variable contribution towards the RMSE values of the dependent variable. The prediction relevance and predictive accuracy measurements are calculated based on RMSE (Leong et al., 2019). A lower RMSE value ascertains model fitness and robust predictive accuracy (V. H. Lee et al., 2020). After the relevance of patient satisfaction prediction and prediction accuracy is determined, a sensitivity analysis is conducted to rank the dimension`s relative importance (T. S. Hew et al., 2016).

6.2.Lean Service Quality Improvement Model Implementation

The purpose of this section is to indicate the way to operationalize the lean service quality improvement model within the specific context of the healthcare sector, demonstrating its significance in enhancing service quality. In this research, the healthcare sector has been selected as a case study to illustrate the model's implementation.

The current trend in the healthcare sector indicates that the quality of healthcare services is highly dependent on the skills and knowledge of medical staff, the technologies used, and access to services. The efforts of medical personnel, top management, stakeholders, and other entities in both the public and private healthcare sectors to monitor and control service quality and reduce waste are commendable. Furthermore, the healthcare sector should intensively focus on meeting patient

needs, minimizing waste, and preventing medical errors through prediction, collaboration, and the engagement of various stakeholders. This approach will improve lean service quality, increase patient satisfaction, and boost medical tourism. To achieve this, it is essential to build a team responsible for ensuring successful implementation. This team should create a shared vision among public-private partnerships, define actionable goals, develop an action-oriented plan, monitor incremental successes, communicate the value of the initiative, and publicize the goals to the medical staff. However, attention must be given to the skills and experience of medical staff, service accessibility, technology, and waste management in order to achieve lean service quality improvement and retain medical travellers.

The strategy for implementing the model in the case healthcare is based on the existing lean thinking approaches already applied in the sector. This implementation requires certain preconditions to achieve significant shifts in technical performance, service quality, and process improvement. There is no standard timeline for implementation, as it varies based on several factors, including the size of the hospitals, the complexity of the systems being installed, public-private partnerships, and available resources. Based on the model's outcomes, key tasks to be implemented include training and raising awareness about waste reduction through machine learning techniques to predict waste generation, disease prevention, and enhancing patient satisfaction.

The study's findings also revealed the impact of public-private partnerships in addressing government resource gaps to achieve improvements in service quality, reduce medical traveller numbers, and attract medical tourism through private collaboration. This objective is accomplished by fostering cooperation between the government and the private healthcare sector, which allows for the pooling of technologies, specialized personnel, and other resources that enhance service quality and medical tourism, ultimately helping to retain medical travellers.

The healthcare sector identifies a key problem in the process that involves defining the issue, gathering data, reviewing procedures, identifying best practices, and developing standards. These activities require team formation to identify waste in the process and create value for the targeted problem or process through collaborative efforts to find solutions, while also ensuring team empowerment and skill development at all staff levels.

In this process, model implementation involves making changes to lean service quality and operations based on the findings. Sharing the results of this implementation and highlighting

changes in key quantitative metrics, such as waiting times, can facilitate a prompt response to the ongoing use of lean service quality practices (D'Andreamatteo et al., 2015). Moreover, identifying changes that demonstrate the value generated by lean service quality approaches such as reduced waiting times, improved service quality, and increased employee engagement will be documented. A Continuous Improvement Program will be conducted by prioritizing the application of lean service quality to key processes within the broader healthcare strategy (Valenzuela, Palomino, et al., 2020).

6.3.Contribution and implication of the study

The contribution and implication of the study are presented in theoretical and practical contribution.

6.3.1. Theoretical contribution and implication

The contributions of this study can be realized at theoretical, methodological, and empirical levels. At the theoretical level, this study develops a conceptual framework based on various literatures, including lean thinking, service quality, patient satisfaction, and medical tourism. The study is original in its focus on developing a lean service quality model using a dual approach within the context of the healthcare sector. It contributes to healthcare lean service quality improvement and better patient satisfaction based on QFD, Six Sigma, and an artificial intelligence approach, as Salamah et al. (2022) also suggested. It combines service quality and lean thinking to nurture healthcare service quality and patient satisfaction.

