Total Quality and Innovation Management in Hospital

Mr. Suebsakul Tonjang

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นายสืบสกุล โทนแจ้ง

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิศวกรรมศาสตรดุษฎีบัณฑิต
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Thesis Advisor	NATCHA THAWESAENGSKULTHAI

Accepted by the FACULTY OF ENGINEERING, Chulalongkorn University in Partial Fulfillment of the Requirement for the Doctor of Philosophy

--- Dean of the FACULTY OF ENGINEERING
(SUPOT TEACHAVORASINSKUN)

DISSERTATION COMMITTEE

--- Chairman
(Patcharin Boonyarangsan)

--- Thesis Advisor
(NATCHA THAWESAENGSKULTHAI)

--- Examiner
(ARISARA JIAMSANGUANWONG)

--- Examiner
(AMONSIRI VILASDAECHANONT)

--- Examiner
(NAPASSAVONG OSOTHSILP)

สืบสกุล โทนแจ้ง : การบริหารคุณภาพและนวัตกรรมในโรงพยาบาล. (Total Quality and Innovation Management in Hospital) อ.ที่ปรึกษาหลัก : ณัฐชา ทวีแสงสกุลไทย

ในอดีตกระบวนการดูแลรักษาผู้ป่วยที่มีคุณภาพและการตอบสนองความต้องการของผู้ป่วยถูกตอบสนองด้วยการบริหารคุณภาพโดยรวมซึ่งเป็นหัวใจหลักตามทฤษฎีบริหารจัดการโรงพยาบาลเพื่อเพิ่มประสิทธิภาพ แต่อย่างไรก็ตามด้วยสภาวะและเทคโนโลยีที่เปลี่ยนไปอย่างรวดเร็ว ทฤษฎีดังกล่าวอย่างเดียวไม่เพียงพอสำหรับการพัฒนาองค์กร งานวิจัยนี้จึงมีวัตถุประสงค์เพื่อบูรณาการการบริหารคุณภาพและนวัตกรรมในโรงพยาบาล อันนำมาซึ่งประสิทธิผลของโรงพยาบาล

เพื่อศึกษาปัจจัยสำคัญของการบริหารคุณภาพโดยรวมและการบริหารนวัตกรรมในโรงพยาบาล ผู้วิจัยทบทวนวรรณกรรมอย่างเป็นระบบ จากนั้นปัจจัยจากการบริหารทั้งสองทฤษฎีถึงบูรณาการเข้าด้วยกันโดยนำมาตรฐานการจัดการนวัตกรรม (ISO 56002) มาเป็นแกนกลาง จะได้ผลลัพธ์เป็นตัวแบบการบริหารจัดการคุณภาพและนวัตกรรมในโรงพยาบาลอันประกอบด้วย 7 มิติ ซึ่งจะส่งผลลัพธ์ที่ดีด้านความยั่งยืนโรงพยาบาลทั้ง 3 มิติ จากนั้นการบริหารจัดการคุณภาพและนวัตกรรมในโรงพยาบาลถูกบูรณาการร่วมกับทฤษฎีการแก้ปัญหาเชิงประดิษฐกรรม (ทริซ) ผ่านวิธีเดลไฟล์ร่วมกับผู้เชี่ยวชาญด้านสาธารณสุข 30 ท่าน ได้ผลลัพธ์เป็นหลักการแก้ไขปัญหาเชิงประดิษฐกรรมของการบริหารจัดการคุณภาพและนวัตกรรมในโรงพยาบาล จากนั้นหลักการแก้ไขปัญหาเชิงประดิษฐกรรมที่ถูกพัฒนาขึ้นถูกยืนยันและศึกษาต่อด้วยการวิเคราะห์องค์ประกอบเชิงยืนยันและการวิเคราะห์โมเดลสมการโครงสร้าง ท้ายที่สุดแอพลิเคชันการบริหารจัดการคุณภาพและนวัตกรรมในโรงพยาบาลถูกพัฒนาขึ้นจากองค์ความรู้และลักษณะสำคัญที่ถูกศึกษามาจากขั้นตอนที่ผ่านมา โดยแอพลิเคชันมีรูปแบบมิตรต่อผู้ใช้งานให้สามารถใช้งานได้ง่าย ช่วยให้นวัตกรเข้าใจหลักการบริหารจัดการคุณภาพและนวัตกรรมในโรงพยาบาลอันจะนำมาซึ่งแนวทางการพัฒนานวัตกรรมในโรงพยาบาล หลักจากการใช้แอพลิเคชันการบริหารจัดการคุณภาพและนวัตกรรมในโรงพยาบาล ความเป็นไปได้และการยอมรับแอพลิเคชันถูกประเมินด้วยทฤษฎีการยอมรับเทคโนโลยี (แทม)

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Previously, quality of care and customers' satisfaction in healthcare services is fulfilled only through total quality management (TQM) which as a core management philosophy, as adopted by many healthcare organizations. Nevertheless, TQM focuses on incremental improvement may prove insufficient to address the new technology and innovation-driven organization with a faster pace. Therefore, this research aimed to integrate quality and innovation management in healthcare affecting healthcare performance. To propose the key factor of both TQM and innovation management in healthcare, we conducted a systematic literature review. Then, TQM and innovation management factors were combined and integrated with ISO 56002 as to the core axis that corresponds to the dimensions in TQIM-H. The TQIM-H is comprised of seven dimensions had a highly positive effect on sustainable innovation. Then, the developed TQIM-H was integrated with the theory of inventive problem solving (TRIZ) through the Delphi method with 30 healthcare experts, resulting in the TQIM-H inventive principle. The TQIM-H inventive principle was confirmed and validated by using confirmatory factor analyses (CFA) and structural equation modeling (SEM). Finally, a TQIM-H program was developed from the knowledge and key characteristics related to the TQIM-H concept obtained in the previous step. The program with a user-friendly user interface would help innovators in understanding TQIM-H which would then help guide healthcare innovation development. After using the TQIM-H program, the feasibility and acceptability of the TQIM-H program were evaluated based on the Technology Acceptance Theory (TAM).

Field of Study:	Industrial Engineering	Student's Signature ....
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CHAPTER 1
INTRODUCTION TO THE RESEARCH STUDY

1.1 Introduction

The COVID-19 crisis, a worldwide disaster, has led to the biggest disruption of healthcare delivery. It has a significant negative impact on the development of the global economy and other businesses. At the same time, it is obvious that this worldwide disaster has also brought a huge crisis to firms not only in Thailand but also in most countries, which has attracted attention to research on what firms should do to survive unexpected disasters in the future. This crisis has and will have impacts on people's lives in many dimensions and aspects. For instance, Maliszewska et al. (2020) have simulated the potential impacts of COVID-19 on gross domestic product and trade, using a standard global computable general equilibrium model. Their illustrative scenarios indicate that the impacted countries experience a loss of revenue, while global GDP has dropped by up to 3.9 percent, and developed countries have hit the hardest (4 percent on average, while some will also experience more than 6.5 percent (Maliszewska et al., 2020). It can be seen that COVID-1 9 has affected communities, businesses, and organizations globally, inadvertently affecting the financial markets and the global economy. The pandemic crisis has made more people pursue healthcare. Due to the outbreak, it has been widely acknowledged that the health crisis threatens the survival of sectors worldwide, and seems unavoidable that this natural disruption has hit the global economy and produced a huge crisis for other areas of society, environment among others (Nicola et al., 2020). As a result, there has been an increase in demands and expectations for healthcare services (Fadhil et al., 2012)

To cope with the critical care crisis and with the demands of customers, hospitals must be prepared to keep pace with global trends and respond to the evolving nature of the needs of patients. They also have to be prepared to handle any disruptive situation because not only do these incidents impact lives, but the way hospitals deal with them also affects credibility, which can contribute to resourceful hospitals being at the forefront of the business in the long run, bringing their advantage to bad situations. Overcoming the challenges of the crisis and turning the crisis into an opportunity are common choices for all businesses in the world. To adapt rapidly to turbulent, unpredictable, and ambiguous situations, the majority of surviving businesses perform fairly well in marketing developments. For example, one of the greatest challenges in the COVID-19 crisis is weak market demand. Therefore, many retailers and even some leading manufacturers prefer to use live streaming as a new channel based on deep insight into the changes in customer psychology and behaviors during home isolation. New normal life can be adapted to the home quarantine policy and makes it more convenient for customers to gain access to the goods or services they need. It has been shown that the pandemic crisis forcing healthcare institutes to qualify and to continually improve the healthcare system to increase performance to cope with competitive advantages, new diseases. Moreover, crisis and social needs also motivate healthcare to seize on opportunities to show their efficiency. Another reason for the introduction of new tools, new technology, and creativity in hospitals within a limited time is the strain resulting from these circumstances. As a consequence, the demands of consumers and pandemic emergencies can be seen to increase significantly and the ever-growing treatment capacities are also attested to. Healthcare must develop the system to increase their capability for patients' care and respond to patients' satisfaction.

Previously, quality of care and customers' satisfaction in healthcare services is fulfilled only through total quality management (TQM) which has been accepted by managers as a change in the quality management approach (Arumugam et al., 2009). Thus, TQM places a strong focus on improving the customer satisfaction index that provides the grater prospect, and combines internal quality measures with value analysis and specification compliance. TQM has thus been appointed as a foundation for healthcare management systems, and this philosophy holds patient rights and medical ethics accountable to healthcare organizations. Also, TQM has been gradually implemented by hospitals to reduce costs, increase performance, and provide high-quality patient care. Acceptable TQM not only includes direct medical services such as diagnoses, medicines, surgery, and treatment but also indirect operations such as administrating and purchasing whose costs are reflected in what the buyer pays. It may also include TQM that is directly related to healthcare safety, security, the attitude of nursing, and word boy, the role of doctors. Moreover, TQM is an ethical, legal, and social rights matter, the health sector has been worried about it for more than a decade. Quality assurance is significant as it concerns customer satisfaction and the reduction of risks connected with health care to a minimum. (Patel, 2009) As a matter of fact, TQM is employed to such an extent that it has become an essential part of the healthcare culture. However, Prahalad and Hamel (1994) also declared that by the year 2000, quality would no longer be a competitive differentiator, it would simply be the price of market entry and might not be adequate to deal with the growing number of new illnesses and anomalies. Yet, Choi and Valikangas (2001) argue that TQM is an important tool, but it cannot create sustainable value unless TQM is coupled with more innovative and forward-looking strategies.

Innovation, an important factor for changes and organizational potential, is now influencing how to conduct business in several industries. Multiple research studies show that innovation is a key success factor of organizations because innovation creates organizational strength, which is important for the survival of the organizations (Kirner et al., 2009; Lee et al., 2011; Wood & Kaplan, 2005). Several industries, therefore, promote and develop various categories of innovations including product, process, and business model innovation. In healthcare, developing healthcare innovation aims at creating in-hospital innovations that maximize effectiveness, speed, and satisfaction of processes that involve patient service and treatment. It should be noted that developing healthcare innovation does not involve the development or advancement of medical devices or tools used for the treatment (e.g. surgery, or dispensing) since the development of medical devices or tools is regulated by medical ethics and laws. Innovation has become a critical capability of all organizational parts which aim at enhancing life expectancy, quality of life, diagnostic and treatment options, as well as the efficiency and cost-effectiveness of the healthcare system (Varkey et al., 2008). Hospital is also a business that needs innovation because of the need to adapt to the fast-changing environment caused by the geriatric society, pandemic crisis, and dynamic health trends. In line with this definition, innovation in healthcare organizations are typically new services, new ways of working and/or new technologies (Länsisalmi et al., 2006) which attend to patient's benefits and either improve health or reduce suffering due to illness (Faulkner & Kent, 2001). The healthcare industry is forced to improve and develop its operating system to increase the working efficiency and to satisfy patient needs (Kriegel et al., 2020; Patrício et al., 2019; Wu et al., 2019). Studies show that hospitals that obtain new technologies or innovation can increase their working efficiency and customer trust, resulting in organizational sustainability (Crespo-Gonzalez et al., 2020; Fleiszer et al., 2015; Moreira et al., 2017). Moreover, innovation has an important role to play in recovering from the aftermath of the pandemic crisis. The speed of innovation implementation not only reflects its ability to control and eradicate emerging diseases, which tend to increase in terms of future fatalities. But also the speed of a business to implement a product or a process compared to its industry rivals. (Rogers, 1985). Many powerful new technologies lack a clear and obvious way to create business value (think of artificial intelligence, or IoT, or blockchain).

From the COVID-19 crisis, the Global Innovation Index (GII), which is a surrogate for the level of innovation, has a positive significant relationship with a country's ability to respond to the crisis because innovation is the path towards finding solutions such as vaccines, treatments, and policies that mitigate the viral quarantine (Dutta & Lanvin, 2012). The Global Innovation Index (GII) provides a starting point for showing the relative performance of countries in terms of innovation inputs and outcomes. Inputs to innovation are institutions, human capital and research, infrastructure, market sophistication, and business sophistication. On the other hand, outputs consider knowledge and technology and creative outputs. The GII provides each country with an overall innovation score based on the performance of its innovation inputs and outputs. Assuming that determinants of the GII score which include institutional considerations, knowledge, human capital, and the ability to turn useful knowledge into innovations are well-functioning, it would be logical to expect countries with high scores to manage the pandemic well.

Innovation hence plays important role in procedures in the hospitals e.g. technology-assisted surgery, customer service, and novel healthcare business modeling. However, innovation in the healthcare business is more challenging than in other businesses since healthcare business requires higher regulations and standards (Akenroye, 2012; Fitzgerald et al., 2003). However, several technologies and innovations have been invented, but without success, because they do not comply with the organizational quality framework so the implementation of such technology or innovation is not allowed (Dana et al., 2019; Yu et al., 2019). To increase the success chance and the efficacy, the development of new technology or innovative system must occur simultaneously with healthcare quality management and must not oppose healthcare standards and regulations (Perlich et al., 2018).

Thus, innovation is a management philosophy that should be adopted, TQM is still indispensable because quality management is the core importance to healthcare industries. For a healthcare organization to achieve success, it has to rely on both TQM and innovation. For the healthcare sector, in particular, Tonjang and Thawesaengskulthai (2020) have demonstrated a positive and direct relationship between total quality management and innovation management because TQM fosters innovation management and vice versa. Innovation management facilitates the creation of innovations, increases organization potential, and improves competitiveness, while quality management maintains the standard of the developed innovation (Lee, 2015; Moreira et al., 2017). Therefore, hospitals should perform innovation management and TQM together to increase healthcare performance which is their efficiency in controlling and curing new diseases with quickness and in time, to satisfy customer needs and to be effective in the face of the world’s transformation and innovation.

In terms of effective innovation, it has been generally defined as the successful application of new ideas that are the result of organizational processes and that the organizations seek to differentiate themselves on the market (Baregheh et al., 2009; Dodgson et al., 2014). Traditionally, the success of innovation activities is evaluated by only economic performance. (Adams et al., 2006; Manion & Cherion, 2009). However, recently the non-economic sphere has increasingly become important in corporate management (Christiansen & Buen, 2002; Hansen & Grosse-Dunker, 2012; Preuss, 2007; Winskel, 2007). There has been increased pressure on organizations to focus on sustainability and accountability in business performance beyond that of financial performance (Lee & Saen, 2012). So, innovation performance included not only the product's economic success but also the direction of sustainability effects. Sustainable innovation is generally defined as the development of new products, processes, services, and technologies that contribute to the development and well-being of human needs and institutions while respecting natural resources and regeneration capacities (Aguilera-Caracuel & Ortiz-de-Mandojana, 2013a, 2013b; Paech, 2007; Tello & Yoon, 2008). Likewise, Bos-Brouwers (2010) explains sustainable innovation by defining it as innovations in which the renewal or improvement of products, services, technological or organizational processes not only delivers an improved economic performance, but also an enhanced environmental and social performance, both in the short and long term can generate positive social and environmental impacts. Sustainable innovation performance covers all aspects of the outcome measurement. Therefore, a sustainable approach to innovation should guide all business choices regardless of products and services. The new business and organizational models need to be adopted as well (Bos-Brouwers, 2010; Szekely & Strebel, 2013). Thus, in this study, the author uses the sustainability of the hospital to measure healthcare innovation performance. The measurement of sustainable innovation in hospitals includes the concept of the Triple Bottom Line, by distinguishing the economic, environmental and social effects of innovations (Edgeman & Hensler, 2001; Garvare & Isaksson, 2001; Hediger, 1999; Rondinelli & Berry, 2000). The social pillar ensures adequate access to healthcare and civil rights; equity, empowerment, engagement, and participation. The economic pillar ensures economic prosperity and security to the healthcare system, as well as other stakeholders. The environmental pillar attempts to ensure cost-effective utilization and protection of the current resources.

1.2 Research Aim and Objectives

This research aims to develop a total quality and innovation management in the hospital (TQIM-H) model, based on the developed TQM and innovation management in the healthcare framework. The outcome of this research will provide total quality and innovation management in the hospital (TQIM-H) system, which includes the level of TQIM-H factors affecting healthcare performance. The research objectives for this research are:

(1) To investigate the relationship between TQM and innovation management in healthcare.

(2) To provide the TQIM-H conceptual framework which was developed from the integration of TQM and innovation management in healthcare.

(3) To develop the TQIM-H inventive principles in managing quality and innovation systems that can be used as a guide for the development of effective innovation projects in hospitals.

(4) To examine the relationship among the TQIM-H factors and the impact of TQIM-H on sustainable innovation.

(5) To develop innovative programs and software that supports the developed TQIM-H system.

1.3 Scope of The Research

The scope and focus of this research are described below:

• The study concentrates on the largest hospital conglomerate in Southeast Asia which comprise of 47 hospitals in Thailand, Cambodia, and Indonesia, consists of six major hospital brands, and is one of the most prestigious hospital networks in the Asia-Pacific region.

• The study concentrates on the healthcare management system, focusing on quality management and innovation management.

1.4 Research Design

The research design was divided into seven phases as shown in Figure 1. 1.

Phase 1
A systematic literature review

↓

Phase 2
The integration of TQIM-H

↓

Phase 3
Delphi study for the development of the TQIM-H inventive principle

↓

Phase 4
50 healthcare innovation projects were used to refine and validate the TQIM-H inventive principle

↓

Phase 5
Examining a relationship among each of TQIM-H and the effects of TQIM-H on sustainable innovation using CFA and SEM

↓

Phase 6
Developing Innovative TQIM-H program using cloud computing technology

↓

Phase 7
The developed program was tested by TAM to validate the reliability and usability

Figure 1.1 Research design process

In the first phase, the research was designed to develop the conceptual by using a systematic literature review method to explore four main areas, which are TQM in healthcare, innovation management in healthcare, healthcare performance, and reviews of research methods. The second phase is theory building, TQM factors and innovation management factors from a systematic literature review were analyzed and combined based on ISO 56002 by 30 healthcare experts resulting in the integration of TQIM-H. The third phase which deployed Delphi study method with healthcare experts is to develop the TQIM-H inventive principle. Then, the impactful innovation case studies were studied to refine and confirm the new TQIM-H inventive principle. To examine a relationship among each of TQIM-H and the effects of TQIM-H on sustainable innovation, in phase five, the TQIM-H framework was tested by using confirmatory factor analysis (CFA) and structural equation modeling (SEM). The result from this phase is a new TQIM-H structural model. In the final phase, the innovation TQIM-H program was developed based on the study in the previous phase. Then, healthcare innovator was invited to use and test the developed program. Finally, the author surveyed the ability and efficiency of the TQIM-H program through

Technology Acceptance Model (TAM) via a questionnaire. The detail of the research method was described in chapter 3.

CHAPTER 2
LITERATURE REVIEW

This chapter reviews the relevant literature on the specific areas that involve five main categories.

2.1 Total Quality Management (TQM)

2.1.1 Total Quality Management (TQM) Background

2.1.2 Total Quality Management in Healthcare

2.1.3 Total Quality Management Dimensions

2.2 Innovation Management

2.2.1 Innovation Management Background

2.2.2 Innovation Management in Healthcare

2.2.3 Innovation Management Dimensions

2.3 The Relationship between Total Quality Management (TQM) and Innovation Management

2.3.1 Arguments in Support of the Positive Relationship between TQM and Innovation

2.3.2 Arguments in Support of the Negative between TQM and Innovation

2.4 Healthcare Performance

2.4.1 Healthcare Performance Background

2.4.2 Sustainability

2.4.3 Healthcare Sustainability

2.5 Techniques and Research Method

2.5.1 Systematic Literature Review Method

2.5.2 Case Study Research Method

2.5.3 Delphi Study

2.5.4 Theory of Inventive Problem Solving (TRIZ)

2.5.5 Structural Equation Modeling (SEM)

2.5.6 The Technology Acceptance Model (TAM)

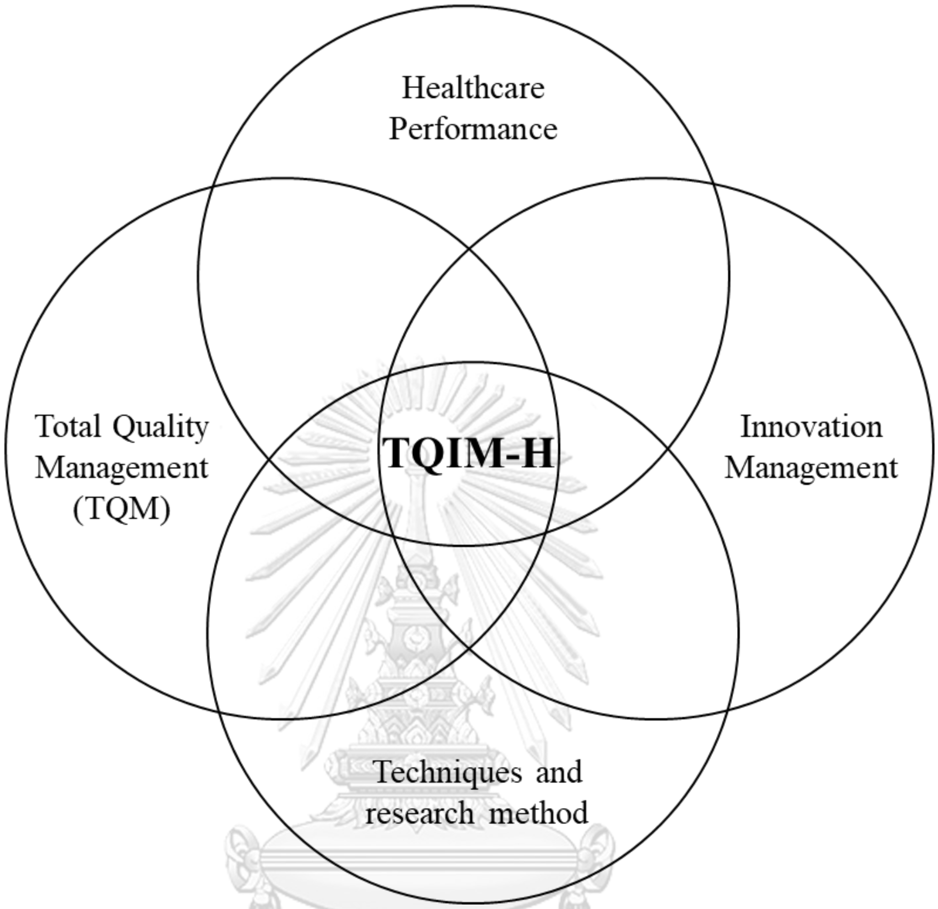

Figure 2.1 Literature review framework

Figure 2.1 illustrates the author's focus on this research. Firstly, the review of Total Quality Management (TQM), Innovation Management, and Healthcare Performance utilizes a systematic literature review method, which selects keywords and phrases that are derived from the research question. Innovation projects in healthcare were used to allow more efficient searching which ensured the relevant information. The results of each search string are assessed on the screen to select the contribution that relates to the inclusion criteria. Secondly, the review of the Delphi study provides an understanding of the survey process that is conducted in three rounds and provided the experts with the feedback of the previous round then adjusted the original assessments. Thirdly, TRIZ which is a powerful knowledge-based and systematic procedure to generate quality and innovative solutions was used to establish the inventive principle of the developed TQIM-H. Then, the utilization of the Structural Equation Modeling (SEM) approach can restrict which variables are loaded on which factors, as well as which factors are correlated. Finally, the developed program was established based on TQIM-H characteristics and it was tested by TAM to validate the reliability and usability.