The study presents the integration of service quality and lean thinking to enhance healthcare service quality. The lean thinking and service quality integration is the new path for further extended research to achieve patient expectations that in turn attract medical tourism and enhance economic growth. The integration depends on the common measurements which includes responsiveness, waiting time, safety, and perfection. Using these common dimensions, lean service quality is built as dependent variable in healthcare service quality improvement. These common measurements were used as a measurement for lean service quality in improving patient satisfaction, medical tourism, and national economy.

Lean service quality encourages healthcare services to avoid focusing solely on one aspect of their practices. Better outcomes can be achieved by implementing strategies from both sides. Lean service quality differentiates between value-adding and non-value-adding activities, which can motivate and justify the need for lean practices aimed at eliminating waste associated with non-value-adding

activities. It operates as a socio-technical system that influences healthcare service quality through collaboration among all stakeholders. In lean thinking, the patient is primarily a passive actor. In contrast, service quality emphasizes the active patient and reciprocity. Therefore, understanding and analyzing patient resources such as the time and effort invested is critical to assessing productivity in service quality. The lean service quality integration provides a broader viewpoint for scholars enabling them to gain a holistic understanding because it is extended to different detailed contexts. It also delivers insightful information and contributes knowledge in the body of art in the areas of healthcare service quality, lean thinking, and lean service quality from the existing literature.
The integrated approach of lean service quality aims to reduce embedded waste in healthcare through Six Sigma methodologies, specifically DMAIC. This approach enhances fundamental benefits, including reduced waiting times and the elimination of non-value-added activities. The methodology combines DMAIC, QFD, Cause and Effect Diagrams, and machine learning techniques to better understand patient expectations and waiting times.

While various studies have been reviewed, the intersection of lean thinking, service quality, Six Sigma, and Lean Six Sigma (LSS) in service literature remains limited, as noted by Sreedharan et al. (2018) and Sreedharan V et al. (2019). Furthermore, the applicability of integrating service quality and LSS to achieve success in the service sector, particularly in healthcare, has not been thoroughly addressed, as highlighted by Ball et al. (2017) and Karel et al. (2017). This study also incorporates patient voices by considering both functional and technical requirements in service quality and LSS. Additionally, it addresses healthcare waiting time prediction by identifying the highest waiting times and the factors contributing to increased waiting durations.

The study provides suggestions on a machine learning techniques to reduce healthcare embedded wastes by identifying waste causing factors. It has contributed to the body of art by providing not only theoretical and conceptual developed framework but also empirical data that emphasizes the machine learning-based lean service quality improvement and the effect of service quality, lean thinking, lean service quality, and patient satisfaction on medical tourism to fill gaps in the theoretical model of the previous literature.

The successful integration of SEM and ANN to predict patient satisfaction in healthcare service quality is very significant for theoretical and empirical contributions. The study integrated healthcare service quality, lean thinking, lean service quality, and patient satisfaction to enhance

medical tourism and economic growth. It additionally extended the existing methodology-based literature gaps using a dual approach method based on theory and data-driven.

The medical tourism attraction predictions are conducted as a pre-determined principle to adjust the healthcare performance to exceed patient expectations. Medical tourism attraction prediction plays a key role in patient satisfaction (Dormann et al., 2020). The study also incorporates artificial intelligence, i.e., ANN with lean service quality, to predict patient expectations and rank the importance level of the dimension. ANN is a non-compensatory analysis that provides a more realistic outlook and insight than other regression analyses.