2.1 Total Quality Management (TQM)

2.1.1 Total Quality Management (TQM) background

In business literature and practice, the significance of quality to the performance and success of the company in the market is widely recognized (Deming, 1986; Juran, 1992; Smith, 1995) To help businesses increase productivity and competitiveness by improving quality, various approaches to quality management have been proposed. In many corporate organizations, the emergence of quality as a top priority is primarily due to the globalization of world trade and the competitive pressure brought about by the rising demands of customers who want better products and services (Thiagaragan et al., 2001). The theory of total quality management (TQM) is one of the most popular and most frequently suggested holistic approaches that aim to combine all organizational functions to focus on meeting customer needs and organizational goals (Thawesaengskulthai, 2019).

While TQM has been extensively researched for many years now, there is still considerable interest in and need for empirical TQM studies, given that many organizations want to adopt and introduce TQM and its dissemination globally to increase (Osayawe Ehigie & McAndrew, 2005). There is a consensus regarding the essential principles, practices, and values of TQM described TQM as a holistic approach to the international marketplace to improve efficiency, productivity, and competitiveness (Hellsten & Klefsjö, 2000; Pfau, 1989; Yang, 2003). Yang (2006) provides more insight by saying that TQM is an integrated theory of management and a collection of strategies that emphasizes, among other things, quality improvement; meets the needs of consumers; reduces rework; enhances employee engagement, and collaboration; process redesign; strategic benchmarking; team-based problem-solving; constant measurement of results; and closer relationships with suppliers. Moreover, Hellsten and Klefsjö (2000) noticed that TQM is often illustrated by the model of a quality award, such as the MBNQA in the USA (Martin & Przybocki, 2000) or the European Quality Award (Nabitz & Klazinga, 1999) established by the European Foundation for Quality Management (EFQM). They also recognized that these award models and their award criteria had a significant impact on TQM's realistic implementation. Most of the TQM concepts are therefore embodied in the seven MNBQA criteria and are considered central to the establishment of effective TQM systems (Kumar et al., 2009). Moreover, the positive effect of TQM on company performance in terms of operation and financial results, efficiency, customer satisfaction, or employee satisfaction has been argued and empirically checked by numerous authors (Agus & Hassan, 2000; Brah et al., 2000; Choi & Eboch, 1998; Fuentes et al., 2006; Hendricks & Singhal, 1997; Karia & Asaari, 2006; Terziovski & Samson, 1999; Yang, 2006). It can be seen that most of these studies concentrate on finding the most successful and critical TQM activities from the point of view of performance enhancement. Some of those studies focus only on a particular type of performance: quality performance, financial performance, or operating performance (Dale & Wan, 2002).

2.1.2 Total Quality Management in Healthcare

Nowadays, healthcare services are of fundamental importance at all levels of hospitals in our societies. Ultimately, in healthcare systems, increasing value and dependence are placed on complete quality control. This is also reflected in the rising percentage of national and foreign capital allocated to hospital management systems for both the private and public sectors as a result of this growing importance. To minimize costs, boost productivity, and provide high-quality patient care, hospitals, and other healthcare organizations across the globe have increasingly adopted TQM. Furthermore, hospitals in competitive markets are more likely to attempt to differentiate themselves from their competitors by increasing service quality. Thus, TQM, which places a strong emphasis on improving the customer satisfaction index that provides the greater prospect, combines internal quality measures with value analysis and specification compliance. However, since its evolution, quality has been an important part of the health care service as services here are linked to the patient's life. It may also include Total Quality of performance that is directly related to healthcare safety, security, an attitude of nursing and word boy, and the role of doctors (Patel, 2009).

Nowadays, hospitals in competitive markets are more likely to attempt to differentiate themselves from their competitors by improving the service quality. Therefore, TQM, which focuses heavily on improving the customer satisfaction index that provides the greater prospect, integrates internal performance measures with value analysis and requirement compliance. (Smith, 1995). Lee (2012) identified that TQM of healthcare services is critical for the healthcare institutions and that the implementation of quality programs based on quality standards ISO 9001-2008, Malcolm Baldrige Healthcare Criteria for Performance (MBHCP), European Foundation for Quality Management (EFQM), and Joint Commission Model of Accreditation (JCI) helps hospitals to gain patient satisfaction and safety and also a source to enter in the international market to attract the international healthcare tourism. Furthermore, it is further claimed by the author that quality control and TQM are the most widely used quality programs in healthcare institutions (Yang, 2001).

Many hospitals are an organizational structure and culture, management philosophy, and established norms that are hostile to the principles of TQM. Close scrutiny reveals that each industry specifies different sets of TQM basics (Gözükara et al., 2019) as demonstrated in table 1 below, which reviews past papers showing different uses of TQM in manufacturing industries, service industries, and hospitals.

Table 2.1 Total quality management practices in different industries

Dimensions	Manufacturing industry											
	1	2	3	4	5	6	7	8	9	10	11	Total
Top Management Commitment	x	x	x	x	x	x	x	x	x	x	x	11
Quality Data and Reporting	x		x	x	x	x		x	x		x	8
Customer Focus	x	x	x	x		x	x			x	x	8
Process management							x	x		x	x	4
Supplier Quality Management	x	x	x		x	x	x	x	x	x	x	10
Training and education	x	x	x	x	x	x		x	x		x	9
Employee involvement	x		x	x	x	x	x		x	x	x	9
Continuous quality improvement												0
Strategic quality planning												0
Benchmarking												0
Quality management system			x	x	x	x		x	x	x	x	8
Cultural Change												0

Dimensions	Service industry											
	12	13	14	15	16	17	18	19	20	21	22	Total
Top Management Commitment	x	x	x	x	x	x	x	x	x	x	x	11
Quality Data and Reporting												0
Customer Focus	x	x	x	x		x	x	x	x	x		9
Process management												0
Supplier Quality Management					x	x	x		x		x	5
Training and education	x			x		x	x		x		x	6
Employee involvement	x	x	x	x	x	x	x	x	x	x		10
Continuous quality improvement		x	x	x	x		x		x	x	x	8
Strategic quality planning												0
Benchmarking		x	x			x			x	x	x	6
Quality management system	x											1
Cultural Change		x	x				x		x	x		5

Dimensions	Hospital										
	23	24	25	26	27	28	29	30	31	32	Total
Top Management Commitment	x	x	x	x	x	x	x	x	x	x	10
Quality Data and Reporting				x	x	x	x			x	5
Customer Focus	x	x	x	x	x	x	x	x	x	x	10
Process management	x	x	x	x	x	x				x	7
Supplier Quality Management						x				x	2
Training and education	x									x	1
Employee involvement	x	x	x	x	x	x	x	x	x		9
Continuous quality improvement	x	x	x	x		x	x	x	x	x	8
Strategic quality planning	x	x									2
Benchmarking											0
Quality management system						x					1
Cultural Change									x		1

1: (Ahire et al., 1996), 2: (Dow et al., 1999), 3: (Salaheldin, 2009), 4: (Erdil), 5: (Joseph et al., 1999), 6: (Sohal & Terziovski, 2000), 7: (Sila & Ebrahimpour, 2005), 8: (Demirbag et al., 2006), 9: (Yusof & Aspinwall, 2000), 10: (Arumugam et al., 2008), 11: (Zhang et al., 2000), 12: (Majumdar & Manohar, 2016), 13: (Sureshchandar et al., 2002), 14: (Saravanan & Rao, 2007), 15: (Samat et al., 2006), 16: (Shieh & Wu, 2002), 17: (Brah et al., 2000), 18: (Tsang & Antony, 2001), 19: (Kanji & Wallace, 2000), 20: (Mahapatra & Khan, 2006), 21: (Al-Marri et al., 2007), 22: (Khamalah & Lingaraj, 2007), 23: (Talib et al., 2011), 24: (Manjunath et al., 2007), 25: (Yang, 2003), 26: (Raja et al., 2007), 27: (Dilber et al., 2005), , 28: (Patel, 2009), 29: (Irfan et al., 2014), 30: (William, 1989) (2017), 31: (Gözükara et al., 2019), 32: (Benzaquen et al., 2019)

The authors' study found that hospitals, in particular, tend to differentiate themselves from their competitors in terms of service quality. They face many challenges that can be classified into four major areas: increases in the cost of health services (Wongrukmit & Thawesaengskulthai, 2014), more technology dependence, pressure on health organizations to decrease costs and improve quality to keep up with the international organizations that establish standards and give licenses and finally satisfying patients' needs, a major demand requiring hospitals to maintain high-quality services (Al-Shdaifat, 2015).

Not only do acceptable quality services include direct medical services, such as diagnosis, medicines, surgery, and treatments, but they also cover indirect operations, such as administration and purchasing of which the costs are fairly high. They may also include Total Quality of performance that is directly related to healthcare safety, security, attitudes of medical staff (Patel, 2009). Due to the safety, quality, and cost responsibility of the hospital, TQM hence becomes vital and cannot be desert from the hospital management system (Thawesaengskulthai et al., 2015). Hospitals must have TQM as an integral part of quality management and of satisfying customers' needs. Having said that, hospitals make use of TQM in a manner dissimilar to others due to their unique and complex nature. To elaborate, TQM implementation in hospitals requires a large number of staff working in numerous departments. It also requires many changes in the hospital and its business strategy and management culture. These changes range from dealing with patients and suppliers to involving physicians, and from specifying nurses' and employees' responsibilities in managing processes to collecting and analyzing data. Hence, many elements have to converge smoothly for TQM implementation to be successful. Moreover, it involves the law, safety regulations, patients' rights, and medical ethics.

2.1.3 Total Quality Management dimensions

The review of the literature in table 1 reveals that there are twelve TQM practices in three different sectors i.e. manufacturing, service, and hospital. The present study shows that the four TQM practices identified are similar and common in manufacturing, service industries, and healthcare organizations. They are Top Management Commitment, Employee Involvement, Customer Focus, and Continuous quality improvement. To elaborate, while leaders foster organizations, other employees' commitment will also contribute to organizational success. Meanwhile, success also comes from rightly responding to customers' demands, which are tackled by continuous improvement to keep up with them. In contrast to the above results, quality data and reporting, process management and quality systems represent the other three major TQM practices in manufacturing industries while continuous improvement, benchmarking, and information and analysis are more important TQM practices in service industries. In the case of hospitals, the study revealed the combination of service and manufacture, the involvement of data, the management of the process, process management, and the continuous improvement and innovation of the system. Taking past research and the study of hospital systems into account, the authors summarize six key dimensions of TQM and hospital management to be studied.

2.1.3 Total Quality Management dimensions

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Table 2.2 Total quality management practices in healthcare

Dimension	Factor
A1.Top Management (TM)	A1.1 Allocating resources.
	A1.2 Vision, Policy
	A1.3 Assuming responsibility.
	A1.4 Supporting employees' suggestion
A2. Customer Focus (CF)	A2.1 Customer (patient etc.) satisfaction.
	A2.2 Solving the patient's complaints.
	A2.3 An effective system for patient's rights
	A2.4 Identifying Patients at Low Risk
A3. Continuous Improvement (CI)	A3.1 Quality audits
	A3.2 Continuous solving
	A3.3 Improving product and process quality
	A3.4 Achieving quality standards
A4. Employee Involvement (EI)	A4.1 Holding responsible for error-free output.
	A4.2 Educating employee
	A4.3 Decision-making to solve problems.
	A4.4 Informing the hospital's achievements
	A4.5 Training programs.
A5. Process Management (PM)	A5.1 Creating a strategic plan
	A5.2 Monitoring and evaluation
	A5.3 Amount of preventive equipment maintenance
	A5.4 Litigation law refers to the rules and practices
	A5.5 Risk management system
A6. Information and Analysis (IA)	A6.1 Information management
	A6.2 Data integrity and security
	A6.3 Data availability and accuracy

When considering studies on TQM in healthcare with its six dimensions and 25 factors, the author found that

Top Management: Top management role is more crucial when compared to other service environments and is responsible for the quality of care and overall hospital system (Prajogo & Sohal, 2003). Leadership roles of administrative staff and those working in subordinate departments are efficient in the implementation process. Leaders also have to encourage the rest to contribute to its success (Al-Shdaifat, 2015). The organization leaders' visions are thus crucial for driving quality systems in hospitals. Most vital is their role in allocating budgets needed for projects. Leaders are aware of the significance of TQM, have visions, and implement policies about TQM in hospitals. Also, they are cognizant of standard service and support resources required in doing TQM, making it efficient. Also, those in the top positions should offer advice to their subordinates.

Customer Focus: TQM calls for all organizational efforts on focusing on customer satisfaction in a right-first-time and every time approach (Klefsjö et al., 2008). Patients' suggestions and concerns could help hospitals to improve procedures and improve the quality of service offered to patients. This includes identifying both internal and external customers and meeting and exceeding their expectations. In this respect, the optimal satisfaction of both parties is a very complex subject. In addition, hospital service is regulated with laws and medical ethics because sometimes satisfying service might be tantamount to ethical transgression and vice versa. Hence, the middle ground should be established. Moreover, customers' complaints should not be neglected, be it from internal personnel or patients themselves because to have quality service means responding to their demands. Patients' rights are also of paramount importance since they are part of the laws by which hospitals should abide and the least risks should occur during treatment.

Continuous Improvement: In hospitals, due to the complexities of diseases and the changing of disease patterns, the most advanced equipment, technical system, methods that help in the right diagnostics, and continuously updating the knowledge and skill of all involved human resources are required. It is considered as a dynamic process that focuses on improvement and builds a relationship with other elements and also affects the organization's environment (Patel, 2009). Therefore, hospitals need to have continuous monitoring and upgrading of the knowledge base of their people as well as infrastructure for delivering quality healthcare services to the patients to gain their delight. Also, there should be continuity in problem-solving and the development of the system. Developing products and processes is also pivotal for the overall system to defeat new diseases and the changing nature of our society.

Employee Involvement: A healthcare institute's success depends increasingly on the knowledge, skills, and motivation of its workforce. Department works together towards system optimization through cross-function teamwork but human resources management in hospitals is also complicated. This is a result of differences in educational backgrounds and visions among different departments. Therefore, they should be directed in the same direction can be difficult.

Process Management: In health care setup, it is more critical due to the health care service environment because hospitals are delivering both tangible and intangible services. Furthermore, the process management system in the hospital is complex, for it involves many organizational parts working together. Therefore the system should always be monitored hygienic environment to the patient and error-free, especially when it is a matter of life and death. Thus process management addresses and meets the patient’s perceptions and expectations during a treatment process and the final outcome of the treatment process.

Information and Analysis: This factor requires more importance as investigation in the right diagnostics, doctors need accurate data regarding lab reports, previous medical examinations, reports, and patient history. It also allows us to record and report errors, cost of quality. This step is crucial because the handling of patients' information has to be infallible. Also, the utmost importance is keeping patients' information confidential, as it is ethics and law that hospitals have to abide by.

2.2 Innovation Management

2.2.1 Innovation Management background

After the 1980s, global competition forced companies to concentrate on their business strategies, in particular on innovations. (Kuratko & Hodgetts, 1998). Because of the tough global market, both individuals and enterprises are currently beginning to analyze and apply their creative techniques and entrepreneurial skills to achieve a competitive advantage. (Drucker, 1985). The Advisory Committee on Measuring Innovation in the 21st Century Economy (Schramm, 2008) defines innovation as the design, invention, development, and/or implementation of new or altered products, services, processes, systems, organizational structures, or business models to create new value for customers and financial returns for the firm. This definition is largely accepted among researchers in the field (Anderson et al., 2004), as it captures the most important three characteristics of innovations: (a) novelty, (b) an application component, and (c) an intended benefit (Länsisalmi et al., 2006). Innovativeness is also one of the essential instruments of growth strategies for entering new markets, growing established market share, and creating a competitive advantage for the business (West, 1990). Companies have begun to understand the importance of innovation, driven by growing competition in global markets because rapidly evolving technology and intense global competition rapidly erode the value-added of existing goods and services (Hitt et al., 2001; Kuratko et al., 2005). Innovation as a concept applies not only to products and procedures but also to marketing and organization as well (Metcalfe, 1998).

However, evidence from both small and medium-sized companies and large organizations shows that effective innovation is not only the product of technological innovation but also highly reliant on what has been called 'innovation management.' Innovation management consists of changing a company's organizational structure, procedures, and processes in a way that is specific to the company and/or sector and that results in the utilization of the company's technological knowledge base and its performance in terms of innovation, effectiveness, and competitiveness (Birkinshaw et al., 2008). Moreover, as recent work emphasizes the importance of management innovation for firm performance, both as a complement to technological innovation (Damanpour et al., 2009) and as an independent phenomenon (Mol & Birkinshaw, 2009; Stienstra et al., 2004), a better understanding of management innovation should be high on the research agenda. For example, Feigenbaum argues that 'the systematization of management innovations will be a critical success factor for 21st century companies'(Volberda & Van Den Bosch, 2011). Mol and Birkinshaw (2009) state that it is 'one of the most important and sustainable sources of competitive advantage' as well as 'needed to make technological innovation work'.

Management innovation reflects changes in the way management work is done, involves a departure from traditional processes (i.e., what managers do as part of their jobs); in practices (i.e., the routines that turn ideas into actionable tools); in structure (i.e., how responsibility is allocated); and in techniques (i.e., the procedures used to accomplish a specific task or goal) (Birkinshaw et al., 2008). With this, Birkinshaw and Goddard (2009) propose that management innovation tends to emerge through necessity, as opposed to technological innovations that may first be developed in a laboratory and for which an application may subsequently be found. Further, due to its nature, management innovation is likely to constitute a rather diffuse and difficult-to-replicate attribute for any firm that successfully develops one (Daft & Becker, 1978).

Table 2.3 Several definitions of management innovation.

Authors	Definition:
(Birkinshaw & Goddard, 2009)	'The introduction of management practices that are new to the firm and intended to enhance firm performance'.
(Birkinshaw et al., 2008)	'The generation and implementation of a management practice, process, structure, or technique that is new to the state of the art and is intended to further organizational goals'.
(Hamel, 2006)	'A marked departure from traditional management principles, processes, and practices or a departure from customary organizational forms that significantly alter the way the work of management is performed'.
(Kimberly, 1981)	'program, product or technique which represents a significant departure from the state of the art of management at the time it first appears and which affects the nature, location, quality, or quantity of information that is available in the decision-making process'.

2.2.2 Innovation Management in Healthcare

The proliferation of innovations in the health care industry is aimed at enhancing life expectancy, quality of life, diagnostic and treatment options, as well as the efficiency and cost-effectiveness of the healthcare system (Varkey et al., 2008). Moreover, innovations in healthcare organizations are typically new services, new ways of working, and/or new technologies (Länsisalmi et al., 2006) that help healthcare practitioners focus on the patient by helping healthcare professionals work smarter, faster, better, and more cost-effectively safety. (Faulkner & Kent, 2001; Varkey et al., 2008). From the patient's point of view, the intended benefits are either better health or less suffering due to illness (Faulkner & Kent, 2001). From an organizational point of view, the desired benefits are often enhanced efficiency of internal operations and/or the quality of patient care. It can be seen thathealthcare innovation is described as the adoption of best-proven practices that are successful and the implementation of those practices while ensuring patients' safety and best results and whose adoption might also affect the performance of the organization(Varkey et al., 2008).

However, several reasons make the management of innovation in healthcare difficult. There are constant circulations of patients and steady disease mutations. Also ever-changing are patient behaviors, resulting in organizational self-development. Several researchers have suggested that it is difficult to change the behaviors of clinicians (Greco & Eisenberg, 1993), current medical practices, and healthcare organizations (Shortell et al., 1998). Moreover, in healthcare organizations performance gaps, typical starting points of an innovation process, may lead to death, disability, or permanent discomfort (Länsisalmi et al., 2006). This, together with the clinicians' tendencies to protect their autonomy and reputation, can promote a culture of blame and secrecy that inhibits organizational learning and the generation of innovations (K Arya, 2016). In medicine, new practices on patient care are traditionally examined thoroughly in their early development phases, so that potentially harmful innovations are not adopted (Faulkner & Kent, 2001).

2.2.3 Innovation Management dimensions

Research on innovation management in healthcare could be grouped in five dimensions and 21 factors as shown in Table 2.4 and described below.

Table 2.4 Innovation management dimensions

Dimension	Factor	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
Market demand	Country and Culture	x				x			x			x									4
	Market Demand and Customer Need	x						x	x			x	x		x			x			7
	Competitors	x							x				x					x			4
	Technological Change	x						x	x	x								x			5
Strategy	Organizational strategy	x	x			x			x	x	x	x	x	x	x	x	x	x			13
	Leadership and Support from Top Management	x		x		x						x	x	x			x	x	x		12
	Alignment of innovation	x	x		x				x	x	x	x		x				x	x	x	11
	Innovation initiative with business needs and strategy	x	x	x		x			x					x			x	x	x	x	10
	Alignment of innovation		x			x				x			x						x		5
Resource	Facilities	x					x	x	x	x	x		x	x	x			x	x		11
	Budgets	x			x		x			x	x		x					x	x		8
	Having knowledge and education			x	x	x		x				x	x		x			x	x		9
	Human Resources	x		x			x		x	x	x		x	x	x	x	x	x	x		13
System management	Process management	x		x					x			x						x		x	6
	Internal and External Networking	x	x						x	x		x	x					x			7
	Knowledge Management	x							x	x	x							x	x		6
	Portfolio Management	x			x				x		x		x	x				x			7
Build on expertise and enhanced reputation	Build a distinctive competencies and competitive advantage	x																x	x	x	4
	Well-defined processes and formalized tools	x															x	x			3
	Establishing an innovation award	x												x				x			3
	Best practices documented and shared	x																x		x	3

1: (Janchome & Thawesaengskulthai, 2016), 2: (Jaruzelski et al., 2014), 3: (Wonglimpiyarat, 2010), 4: (Adams et al., 2006), 5: (Eveleens, 2010), 6: (Karaveg et al., 2016), 7: (Tidd, 2006), 8: (Nagano et al., 2014), 9: (Aujirapongpan et al., 2010), 10: (Adams et al., 2006), 11: (Volberda et al., 2013), 12: (Hidalgo & Albors, 2008), 13: (Pakdeelao, 2011), 14: (Dutta et al., 2018), 15: (Wang et al., 2008), 16: (Higgins, 1995), 17: (BSI, 2008), 18: (Davila et al., 2009), 19: (Kaplan et al., 2001).