6.3.2. Practical contribution and implications

The study findings have potential benefits for different sectors, such as banking industries, telecommunication, finance, and others. The Ministry of Health policies play a significant role in technical capability, patient and healthcare productivity, medical tourism attraction, and national economic growth. This needs a policy revision to improve the medical staff`s technical capability, healthcare `s performance development in artificial intelligence and other indigenous technologies, to create a good healthcare environment. The study also indicated service quality improvement in research and development, service delivery time, waiting time, and technical improvement through artificial intelligence. Medical staff, technical and theoretical skill gaps, and competency improvement, through training, research, and development are very important. The empirical result of the study indicated that service quality, lean service quality, and patient satisfaction have the most influence on medical tourism attraction. Medical tourism is the most significant outcome considered followed by patient satisfaction based on service quality, lean thinking, and lean service quality.

The fundamental goal of these techniques is to predict a more accurate waiting time, which is one of the ultimate indicators of low quality and patient dissatisfaction that affects patients, healthcare, and country by economic aspect, as Li et al. (2023) also suggested. A comparison of all models' actual and predicted waiting periods reveals insights to represent the diversity in patients' time-to-treatment. The prediction of patient`s waiting time is very significant because they may be happy to be seen before the predicted time (M. Ali, 2018). Another method to predict the waiting time in the healthcare sector was proposed which is consistent with (Mendo et al., 2021) to improve the accuracy of service quality. From the identified models, SVM was found to perform the best among the RF and NN algorithms. Its predictive model reports higher accuracy than the RF and NN. The long waiting time is improved by number and magnitude by considering and implementing these

models, as (Pak et al., 2021) also proposed to save patient life and time and have a social and economic impact. Furthermore, there are limited studies that consider machine learning techniques to predict healthcare service quality wastes to enhance patient satisfaction. This creates a fundamental opportunity to explore service quality, LSS, QFD, and machine learning techniques to increase service quality. There is a limitation of the study in predicting the number of beds and patient expectations in healthcare service quality.

The study used SEM to measure the linear relationship among the constructs and hypothesis testing while ANN is integrated into SEM to check the non-linear relationship and sensitivity analysis as a new perspective to examine the relative importance of the dimension to develop the lean service quality improvement model. Therefore, the study used a relatively new approach to address multivariate assumption and nonlinear correlation and provided empirical evidence for scholars to further pursue the analysis using the dual approach in the context of healthcare lean service quality. The linear and nonlinear relationship investigation is recognized, and a nonlinear relationship was also discovered by applying a machine learning technique (i.e., ANN) as a robust novel approach for better predictions. Finally, different relationships based on the framework that are not found in the existing literature arise from the perspective of healthcare service quality. The results enable practitioners to gain insight into lean service quality and apply the results in future research studies to extend their knowledge bases about healthcare service quality improvement.

6.3.3. Managerial implications

The study developed a lot of administrative and management insights through lean thinking considerations in services. It presented numerous theoretical contributions, proposing that the healthcare sector improve service quality to improve patient satisfaction, medical tourism, and economic growth by using lean thinking, building healthcare corporate image, accessibility, healthcare technicality, and artificial intelligence (Y. H. Hu et al., 2020; Punnakitikasem et al., 2012). The quality of healthcare services needs a comprehensive investigation to increase patients` trust in their service delivery in policy and strategy. The lean thinking concept determines the relevance of waste reduction and waste-generated prediction in the healthcare sector. It is integrated with service quality to enhance patient satisfaction and medical tourism. Besides, the study recommends artificial intelligence in nurturing healthcare service quality improvement to predetermine patient expectations and medical tourism to reduce patient waiting time (Salamah et

al., 2022). The sector should relate more with their patients to obtain better-perceived patient needs (Islam et al., 2023).

Lean service quality improvement used DMAIC, QFD, and machine learning techniques to predict patient waiting times. It provides more realistic insights by announcing waiting times to enable data-driven service quality deliveries. Analysing and managing lean service quality improvement and its implementation is challenging because patient expectations are rapidly changing from time to time. However, by taking waiting time and patient expectation prediction into account, the study supports managers and healthcare policymakers in using machine learning and reducing the barriers that hinder service quality improvement and patient satisfaction.