Market demand: In this dimension, market demand, which is the study that answers who the customers are, and what they desire, is studied. It is considered a crucial part of product and service design, which is intended to respond to the demand of customers (patients and hospital personnel) in the changing situation of a new generation. Their demands are ever-changing and they share different views on hospitals. Also, new technologies have been developed, altering customers' expectations and demands according to new scenarios. Furthermore, it is also vital to study "rivals" in the healthcare business

Strategy: This is to set the shared goals together with establishing clear policies in hospitals. These actions are important for management and collaboration from all departments in a hospital. Top-down support is also important, as it is regarded as a key factor for creating an organizational environment where people are aware of the benefits and values of innovation, which is expected to lead to new collaboration and bodies of knowledge from actual practitioners of innovation.

Resource: Innovation cannot be engendered unless there are resources important for innovation management, namely facilities and proportionally right budgets, which will foster innovation management in hospitals. The hospital business is diverse in terms of professions, each having specific techniques and expertise needed to take care of patients' health. As a result, doing innovation in hospitals requires encompassing the management of personnel with specific expertise to maximize their performance. Furthermore, an entrepreneurial mindset becomes the key success factor of innovation management because is the ability to rapidly sense, act, and mobilize, even under uncertain conditions.

System management: In this process, each department in a hospital is connected despite their differences in terms of knowledge and working approaches. The organization is managed through integration, with the ultimate goal of efficiency and customer satisfaction. Therefore, system management in process, knowledge, and communication is essential to healthcare performance. Likewise, portfolios are one approach to generate innovation that will develop new approaches and knowledge for those interested in innovation.

Build on expertise and enhanced reputation: Having effective models and channels for learning about innovation will enable those interested in generating innovation in hospitals to learn and find approaches to do so. Healthcare staff is those with knowledge about medical treatment and health. Therefore, the development of management will occur effectively when it occurs through learning from examples. In addition, innovation awards are regarded as a source of inspiration for those interested in innovation.

2.3 The Relationship between TQM and Innovation Management

In today’s business environment, the basis of competitive advantage has shifted from quality to innovation (Martinez-Costa & Martínez-Lorente, 2008). Innovation allows companies adaption to changes quickly and helps find new markets (Prajogo & Brown, 2004). Several companies that have benefited from innovation have improved their earnings and market share. But the important point is that a firm cannot succeed by innovation if its’ products do not meet acceptable quality standards (Nowak, 1997). Therefore, TQM is a good way of improving quality while facilitating the innovation process (Martinez-Costa & Martínez-Lorente, 2008). However, when the literature is examined, the findings are inconsistent and complex (Prajogo & Sohal, 2001). Discussions on the relationship between TQM and innovation do not appear very often in the literature. In essence, there is only a small amount of such literature supported by theoretical concepts or empirical evidence. One group of claims, as presented in previous studies, supports the positive relationship between TQM and innovation, suggesting that innovation would be efficient for organizations that adopt TQM. The opposite group of arguments claims that TQM will hinder organizations from being innovative due to several inherent elements that are not congruent with the spirit of innovation. These two arguments are each considered in turn.

2.3.1 Arguments in support of the positive relationship between TQM and innovation

The argument supporting the positive relationship between TQM and innovation is also substantiated by several empirical studies. There have empirically demonstrated that the quality management practices are positively related to innovation (Abrunhosa & Sá, 2008; Feng et al., 2006; Hoang et al., 2006; Lee et al., 2010; Martinez-Costa & Martínez-Lorente, 2008; Perdomo-Ortiz et al., 2006; Prajogo & Hong, 2008). Companies embracing TQM in their system and culture provide a fertile environment for innovation because TQM embodies principles that are congruent with innovation (Bossink, 2002; Hung, 2007; KP & Srinivasan; Prajogo & Brown, 2004; Prajogo & Sohal, 2003). The findings of Gustafson and Hundt (1995) suggest that such elements as customer mindedness, management/leadership, benchmarking, the constancy of purpose, data/information, quality mindedness, employee mindedness, process mindedness, and continuous improvement are central to successful innovation and improvement, although not all of them are of equal importance in predicting success. In this regard, the customer focus principle encourages organizations to continuously look for new customer requirements and demands and therefore leads companies to be creative in the creation and implementation of new products as a continuous adaptation to the evolving needs of the market (Juran & Gryna, 1988). The value of delighting clients is also indicated by customer attention. This implies that suppliers need not only to follow the specific and specified requirements of customers but also to be creative to exceed those requirements and standards. This is a strategy very much associated with innovation (Juran & Gryna, 1988). The principles of empowerment, involvement, and teamwork are also substantial in determining the success of organizational innovation (Lorente et al., 1999; Prajogo & Sohal, 2001). Furthermore, the adoption of quality management in innovative activities helps the organization to upgrade itself to minimize the activities that do not create value and reduce time and costs in the development of new products (Kim et al., 2012).

On the other hand, a study on best practice of innovation management (Ahmed & Zairi, 1999) among several world-class organizations, including D2D, Rover Group, IBM (UK) Ltd, 3M, Ford, AT&T, Cadillac, Hewlett Packard, Rank Xerox, Exxon Chemical, and Kodak Ltd, reveals that some of the practices are well recognized as TQM elements. These practices include an implementation of such principles as “quality culture”, “learning organization”, “customer-driven organization”, and “continuous improvement”. More specifically, a wide variety of the so-called quality tools, including quality function deployment (QFD), Taguchi methods, design of experiments, statistical process control (SPC), failure mode and effect analysis (FMEA), Poka Yoke, benchmarking, six-sigma design, seven problem-solving tools, seven planning tools, ISO 9001 quality system standards, employee empowerment and involvement, multifunctional teamwork, and supplier partnership, are also included in these practices.

2.3.2 Arguments in support of the negative relationship between TQM and innovation

In contrast to the above claims, the positive relationship between TQM and innovation is dismissed by several scholars because it has values and practices that could obstruct innovation brought forward by several scholars (Bennett & Cooper, 1981; Doz et al., 1989; Kim & Mauborgne, 1999; Lawton & Parasuraman, 1980; Wind & Mahajan, 1997). Hoang et al. (2006) agree that a customer focus philosophy could easily lead organizations to focus only on incremental improvements in their current products and service activities rather than trying to create novel solutions. Consequently, this leads to the development of uncompetitive products rather than the development of real innovation. In this way, such firms could fail to explore customers' latent needs. Furthermore, Atuahene-Gima (1996) argued that customer focus is concerned with product conformance (product quality), but not with product newness (product innovation).

Similarly, continuous improvement requires regulatory standards and activities that are sufficiently routine to be well understood. Hence, control and stability are the core of the continuous improvement process (Berger, 1997; Michela et al., 1996). Whilst standardization is necessary for conformance and error reduction, from the innovation point of view, it could trap people into staying with what is workable; resulting in rigidity (Glynn, 1996; Kanter, 1983). In addition, Lawler III (1994) and Samaha (1996) suggest that the concept of continuous improvement is basically aimed at simplifying or streamlining a process and carrying it out in a better or faster manner. Such an approach could be detrimental to innovation because companies may continually work upon, and improve, processes that are already fundamentally flawed. Moreover, scholars like Wind and Mahajan (1997) and Harari (1993) have been quoted as stating that TQM centered on incremental improvements, resulting in product conformance rather than radical innovation. Moreover, (Prajogo & Sohal, 2001) claimed that TQM prevented companies from being broadminded.

The contents of these opposing arguments can also be extended to address the relationship between quality management and innovation management; whether they are positively associated with each other or not. Thus, it can be seen that culturally and structurally different organizations will have different approaches to this relationship. The existing empirical studies (see Table 2.5 for detailed information) analyzing the relationship can be classified into:

Table 2.5 An analysis of TQM and innovation management relationship

Author/s	**Significant Positive relationship?**	**Data characteristics**			**Relationship dimensions**
		Sample (organizations)	**Method**	**Country**	
(Kanji, 1996)	Yes	3	Case study	United Kingdom	TQM: customer satisfaction, internal customers are real, all work is a process, measurement, teamwork, people make quality, continuous improvement cycle, prevention Innovation: product innovation, process innovation, application

Author/s	Significant Positive relationship?	Data characteristics			Relationship dimensions
		Sample (organizations)	Method	Country	
					innovation, system innovation, core competence innovation, horizontal transfer innovation
(Bossink, 2002)	Yes	40	Case study	Holland	TQM: strategic function of quality, integration of quality in the strategy of the organization, orientation towards processes and teamwork Innovation: creating innovation context, supervising innovation processes, initiation innovation processes, producing innovation content, implementing innovation results
(Prajogo & Sohal, 2003)	Yes	194	Survey	Australia	TQM: leadership, strategic planning, customer focus, information and analysis, people management, process management, product quality Innovation: product innovation, process innovation
(Prajogo & Brown, 2004)	Yes	194	Survey	Australia	TQM: mechanistic: customer focus, process management, strategic planning, and information & analysis, organic: leadership and people management, product quality Innovation: product innovation
(Singh & Smith, 2004)	No	418	Survey	Australia	TQM: top management leadership, customer focus, employee relations, relationship with suppliers, competitors, communication/Information systems, product/process management Innovation: innovative processes/products/services commercialized, R&D as a world-class techniques/technologies developer, innovation rate of new operational processes, the introduction rate of new products and services
(Cho & Pucik, 2005)	Yes	488	Survey and databases	United States	TQM: Fortune Reputation Survey measures Innovation: Fortune Reputation Survey measures
(Perdomo-Ortiz et al., 2006)	Yes	103	Questionnaires	Spain	TQM: management support, information for quality, process management, product design, human resource management, relationship with suppliers and customers Innovation: planning and

Author/s	Significant Positive relationship?	Data characteristics			Relationship dimensions
		Sample (organizations)	Method	Country	
					commitment on the part of management, behavior and integration, projects, knowledge and skills, information and communication, external environment
(Prajogo & Sohal, 2006)	Yes	194	Questionnaires	Australia	TQM: leadership, strategic planning, customer focus, information & analysis, people management, process management, quality: product quality Innovation: technology management, R&D management, product innovation, process innovation
(Moura E Sá & Abrunhosa, 2007)	No	16	Mailed survey	Portugal	TQM: people management practices, work organization issues Innovation: Technological innovation
(Santos-Vijande & Álvarez-González, 2007)	Yes	93	Mailed survey	Asturias (Spain)	TQM: leadership (12 items), people (12 items), policy and strategy (7 items), processes (11 items), partnership and resources (9 items) Innovation: Innovativeness (5 items), technical and administrative innovation (4 items)
(Abrunhosa & Sá, 2008)	No	20	Survey	Portugal	TQM: autonomy (4 items), internal communication (4 items), consultation (4 items), qualitative flexibility (6 items), supportive people management practices (2 items) Innovation: number of innovations adopted over time, time of adoption of innovations
(Martinez-Costa & Martínez-Lorente, 2008)	Yes	451	Interviews	Spain	TQM: continuous improvement activity, use of tools for quality improvement in teamwork, statistical process control, supplier selection based on quality criteria, employee training in quality management, quality leadership, total preventive maintenance, meetings with customers to evaluate product quality Innovation: product innovation, process innovation
(López-Mielgo et	Yes	992	Secondary source	Spain	TQM hard components: related to control of processes and products

Author/s	Significant Positive relationship?	Data characteristics			Relationship dimensions
		Sample (organizations)	Method	Country	
al., 2009)					to comply with quality standards and satisfy specifications Innovation: innovation experience (product and process), R&D, technological level
(Pekovic & Galia, 2009)	Yes	1146	Secondary source	France	Three different quality levels: top, medium, and low Innovation: new or improved products for the firm, turnover due to new or improved products, new or improved products on the market, the share of new or improved products to the market, new or improved processes for the firm, technologically new process, new process (non-technological), total innovation expenditure, number of innovation projects
(Perdomo-Ortiz et al., 2009)	Yes	105	Mailed questionnaire	Spain	TQM: management support, information for quality, process management, product design, human resource management, relationship with suppliers, and customers. Innovation: BIC measurements, technological innovation measurements
Simon and Pentji Yaya (2012)	Yes	76	Survey	Spain	Integration benefits Innovation: process, organization, marketing
(Moreno-Luzon et al., 2013)	No	72	Survey	Spain	TQM: processes (3 items), people (6 items) Innovation: exploration and exploitation innovation (6 items)

In healthcare cases, TQM and innovation management seem to represent a unique and rather complex case than do other industries because both of them on patient care, treatment practices, and hospital procedures may include significant health risks related to financial, social, and ethical issues (Dervitsiotis, 2011). From a systematic review of Tonjang and Thawesaengskulthai (2020) studying the relationship between TQM to innovation management in the hospital, it was found that TQM exists numerous factors contributing to innovation management in the hospital. The authors, therefore, categorize the positive factors according to the six principles of TQM and describe how these six principles support innovation management in the hospital as in table 2.6.

Table 2.6 TQM factors contributing to innovation in healthcare

Dimensions	Authors	TQM dimensions support innovation

Dimensions	Authors	TQM dimensions support innovation
Top Management	(Berwick, 2003) (Fernández, 2001) (Goes & Park, 1997) (do Carmo Caccia‐Bava et al., 2009) (Länsisalmi et al., 2006)	The leader should have an innovative vision and experiment with new ideas to foster innovation. Top management should support activities conducive to innovation, including money, time, space, and staff management. Also, they should take risks attendant to investment, changes in milieu. Furthermore, organizational policy affecting innovation is enacted from above.
Customer Focus	(Thakur et al., 2012) (Halvorsen et al., 2005) (Varkey et al., 2008) (Wu & Hsieh, 2011) (Akenroye, 2012) (De Vries et al., 2016)	The creation of innovation should take into account customers' needs to respond to their demands. In addition to the identified demand, a new market should be sought and current trends, together with ever-changing customers' needs should be observed. This will help provide customers with new products and services.
Employee Involvement	(Berwick, 2003) (Fernández, 2001) (Herzlinger, 2006) (Varkey et al., 2008). (Wu & Hsieh, 2011). (Yellowlees et al., 2011) (Länsisalmi et al., 2006)	All personnel in the organization should seek opportunities to produce new products and services and should cooperate in doing technology. This is because each department's specific knowledge will constitute innovation. Due to the difference in the basis of their knowledge, each department has unique expertise crucial for innovation. Therefore, brainstorming will develop products and services through cooperation, resulting in new bodies of knowledge and new approaches to innovation. Furthermore, innovation can also be brought about through entrepreneurialism and outspokenness.
Continuous Improvement	(Berwick, 2003) (Wu & Hsieh, 2011) (Wu & Hsieh, 2015) (Akenroye, 2012) (Djellal & Gallouj, 2007) (De Vries et al., 2016)	Cutting-edge innovation can be ushered in by constant development of service treatment methods, awareness of changing society and trends, exploration of newly-identified diseases, and examination of gaps in the patient service. Additionally, opening up new markets, seeking new customers, and studying their future needs constantly will generate new approaches to product design to cater to their demands. In development, routinization and incremental should not be privileged; radical development is to be considered as well.
Process Management	(Thakur & Fontenot, 2012) (Goes & Park, 1997) (Herzlinger, 2006) (Varkey et al., 2008) (Wu & Hsieh, 2015) (Akenroye & Kuenne, 2015)	Appropriate organizational management will be conducive to ways to render innovation accessible to the organization and to foster innovation. All should be involved in developing innovation, joining forces in creating a system in keeping with the law and medical ethics which provides the error-free treatment.
Information and Analysis	(Halvorsen et al., 2005)(Herzlinger, 2006)(Omachonu & Einspruch, 2010) (Yellowlees et al., 2011).(do Carmo Caccia‐Bava et al., 2009) (Akenroye, 2015) (Djellal & Gallouj, 2007)	The use of technology to gather and manage data will create ways to put data into easy use. Also, data analysis will be accurate and effective such that any errors can be detected and corrected. Furthermore, analyses produced should be error-free and staff should keep abreast of new and updated information, normally dynamic. Also, patients' illnesses with accuracy should be forecast. The obtainment of these sorts of information can produce innovation vital to healthcare innovation creation.

A systematic review of TQM and innovation management in healthcare (Tonjang & Thawesaengskulthai, 2020) study the relationship between the two initiatives. The findings revealed that TQM and innovation management are significant in responding to customers' demands with efficiency and sustainability in organizations. Top Management and leader corporations mainly drive organizations and foster innovation. Customer Focus, which involves setting the goal at effecting innovation, is to satisfy customers and open up new markets. This quality is engaged with patient rights. Continuous Improvement posits constant development since healthcare has ever-changing dynamics owing to patients' diverse demands and the prospect of newly-identified diseases. The third quality specifically found in healthcare is employee involvement. Since the hospital has numerous sectors, each with different sets of knowledge, skills, and performance; communication, and cooperation from all sectors in the organization will usher in innovation more easily and more efficiently. Finally, information and analysis are also indispensable since the hospital has a large repository of patients' information that vital to its operation. Thus, if effective, the information system and analysis can locate the areas in need of innovation and the type required in the hospital. Hence, the factors of TQM foster the introduction of innovation management and vice versa in healthcare. With the aim of sustainable operation in the hospital, both TQM and innovation management should be combined to maximize the efficiency required for the competitive climate of business while following the quality standards and safety of patients. The authors thus proposed a conceptual framework of TQM and innovation management in healthcare based on the systematic literature review as shown in Figure 2.2.

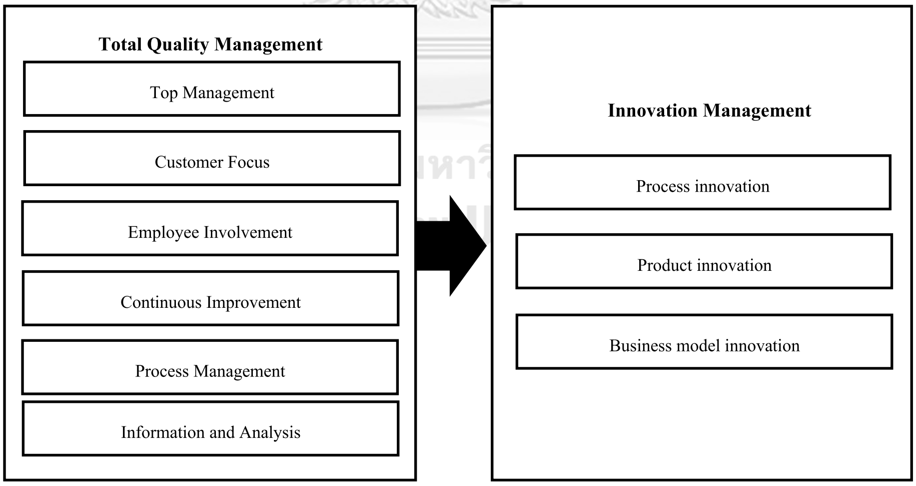


Figure 2.2 TQM and innovation management in healthcare Conceptual framework

2.4 Healthcare Performance

2.4.1 Healthcare Performance Background

A literature review has shown that, in the past, success in an organization has been measured predominantly in the economic sphere (e.g. market success). However, recently the non-economic sphere has increasingly become a matter of corporate management (Christiansen & Buen, 2002; Preuss, 2007). Organizations have been increasingly pressured to focus on sustainability and accountability of business performance, beyond financial performance (Lee & Saen, 2012). So, organization performance includes not only the product's economic success but also the direction of sustainability effects (Paech, 2013). A typical source to define ‘sustainable’ is from a report at the World Commission on Environment and Development 1987. It states that development is sustainable when the development meets the present needs without affecting the capability of the next generation to meet their own needs. Furthermore, the need for sustainability is embedded in achieving a balance between economic activities and associated ecological and social impacts (Edgeman & Hensler, 2001; Hediger, 1999). Sustainability is increasingly becoming a very crucial issue in healthcare services in developing and developed countries (Wijethilake, 2017). The term “sustainability” can be visualized in terms of actions that are designed to drive the triple-bottom-line (TBL) results around economic prosperity, environmental stewardship, and social responsibility. It is important to carry out a strategic and operational redesign while taking into account a sustainable approach based on the TBL (economic, social and environmental) dimensions, to build value along the value chain and, consequently, to make a positive contribution to the sustainable development of the industry (Baumgartner, 2014).

2.4.2 Healthcare Sustainability

Sustainable healthcare can be defined as a complex system of interacting approaches to the management of human health, competitive in the economic and social development (Brown et al., 2003; Organization, 2008). Lopez-Casasnovas (2005) confirms that the healthcare industry needs to pursue sustainability practices to improve its economic and social well-being. The sustainability of healthcare produces value based on these TBL dimensions (Lopez-Casasnovas, 2005; Stevanovic et al., 2017). In the healthcare sector, hospitals establish economic as well as social, and environmental benefits for their stakeholders(Schulz & Flanigan, 2016). Indeed, hospital health services are relevant from an economic point of view and contribute to economic growth (Suhrcke et al., 2007). For instance, when optimizing procedures, a hospital can improve local employment prospects, workforce productivity, and even lower labor costs in the local supply chain (Suhrcke et al., 2007). Apart from economic issues, hospitals also participate in environmental and social aspects throughout the healthcare value chain, promoting and developing sustainability initiatives that improve business-to-business relationships (Suhrcke et al., 2005). In fact, considering the social aspect, the healthcare sector is directly responsible for overall population health (Lopez-Casasnovas, 2005) and, thus, community well-being. Likewise, improving population health, together with local economic regeneration and the development of the local labor market, should lead hospitals to strengthen social cohesion within their scope of influence(Wijethilake, 2017). In terms of environmental concern, the focus on reusing sustainability behavior in hospitals is less common regarding security and infectious risks, and the growing increase in the use of medical disposables is neither environmentally nor financially favorable. Thus, other sustainability initiatives such as the reduction of gaseous emissions, improvement of energy efficiency, stricter control of wasted water, or the recycling of hospital waste have a greater potential impact on environmental sustainability. As sustainability decisions are at the strategic level (Engert et al., 2016) and the CEOs are the ones with the authority to implement sustainability initiatives, private hospitals need to change their entire organizational culture toward sustainability to achieve success regarding such actions.

2.4.3 Healthcare Sustainability dimensions

The utilization of sustainable development indicators in the healthcare sector would contribute to a quantification of the economic, social, and environmental efforts of hospitals (Lopez-Casasnovas, 2005). The authors, therefore, review the measurement of sustainability in hospitals from previous studies. The authors conclude factors affecting sustainability in healthcare with three dimensions 33 factors, as shown in Table 2.7.

Table 2.7 Healthcare sustainability from a literature review

Dimension	Factor	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
Economic dimension	Cost in equipment and facilities		x	x			x		x				x									5
	Long-term liability ratio			x		x	x		x					x					x			7
	Utility (water /electricity)								x			x						x	x		x	5
	Staff cost												x		x							2
	Cost in pharmaceutical and medical materials		x					x			x	x						x	x			6
	Marketing cost							x			x	x						x	x			6
	Outsourcing cost (housekeeping/ Food)			x				x	x		x	x		x	x			x			x	9
	Debt-to-assets ratio		x						x		x	x		x	x			x			x	7
	The growth rate in revenue	x	x	x	x	x	x	x	x		x			x			x	x	x		x	14
	Revenue	x	x	x	x	x	x	x	x		x			x			x	x	x		x	14
	Net profit rate	x	x	x	x	x	x	x	x		x	x		x			x	x	x		x	15
	Investment	x	x	x	x	x	x	x	x					x	x				x	x	x	13
Environmental dimension	Energy from renewable	x		x								x	x		x					x		8
	Energy from nonrenewable	x									x									x		9
	Energy regulations/certifications											x					x			x		8
	Natural resource			x		x					x	x	x	x		x						11
	Gaseous emissions																			x		7
	Solid waste								x		x											8
	Liquid waste	x		x																		7
	Other waste and emissions	x																	x			8
	Waste management regulations/certification	x							x		x			x				x		x		11
	Recycled wastes use				x						x	x			x						x	6
	Hazardous wastes											x			x			x	x	x		5
Social dimension	Efficiency, Quality of care	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	18
	Facility	x		x	x		x		x		x	x	x		x		x	x	x	x	x	14
	Technology				x		x		x	x			x	x	x					x	x	9
	Speed of time				x				x	x				x	x							5
	Safety	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x	x	18
	Health					x	x		x	x	x	x	x	x	x				x	x	x	12
	Customer need	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x	18
	Employee engagement				x			x	x		x	x			x			x				7
	Training			x					x			x			x			x				5
	Ethic								x			x										2

1 : (Álvarez-Rodríguez et al., 2020), 2 : (Basole & Rouse, 2008), 3 : (Hwang & Christensen, 2008), 4 : (Njoroge et al., 2019), 5 : (Chung & Meltzer, 2009), 6 : (Alhaddi, 2015), 7 : (Maru & Woodford, 2007), 8 : (Sharma, 2002), 9 : (Wijethilake, 2017), 10 : (Suhrcke et al., 2005), 11 : (i Casasnovas et al., 2007), 12 : (Sumaila et al., 2006), 13 : (Mutingi & Mbohwa, 2014), 14 : (Faezipour & Ferreira, 2013a), 15 : (Faezipour & Ferreira, 2011), 16 : (Ramirez et al., 2013), 17 : (Jamaludin et al., 2013), 18 : (Buffoli et al., 2013), 19 : (Fanta et al., 2015), 20 : (Shuaib et al., 2014).

As a result, the authors summarized the healthcare performance in three dimensions shown in Table 2.8.

Table 2.8 Healthcare sustainability dimensions

Dimension	Factor
Economic Sustainability	Cost in equipment and facilities
	Long-term liability ratio
	Utility (water /electricity)
	Staff cost
	Cost in pharmaceutical and medical materials
	Marketing cost
	Outsourcing cost (housekeeping/ Food)
	Debt-to-assets ratio
	The growth rate in revenue
	Revenue
	Net profit rate
	Investment
Environmental Sustainability	Energy from renewable
	Energy from nonrenewable
	Energy regulations/certifications
	Natural resource
	Gaseous emissions
	Solid waste
	Liquid waste
	Other waste and emissions
	Waste management regulations/certification
	Recycled wastes use
	Hazardous wastes
Social Sustainability	Efficiency, Quality of care
	Facility
	Technology
	Speed of time
	Safety
	Health
	Customer need
	Employee engagement
	Training
	Ethic

Economic Sustainability: Indeed, from an economic point of view, healthcare services from hospitals are relevant and contribute to economic growth (Suhrcke et al., 2007) while exerting a substantial impact on local or regional-related industries (Lopez-Casasnovas, 2005). In the economical part, profitability is imperative for a healthcare organization. This is being driven by both regulatory requirements and competitive pressures. Effectively addressing the challenges of profitability involves mastering a methodology, understanding the business drivers, changing business processes, and introducing a system that supports an efficient process. The impact of profitability and cost management ripples through to all management processes and is a key component of an overall enterprise performance management system. An organization's profit is the surplus left from revenue after paying all costs. Profit is found by deducting total costs from revenue.

Environmental Sustainability: In terms of environmental concern, the focus on reusing sustainability behavior in hospitals is less common regarding security and infectious risks, and the growing increase in the use of medical disposables is neither environmentally nor financially favorable. Thus, other sustainability initiatives such as the reduction of emissions, improvement of energy efficiency, stricter control of wasted water, or recycling hospital waste have a greater potential impact on environmental sustainability. As sustainability decisions are at the strategic level (Engert et al., 2016) and the CEOs are the ones with the authority to implement sustainability initiatives, private hospitals need to change their entire organizational culture toward sustainability to achieve success regarding such actions. Moreover, the utilization of sustainable development indicators in the healthcare sector would contribute to a quantification of the economic, social, and environmental efforts of hospitals (Hansen & Grosse-Dunker, 2012).

Social Sustainability: Hospitals also participate in social aspects throughout the healthcare value chain, promoting and developing sustainability initiatives (Mariadoss et al., 2011). In fact, considering the social aspect, the healthcare sector is directly responsible for overall population health (Lopez-Casasnovas, 2005) and, thus, community well-being (Chung & Meltzer, 2009). Likewise, improving population health, together with local economic regeneration and the development of the local labor market, should lead private hospitals to strengthen social cohesion within their scope of influence (Taylor et al., 2006).

2.5 Techniques and Research Method

2.5.1 Systematic Literature Review Method

A systematic review (SLR) adheres to standardized methodologies/guidelines in systematic searching, filtering, reviewing, critiquing, interpreting, synthesizing, and reporting of findings collecting, critically evaluating, integrating, and presenting findings from across multiple research studies on a research question or topic of a topic/domain of interest (Greenhalgh, 2014). SLRs make themselves ideal for replication because of the extensive documentation and reporting of the steps and assumptions. It provides a wider and more accurate level of comprehension than a conventional analysis of literature (Booth et al., 2016). A systematic literature review followed three stages (Tranfield et al., 2003) and has been adopted by many research areas (Thawesaengskulthai & Tannock, 2008).

1. Planning the review

2. Conducting the review

3. Reporting and dissemination

This systematic literature review methodology as suggested by Tranfield et al. (2003) was employed, as it allows transparency and repeatability, and helps to avoid the potential effects of research bias.

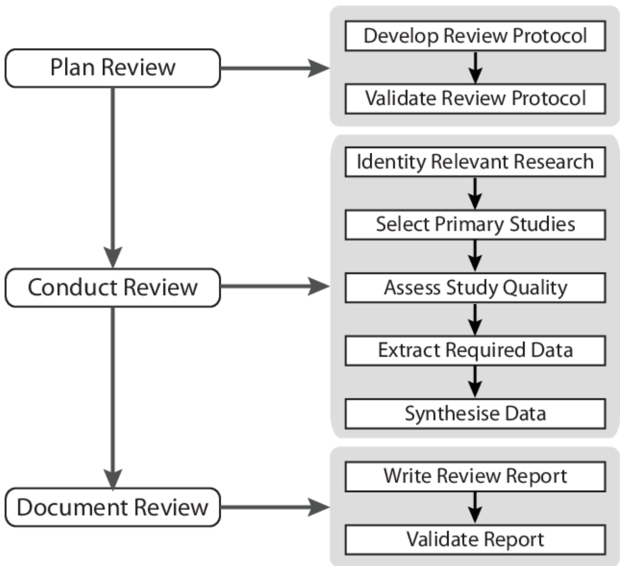


Figure 2.3 A systematic literature review process

Planning the Review

A review panel comprising several experts in the fields of both methodology and theory is assembled before the start of the review. The review panel should help direct the process through regular meetings and resolve any disputes over the inclusion and exclusion of studies. The initial stages of systematic reviews may be an iterative process of definition, clarification, and refinement (Clarke & Oxman, 2001). It will be appropriate to perform scoping studies within management to determine the importance and size of the literature and to delimit the subject area or issue. The scoping study may also include a brief overview of the theoretical, practical, and methodological history debates surrounding the field and sub-fields of study. Where fields comprise semi-independent and autonomous sub-fields, then this process may prove difficult and the researcher is likely to struggle with the volume of information and the creation of transdisciplinary understanding.

The result of these decisions is recorded in a structured analysis through a formal document called the review protocol. The Protocol is a plan that, by including explicit descriptions of the steps to be taken, helps preserve objectivity. The protocol provides information on the particular questions raised by the study, the population (or sample) that the study focuses on, the search strategy for identification of relevant studies, and the criteria for inclusion and exclusion of studies in the review (Davies & Crombie, 1998).

Conducting the Review

A systematic search begins with the identification of keywords and search terms, which are built from the scoping study, the literature, and discussions within the review team (Mulrow, 1994). The reviewer should then decide on the search strings that are most appropriate for the study. The search strategy should be reported in detail sufficient to ensure that the search could be replicated. A full listing of articles and papers (core contributions) on which the analysis will be based should be the output of the knowledge quest. Only studies that satisfy all the inclusion criteria stated in the review protocol and which do not report any of the exclusion criteria should be included in the review. The strict criteria used in the systematic review are linked to the desire to base reviews on the best-quality evidence. The process of selecting studies in systematic review involves several stages. Relevant sources will be retrieved for a more detailed evaluation of the full text and from these, some will be chosen for the systematic review. Quality assessment refers to the appraisal of a study’s internal validity and the degree to which its design, conduct, and analysis have minimized biases or errors.

The data-extraction process requires documentation of all steps taken. When devising the form, reviewers should consider the information that will be needed to construct summary tables and to perform data synthesis. Data-extraction forms should include details of the information source (title, authors, journal, publication details) and any other features of the study such as population characteristics, the context of the study, and an evaluation of the study's methodological quality (Greenhalgh, 2014). Research synthesis is the collective term for a family of methods for summarizing, integrating, and, where possible, cumulating the findings of different studies on a topic or research question (Mulrow, 1994). Some authors contend that there are several philosophical and practical problems associated with 'summing up' qualitative studies, whilst others argue that attempts to 'synthesize existing studies are seen as essential to reaching higher analytic goals and also enhancing the generalizability of qualitative research (Sandelowski et al., 1997). Two interpretive and inductive methods, realist synthesis and meta-synthesis have been developed to fill the gap between narrative reviews and meta-analysis.

Table 2.9 Main differences between narrative and systematic reviews

Methodological stage	**Literature review**	**Systematic review**
Focus of review	Introduces context and current thinking, often without a specific question, in general and covers several aspects of a topic.	Uses a precise question to produce evidence to underpin a piece of research. A stand-alone piece of research should be conducted before undertaking further research, particularly in higher degree theses.
Methods for data collection	Finds papers through a fairly random process, usually searching only a few databases. Using grey literature is common, but not usually systematic.	Searches of several specified databases using precise search terms; a similar systematic search of grey literature is sometimes included, depending on the question.
Methods for data extraction	Papers are read, 'take-home' messages used in the review.	A data extraction tool is used to identify precise pieces of information; two or more researchers undertake data extraction.
Number of papers included in the review	Anything up to 150 papers or more.	Usually less than 50 papers; often fewer than 10.
Methods for data analysis	The writer interprets the meaning of the results.	Recognized, referenced, methods for data analysis; includes analysis of methods, the rigor of conduct of research, the strength of

Methodological stage	Literature review	Systematic review
		evidence, and so on.
Methods for data presentation	Prose papers, are occasionally supported with diagrams.	PRISMA/CONSORT or similar chart/table of included papers.
Publication	Not suitable for Journal publication.	Might be suitable for Journal publication.
Outcome	Actions/directions informed by evidence of various kinds drawn from included papers.	Actions/directions are based on evidence from reviewed papers.

Reporting and Dissemination

A good systematic review should make it easier for the practitioner to understand the research by synthesizing extensive primary research papers from which it was derived. Within management research, a two-stage report might be produced. The first would provide a full (rough-cut and detailed) 'descriptive analysis' of the field. This is achieved using a very simple set of categories with the use of the extraction forms.

Researchers also need to report the findings of a 'thematic analysis', whether or not the results were derived through an aggregative or interpretative approach, outlining that which is known and established already from data extraction forms of the core contributions. Moreover, the discussion section of the article will bring all the information together into a final summary of the evidence, listing limitations of the SLR and offering conclusions stemming from the review.

2.5.2 Case Study Research Method

It is clear that the choice of the research method used to perform research is based heavily on what is meant to be understood, the thrust from which it wishes to be understood, and the depth of the problem to be excavated. A Case study is an ideal methodology when a holistic, in-depth investigation is needed (Feagin et al., 1991). Case studies have been used in varied investigations, particularly in sociological studies, but increasingly, in instruction. (Yin, 2003) and (Stake, 1995) use different terms to describe a variety of case studies. Yin clarified definitions and examples of different types of case studies are shown in Table 2.11.

Table 2.10 Definitions and examples of different types of case studies

Case Study Type	Definition	Published Study Example
Explanatory	This type of case study would be used if you were seeking to answer a question that sought to	Joia (2002). Analyzing a web-based e-commerce

Case Study Type	Definition	Published Study Example
	explain the presumed causal links in real-life interventions that are too complex for the survey or experimental strategies. In evaluation language, the explanations would link program implementation with program effects (Yin, 2003)(Joia, 2002).	learning community: A case study in Brazil. Internet Research, 12, 305-317.
Exploratory	This type of case study is used to explore those situations in which the intervention being evaluated has no clear, single set of outcomes (Yin, 2003) (Lotzkar & Bottorff, 2001).	Lotzkar & Bottorff (2001). An observational study of the development of a nurse-patient relationship. Clinical Nursing Research, 10, 275-294.
Descriptive	This type of case study is used to describe an intervention or phenomenon and the real-life context in which it occurred (Yin, 2003) (Tolson et al., 2002).	Tolson, Fleming, & Schartau (2002). Coping with menstruation: Understanding the needs of women with Parkinson's disease. Journal of Advanced Nursing, 40, 513521.
Multiple-case studies	A multiple case study enables the researcher to explore differences within and between cases. The goal is to replicate findings across cases. Because comparisons will be drawn, the cases must be chosen carefully so that the researcher can predict similar results across cases, or predict contrasting results based on a theory (Yin, 2003)(Campbell & Ahrens, 1998).	Campbell & Ahrens (1998). Innovative community services for rape victims: An application of multiple case study methodology. American Journal of Community Psychology, 26, 537-571.
Intrinsic	Stake (1995) uses the term intrinsic and suggests that researchers who have a genuine interest in the case should use this approach when the intent is to better understand the case. It is not undertaken primarily because the case represents other cases or because it illustrates a particular trait or problem, but because in all its particularity and ordinariness, the case itself is of interest. The purpose is NOT to come to understand some abstract construct or generic phenomenon. The purpose is NOT to build theory (although that is an option (Stake, 1995))(Hellström et al., 2005).	Hellström, Nolan, & Lundh (2005). "We do things together" A case study of "couplehood" in dementia. Dementia, 4(1), 7-22.
Instrumental	Is used to accomplish something other than understanding a particular situation. It provides insight into an issue or helps to refine a theory. The case is of secondary interest; it plays a supportive role, facilitating our understanding of something else. The case is often looked at in-depth, its contexts scrutinized, its ordinary activities detailed, and because it helps the researcher pursue the external interest. The case may or may not be seen as typical of other cases (Stake, 1995)(Luck et al., 2007).	Luck, Jackson, & Usher (2007). STAMP: Components of observable behaviors that indicate the potential for patient violence in emergency departments. Journal of Advanced Nursing, 59, 11-19.
Collective	Collective case studies are similar in nature and description to multiple case studies (Yin, 2003)(Scheib, 2003)	Scheib (2003). Role stress in the professional life of the school music teacher: A collective case study. Journal of Research in

Case Study Type	Definition	Published Study Example
		Music Education, 5 1 ,1 2 4 - 136.

In all of the types of case studies, there can be single-case or multiple-case applications. The unit of analysis is a critical factor in the case study. It is typically a system of action rather than an individual or group of individuals. Case studies tend to be selective, focusing on one or two issues that are fundamental to understanding the system being examined. Moreover, case studies are multi-perspectival analyses. This means that the researcher considers not just the voice and perspective of the actors, but also of the relevant groups of actors and the interaction between them (Feagin et al., 1991). Yin (1994) suggested using multiple sources of evidence as a way to ensure construct validity. The current study used multiple sources of evidence including survey instruments, interviews, and documents (Yin, 1984; Yin, 1989, 1994). The specification of the unit of analysis also provides internal validity as the theories are developed and data collection and analysis test those theories. Yin (1994) presented four processes to analyze case study research shown below.

1. Design the case study protocol:

2. Conduct the case study:

3. Analyze case study evidence:

4. Develop conclusions

The following sections expand on each of the stages listed above, in the order in which they are executed in the current study. Each section begins with the procedures recommended in the literature, followed by the application of the recommended procedure in the current study.

Design the Case Study Protocol

The first stage in the case study methodology recommended by Yin (1994) is the development of the case study protocol. This stage is composed of two subheadings: determine the required skills and develop and review the protocol. Yin (1994) suggested that the researcher must possess or acquire the following skills: the ability to ask good questions and to interpret the responses, to be a good listener, to be adaptive and flexible to react to various situations, to have a firm grasp of issues being studied, and to be unbiased by preconceived notions. The investigator must be able to function as a "senior" investigator (Feagin et al., 1991). The literature contains major refutations by Yin, Stake, Feagin, and others whose work resulted in a suggested outline for what a case study protocol could include. While it is desirable to have a protocol for all studies, Yin (1994) stated that it is essential in a multiple-case study. The protocol should include the following sections:

1. An overview of the case study project - this will include project objectives, case study issues, and presentations about the topic under study

2. Field procedures - reminders about procedures, credentials for access to data sources, location of those sources

3. Case study questions - the questions that the investigator must keep in mind during data collection

4. A guide for the case study report - the outline and format for the report.

Conduct the Case Study

The second stage of the methodology recommended by Yin (1994) and which was used in this study, is the conduct of the case study. Three tasks in this stage must be carried out for a successful project: preparation for data collection, distribution of the questionnaire, and conducting interviews.

These stages are presented together in the following section since they are interrelated. Once the protocol has been developed and tested, it puts the project into the second phase the actual execution of the plan. In this phase, the primary activity is that of data collection. In the case of studies, data collection should be treated as a design issue that will enhance the construct and internal validity of the study, as well as the external validity and reliability (Yin, 1994). Most of the field methods described in the literature treat data collection in isolation from the other aspects of the research process (Yin, 1994), but that would not be productive in case study research.

Yin (1994) identified six primary sources of evidence for case study research. The use of each of these might require different skills from the researcher. Not all sources are essential in every case study, but the importance of multiple sources of data to the reliability of the study is well established (Stake, 1995; Yin, 1994). The six sources identified by Yin (1994) are shown in Table 2.12.

Table 2.11 The strengths and weaknesses of each type of the study research

Source of Evidence	Strengths	Weaknesses
Documentation	• stable - repeated review • unobtrusive - exist before case study • exact - names etc. • broad coverage – the extended time span	• retrievability - difficult • biased selectivity • reporting bias - reflects author bias • access - may be blocked
Archival Records	• Same as above • precise and quantitative	• Same as above • privacy might inhibit access
Interviews	• targeted - focuses on the case study topic • insightful - provides perceived causal inferences	• bias due to poor questions • response bias • incomplete recollection • reflexivity - interviewee expresses what interviewer wants to hear
Direct Observation	• reality - covers events in real time • contextual - covers event context	• time-consuming • selectivity - might miss facts • reflexivity - observer's presence might cause change

		• cost - observers need time
Participant Observation	• Same as above • insightful into interpersonal behavior	• Same as above • bias due to investigator's actions
Physical Artifacts	• insightful into cultural features • insightful into technical operations	• selectivity • availability

No single source has a complete advantage over the others; rather, they might be complementary and could be used in tandem. Thus a case study should use as many sources as are relevant to the study. Moreover, the data that is collected during this phase need to be organized and documented just as it is in experimental studies. The design of the databases should be such that other researchers would be able to use the material based on the descriptions contained in the documentation.

Analyze Case Study Evidence

Yin (1994) suggested that every investigation should have a general analytic strategy, to guide the decision regarding what will be analyzed and for what reason. He presented some possible analytic techniques: pattern-matching, explanation-building, and time-series analysis. In general, the analysis will rely on the theoretical propositions that led to the case study. Trochim (1989) considered pattern-matching as one of the most desirable strategies for analysis. This technique compares an empirically based pattern with a predicted one. If the patterns match, the internal reliability of the study is enhanced. The actual comparison between the predicted and actual patterns might not have any quantitative criteria. The discretion of the researcher is therefore required for interpretations. Explanation-building is considered a form of pattern-matching, in which the analysis of the case study is carried out by building an explanation of the case. Another option is a time-series analysis which is a well-known technique in experimental and quasi-experimental analyses. A single dependent or independent variable could make this simpler than pattern-matching, but sometimes there are multiple changes in a variable, making starting and ending points unclear.

Develop Conclusions

The reporting aspect of a case study is perhaps most important from the user perspective. It is the contact point between the user and the researcher. A well-designed research project that is not well explained to the reader, will cause the research report to fall into disuse. In this section, the researcher must refrain from technical jargon and resort to clear explanations. Those explanations are necessary to help the user understand the implications of the findings.

2.5.3 Delphi study

The Delphi Method is based on a structured process for collecting and distilling knowledge from a group of experts using a series of questionnaires interspersed with controlled opinion feedback (Adler & Ziglio, 1996; Czinkota & Ronkainen, 1997; Halal et al., 1997; Helmer, 1977; Howze & Dalrymple, 2004; Levary & Han, 1995; Linstone & Turoff, 1975; Skulmoski & Hartman, 2002). According to Helmer (1977), Delphi represents a useful communication device among a group of experts and thus facilitates the formation of a group judgment (Wissema, 1982). It is a method for structuring a group communication process to facilitate group problem solving and to structure models (Linstone & Turoff, 1975). The Delphi method is a mature and very adaptable research method used in many research arenas by researchers across the globe (Adler & Ziglio, 1996; Delbeq et al., 1975; Rowe & Wright, 1999).

The original Delphi method was developed by Dalkey and Helmer (1963) of the RAND Corporation in the 1950s for a U.S.-sponsored military project. Dalkey and Helmer (1963) stated that the goal of the project was "to solicit expert opinion to the selection, from the point of view of a Soviet strategic planner, of an optimal U.S. industrial target system and to the estimation of the number of A-bombs required to reduce the munitions output by a prescribed amount". Dalkey and Helmer (1963) characterize the classical Delphi method by four key features:

1. Anonymity of Delphi participants: allows the participants to freely express their opinions without undue social pressures to conform to others in the group. Decisions are evaluated on their merit, rather than who has proposed the idea.

2. Iteration: allows the participants to refine their views in light of the progress of the group's work from round to round.

3. Controlled feedback: informs the participants of the other participant's perspectives and provides the opportunity for Delphi participants to clarify or change their views.

4. Statistical aggregation of group response: allows for quantitative analysis and interpretation of data.

Some (Rowe & Wright, 1999) suggest that only those studies true to their origins that have the four characteristics should be classified as Delphi studies, while others (Adler & Ziglio, 1996; Delbeq et al., 1975; Linstone & Turoff, 1975) opposed that the technique can be effectively modified to meet the needs of the given study. Perhaps a distinction might be made by using the term Classical Delphi to describe a type of method that adheres to the characteristics of the original (Hsu & Sandford (Hsu & Sandford, 2007; Rowe & Wright, 1999).