Using CFA and SEM, the study identifies service quality, lean thinking, lean service quality, and patient satisfaction as crucial dimensions for attracting medical tourists. Ensuring quality services and patient satisfaction requires not only a well-maintained hospital environment and robust infrastructure but also the healthcare manager's ability to employ well-trained and skilled administrative staff, physicians, and nurses who exhibit strong interpersonal skills.

Furthermore, the study adds to the body of knowledge on medical tourism and healthcare service quality by highlighting the significance of patient satisfaction in attracting both domestic and international medical tourists. The results of this study will also fill in existing knowledge gaps and add to the following areas of future research: lean thinking, medical tourism, patient satisfaction, and service quality. As the patient's perception of service quality leads to patient satisfaction and the appeal of medical tourism, this study shows that healthcare must take into account the enormous benefits of being patient-oriented. Managers and policymakers must recognise that patients who get healthcare services from the healthcare sector have a favourable opinion of the quality of those services.

Chapter Seven

7. Conclusion and Recommendation

The study's output is concluded in this chapter. Additionally, recommendation for future directions is made. According to the conclusion, the model that was created shows promise in raising healthcare service improvement.

7.1.Conclusion

The study explores various dimensions of healthcare service quality improvement and the factors that influence service quality, patient satisfaction, and medical tourism. Based on this investigation, the study identified dimensions (service quality, lean thinking, lean service quality, patient satisfaction, medical tourism) and effective tools for enhancing service quality, which in turn improves patient satisfaction, boosts medical tourism, and contributes to economic growth.

Healthcare service delivery is one of the most complex systems globally, facing challenges such as increasing pressure, long waiting times, an aging population, rising patient expectations, limited resources, and competing social needs. This study aims to present lean service quality that positively impact patient satisfaction and attract medical tourism in Ethiopia.

For Ethiopia to become a regional hub for medical tourism, significant improvements in healthcare service quality standards are essential. This study is significant as it contributes to the theoretical development of the healthcare sector and clarifies the structured multidimensional relationships among various dimensions.

The study conducted systematic literature review by collecting 162 pieces of literature that cover healthcare service quality, healthcare service quality measurement, lean, lean thinking, six-sigma, QFD, patient satisfaction, and medical tourism to identify research gaps. The literature review analysis result shows lack of available literature and the need for additional research on lean service quality, Six Sigma, waiting time prediction, and improvement opportunities in the healthcare sector. As a result, the study integrated lean thinking and service quality based on the common dimensions and driving factors to indicate the interdependence among the two concepts. Hence, the integration of service quality and lean thinking is very significant to create active patient involvement in both service quality and lean thinking. The literature review suggests the adoption of lean service quality

to enhance patient satisfaction by tackling a broader variety of complex problems encountered in the sector.

The study presented healthcare lean service quality improvement by applying six-sigma, i.e., the DMAIC and machine learning, in combination to reduce waiting time and non-value-add activities. Healthcare lean service quality and patient congestion, particularly in the outpatient department, are the fundamental issues that create prolonged waiting times. These prolonged patient`s waiting times and overcrowding require machine learning to predict waiting times for responsive allocation of resources. This patient waiting time prediction improves service quality and patient satisfaction. The DMAIC method was used to identify potential problems and healthcare process variations. Patient requirements and technical specifications were determined using QFD. The study stated that machine learning was applied to predict healthcare patient waiting times to enhance service quality. Thus, machine learning techniques such as RF, SVM, and NN are used to significantly improve healthcare service quality by announcing waiting times. From these models, a SVM achieved better prediction accuracy for the healthcare waiting time prediction model based on RMSE, MAE, and R2 metrics. Moreover, the SVM model developed results in a 1.73% error reduction.

The study developed a model to investigate the relationship between service quality, lean thinking, lean service quality, and patient satisfaction, aiming to enhance medical tourism attraction through Structural Equation Modeling (SEM) and Artificial Neural Networks (ANN). The SEM-ANN dual approach was used to develop a lean service quality model to determine the dimensions that significantly impact medical tourism and rank them using sensitivity analysis to provide better insights and alternatives. Service quality and lean thinking are fundamental dimensions that enhance lean service quality, which in turn improves patient satisfaction and contributes to medical tourism, fostering economic growth.