The selected experts in the Delphi panel are the perceived subject expertise, not for demographic representativeness. (Scheele, 1975) recommended the panel must be chosen from stakeholders who will be directly affected, experts with relevant background and experience, and facilitators in the field under study. The sample size of the Delphi study should be a sufficient number of experts suggested that "a suitable minimum panel size is seventeen" (Linstone, 1978). Also, they should be willing to complete the entire study and provide enough information. The technique allows experts to deal systematically with a complex problem or task. The essence of the technique is fairly straightforward. These questionnaires are designed to elicit and develop individual responses to the problems posed and to enable the experts to refine their views as the group's work progresses in accordance with the assigned task. The main point behind the Delphi method is to overcome the disadvantages of conventional committee action. According to Fowles (1978) anonymity, controlled feedback, and statistical response characterize Delphi. The group interaction in Delphi is anonymous, in the sense that comments, forecasts, and the like are not identified as to their originator but are presented to the group in such a way as to suppress any identification. From studying other researchers, and displaying the flexibility of the method, the authors summarized the number of rounds and sample size below (Table 2.10).

Table 2.12 Delphi method diversity - published research

Authors	Delphi Focus	Rounds	Sample Size
Brown (1988)	Identify the ethical dilemmas known to be encountered by the University or College Counseling Center Directors in the practice of their professional responsibilities in University or College Counseling Centers.	3	28
Cramer (1990)	Investigate the areas of disagreement among experts on important issues in the education of the gifted in the United States.	3	29
Braguglia (1995)	Achieve an understanding of the knowledge, skills, and attitudes needed by merchandising students for entry-level executive positions in the fashion industry.	3	30
Carman (1999)	Investigate the technology infrastructures that will have an impact on school systems in West Virginia that desire to either retrofit existing high school structures or construct new ones.	3	21
Whittinghill (2001)	Identify the initial curriculum components necessary for the preparation of graduate-level substance abuse counselors.	3	28
Cabaniss (2001)	Assess how much and in what ways counselor experts believe computer-related technology (CRT) is being utilized by professional counselors today.	3	21
Christian (2004)	Essential characteristics of health education accreditation site visit team members.	3	31
Zanetell (2003)	Develop global and local visions for assessment; stakeholder involvement; and evaluation of water resource management.	3	30
Holmes (2005)	Identify and investigate the nature of emerging practice within the profession of occupational therapy, its rewards and challenges, and the professional competencies for practice.	3	24
Tsou (2005)	Investigate the consensus of two groups, Taiwanese university vocational educators and five-star hotel managers, regarding the components of an effective hospitality	3	20

Authors	Delphi Focus	Rounds	Sample Size
	management internship program.		
Topper (2006)	Seek consensus for those best practices and strategies that are seen as paramount for succession planning and business survival by executives from privately controlled organizations.	3	37

In the original Delphi process, the key elements were (1) structuring of information flow, (2) feedback to the participants, and (3) anonymity for the participants. These characteristics may offer distinct advantages over the conventional face-to-face conference as a communication tool. The interactions among panel members are controlled by a panel director or monitor who filters out material not related to the purpose of the group (Rowe & Wright, 1999). The usual problems of group dynamics are thus completely bypassed. The Delphi process has been comprehensively reviewed elsewhere (Adler & Ziglio, 1996; Delbeq et al., 1975; Linstone & Turoff, 1975) and presented below (Figure 2.4).

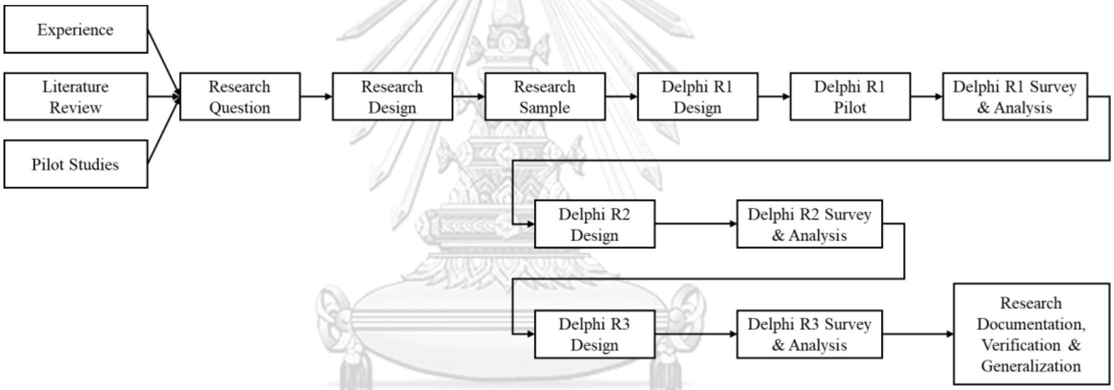


Figure 2.4 Three round of Delphi process

A general guideline for conducting a Delphi study has been established (Linstone & Turoff, 1975; Rowe & Wright, 1999). The process begins with the identification of an objective, topic, question, or other related purposes for which a panel of experts is required. From there, the process continues with the selection and recruitment of experts to serve as participants in the study. Then the study's administrator obtains the respondents' commitment and communicates how the study will be performed, including background on the Delphi technique, information on rounds and deadlines, expectations from participants, reporting of results, and preservation of anonymity. Next is the creation of a Round 1 questionnaire, which should be open-ended or 'unstructured', easy to comprehend, and as brief as possible to encourage participation. Subsequently, the administrators disseminate the survey to the respondents and wait for their replies. After the Round 1 deadline has passed, the study's administrator analyses the aggregate responses to the Delphi-specific questions and generates a Round 2 questionnaire to refine the ideas, explore agreements and disagreements, or probe the strengths and weaknesses of the ideas. Then Round 2 is disseminated, its results are collected and analyzed, and the process iterates until the administrator has satisfactorily addressed the study's objective. Typically, at the end of the study, the final set of results is shared with the participants.

The discussion in this section highlights the versatility of the Delphi method as a research tool that is particularly well suited to new research areas and exploratory studies. Through this discussion and detailed example of a Delphi study design, we hope to heighten awareness of the utility of the method for different purposes in the theory-building process. In conclusion, we encourage researchers to consider incorporating this tool in their repertoire of research methods so that it is available to them to use as needed to accomplish their research objectives.

2.5.4 Theory of Inventive Problem Solving (TRIZ)

The TRIZ methodology is a well-structured inventive problem-solving process. The application of TRIZ in diverse industries successfully replaces the trial-and-error method which is not systematic. The acronym TRIZ, known as Creative Problem Solving Theory, consists of the initials of the words "Teoriya Resheniya Izobreatatelskikh Zadatch". Genrich Saulovich Altshuller, who worked as a patent specialist in the Soviet Union in 1946, was a set of methods that emerged as a result of the fact that the idea put forward as a new invention during the patents examined basically contains similarities (Al′tshuller, 1999; Cavallucci & Khomenko, 2007; Ilevbare et al., 2013). Altshuller analyzed more than 200,000 international patents from leading engineering fields and categorized these patents in a novel way. It can be seen that TRIZ inventions are not developed or do not occur randomly but are developed or occur predictably with the combination of certain laws and rules that are systematically studied. Hence, TRIZ is a reliable process that results in the development of innovation systematically (Karnjanasomwong & Thawesaengskulthai, 2019). summarized engineering problems; named technical contradictions; and proposed 40 fundamental solutions to these problems. The solution was called the inventive principle (Moehrle, 2005). The 40 inventive principles currently contained within the TRIZ methodology present complete descriptions of details and patterns contained in each principle, and present a few samples of how other problem solvers have used a particular principle to solve a given situation involving a contradiction (Chen et al., 2010; Chen & Liu, 2001; Cong & Tong, 2008; Gazem & Rahman, 2014b; Su et al., 2008). To facilitate learning and understanding TRIZ principles, each principle must have an introduction, instructions that explain how the problem solver can use this principle, and a demonstration that includes actual examples, as shown in Table 2.13.

Table 2.13 Interpreting 40 inventive principles for performing services

Principles	Description	Hints
1.Segmentation	The primary goal is to divide the service process. Segmentation has contradictory meanings. It can mean dividing a system into parts to isolate a beneficial or harmful function, or it can mean	a) Make a service easy to disassemble. • Some insurance companies have categories for car insurance (first, second, or third party) b) Break down the services process into small processes or increase the degree of fragmentation or segmentation of the service process.

Principles	Description	Hints
	integrating several components of a system where each component is used to perform a specific task. Segmentation may also change the process that contains the problem to create new useful processes for the system.	• Supermarkets provide express checkout lanes to expedite the payment process. c) Target the service to customers based on their needs, ages, buying behaviors, etc. • Wholesale companies can target customers who are willing to buy in quantity, do without frills, and serve themselves (Zhang et al., 2003) d) Dividing service into several components that can work together or independently. • Some companies divide the service process to speed of service delivery (e.g., hotels would ask a customer to use the internet to make their reservations.
2.Take Off (Extraction)	The primary goal here is to separate services. Low-value service processes may be eliminated or high-value processes may be extracted and used elsewhere in different circumstances. "Extraction" is very similar to "Segmentation" but the difference is that extraction suggests the elimination of the process from the system, while Segmentation offers another way to use the process in the system. Extraction could be actual or virtual (Altshuller et al., 2005). For example, extracting information from a database based using keywords is a virtual extraction, while extracting physical documents from the library is an actual extraction.	a) Extract the most wanted or the most unwanted process from the service so that they can work alone. • Automated Teller Machines (ATM) extract the core functions that essentially perform the banking transactions such as cash withdrawal and funds transfer, and make them perform outside banks. b) Deliver the service to customer location. • Post offices in Malaysia in residential areas enable customers to renew car road taxes or driving licenses so that they do not need to travel to official government offices. c) Change the service operation to self-service. • Train stations set up automated ticket machines. d) Outsource a part of a service. (e.g., use another party to perform the most costly processes in a service) • Online reservation systems (J. Zhang et al., 2003)
3.Local Quality (Optimal Resource)	The primary goal is to customize a service. Local Quality can refer to customization. It indicates making changes in the service to provide multiple or different features in different environments. Local Quality emphasizes the interaction between location, time, and different features of the service. This principle can be used as a lens for changing specific parts of a service that require different conditions or different locations to reach optimal performance.	a) Change the structure of service from uniform to non-uniform according to the external environment for optimal performance. • Supermarkets locate goods that are discounted to different places so that they will be recognized by customers. b) Customize service to meet customer needs. • Swimming clubs located swimming pool for adults and another pool for kids. c) Customize services according to the interaction between customers and the environment, or according to the time of customers demand. • Some websites give the visitors features to customize the page according to their language or favorite colors. d) Make the service capable of accommodating different features. • Hotels use different features in their websites so that customers can make room reservations and use links to local attractions or taxi services. e) Use the environment surrounding a service to create a good experience for customers. • Shopping malls change their internal environments for special occasions such as New Year's celebrations.
4.Asymmetry (Symmetry	The primary goal is to differentiate the service.	a) Differentiate a service from the standard to create a custom service or unique experience for

Principles	Description	Hints
Change)	Asymmetry alters a process so that it is different from standard methods. This principle provides a map that shows designers how to change a service or how to differentiate the service provided for each customer. Implementing asymmetry in a service would bring a new prospective to service performance. For example, telecommunication companies may provide different SIM cards according to user needs, such as special offers for students, youth, or business.	customers. • Banks offer free financial consultation services for clients who make large deposits (J. Zhang et al., 2003). b) Change the standard interaction between a service provider and the customer. • Change traditional learning in universities to distance learning. c) Differentiate customers. • Using membership cards.
5.Merging (Consolidation)	The primary goal is to consolidate services. Merging means gathering things in order to produce or develop a new method or a new service. It also can be used to combine ideas, needs, and feedback from customers, suppliers, or service providers to produce new services or new delivery methods. It can also be used to think about how existing services can be packaged differently to innovate new services.	a) Make services work in parallel with other services. • Grid computing. b) Package services with other internal or external services. • Some shops give gifts if the customer buys a particular good, or uses a discount package (buy one get one free). c) Look to identical services and try operating them together. • " In shopping malls, cashier counters are usually positioned together to expedite the transaction time" (J. Zhang et al., 2003) . d) Segment customers and provide a service package for them. • Platinum or gold credit cards: give the customers group of advantages by using member card (Gazem & Rahman, 2014a)
6.Universality (Multi-functionality)	The primary goal is to use the service for different purposes. Universality means make something multi-purpose and multi-functional. Service processes can be more effective if it is not acting independently. This principle can be used as lens to find ways of making a service more dynamic and used in different ways or situations. This involves considering how to allow the customer to observe the multiple benefits from the service, or how the services can be used for different purposes to satisfy different customer needs.	a) Services should offer multiple functions to fulfil various customer needs. • Internet services that allow customers to perform different processes. For example, a bank website where customers can transfer funds or pay bills. b) Allow a service to perform different purposes, in different situations, or in different ways. • In some supermarkets, membership cards can be used for multiple functions such as providing discounts or earning points so customers can use those points later to get a gift or voucher. c) Eliminate some service processes and substitute them with other processes that can perform same task. • Instead of having many agent' offices for different tourism companies, one agent office can be used to facilitate ticket sales from different companies. d) Principles "#5: Merging" and "#4: Asymmetry" provide further information about how to create multiple function in a single service.
7.Nested doll (Nesting)	The primary goal is to add a new service inside current service. This principle is about embedding a service inside other services. Nesting service with other services would produce multiple function services.	a) Create a new service inside a current service. • Messenger applications like Skype has embedded advance Communication and Information Technology (ICT) like Voice Over IP (VOIP) in order to give users another option for making telephone calls. b) Add a new experience for customers by exploiting the environment around a service and add activities to existing services in order to add

Principles	Description	Hints
		excitement. • Air traveling would be a boring experience if no extra services like entertainment were incorporated. c) Nesting a service in a service provided by someone else. • Samsung nested its Apps market inside the Android operating system to give users more options for downloading applications. d) Implant technology in a current service. • Restaurants set a "calling waiter" device in each table. e) Principle "# 5 : Merging" provides further information regarding the creation of multiple and different functionalities.
8.Anti-weight (Counter Balance)	The primary goal is to mitigate risks. This principle is can also be named as a "Counterweight". It can be used to avoid heavy loads or expenses. The challenge is to find ways to offset the risk of undesired functions in an exiting service. One option is to move the risk represented by a service to another party. This principle provides a way to control services by mitigating any undesirable effects during service delivery (e.g., angry customer caused by delayed services).	a) Have more control over services by merging them with the services offered by another service provider. • Small corporations that sell their products online use e-commerce payment service providers to control the online payment process for them. b) Shift some service tasks to the customer in order to defray expenses. • Some companies depend on using customer as a communication medium by word-of-mouth effect for marking their services (J. Zhang et al., 2003) c) Bundle service with consulting offers. • Herbalife Company offers free consulting and monitoring in order to ensure customers follow the program.
9.Preliminary Anti-Action (Prior Counteraction)	The primary goal here is to prevent potential failure or counteraction before it happens. Preliminary anti-action ensures that a service will be used without any problems. When the risks or undesirable functions of a service are identified, action can be taken to eliminate, prevent, or reduce potential failures.	a) Before negative or harmful effects occur they should be eliminated, prevented or reduced. • Some companies declare that if their customers are not satisfied with their products or services, they can get their money back (Chai et al., 2005) b) Have a support plan to control the harmful effects and raise the positive effect of the service. • Using antivirus software to secure a PC. c) Tell customers about the potential for failure in service if they do not follow instructions. • Cars factories provide guide books for new cars. d) Draft an agreement between the service provider and customers. • A mobile phone warranty is limited to component and does not cover accidents such as water damage. e) Prepare a support service team. • Telecommunication companies provide online customer support services. f) In some cases, the preliminary counteraction involves leaving a seemingly negative effect in place (Fox, 2008). • Companies increase their service levels before they increase their service prices (Gazem & Rahman, 2014a) g) Principle "#11: Beforehand cushioning" provides suggestions for contingency plans.
10.Preliminary Action (Prior Action)	The primary goal is to provide a Pre-Service. This principle indicates that a prior action is performed before the service is launched. Preliminary action, or pre-service, can lead to faster and easier services. Preparing all the	a) Speed up the service by creating appropriate conditions before it is launched. • Online services that require the customer to enter their information before they can request a service. b) Get feedback from customers in order to prepare a service according to their needs. • Data Mining, where the needs and services are

Principles	Description	Hints
	facilities and utilize the resources associated with the service will add value and improve the quality of the service. Pre-service sometimes requires learning new skills from consumers before they launch it. For instance, a customer booking tickets online before leaving to the theatre.	studied ahead of time. c) Single processes or create additional functions before delivering the service. • Educational CDs come with prepared examples to help learners. d) If the customer requires the service immediately, the service process should be simplified to improve its efficiency. • A university may ask new students to fill their information and submit their documents online before they register.
11.Beforehand Cushioning	The primary goal is to mitigate harmful effects. We should accept the fact that nothing is perfect. This principle is used to prepare for worst-case scenarios. Harmful processes or undesired actions that mitigate the effects, instead of looking to eliminate them.	a) Manage service capacity and smooth customer demand by using a set of preventive strategies (Chai et al., 2005). • Travel agencies offer lower prices during the off season. b) Have a contingency plan for any problems that may affect the service. • Backing up data to a server so that no information is lost. c) Find a way to reduce the effects of a harmful function. • An operating system, like Windows, embeds a help feature in case the user faces any problems. d) Compensate for low reliability in a service by providing supporting services. • Provide guide books for digital equipment. e) If necessary, illustrate to customers the risks of using a service. • Hospitals frequently reduce their responsibility by having patients sign a waiver before undergoing surgery. f) Shift the risk of failure to a third party. • Enterprises use insurance companies to cover the costs of disasters including fire, earth quakes and robbery
12.Equi-Potentiality (Remove Tension)	The primary goal is to provide the service with minimum energy spends for auxiliary reasons. This principle is related to changing a service so that it is less expensive or stressful. For example, a tourist vacationing abroad may realize that they have too much luggage and decide to ship some of it to their destination rather than carrying it with them. This prevents stress and potential problems. In terms of providing a service, processes and tasks can be changed to reduce stress by reusing current resources, capitalizing on environmental traits, or restructuring the service.	a) Limit the service conditions to make it more comfortable for the customer. • A car rental company may allow a customer to return their rental to another branch at a more convenient location. b) Eliminate the pressure on a service by changing the service offer. • In universities, instead of offering many classes in a semester, classes are provided during semesters break. c) Make customers do less to minimum efforts for receiving the service. • E-banking allows customer to complete their transactions online instead of visiting the bank. d) Lower service capacity. • First come first served. e) Principle "# 9 : Preliminary anti-action" provides further information for avoiding problems before they happen.
13.The Other Way Round (Inversion)	The primary goal is to think about a service from an opposite viewpoint. This principle is very important. It encourages a different perspective and finds unique ways of solving a problem. Doing the opposite of	a) Make the service delivery in an opposite way. • Hospitals send imbalance to bring a patient. b) Instead serving customers directly, provide a self-service option. • E-services allow customers to shop and make payment without the need to go to the store (J. Zhang et al., 2003).

Principles	Description	Hints
	what is normal differentiates a service and brings in new customers. Moreover, this principle can help a service provider become more competitive by discovering the deficiencies of competing service providers so that those deficiencies can be avoided. The other way around principle also may guide for producing a service in a field that most competitors are not interested in providing.	c) Create a service that does the opposite of what others do. • In some gas stations, consumers pump their own gas from the pump and use a credit card at the gas pump to pay. d) Add new functions or features that make the service act in an opposite way. • Pay for customers in some conditions by offering free vouchers after the customer buys a certain amount of product. e) Increase service capacity instead of decreasing it during a recession (Conley, 2009). • To attract more students, some language institutes offer an extra remedial course. f) Allow customers to design the service (Retseptor, 2005) • Companies conduct surveys, interview, and listen to customer complaints in order to enhance their services.
14.Spheroidality (Curvature)	The primary goal is to create a nonlinear process. This principle can be used as a lens to identify where change is needed in the service process, or where processes can be combined with other process or functions. In particular, linear services can be transformed into iteration. For example, in order to keep up with customers need changes, a service provider conduct an iterative survey or interview customers to get their ideas for developing a new service or redesigning a current one. This principle can also be used to identify if a services that are frequently used by customers. Moreover, the Spheroidality Principle also helps to develop indirect services. For instance, creating a cheerful atmosphere will indirectly create a good impression on a customer.	a) Avoid service obstacles by moving around them instead of fighting through them (Conley, 2009). • Positive customer feedback helps companies eliminate obstacles that convince new customers to avoid using their services. b) Add a new indirect value to the service instead of looking for direct value. • Background elements (temperature, lighting, music, color, furnishings) in a service facility provide indirect value to customer. c) Make necessary service events, offers, or process occur more frequently. • Co-creation to enhance a service. d) Turn linear service into a circular one. • In some English institutes, they rotate their teachers each term to avoid boring routines.
15.Dynamization	The primary goal is to allow service processes to change. Dynamization principle makes services more flexible so that they can meet the demands of customers. The need for flexibility could be related to temporary situations (time), environment (location), or a group of people (customization). This principle acts as a lens for viewing possible service changes to make services more movable, flexible, and adaptable in different situations.	a) Change the service according to the circumstances. • Some stores change the price of products or services according to the season. b) Increase or decrease service capability based on time or demand. • Cinemas increase display sections during the weekend. c) Make the service adapt to the environment. • Some websites change their language automatically according to the user's profile. d) Allow a service to move from location to another. • A community service moves from one place to another to conduct social activities. e) Allow customers to customize the service according to their needs. • Students choose different courses each semester. f) Principle "# 3 : Local Quality" provides more

Principles	Description	Hints
		customizing ideas.
16.Partial or Excessive Actions (Slight Less/Slightly More)	The primary goal is to do more or less functions, efforts, tasks, or activities. In some situations, services cannot achieve their desired results even though they have a reasonable amount of features or functions. Using more or less features or functions in a service process may provide a solution. For example, management meetings may change from monthly to weekly or even every 3 months. This principle can also be used to mitigate negative effects.	a) Improve the process of the service by using a little less (or more) push. • Service regulations can be more flexible so customers can use it without the need to go in many processes. b) Consider new conditions or a new market for the service and avoid wasting your time or efforts where it is not suitable or demanded. • Companies open different branches in different locations. c) Think of ways to make services exceed customer expectations. • Mall centers sometimes offer child care and entertainment for children to make parents shopping less exhausting (J. Zhang et al., 2003). d) Find ways to mitigate undesirable service processes as much as possible. • Some universities focus on increasing the number of postgraduate students and decrease the number of bachelor students so that they can be considered to be research universities.
17.Another Dimension	The primary goal of this principle is to think about different versions or levels in the service. This principle encourages thinking about changing the look of a service, how the service is used, how it can be differentiated, or add a new concept for performing the service. For instance, when the results of a particular service are reported, new ways of relating this information to the customer should be considered, such as using figures or charts instead of numbers or data.	a) Add a new dimension to the service that will create a new value. • Mobile applications, such as Windows for mobile is a new dimension that was added to the formal operating system. b) Differentiate a service by bringing a new experience to customers. • 3 D cinemas provide a new and exciting experience to the audience c) Improve service performance by providing different means to access and utilize it. • Banks authorize customers to manage their financial and transportation online. d) Consider using different service levels for different types of customers. • Airlines have different travel class such as economic, business, and first class
18.Mechanical Vibration (Resonance)	The primary goal of this principle is to consider instability. Services may need to change from being stable to being variable. This principle is used to improve service quality or change company services according to the vagaries market or customer demands. Resonance principle also suggests using other parameters to "stir things up".	a) Increase the frequency of service offers. • Shops make discount offers frequently. b) Alter service offers to meet customer expectations. • Restaurants diversify their menus from one day to another. c) Make the operation of the service, its capacity, or other offers variable. • Some telecommunication companies offer discounts for conducting calls during certain hours. d) Principle "# 1 5 : Dynamization" provides additional suggestions for increasing the efficiency of a service.
19.Periodic Action	The primary goal of this goal is to think of opposite continuity. This principle refers to changing a service offers, or delivery from continuous to periodic. Periodic actions can be used to increase or decrease a service. In addition, particular occasions or events in the market may require using the principle of periodic actions for a	a) If a service is available all the time, it may be beneficial to make it available only during certain occasions. In other words, change the service from continuous to periodic. • Tourism companies include visits to certain islands only in the summer. b) If the service is already periodic, its frequency can be changed. • If a travel agency already includes visiting islands only in summer, change the time of the visits to

Principles	Description	Hints
	service such as changing the frequency of the action, or perform other actions from time to time.	spring. c) Exploiting decreasing demand for services to perform other functions. • Universities exploit summer vacation to promote themselves in other countries. d) Provide special offers only during off-peak times. • " Some cinemas put on more show sessions in weekends",(J. Zhang et al., 2003). e) Refer to Principle "# 1 : Segmentation" in order learn more about segmenting a service and to Principle "# 1 8 : Mechanical Vibration" for further information about the frequency of a service.
20.Continuity of Useful Action	The primary goal of this principle is to do continuously the useful actions. This principle refers to making the useful actions in a process work continuously. The process may have idle or ineffective processes that can be removed to increase efficiency. Moreover, this principle attempts to provide many services simultaneously.	a) Make services available as long as you can. • Instead of providing a service for 1 2 hours, providing it for 24 hours. b) Make services available more frequently. • Online booking system allows customers to access the service any time. c) Eliminating idle or intermittent actions or work to ensure continuity of service. • Instead of checking emails using PC, software such as Android synchronizes emails with a mobile phone automatically. d) Exploit useful functions in the service to do other tasks in parallel to achieve continuously useful functions. • Cinemas provide food and drink to the audiences while they watch the movie.
21.Skipping (Hurrying)	The primary goal of this principle is to shorten waiting times. This principle suggests increasing the speed of delivering services. This principle can be used to skip unnecessary functions that may cause delay. One way to alter the performance speed is by allowing customers to serve themselves. In addition, this principle can improve competitiveness. Removing a long and boring process from a service will add value to the service.	a) Shorten the waiting time for a service. • Emergency departments in hospitals shorten the time it takes to see a specialist. b) Increase the level of automation in the service. • Auto answer machines. c) Change the service to reduce customer contact time. • ATM machines. d) Accelerating the functions or actions of the service process. • Use touch and go in Plaza tolls. e) Principle "# 1 8 : Preliminary Action" provides more information about how to speeding up a service actions.
22.Blessing in Disguise" or "Turn Lemons into Lemonade (Convert Harm Into Benefit)	The key purpose of this principle is to convert a harmful process, function, or event into a useful one. A harm action, function or event could happen any time a service is provided to customers. Usually, the negative effects are associated with the environment, time, place, resources, information, and function of the service. This principle suggests using harmful occurrences as a way to realize benefits. It also recommends exploiting harmful functions in order to determine weakness in a service and take effective actions to reduce harmful effects.	a) If a harmful action or event is inevitable, increase the harmful action or event in order to provide a new value. • Increase the cost of water services to reduce usage. b) Use resources to convert a harmful event into a useful service. • Listen to customer complaints to find ways to enhance services. c) Learn from mistakes to avoid failure in future. • Experiment by providing a trial service to some customers in order to learn about any weakness.
23.Feedback	The key purpose of this principle	a) Improve a service by getting feedback from

Principles	Description	Hints
	is to use outputs as inputs. This principle refers to utilizing market indicators or information from the market in order to improve a service. Any output from a service can be used as input to enhance that service. Thus, focusing on customer perceptions provides good feedback for an organization and can direct the organization to add more value to the service.	customers and data analysis. • Data mining b) Utilize customer behaviors in order to make a service more appealing. • Some companies use bar coding or checkout scanner technology to collect and analyze customer buying behaviors.
24.Intermediary	The key purpose of this principle is to find a temporary element that can be easily removed. This principle suggests outsourcing a part of a service, or for carrying of non-core function, process or action in existing service to improve its capacity or capabilities. The Principle of Intermediary is not usually related to service processes, but it may be used to insure the stability of a service and keep it work continuously. It also can be used to reduce obstacles or harmful actions.	a) Associate core services with temporary related services to enhance delivery. • Using the delivery service offered by restaurants. b) Use technology as intermediary to deliver a service. • The Internet is used by some people as an intermediary to find a spouse. c) Utilize the environment, people, or other resources as an intermediary. • Companies use their customers to advertise service offer. d) Involve others functions as intermediary to reduce harmful actions, other risks, or to improve a service. • Hire temporary employees during busy seasons. e) Organizations can outsource non-core functions or process so that they can focus on more valuable functions. • Using PayPal for payment.
25.Self-Service	The key purpose of this principle is to allow the customer to play a role in the delivery of the service. In order to deliver the service, customers require limited skills so they can use the service by themselves. This principle can be used as a cost-saving strategy when the delivery of the service does not require the customers to interact with front line employees. The Self-service Principle also encourages the problem solver to think about how to create new values from operating a current service. For example, increasing the speed of a service will make a good impression on customers and they may introduce the service to others.	a) Make the service to be utilized by the consumers without interaction with front line employees. • Using ATM to do various financial transactions. b) Determine which part of the service is most affected by delivery speed. Then find a way to convert that process to a self-service method. • Online payments can be used to speed sale transactions. c) Facilitate a service by providing automatic support functions or processes for the customer. • In supermarkets, customer can use scanners to check the prices of some goods. d) Increase customer participation in the delivery of the service. • Consumers pump their own gas and use a credit card at the gas pump to pay.
26.Copying	The key purpose of this principle is to copy things from others The Copying principle is useful in terms of competition. This principle can be used to imitate another service, but in a less expensive way. Moreover, this principle also suggests applying concepts from other fields. Technically, the Copying Principle suggests replacing an	a) Replace a high cost or fragile service with low-cost or durable copies. • Use electronic media, such as CDs to learn instead of attending a class. b) Make different copies of a service and give the customer a chance to choose one that is convenient. • Download websites give options such as free limited speed downloads or premium accesses for fast download. c) Apply other business, mathematical, or computer models or simulations to a current service.

Principles	Description	Hints
	object or process with visual copies. For example, CCTV can be used to provide feedback regarding customer behavior instead of using a survey or customer interviews.	• Automatic vending machine can perform different services such as returning library books or posting letters. (Chai et al., 2005).
27.Cheap Short-Living Objects (Cheap Disposables)	The key purpose of this principle is to replace an expensive object with a cheap object. This principle encourages the creation of an inexpensive copy that can be used and disposed after period of time. This principle does not mean replacing an object. Instead it refers to adding a cheap, short-lived disposables function or process to a core service.	a) Give a simple copy of the service to the customer in order to try it before they make their purchase. • Trial software. b) Add a new function, process, or part to the core service that can be easily disposed after the service has been delivered. • Restaurants hire extra temporary employees during peak seasons. c) Perform some process or functions of the service ahead of time in order to reduce costs, facilitate the delivery of the service, or increase convenience. • Universities provide guide books to students before they register.
28.Mechanics Substitution (Another Sense)	The key purpose of this principle is to use the senses. This principle substitutes mechanical means with sensory means. This principle provides several options to make changes in your service using sensory means (visual/ optical, audio/sound, smell, touch, or test).	a) Use sense means such as visual/ optical, temperature, lighting, music, olfactory, or test or improve value. • " Supermarkets pump bakery odours around the store to help advertise bread products",(Mann, 2007)
29.Pneumatics and Hydraulics (Intangibility)	The key purpose of this principle is to focus on customer mindsets. Customers sometimes require different values in order to convince them to purchase a product or service. This principle suggests evaluating and focusing on intangible issues, such as quality.	a) Advertise a service differently in order to generate value. • An organization may support social activities in the community to indirectly advertise their product. b) Focus on the quality of a service to entice customers. • a brand associated with a service can be a guarantee of service quality (Chai et al., 2005)
30.Flexible Shells and Thin Films (Thin and Flexible)	The key purpose of this principle is to isolate harmful issues by using thin barrier or using a flexible structure. This principle is concerned with isolating functions, process, activities, or problems in order to improve service quality, reduce costs, and increase reliability.	a) Flexibility can improve the interaction between customers, employees, and management. • Some companies use customer service employees as a 'flexible shell' to reduce obstacles between management and customers. b) Use a thin barrier to improve service quality • E-banking sends an approval code (thin barrier) to a customer's mobile as part of a security procedure when the customer wants to transfer money from one account to another. c) Isolate a customer from harmful environments or interactions using a flexible structure. • Internet coffee houses isolate smokers from non-smokers d) Isolate a harmful function in a service from its environment using flexible procedures. • Some car maintenance shops offer a rental car to their customers if maintenance will take some time to complete.
31.Porous materials (Holes)	The key purpose of this principle is to create holes in a system to improve a service preforming. This principle refers to two steps. The first step is to open channels to obtain useful information for	a) Open channels (hole) to listen to consumers in order to enhance the service. Principle "# 2 3 : feedback" provides further suggestion for listening to customers. • Live chat function on websites. b) Use technology to connect with customers and

Principles	Description	Hints
	creating new ideas for a service. The second step is to improve service interactions through enhance service proactivity, function, or internal or external communication. In addition, porous materials can be used as a lens to see deficiencies and find the time, resources, space or functions that can fill these voids with useful activities or functions.	remotely a service. • Patients can get online assistance from their doctors. c) Eliminate any obstacles to the delivery of service by creating holes in the service in order to facilitate service consumption. • An express counter (holes) in supermarkets expedites the sale process. d) Utilize company resources to open channels to reach and receive the service effectively. • Some universities allow their students to access university resources such as the library, or laboratories any time by using smart cards. e) Make space in service operations to allow other tasks or services to be performed. • While patients wait to see a doctor in the clinic, they can use the clinic library to read books, newspaper, or watch TV.
32.Color Changes (Change the Color)	The main task of this principle is to focus on customer comfort or the reliability of a service. This principle can be used to address physical characteristics such as the colors in the external environment to satisfy a customer, or intangible aspects, such as offering different options for delivering the service that add value to customer. Color change can also be related to transparency and trust.	a) Make the environment around the service enjoyable. • Malls provide different activities with different decorations to cheer their visitors. b) Provide the same service with different options (color change) according to customer requests. • Banks provide different levels of service according to what type of accounts a customer has. c) Encourage the customer trust a service. • Some restaurants provide a view into the kitchen (J. Zhang et al., 2003)
33.Homogeneity	The main goal of this principle is to focus on the consistency of a service. Homogeneity can be used to looking similar features and functions in a service that can be grouped or work with the culture of customers in order to satisfy their needs.	a) Segment people and develop services that are consistent with their needs. Principle "# 1 : Segmentation" for a further illustration of segmentation. • Schools employee experts who have experience teaching students according to their ages. b) Make a service work with other similar services. • Some parking lots provide secure gates to keep a car safe and provide a car washing service while the car is parked. c) Package similar services together. Principle # 5 "Merging" to learn more about merging services. • Gyms provide nutritional consulting as part of their health programs to give additional value to their customers. d) Make a service suitable for a specific culture. • Some Hotels in Japan provide a copy of the holy Quran (Muslims holy book) and prayer rugs for any Muslim customers who stay in their hotels.
34.Discarding and Recovering (Rejecting and Regenerating Parts)	The key purpose of this principle is to remove and reuse elements directly after they have fulfilled their functions. This principle has two methods. The first method is to remove some functions or resources from a service after completing a task. The second method is to reuse some functions or resources after fulfilling the assistance job. Think about an unnecessary aspect of a service	a) Group a permanent service with a temporary service and then separate them after the service is performed. See principle #27 "Cheap short-living objects" for further information on cheap disposable services. • E-banks sometimes give a customer a tag number to be used during a period of time for any transportation or any mobile payments. b) Reuse information from a service to enhance the service. • Some companies use bar coding or checkout scanner technology to collect and analyze customer

Principles	Description	Hints
	that can disappear after its use fulfilling (Fox, 2008)	buying behaviors. c) Change a how a service operates for a period of time. • Manufacturers of soft drinks may launch an awareness campaign to educate people about harmful effects of metal cans or plastic on the environment while providing collection points for these cans for recycling.
35.Parameter Changes (Transformation of Properties)	The key purpose of this principle is to focus on the properties of a service. This principle is about changing the properties of a service such as service flexibility, consistency, ship, quality, etc. Think in resources are available within the service and how those resources can be utilized for changing the service operation, and enhancing customers prospective, experience, or value.	a) Change how the physical service is delivered. • Virtual shopping (e.g. ebuy.com). b) Change the concentration or consistency of a service. • Telecommunication companies provide different services to businesses. c) Change the flexibility of a service and customize services according to customer needs. • Some restaurants provide open buffets to allow their customers to customize their meals according to their needs. d) Focus on adding value to the service environment. • Coffee shops add value by playing mood music in the background and displaying paintings.
36.Phase Transitions (Phenomenon Utilization)	The key purpose of this principle is to exploit an existing phenomenon. Any changes in the environment, culture, occasion, or events could be utilized to create new services or add value to a current service. This principle may also use to think on the advantage from economy phenomena. For example, enter to market when others shift out.	a) Exploit the phenomena of other services to enhance or produce new services. • Data centers are a good example of exploiting the phenomena of increasing data to sell storage. b) Exploit the environment, an occasion or event to produce new services or change how a service is delivered. • Offer light clothing in the summer, and heavy clothing in the winter. c) If a customer plans to use a service on a particular occasion, prepare a service that accommodates their demands. • Create new programs in a mall for New Years.
37.Thermal Expansion (relative change)	The key purpose of this principle is to response to changes. This principle refers to the expansion and contraction of the service market. It also means arranging different parts of a service to work differently according to fluctuating customer demands.	a) Expand or contract the service capacity or location. • Restaurants hire temporary staff to meet peak demand. b) Exploit service contractions to expand service capacity in another area. • Domino Pizza depends more on its delivery services than it does on its restaurants. c) If another competing service is similar, target new markets or customers. • Some telecommunication companies offer high speed Internet with better capacity instead of offering low long distance costs.
38.Strong Oxidants (Enriched Atmosphere)	The key purpose of this principle is to enrich a service with different capabilities or activities. This principle refers to adding stimulation to a service and introduces elements that accelerate the service process.	a) Increase customer participation in the delivery of a service. • Herbalife uses its customers as independent distributers and share revenue with them in order to encourage their sales. b) Keep using stimulation to differentiate a service. • Prize draws for cars or money in malls. c) Enrich a service with other activities, or features. • Students have practical classes to apply what they have learned.
39.Inert Atmosphere (Calm	The key purpose of this principle is to reduce something in the service. This principle is about	a) Eliminate stimulates things. • Increase payments for the service. For example, in order to balance Internet bandwidth between users,

Principles	Description	Hints
Atmosphere)	reducing risk while operating a service. The environment that the service operates in, the way a service interacts with customers, and the easiest and cheapest way to improve the delivery of the service must be considered. The Calm Atmosphere can be also related to remove any elements that have been used for stimulating a service	websites charge customers more for increased internet speeds. b) Reduce harmful interactions in the service environment. • Amusement parks increase ticket prices to avoid overcrowding during the weekend. c) Make a service more convenient and quite for customers. • Create quiet areas in the work environment (Mann, 2007) d) Reduce customer concerns regarding any risks they may expose to from a service. • Online financial transactions reduce customers concern regarding their private information. Customers serve themselves without direct interaction with bank stuff.
40.Composite Materials (Non Homogeneity)	The key purpose of this principle is to change homogeneous parts. This principle opposite of principle "#33: Homogeneity". It is about mixes non-homogenous service to increase service value or make it available for different types of people.	a) Combine multiple types of services from different areas. • Cable companies create diversity by offering different channels packages. (e.g., movies, educational, cartoons, news, etc.). b) Use a service for different purposes. • Facebook can be used for social or business purposes. c) Add tangible elements to intangible elements in a service. • Hotels provide complimentary toiletry items with the hotel name prominently displayed (J. Zhang et al., 2003).

Although TRIZ was mainly developed in the engineering field. Many of its principles and tools were originally designed to provide innovative solutions to technical problems. However, the trend now is to use TRIZ to solve non-technical problems such as those found in the service sector (Altuntaş & Yener, 2012; Gazem & Rahman, 2014a; Ilevbare et al., 2013). Thus, different studies have used several TRIZ inventive principles to help problem solvers find solutions for service system contradictions. To implement TRIZ in the development of projects in the service sector, the inventive principle of each service project was analyzed as shown in Table 2.14.

Table 2.14 TRIZ inventive principle in service industries

No.		**Studies utilizing TRIZ in service industries**												**Frequency**
		1	2	3	4	5	6	7	8	9	10	11	12	
	Service Industry / **Principle title**	Airline service	Washing and Clean Clothes Supply	Aging-in-place service	E-commerce service	Online application software services	Self-service restaurants	Telecommunication service	Aging-in-place service	Product service	Home-care service	Shopping navigation service	Banking service	
1	Segmentation	/	/	/	/	/	/	/	/	/	/	/	/	12
2	Taking out or Extraction		/	/		/		/		/	/	/	/	8
3	Local quality		/	/	/	/	/	/		/	/	/	/	10
4	Asymmetry			/		/	/				/			4
5	Merging, Consolidation or combining	/	/	/							/	/	/	6
6	Universality		/	/	/		/			/	/	/		7
7	Nested doll		/	/		/						/	/	5
8	Anti-weight			/	/		/	/			/	/	/	7

9	Preliminary anti-action	/	/	/		/	/			/		/		7
10	Preliminary action		/	/	/		/			/	/	/	/	8
11	Beforehand cushioning		/	/		/	/	/		/	/	/	/	9
12	Equipotentiality		/		/	/		/				/	/	6
13	The other way round		/	/	/	/	/	/		/	/	/	/	10
14	Spheroidicity – Curvature	/			/		/							3
15	Dynamics		/		/	/	/		/	/	/	/	/	9
16	Partial or Excessive actions	/				/	/			/				4
17	Another dimension		/	/		/	/				/	/		6
18	Mechanical vibration				/		/			/	/		/	5
19	Periodic action	/	/				/		/	/	/		/	7
20	Continuity of useful action		/	/			/			/	/			5
21	Skipping or Rushing Through		/	/		/	/			/				5
22	Blessing in disguise - Harm into benefit	/	/			/	/			/		/		6
23	Feedback		/	/	/	/	/		/					6
24	Intermediary/Mediator	/	/	/	/	/	/	/		/	/	/	/	11
25	Self-Service		/	/			/			/	/	/		6
26	Copying					/	/	/			/	/	/	6
27	Cheap short-living objects		/			/	/	/		/	/	/	/	8
28	Mechanics substitution		/	/	/	/	/		/	/	/	/	/	10
29	Pneumatics and hydraulics				/	/	/					/	/	5
30	Flexible shells and thin films		/							/	/			3
31	Porous materials			/						/		/		3
32	Color changes					/	/	/	/	/	/	/	/	8
33	Homogeneity			/			/					/		3
34	Rejecting, Discarding*		/				/	/				/		4
35	Parameter Changes			/	/	/	/	/		/	/	/	/	9
36	Phase transitions		/		/	/	/			/		/		6
37	Thermal expansion	/				/	/				/	/	/	6
38	Accelerated oxidation			/						/			/	3
39	Inert atmosphere							/		/		/		3
40	Composite materials		/			/	/	/		/	/		/	7

1; (Jeeradist et al., 2016), 2; (Yang & Xing, 2013), 3; (Gazem & Rahman, 2014a), 4; (Su & Lin, 2008), 5; (Su et al., 2008), 6; (Wang et al., 2017), 7; (Boavida et al., 2020), 8; (Chen et al., 2010), 9; (Kim & Park, 2012), 10; (Wang & Chen, 2010), 11; (Lee et al., 2020), 12; (Shahin et al., 2016)

* Stands for: Rejecting, Discarding – Recovering, Regeneration

2.5.5 Structural Equation Modeling (SEM)

Structural Equation Modeling (SEM) is a very general statistical modeling technique, which is widely used in the behavioral sciences. SEM has been published quarterly since 1994 in the multidisciplinary journal which proposes that “structural equation modeling can perhaps best be defined as a class of methodologies that seeks to represent hypotheses about the means, variances and covariances of observed data in terms of a smaller number of ‘structural’ parameters defined by a hypothesized underlying model” (Bollen, 1989; Bollen & Long, 1992; Byrne, 2001a, 2001b; Hancock & Mueller, 2013; Hayduk, 1987; Hox & Bechger, 1998; Hoyle, 1995; Kaplan, 2000; Kline, 1998; Mueller, 1997; Shipley, 2000; Yuan & Bentler, 1998). SEM is a modeling technique that can handle a large number of endogenous and exogenous variables, as well as latent (unobserved) variables specified as linear combinations (weighted averages) of the observed variables. Regression, simultaneous equations (with and without error-term correlations), path analysis, variations of factor analysis, and canonical correlation analysis are all special cases of SEM. It is a confirmatory, rather than exploratory method, because the modeler is required to construct a model in terms of a system of unidirectional effects of one variable on another. Each direct effect corresponds to an arrow in a path (flow) diagram. In SEM one can also separate errors in measurement from errors in equations, and one can correlate error terms within all types of errors. Estimation of SEM is performed using the covariance analysis method (method of moments). There are covariance analysis methods that can provide accurate estimates for limited endogenous variables, such as dichotomous, ordinal, censored, and truncated variables. Goodness-of-fit tests are used to determine if a model specified by the researcher is consistent with the pattern of variance–covariances in the data. Alternative SEM specifications are typically tested against one another, and several criteria are available that allow the modeler to determine an optimal model out of a set of competing models. Most applications have been in psychology, sociology, the biological sciences, educational research, political science, and market research.