The results indicate that service quality significantly influences lean service quality, patient satisfaction, and medical tourism. The results of this study confirm that service quality positively and significantly influences lean service quality and patient satisfaction, which in turn enhances medical tourism in a positive and significant manner. Similarly, lean service quality and patient satisfaction have been shown to have a significant and direct impact on medical tourism. The hypotheses H1, H2, H3, H4, H6, H7, and H8, were supported. However, lean thinking (H5) did not support patient satisfaction. Consequently, healthcare providers must explicitly focus on these dimensions to increase medical tourism visits and promote national economic growth.

The dimensions served as input units for three ANN models. Model 1 included lean thinking and service quality as inputs, producing lean service quality as the output. Model 2 incorporated lean thinking, service quality, and lean service quality as inputs, with patient satisfaction as the output. Model 3 used lean thinking, service quality, lean service quality, and patient satisfaction as inputs, yielding medical tourism as the output.

The SEM and ANN results reveal differing relationships between lean thinking and service quality concerning medical tourism. The ANN analysis underscores the importance of service quality, lean service quality, lean thinking, and patient satisfaction in attracting medical tourism. This study highlights the effectiveness of a hybrid SEM and ANN approach in identifying significant dimensions for enhancing healthcare lean service quality.

The RMSE with a value of 0.12 for testing and 0.08 for training shows the ANN method achieves high prediction accuracy. Based on the ANN sensitivity analysis ranking, the most significant medical tourism predictor's ranks are service quality, lean service quality, lean thinking, and patient satisfaction.

7.2. Recommendation

The fundamental goal of the healthcare sector is service delivery based on patient needs. Based on patients' needs, different decisions can be made. This study integrated lean thinking and service quality to address the literature gaps in lean service quality and healthcare waiting time prediction. The study also combined SEM and ANN to see the dimensions' causal and non-linear relationships. The motivation for this research was to improve healthcare lean service quality in order to enhance patient satisfaction and retain medical travel, addressing the issue of low healthcare service quality in the country. To improve this low service quality, the study revealed different lean service quality improvement dimensions and their causal relationships. Consequently, improving lean service would improve patient satisfaction, medical tourism, and economic growth. Empirical evidence also ensured that lean service quality improvement significantly impacts patient satisfaction and medical tourism. Based on the study's core findings, the following recommendations are suggested to the healthcare sector and other stakeholders to enhance patient satisfaction and medical tourism attraction.

- ✓ The government should focus on increasing healthcare coverage, infrastructure, and service access and creating skilled and experienced medical staff through capacity-building training, healthcare education policy, strategy formulation, public-private partnerships, and policy development to achieve patient expectations.
- ✓ The model use as reference for the national and healthcare policy and strategy developments to enhance patient satisfaction and promote medical tourism.
- ✓ Establishing collaboration between public-private partnerships and R&D institutions to improve healthcare lean service quality in line with patient expectations.
- ✓ The study also recommends that improving lean service quality is a significant economic strategy for attracting medical tourism. Therefore, policymakers should revise healthcare service quality improvement policies to reduce medical travel, allocate budgets effectively, and enhance healthcare quality assurance institutions through public-private partnerships and R&D.
- ✓ The study also strongly recommends that the government should not consider taxes related to modern technological changes and other healthcare infrastructures. This adaptability is crucial for the healthcare sector to remain relevant and effective in the face of rapid technological and environmental shifts, ultimately improving service quality and enhancing medical tourism attraction.

- ✓ The healthcare sector is one of the pillars of the development plan, which aims to enhance patient well-being, improve family time, and attract foreign patients. Therefore, the Ministry of Health, stakeholders, and the government should focus on reducing patient wait times and increasing access to services. It helps to remain competitive, the healthcare sector must provide responsive, reliable, and error-free services to ensure patient satisfaction and attract medical tourism. The findings emphasize the importance of addressing both lean principles and service quality considerations to enhance the overall healthcare experience and attract medical tourism.