In general, SEM can have any number of endogenous and exogenous variables. SEM structural model is used to capture the causal influences (regression effects) of the exogenous variables on the endogenous variables and the causal influences of endogenous variables upon one another. Simultaneous equations (typically estimated using instrumental variables methods) and path analysis are special cases of SEM with observed variables, while ordinary linear regression is the special case of SEM with one observed endogenous variable and multiple observed exogenous variables. An SEM measurement model is used to specify latent (unobserved) variables as linear functions (weighted averages) of other variables in the system. When these other variables are observed, they take on the role of ‘‘indicators’’ of the latent constructs. In this way, SEM measurement models are similar to factor analysis, but there is a basic difference. In exploratory factor analysis, such as principal components analysis, all elements of the matrix defining the latent variables (factors) in terms of linear combinations of the observed variables take on non-zero values. These values (factor loadings) generally measure the correlations between the factors and the observed variables, and rotations are routinely performed to aid in interpreting the factors by maximizing the number of loadings with high and low absolute values.

An important distinction in SEM is that between direct effects and total effects. Direct effects are the links between a productive variable and the variable that is the target of the effect. Each direct effect corresponds to an arrow in a path (flow) diagram. SEM is specified by defining which direct effects are present and which are absent. With most modern SEM software this can be done graphically by manipulating path diagrams. These direct effects embody the causal modeling aspect of SEM. Total effects are defined to be the sum of direct effects and indirect effects, where the indirect effects represent the sum of all of the effects along the paths between the two variables that involve intervening variables. The total effects of the exogenous variables on the endogenous variables are sometimes known as the coefficients of the reduced form equations. The general SEM system is estimated using covariance (structure) analysis, whereby model parameters are determined such that the variances and covariances of the variables implied by the model system are as close as possible to the observed variances and covariances of the sample. Moreover, advantages of SEM compared to most other linear-in-parameter statistical methods include the following capabilities:

(1) treatment of both endogenous and exogenous variables as random variables with errors of measurement

(2) latent variables with multiple indicators

(3) separation of measurement errors from specification errors

(4) test of a model overall rather than coefficients individually

(5) modeling of mediating variables

(6) modeling of error-term relationships

(7) testing of coefficients across multiple groups in a sample

(8) modeling of dynamic phenomena such as habit and inertia

(9) accounting for missing data

(10) handling of nonnormal data.

Furthermore, sample size issues have received considerable attention (Anderson & Gerbing, 1988; Bentler, 1990; Hoogland & Boomsma, 1998). Based on Monte Carlo studies of the performance of various estimation methods, several heuristics have been proposed: (1) A minimum sample size of 200 is needed to reduce biases to an acceptable level for any type of SEM estimation (Hoogland & Boomsma, 1998). (2) Sample size for maximum likelihood estimation should be at least 15 times the number of observed variables. (3) Sample size for maximum likelihood estimation should be at least five times the number of free parameters in the model, including error terms (Bentler & Chou, 1987); and (4) with strongly kurtotic data, the minimum sample size should be 10 times the number of free parameters (Hoogland & Boomsma, 1998). Bootstrapping is an alternative for maximum likelihood estimation with small samples.

Many criteria have been developed for assessing the overall goodness-of-fit of SEM and measuring how well one model does versus another model. Most of these evaluation criteria are based on the chi-square statistic given by the product of the optimized fitting function and the sample size. The level of statistical significance indicates the probability that the differences between the two matrices are due to sampling variation. Several goodness-of-fit indices compare a proposed model to an independence model by measuring the proportional reduction in some criterion related to chi-square; the indices. Most programs calculate several of these indices using the definition of an independence (null) model with no restrictions whatsoever. Using such a baseline, a rule of thumb for most of the indices is that a good model should exhibit a value greater than 0.90 (Bentler, 1990; McDonald & Marsh, 1990).

The performance of models with substantially different numbers of parameters can be compared using criteria based on Bayesian theory. The model that yields the smallest value of each criterion is considered best. Goodness-of-fit measures based on the direct comparison of the sample and model implied variance-covariance matrices include: (1) The root means square residual (RMR, or average residual value), (2) the standardized RMR (SRMR), which ranges from 0 to 1, with values less than 0.05 being considered a good fit (Steiger, 1990), (3) the goodness-of-fit index (GFI), (4) the adjusted goodness-of-fit index (AGFI, which adjusts GFI for the degrees of freedom in the model), and (5) the parsimony-adjusted goodness-of-fit index (PGFI) (Mulaik et al., 1989). R^2 values are also available by comparing estimated error-term variances to observed variances. It is important to distinguish between R^2 values for reduced-form equations and those for structural equations.

Based on these goodness-of-fit tests for a model, a travel demand modeler can take one of three different courses of action:

(1) Confirm or reject the model being tested based on the results. If a model is accepted, it should be recognized that other unexamined models might fit the data as well or better. Confirmation only means that a model is not rejected.

(2) Two or more competing models can be tested against each other to determine which has the best fit. The candidate models would presumably be based on different theories or behavioral assumptions.

(3) The modeler can also develop alternative models based on changes suggested by test results and diagnostics, such as first-order derivatives of the fitting function.

Table 2.15 Overall Goodness-of-Fit measures for SEM

Goodness-of-Fit	Recommended value	Description
GFI	≥0.9	GFI is a measure of the relative amount of variances and covariances jointly accounted for by the model. GFI is independent of the sample size and relatively robust against departures from normality $GFI = 1 - tr[(\Sigma^{-1}S - I)^2]/tr[(\Sigma^{-1}S)^2]$ for maximum likelihood
NFI	≥0.9	NFI is a measure ranging from 0 (no fit at all) to 1.0 (perfect fit). It is a ratio of the difference in the χ^2 value for the proposed model and a null model divided by the χ^2 value for the null model $NFI = \chi_{null}^2 - \chi_{proposed}^2/\chi_{null}^2$
NNFI	≥0.9	NNFI uses a similar logic but adjusts the NFI for the number of degrees of freedom in the model $NNFI = (\chi_{null}^2/df_{null}) - (\chi_{proposed}^2/df_{proposed})/(\chi_{null}^2/df_{null}) - 1$
CFI	≥0.9	CFI is based on the non-central parameter, which can be estimated as $\chi^2 - df$. It also ranges between 0 and 1, with values

Goodness-of-Fit	Recommended value	Description
		exceeding 0.90 indicating a good fit to the data CFI = 1 − $\chi_{proposed}^2$ − $df_{proposed}/\chi_{null}^2$ − df_{null}
RMSR	≤0.05	RMSR is the square root of the mean of the squared residuals—an average of the residuals between individual observed and estimated variance and covariance terms RMSR = $\sqrt{2\Sigma_{i=1}k\Sigma_{j=1}i\ (sij - \hat{\sigma}ij)^2/k(k+1)}$
Root Mean Square Error of Approximation (RMSEA)	≤0.08	Similar to RMSR, RMSEA is based on the analysis of residuals, with smaller values indicating a better fit to the data RMSEA = $\sqrt{(\chi_{proposed}^2/df_{proposed}) - 1/n - 1}$

Where ∑, the estimate of a structured covariance matrix; S, an unbiased sample covariance matrix; I, an identity matrix; tr[ ], the trace of the matrix, i.e. the sum of the diagonal elements; $\chi_{proposed}^2$, the non-centrality parameter for the model tested; $df_{proposed}$, the degrees of freedom for the model tested; χ_{null}^2 and df_{null}, the non-centrality parameter for the null model; *sij*, an element in the observed covariance matrix; $\hat{\sigma}ij$, an element in the fitted covariance matrix (estimated); *k*, the total number of observed variables in the model; *n*, sample size.

2.5.6 The Technology Acceptance Model (TAM)

The choice of an individual to voluntarily accept new technology is known as technology acceptance. For successful implementation and utilization of technology, users' willingness is a crucial factor (Aggelidis & Chatzoglou, 2009). During the last few decades, researchers have developed several models to understand the attributes of technology acceptance among users. These models have been verified multiple times to determine their effectiveness for many information technology-based programs (Carter & Bélanger, 2005). The technology acceptance model (TAM) was presented in 1989 and has during this period been applied and empirically tested in a wide spectrum of ICT program areas. Also, the TAM is one of the most popular research models to predict use, a person's intention to perform a particular behavior, and acceptance of information systems and technology by individual users. Originally, the TAM was derived from the social psychological theories of reasonable action (TRA) and planned behavior (TPB), these three models focus on a person's intention to perform the behavior, but the constructs of these three models are different and not exactly the same. The TAM has become the dominant model for investigating factors affecting users' acceptance of novel technical systems. The basic model presumes a mediating role of perceived ease of use and usefulness in the association between system characteristics (external variables) and system usage (as shown in Figure 2.5).

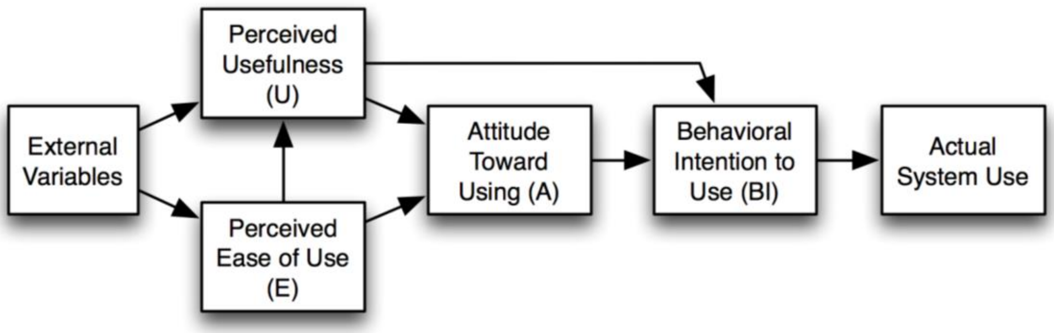


Figure 2.5 Technology Acceptance Model (TAM)

From Figure 2.5, the model has been designed to show how users come to accept and use technology. The theoretical basis is built on the premise that when users are presented with new technology, three major factors influence their decision on how and when they will use it. The first determinant is its perceived usefulness (PU), the second is the perceived ease of use (PEOU), and the third determinant is user attitude towards usage (ATU). According to Davis perceived usefulness is the degree to which a user believes that using a particular system would enhance his or her job performance (Davis, 1989). On the other hand, perceived ease-of-use is the degree to which a user believes that using a particular technology would be free from effort. In other words, it is the degree to which consumers perceive technology as better than its substitutes, (Jahangir & Begum, 2008). Commenting on the model, Chen et al. extends the argument that perceived usefulness and perceived ease of use positively affects the attitudes toward the usage of a technology(Chen et al., 2011).

The TAM model is a valid and robust predictive that has been used extensively (King & He, 2006). Furthermore, the Unified Theory of Acceptance and Use of Technology (Venkatesh et al., 2003) is used to describe the adoption possibilities and acceptance patterns of new technology. Meanwhile, the diffusion of innovation (Rogers, 2003) is used to describe the adoption and/or diffusion of technological information and communication based on five innovative characteristics: the relative advantage, the compatibility, the complexity, the trialability, and observability (Jin & Chen, 2015). The development of the Technology Acceptance Model (TAM) is defined in Table 2.16.

Table 2.16 The development of TAM

Source	Year	Technology Acceptance Model
Ajzen and Fishbein	1980	Theory of Reasoned Action (TRA) is one of the most fundamental and influential theories of human behavior. To discover the impacts of external

		variables on a user's perceptions, attitudes, intentions, and actual usage of the technology(Ajzen & Fishbein, 1977).
Davis et al.	1989	Technology Acceptance Model (TAM) is based on the Theory of Reasoned Action (TRA). TAM is to predict user acceptance of Information Technology and its usage with two specific variables, perceived usefulness (PU) and perceived ease of use (EU) and the dependent variable behavioral intention (BI). By using this model, almost 40% of the variance in attitude towards use can be explained. (Hu et al., 1999)
Ajzen	1985, 1991	Theory of Planned Behavior (TPB) was extended from TRA by adding perceived behavioral control in the model. Therefore the constructs of TPB are attitude, subject norm, and perceived behavioral control
Venkatesh and Davis	2000	Technology Acceptance Model 2 (TAM2) is to predict user acceptance of Information Technology and their usage with two particular variables, perceived usefulness and ease of use, which did not include “Attitude Toward Use” and incorporated additional variables to perceived usefulness
Pedersen et al.	2003	TPB-based adoption model was modified and extension of the theory of planned behavior (TPB) to study the adoption of mobile services and propose adoption model difference across service categories and user segments.
Venkatesh et al.	2003	Unified Theory and Acceptance and Use of Technology model (UTAUT) is adapted from the original TAM model, has three direct determinants of behavioral intention: performance expectancy, effort expectancy and social influence; one direct determinant of use behavior: facilitation conditions. All factors to behavior intention and use behavior are moderated by gender, age, experience, and voluntariness of use.
Rogers	2003	Diffusion of Innovation Model described the innovation diffusion process and proposed five attributes of innovation to explain the rate of adoption of innovation which are relative advantage, compatibility, complexity, trialability and observability.
King and He	2006	Technology Acceptance Model incorporated four major categories of factors; these included external factors, contextual factors, other factors from other theories and consequence measures

Chuttur argues that the wide acceptance of TAM is based on the fact that the model has a sound theoretical assumption and practical effectiveness (Chuttur, 2009). From the time it was proposed in 1985, the model has been refined to incorporate variables and relationships obtained from the Fishbein and Ajzen theory of reasoned action (TRA) of 1975. The output from the adjustments was a more refined model essential for anyone willing to interrogate the theory around technology acceptance and its utilization in learning. In addition, both perceived ease of use and perceived usefulness are influenced by some critical variables. Different scholars have given their suggestions on the variables that determine the usefulness and ease of use of technology. While investigating the implementation of Learning Management Systems at the University of Saudi Arabia, Asiri, Mohamud, Abu-Bakar and Ayub in Alharbi and steve proposed two categories of such variables: internal variables and external variables. Internal variables consist of factors such as the attitude of the user, their pedagogical beliefs, and their level of competency (Alharbi & Drew, 2014). Further, along similar lines with other studies, beliefs about e-learning were found to be important in determining the use of technology. The study noted that the use of technology could be predicted by competency level, meaning that having the skills and knowledge to use a system will affect its utilization. On the other hand, external variables include those external barriers faced by users during utilization. Such factors include organizational barriers, technological barriers, and social barriers. Similarly, demographical factors such as gender, computer self-efficacy, and levels of training (competency) are also used to predict technological usage. Moreover, TAM has been successfully applied to explain differences in gender perception and social usage of technology (Gefen & Straub, 1997; Venkatesh & Morris, 2000), and in multiple cultural settings (Straub et al., 1997). Given TAM's antecedents in consumer behavior theory (Ha & Stoel, 2009; Koufaris, 2002), with the advent of the World Wide Web, TAM has proved especially helpful in examining varying implementations of web-based technologies (Venkatesh & Ramesh, 2006). Many scholars have applied TAM to eLearning and education, with several articles examining student and faculty adoption of web-based learning technologies (Gong et al., 2004; Roca et al., 2006). TAM has also proven beneficial in exploring reasons for consumer usage of the wireless internet (Lu et al., 2003; Venkatesh & Ramesh, 2006), mobile phone adoption (Kwon & Chidambaram, 2000), internet and online banking (Pikkarainen et al., 2004), online shopping (Vijayasarathy, 2004), e-government initiatives and e-commerce in general (Pavlou, 2003). So prevalent is the use of TAM in the analysis of web-related technologies, that Davis and fellow researchers have expanded the TAM model to encompass issues especially salient to the World Wide Web, including that of trust, privacy, risk, and social awareness (Thong et al., 2011; Venkatesh & Morris, 2000; Venkatesh et al., 2003). This expanded model has been successfully applied to the analysis of user privacy and trust-related topics in mobile phone usage (Venkatesh et al., 2012) and participation in social media sites such as Facebook (W. Lee, Xiong (Lee et al., 2012), & Hu, 2012). Furthermore, TAM has been used to analyze technology acceptance in industry specific analysis such in healthcare (Holden & Karsh, 2010), physician acceptance of telemedicine (Hu et al., 1999), and even the efficacy of physicians' choice of technologies (Chismar & Wiley-Patton, 2003).

Technology Acceptance Model in Healthcare

In studies analyzing the TAM in the healthcare industry, the inconsistent results identifying the relationship between perceived ease-of-use and behavioral intention to use still exist. Furthermore, more recent studies attempt to identify the external factors influencing perceived ease-of-use and perceived usefulness in the healthcare industry. Melas et al. (2011) test external factors influencing participants' attitudes towards the computer information system, and determine that self-reported measures related to information and communication technology understanding influence perceived ease-of-use and perceived usefulness (Melas et al., 2011). Additionally, Melas et al. (2011) confirm findings that healthcare professionals are more likely to adopt systems that they perceive to be compatible with their current work processes, and also confirm the predictive pattern of attitude to usage. Walter and Lopez (2008) find that perceived threat to autonomy has a significant negative effect on perceived usefulness and behavioral intention to use when considering the adoption of both clinical decision support systems and electronic medical records systems (Walter & Lopez, 2008). Both of these studies validate the use of the TAM in the healthcare industry. Additionally, the existing studies identify perceived usefulness in a broad context by defining it as follows: leading to the enhancement of gains in job performance. In healthcare, usefulness may also be defined in terms of efficacy, cost reduction, and improved quality and safety of care. Usefulness could also be assessed from the point of view of various people involved in the care process: physicians, specialists, patients, and family members.

Table 2.17 TAM in healthcare

Author(s)	**Technology studied/Platform**	**Objective**	**Sample population and approved factors**	**Setting**	**Country**
(DJ et al., 2003)	Spoken dialogue system (SDS)	The application of TAM, to use spoken dialogue technology for recording clinical observations during an endoscopic examination	Clinicians (N = 12)	Endoscopy center	United Kingdom
(Chang, Hsu, Tzeng, Hou, et al., 2004)	Triage-based emergency medical service (EMS) personal digital assistant (PDA) support systems	Developing triage-based EMS (PDA) support systems among nurses and physicians by TAM	Physicians, nurses (N = 29)	Emergency medical center	Taiwan
(Chang, Hsu, Tzeng, Sang, et al., 2004)	Emergency medical service PDA support systems	Extending well developed, triage-based, EMS (PDA) support systems to cover prehospital emergency medical services	Physicians, nurses (N = 29)	Hospital	Taiwan
(Wilkins, 2009)	Electronic health records (EHR)	Examining factors that may influence the adoption of electronic health records by TAM	Health information managers (N = 94)	Hospital	United States
(Van Schaik et al., 2002)	Portable system for postural assessment	Assessing the TAM for the new system	Physiotherapists (N = 49)	Spinal unit	United Kingdom
(Huser et al., 2010)	A prototype of a flowchart-based analytical framework (RetroGuide)	Exploring acceptance of query systems called RetroGuide for retrieval EHR data	Human subjects (N = 18)	Laboratory	United States
(Cranen et al., 2011)	Web-based telemedicine service	The patients' perceptions regarding a Web-based telemedicine service with TAM among patient	Patients (N = 30)	Homecare	The Netherlands
(Aldosari, 2012)	Picture archiving and	The TAM was used to assess the level of acceptance of the host	Staffs (N = 89)	Radiology department	Saudi Arabia

Author(s)	Technology studied/Platform	Objective	Sample population and approved factors	Setting	Country
	communication system (PACS)	PACS by staff in the radiology department			
(Noblin et al., 2013)	Personal health record	The TAM was used to evaluate to adopt personal health record	Patients (N = 10)	Hospital	United States
(Martínez-García et al., 2013)	Social network component	Assessing acceptance and use of the social network component (web 2.0) to enable the adoption of shared decisions among health professionals (this is highly relevant for multimorbidity patients care) using TAM	Health care professionals (N = 10)	Health care center	Spain
(Cilliers & Flowerday, 2014)	Telemedicine	Using the TAM to identify the factors that influence the user acceptance of telemedicine among health care workers	Health care workers (n = 75)	Hospital and clinic	South Africa
(Money et al., 2015)	Computerized 3D interior design applications (CIDAs)	Exploring the perceptions of community-dwelling older adults with regards to adopting and using CIDAs with TAM	Older adult (N = 10)	Homecare	United Kingdom
(Faruque et al., 2015)	Geoinformatics technology in disaster disease surveillance	Assessing the feasibility of using geoinformatics technology in disaster disease surveillance uses by self-administration based on the technology acceptance model (TAM)	Personnel (N = 50)	Health centers	Iran
(Abdullah et al., 2016)	Telemonitoring of home blood pressure (BP)	Exploring patients' acceptance of a BP telemonitoring service delivered in primary care based on the technology acceptance model (TAM)	Patients (N = 17)	Homecare	Malaysia
(Hanauer et al., 2017)	Computer-based query recommendation algorithm	Assessing computer-based query recommend the algorithm as part of a search engine that facilitates retrieval of information from EHRs using TAM	Clinicians, staffs (N = 33)	Hospital	United State

CHAPTER 3
RESEARCH STRATEGY AND METHODOLOGY

This chapter describes the research design and methodology by beginning with a review of the methodology employed in the research. This research uses quantitative and qualitative approaches to develop total quality and innovation management in the hospital model divided into seven phases.

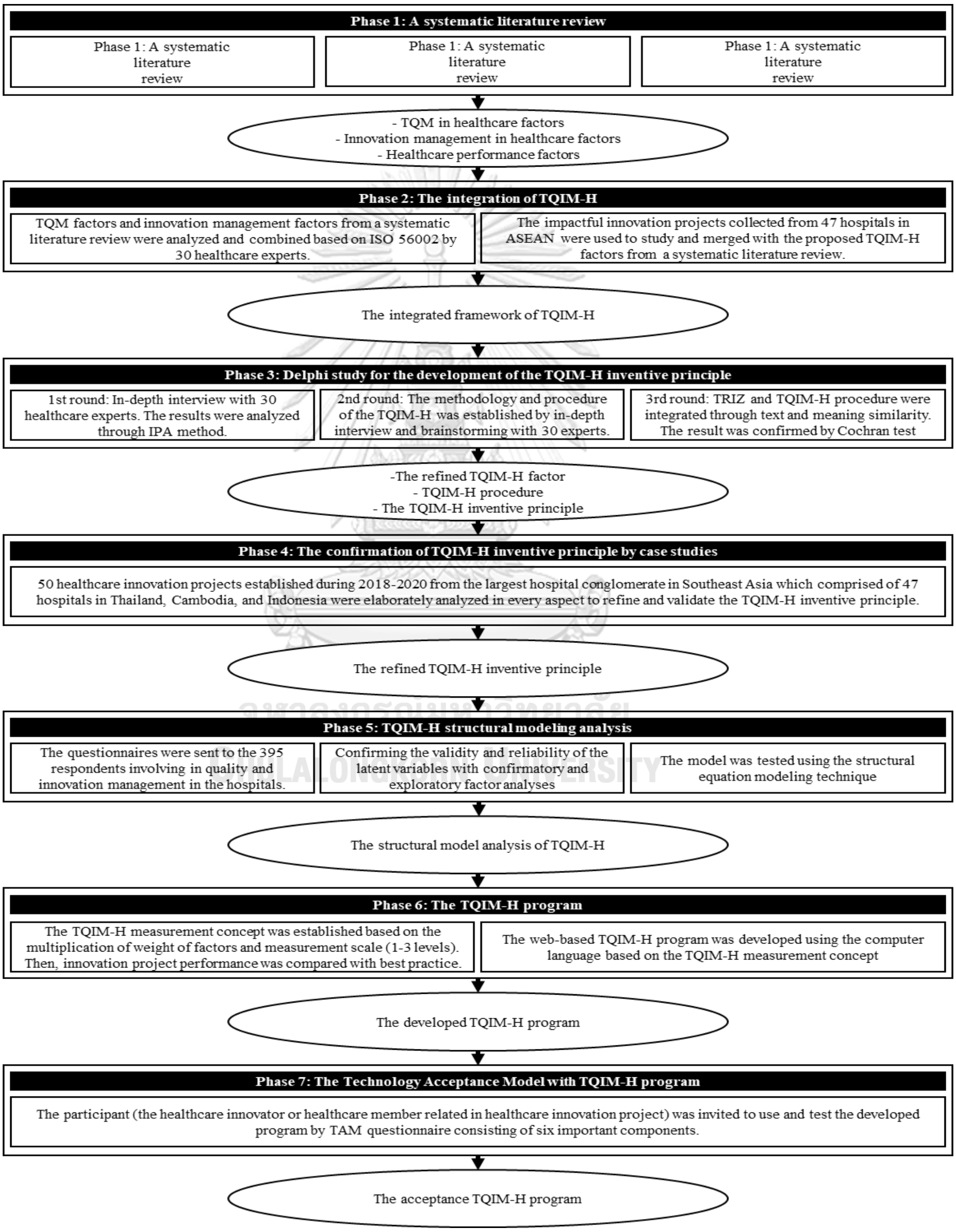


Figure 3.1 The research framework

3.1 RESEARCH DESIGN

The development of the total quality and innovation management in hospital (TQIM-H) system requires five main outputs, which are a key factor in managing quality management and innovation management in healthcare affecting healthcare performance, a conceptual framework of the integrated TQIM-H, the TQIM-H inventive principle, the developed TQIM-H structural model, and the TQIM-H program validated by TAM.