7.3.Future Research Direction

Future research can be done on a larger population to study the demographic variables of healthcare service quality in detail, which will give a better representation of the results. Healthcare service quality dimensions often vary with demographic characteristics such as region, income, and occupation of the consumers, culture, and social backgrounds.

The theory behind healthcare service quality can be improved more thoroughly, concisely, and robustly by integrating lean principles with service quality. Different kinds of literature emphasize that the patient is mostly a passive player in lean thinking because lean thinking focuses on eliminating waste to deliver value in isolation from the patient. There is no patient training on addressing predictable and unpredictable waste generation for efficient service. Therefore, lean thinking is within the healthcare sector's boundaries, which may create inefficiency. In contrast, Patient involvement is fundamentally concerned with enhancing medical tourism, productivity, and economic growth to save resources such as time and effort in healthcare. Hence, the patient is active in service quality. Patients and stakeholders are encouraged by the mindset that the customer is king in healthcare to improve service quality, i.e., to indicate service quality is beyond the boundaries of the healthcare sector. Hence, lean service qualities overcome these barriers by widening the lean service quality through patient training beyond healthcare boundaries (Amos et al., 2022). Moreover, integrating service quality and lean thinking is essential to create active patient involvement. This link (i.e., service quality and lean thinking) can assist as the starting point for developing the lean service quality approach. It redesigns the waste-free service process with a patient-centred viewpoint to realize efficient processes and productivity. Lean thinking in the context of healthcare service quality improvement enhances patient satisfaction when managers understand patients' operational processes to improve healthcare productivity. Patient awareness creation enhances value creation to improve service productivity (Endeshaw, 2021). Hence, lean thinking is a valuable philosophy for the healthcare system to enhance service quality and better understand service productivity improvement (Carlborg et al., 2013). It is important to emphasize and clarify the idea of Lean Service quality in future studies. Conversely, it is imperative that healthcare professionals understand the significance of the study to prevent mistakes, dissatisfaction, and disappointment when implementing lean concepts.

Furthermore, the study highlights ways to improve service quality, lean thinking, lean service quality, and patient satisfaction to attract medical tourism specifically in the Ethiopian context,

which limits the applicability of the findings to other nations. Future research that replicates this study in different contexts would be valuable and would enhance our understanding of how improvements in healthcare lean service quality impact patient satisfaction and medical tourism. The study can assist researchers aiming to improve healthcare service quality to attract medical tourists. Additionally, hospital management professionals can use the findings as a reference to better understand how healthcare service quality significantly impacts medical tourism.

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Appendixes

Dec 29, 2022

St. Paul's Hospital
Millennium Medical College
Addis Ababa, Ethiopia

Dear Sir/Madam,

Mr. Berhanu Tolosa, a PhD candidate under my supervision, is conducting a research entitled as "**Improving Service Quality of Ethiopian Healthcare Sector – The case of St. Paul's Hospital**", in partial fulfillment of Ph.D. degree in Industrial Engineering in the school of Mechanical and Industrial Engineering, Addis Ababa Institute of Technology, Addis Ababa University.

The objective of the research is to develop an operational and lean management conceptual framework to improve service quality of the healthcare sector. To accomplish the stated objective, both primary and secondary data are required from the healthcare sector.

Primary data will be collected through the researcher's visits to the hospitals while the secondary data will be collected from reports, like emergency department, laboratories, and operation room reports. From the study on the hospital sector operational and lean management reports, the critical service quality risks that affect patient will be determined and state-of-the-art dimension capabilities will be proposed based on experts' judgment and literature review.

To this end, your support in providing reliable information and data regarding existing phenomena on operational activities, lean management and service quality of the sector will be of vital importance. I would like to assure you that the collected data will only be used for academic purposes, and it will not be disclosed to any third party nor presented at any level without your consent.

If you have further inquiry regarding the research, please do not hesitate to contact me or the researcher at: +251967052877, berhanu.tolosa@aait.edu.et

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Ref. No. [illegible]

Date: [illegible]

Institutional Review Board (IRB) of St. Paul's Hospital Millennium Medical College (SPHHMC)

Ethical Clearance

Research Title:.Improving Healthcare Service Quality through Operational and Lean Management Model at Ethiopian Healthcare Sector (A case of. St Paul`s Hospital Medical College

Principal Investigator: Berhanu Tolosa

The IRB of SPHMMC has reviewed the above mentioned research proposal and made the following decision:

- Approved:- ____x____
- Approved with recommendation:- ________
- Approved on condition :-________
- Disapproved:- ________

The decision is valid for 12 months and the research should be conducted in compliance with the protocol/proposal approved by the IRB of SPHMMC. Any subsequent revision/amendment of the protocol/propposal needs approval before conduct of the research. The researcher should also submit written summaries of the research status to the IRB every 03 months. Upon the conclusion of the study, manuscripts and thesis work to the final/completed research project needs to be submitted to the IRB.

IRB Chair:

Signature: ________ **Mahteme Bekele (MD)**
Professor of Surgery
Research Directorate Director

Date: febrara 15, 2023

Federal Ministry of Health
St. Paul's Millennium Medical College

Cc:

- Vice Provost for Academic and Research
- IRB
- Berhanu Tolosa
  SPHMMC

Questionnaire

General Information

Part I: Demographic characteristics of the respondent

1. Please indicate your gender

   Male ☐ Female ☐

2. Please indicate your age group

   18-25☐ 26-35☐ 36-45☐

   45-56☐ above 56☐

3. Kindly indicate your highest education qualification

   Level IV ☐ BSC/BA ☐ MSC/MA ☐ PhD ☐

4. Kindly indicate your work experience

   0-2 years ☐ 3-6 years ☐ 7-10 year ☐ 11-15 years ☐ More than 16 years ☐

Please Tick ("√") the appropriate number to indicate the extent to which you agree or disagree with each statement. The item scales are five-point Likert type rate scales with; **1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree**

Sq.	Service Quality	1	2	3	4	5
1	The healthcare services are provided as promised without errors					
2	The staff delivers services consistently					
3	Healthcare providers respond quickly to my needs					
4	The staffs are willing to help me when needed.					
5	I feel confident in the skills of my healthcare providers.					
6	I feel safe receiving care in this facility.					
7	Healthcare providers show genuine concern for my well-being.					
8	The staff understands my individual needs.					
9	The healthcare facility is clean and well-maintained.					
10	The medical equipment is modern and functional.					
	Lean Thinking					
1	There is a culture of continuous improvement in my organization.					
2	Staffs are encouraged to suggest improvements to processes.					
3	Standardized procedures are in place for most tasks.					
4	I am satisfied with the waiting time before being seen by a provider.					
5	Staff provide timely updates on expected waiting times.					
6	There is an ongoing culture of continuous improvement in my organization.					
7	The waiting time in the healthcare is reduced from time to time.					
8	Special training sessions are conducted to improve skills and profession of employees					
	Lean Service Quality					
1	Employees are empowered to make decisions that enhance service quality.					
2	The healthcare sector actively identifies and eliminates waste in service delivery.					
3	Healthcare service processes are designed to minimize delays and waste.					
4	Healthcare prioritizes understanding patient needs and expectations.					

	Patient satisfaction					
1	The healthcare providers communicated clearly with patient.					
2	Patients are satisfied with the quality of care they received.					
3	The healthcare service provider showed concern for patient health and well-being.					
4	The staffs are courteous, respectful, and knowledgeable.					
	Medical Tourism					
1	The quality of medical services in the destination country is high.					
2	The healthcare providers are well-trained and experienced..					
3	The cost of treatment abroad is significantly lower than in my home country.					
4	The treatments I am seeking are readily available in the destination country					
5	The level of satisfaction of the patients currently in hospital, attract the foreign patients.					

Thank you for your time and participation!!