Table 3.1 Outlines the research objective, process, and result

Phase	Objective	Process & Information	Result
Phase 1: A systematic literature review	To study the scope and key factor of TQM and innovation management in healthcare	The systematic review consisted of three phases including planning the review, executing the review, and reporting the review in three areas - Total Quality management in healthcare - Innovation management in healthcare - Healthcare performance	- TQM in healthcare factors - Innovation management in healthcare factors - Healthcare performance factors
Phase 2: The integration of TQIM-H	To develop the integrated framework of TQM and Innovation management in healthcare	TQM factors and innovation management factors from a systematic literature review were analyzed and combined based on ISO 56002 by 30 healthcare experts. Then, the impactful innovation projects collected from the largest hospital conglomerate in Southeast Asia which comprised of 47 hospitals in Thailand, Cambodia, and Indonesia were used to study and merge with the proposed TQIM-H factors from a systematic literature review.	- The integrated framework of TQIM-H - The TQIM-H factors
Phase 3: Delphi study for the development of the TQIM-H inventive principle	To create inventive principles in managing quality and innovation systems	A Delphi survey on TQIM-H issues with 30 experts in five related areas of expertise in quality management and innovation management in healthcare was conducted in three rounds to gain a further consensus.	The results were provided in three parts including:
		1st round: In-depth interview with 30 healthcare experts in two parts including open questionnaire and importance and working performance questionnaire. Then, the results were analyzed through the IPA method.	The refined TQIM-H factor
		2nd round: The methodology and procedure of ("how to achieve") the TQIM-H was established by in-depth interview and brainstorming with 30 healthcare experts.	TQIM-H procedure
		3rd round: TRIZ and TQIM-H procedure	The TQIM-H

Phase	Objective	Process & Information	Result
		were integrated through text and meaning similarity analysis by experts' brainstorming. Then, the Cochran test was used to confirm the developed TQIM-H inventive principle.	inventive principle
Phase 4: The confirmation of the TQIM-H inventive principle by case studies	To refine and confirm the TQIM-H inventive principle	50 healthcare innovation projects established during 2018-2020 from the largest hospital conglomerate in Southeast Asia which comprised of 47 hospitals in Thailand, Cambodia, and Indonesia were elaborately analyzed in every aspect to refine and validate the TQIM-H inventive principle.	The refined TQIM-H inventive principle
Phase 5: TQIM-H structural modeling analysis	To examine a relationship among each of TQIM-H and the effects of TQIM-H on sustainable innovation.	The questionnaires were sent to the 395 respondents involved in quality and innovation management in the hospitals. After confirming the validity and reliability of the latent variables with confirmatory and exploratory factor analyses, we tested the model and hypotheses using structural equation modeling.	The structural model analysis of TQIM-H
Phase 6: The TQIM-H program	To develop the TQIM-H program that guides developing healthcare innovation	The TQIM-H program was developed based on the TQIM-H characteristics established in the previous stage. The program was developed in two parts: - The TQIM-H measurement concept. - The TQIM-H program was developed using the computer language	The developed TQIM-H program
Phase 7: The Technology Acceptance Model with the TQIM-H program	To test the ease of the TQIM-H program's use and show the acceptance level of TQIM-H program	The participant (the healthcare innovator or healthcare member related to the healthcare innovation project) was invited to use and test the developed program by TAM questionnaire consisting of six important components.	The acceptance TQIM-H program

In the first phase, the systematic literature review provides factors of quality management in healthcare, innovation management in healthcare, and healthcare performance, which could be found in chapter two. In phase 2, the integration of TQM and innovation management factors from the literature review were combined in ISO 56002 by healthcare experts. In phase 3, the 3 rounds of the Delphi study was used to extract the key characteristic of TQIM-H from 30 healthcare experts. In 1st round, an In-depth interview with 30 healthcare experts and the IPA method was used to provide the refined TQIM-H factor. Then, in the 2nd round, the TQIM-H methodology and/or procedure of the TQIM-H was established by in-depth interviews and brainstorming among experts. In the last round, TRIZ and TQIM-H procedures were integrated and confirmed by the Cochran test resulting in the TQIM-H inventive principle. In phase 4, 50 healthcare innovation projects established during 2018-2020 from the largest hospital conglomerate in Southeast Asia were used to refine and validate the TQIM-H inventive principle by brainstorming among the authors and TRIZ team. In phase 5, the TQIM-H structural model was established by using CFA and SEM analysis. In phase 6, the web-based TQIM-H program was established based on the TQIM-H characteristic presented in the previous stage. Then, the developed program was tested by TAM to validate the reliability and usability in the last phase. It can be seen that the research conducts in stages, as shown in figure 3.1.

3.2 PHASE 1: SYSTEMATIC LITERATURE REVIEW METHOD

3.2.1 Objective and Inclusion Criteria

The main objectives of the review are (1) to explore the research themes and trends arising in the reviewed literature. (2) to explore the existing total quality management and innovation management in healthcare (3) to compare the determinants of total quality management and innovation management in healthcare (4) to explore the healthcare performance measurement (5) to propose the new total quality and innovation management in hospital model for hospitals by applying contribution from the reviews (6) to identify an area for future research for quality and innovation management and performance measurement in healthcare.

Although a large number of studies have been conducted in total quality management and innovation management in the healthcare area, little attempt has been made to translate these findings systematically. Consequently, the complexity of the issues involved requires a systematic review exploring all aspects of the existing literature. According to the study of Mulrow (1994), a systematic review (systematic overview) is a review of the articles that clearly formulate the searching strategy and method of screening. The large quantities of information must be reduced into pieces of important information. The result will limit bias and, will improve the reliability and accuracy of conclusions (Mulrow, 1994).

3.2.2 Systematic Literature Review Method

Factors affecting TQM and innovation management in healthcare were studied using a literature review. The review was limited to articles in English-speaking outlets since 1985 as the integration of total quality management and innovation management in organizations emerged during that time. This chosen timeframe ensures that the data were up to date and relevant. SCOPUS, MEDLINE, Web of Science, Google Scholar, Science Direct, and ABI/INFORM were explored to select the relevant research papers. The databases were selected based on the research domains and types of publications included in them. The authors are confident that the findings from these databases are representative of the literature available within the search parameters utilized. The search words 'Total Quality Management', 'Innovation management', 'Healthcare', 'Quality and Innovation', 'The relationship TQM and Innovation Management', 'Healthcare Performance', and 'Sustainability Measurement' were selected based on the main objective of the systematic review. Initially, high-quality journals related to service quality, service innovation, and healthcare, such as Total Quality Management & Business Excellence, International Journal of Production Research, Managing Service Quality, International Journal of Health Care Quality Assurance, Production and Operations Management, International Journal of Production Economics, International Journal of Production Research, Managing Service Quality, International Journal of Quality & Reliability Management, Quality Assurance in Healthcare, Academic Emergency Medicine, and International Journal of Health Services, were searched for relevant literature.

The inclusion criteria for this research are:

1 . Peer-reviewed journal articles. Book chapters, non-peer-reviewed publications, and newspaper articles were not included.

2. Publications from conception to 2020.

3. Articles focusing on total quality management and innovation management in the healthcare area.

4. Articles focusing on the relationship between total quality management and innovation management.

5. Articles focusing on healthcare performance measurement.

6. Qualitative and quantitative empirical studies to capture all evidence of previous studies.

This study employed a systematic review to define characteristics, scope, and factors involved in TQM and innovation management in healthcare from previous studies. The systematic review consisted of three phases including planning the review, executing the review, and reporting the review (Thawesaengskulthai & Tannock, 2008; Thomas et al., 2004; Tranfield et al., 2003). The systematic literature review was conducted by following the steps summarized in the PRISMA diagram (Figure 3.2).

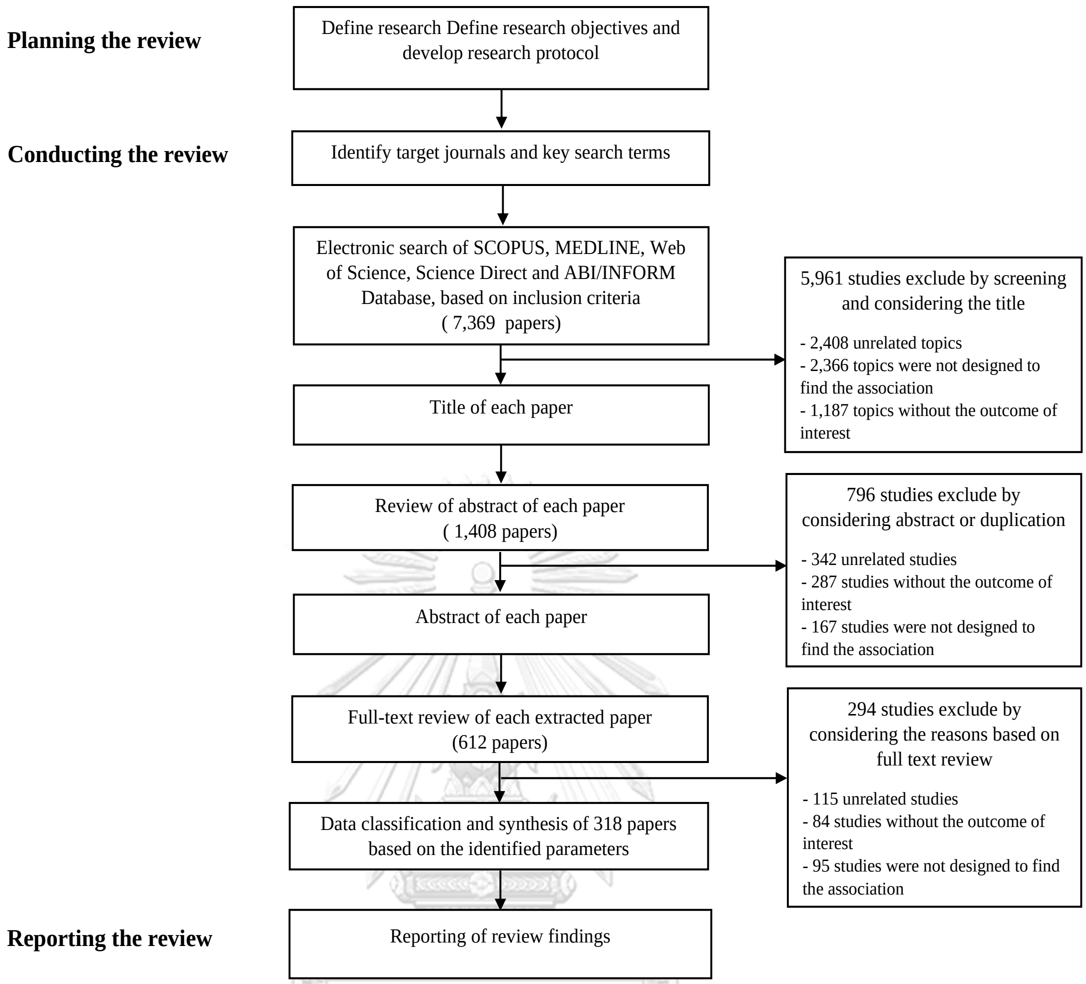


Figure 3.2 Systematic Literature Review Diagram

With the key search words, the searches were also undertaken with filtering keywords namely 'peer-reviewed journals', and 'full text' to scope the criteria. The publication time frame spanned within the last twenty years and the search dates were limited from 1985 to 2020. This time frame was used to ensure that the journal articles' are up-to-date and relevant. After reviewing the titles and abstracts, 318 journal articles remained for a complete review. The final papers are then summarized and organized in chronological order.

Table 3.2 List of reviewed journals and the number of papers extracted

Title Journal	***Number of articles***	***Percent***
Total Quality Management and Business Excellence	45	14.15
International Journal of Production Research	28	8.81
International Journal of Production Economics	23	7.23
Managing Service Quality	23	7.23
International Journal of Technology Management	19	5.97
Journal of Product Innovation Management	17	5.35

Title Journal	Number of articles	Percent
International Journal of Quality and Reliability Management	15	4.72
International Journal of Health Care Quality Assurance	15	4.72
Technovation	12	3.77
Production and Operations Management	10	3.14
International Journal for Quality in Health Care	10	3.14
International Journal of Innovation	10	3.14
International Journal of Project Management	9	2.83
Construction Management & Economics (CME)	9	2.83
Total Quality Management	6	1.89
International Journal of Business and Social Science	6	1.89
TQM Journal	5	1.57
International Journal of Business Excellence	5	1.57
TQM Magazine	5	1.57
Measuring Business Excellence	5	1.57
Benchmarking	4	1.26
International Journal of Productivity and Performance Management	4	1.26
The Quality Management Journal	4	1.26
Other	29	9.12
	318	100.00

3.3 PHASE 2: DEVELOP THE INTEGRATION OF TQIM-H BY HEALTHCARE EXPERTS

This stage aimed to develop the integrated framework of total quality and innovation management in hospital (TQIM-H)affecting healthcare performance. TQM factors and innovation management factors from a systematic literature review were analyzed and combined based on ISO 56002, with dimensions of ISO 56002 as the core axis by 30 healthcare experts. This was undertaken in response to Rebelo, et al., who established that the integrated methodology should have used "management system standards" (Rebelo et al., 2016) as the core axis, an argument similarly found in research by several authors (Beckmerhagen et al., 2003; Jørgensen, 2006; Karapetrovic & Jonker, 2003; Pojasek, 2006), who have highlighted the efficiency of standards or awards. So, we decided to adopt ISO 56002 dimensions as the core axis in the process of integration, as ISO 56002 is a newly-established standard, modern, comprehensive, and is widely accepted in the management system sphere. The process of this phase was divided into two steps such as the TQIM-H integration step and the TQIM-H confirmation step using 50 innovation case studies.

The TQIM-H integration step

1. A group of experts was invited to provide opinions on the suitability of a certain procurement path for a given criterion. Since the information solicited requires in-depth knowledge and sound experience about quality and innovation management in the healthcare context (Bryman, 2003; Chan et al., 2001; Edmunds, 1999; Morgan & Krueger, 1998). The following criteria were devised to correctly identify eligible participants for this process.

1.) Practitioners had extensive working experience in healthcare for more than 10 years.

2.) Practitioners currently, recently, or directly involved in the management of healthcare.

3.) Practitioners had detailed knowledge of quality management and innovation management.

2. The expert panels studied and reviewed data collected from a systematic literature review to understand the characteristics and factors of TQM and innovation management in healthcare.

3. TQM and innovation management factors were categorized into the seven dimensions, according to iso 56002, and analyzed. Parallel statements were matched after discussions, resulting in proposed TQIM-H factors.

4. The proposed TQIM-H factors were compared with those formulated by three experts in terms of similarities and differences.

5. Discrepancies were examined and analyzed before reaching a consensus by a focusing group of experts.

The TQIM-H confirmation step using 50 innovation case studies

The integrated framework of TQIM-H developing in the previous stage was refined and confirmed through the healthcare innovation projects. The effective case studies which have been established and launched in 47 hospitals in Thailand, Cambodia, Indonesia during 2018-2020 were studied and analyzed. The factor used in these projects that correspond to the factors in the proposed TQIM-H was presented to confirm and define the TQIM-H framework.

1. Impactful innovation projects that provided the organizational advantages from the selected hospital groups were selected as successful case studies. The case hospital was selected base on:

   1.) JCI or/and HA certified with representing TQM practices.
   2.) Innovation-led vision with tangible results.

2. Three healthcare experts were invited to discuss the innovation projects to classify factors used in each project.

3. The project proposal included background, objective, characteristics, management factors used to develop a project, goals, and results were presented to healthcare experts.

4. Expert panels analyzed and extracted management factors affecting healthcare innovation in 50 projects. The panels also studied the healthcare performance measurement of each project.

5. Factors from the innovation projects were matched with the proposed TQIM-H factors, resulting in refined TQIM-H factors.

6. The refined TQIM-H factors were compared with those formulated by three experts in terms of similarities and differences.
7. Discrepancies were examined and analyzed before reaching a consensus.
8. Verifying the preciseness using the Item-Objective Congruency index (IOC) by seven healthcare experts. Each of the refined TQIM-H factors was rated as -1, 0, and +1 representing disagreement, uncertainty, and agreement, respectively. IOC index of at least 0.5 is considered acceptable.
9. Brainstorming and analyzing average IOC scores in each factor with seven healthcare experts through characteristics and definitions of the refined conceptual framework of TQIM-H.

3.4 PHASE 3: DEVELOP TQIM-H INVENTIVE PRINCIPLE THROUGH DELPHI STUDY

This phase was designed to develop the TRIZ inventive principle to provide practitioners with an effective procedure to manage quality and innovation management systems in healthcare (TQIM-H) through the Delphi method. To develop an effective TQIM-H inventive principle, it was necessary to define two subsidiary objectives:

1. To identify the scope and extract the procedure of the TQIM-H.

2. To develop the TRIZ inventive principle to provide practitioners with an effective procedure to manage TQIM-H.

3.4.1 Delphi Method

The Delphi study was originally developed by the RAND Corporation in California in the 1950s and 1960s to elicit expert opinions (Woudenberg, 1991). The Delphi is a tool for discovering agreement and consensus by sharing the criticism (Buckley, 1995; Delbecq et al., 1975). Delbecq et al. (1975) describe the Delphi process as the approach that contains a survey conducted in two or more rounds and provides the experts in the second round with the feedback of the previous round then adjusts the original assessments. The same experts assess the specific topic in two or more rounds and the result of the next round was influenced by the opinions of the other experts(Linstone & Turoff, 1975). Linstone and Turoff (1975) stated that the method requires expert contributors submitted separate responses to questions to a central coordinator. Delphi method is suitable for experts in different locations and if there are political issues among a group. The benefits of the Delphi technique are the potential for anonymity, the ability to equalize participants, and the ability to remove personality factors from the process (Howze & Dalrymple, 2004). The sample size of the Delphi study should be a sufficient number of experts. In addition, experts should be willing to complete the entire study and provide enough information.

The methodology of this study was a Delphi survey on TQIM-H issues which was conducted in three rounds to gain a further consensus. Developing an effective

TQIM-H inventive principle would lead to the ability to create innovative projects in hospitals, thus improving the potential of the hospitals. The conceptual framework of this research is shown in Figure 3.3.

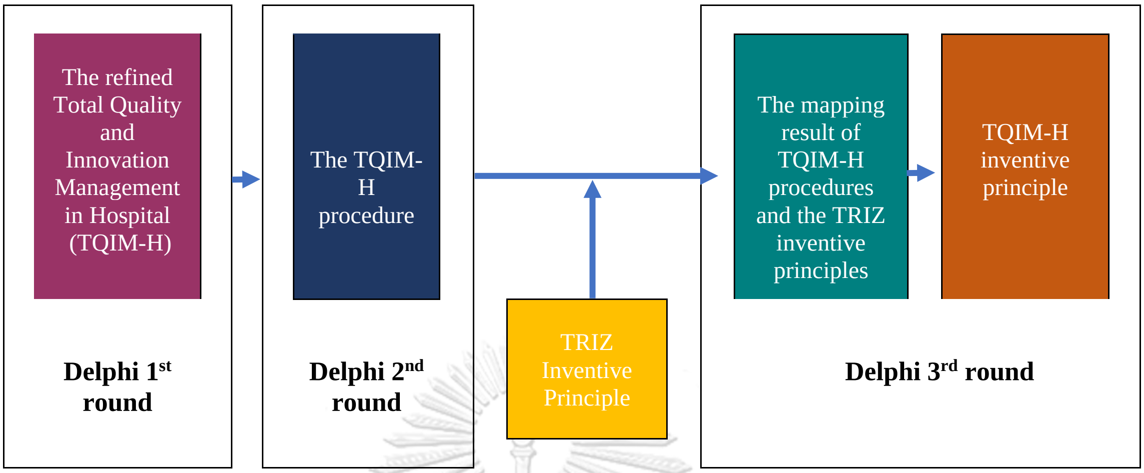


Figure 3.3 The conceptual framework of the TQIM-H inventive principle

In the first round, the study started with refining the TQIM-H factor through in-depth interviews with 30 healthcare experts using importance and performance analysis (IPA). Then, the second round is to develop the TQIM-H procedure or (How to achieve) TQIM-H via an in-depth interview with healthcare experts. Finally, the third round is to establish TQIM-H inventive principle through integrating the TQIM-H procedure and TRIZ inventive principle by analyzing and brainstorming among the TRIZ team. Then, the correlation of TQIM-H procedures and the TRIZ inventive principle was confirmed and approved by 30 expert panels via questionnaire.

Table 3.3 Three rounds of Delphi methodology

Delphi	Objective	Method	Tool	Result
1^{st} round	To refine the TQIM-H factor	- In-depth interview - Importance performance analysis	- Open questionnaire - Importance performance scale questionnaire	The refined TQIM-H factor
2^{nd} round	To develop the TQIM-H procedure	- In-depth interview - Brainstorming	- Open questionnaire	TQIM-H procedure
3^{rd} round	To develop the TQIM-H inventive principle	- In-depth interview - Text and meaning similarity analysis - Brainstorming	- Questionnaire - The Cochran test	TQIM-H inventive principle

The rationale for the use of the Delphi approach for TQIM-H research and evaluation was several. First, it is a good research method for deriving consensus among a group of experts on complex and subjective topics (Linstone & Turoff, *1975). Second, participants are separated by physical distance, so the information can derive from various companies without any political barrier. Last but not least, the Delphi approach is well known and accepted in several areas. Christian (2004) supported that Delphi was studied more than 612 articles in many research areas including information management, healthcare, banking, and quality management. However, the Delphi approach is time-consuming (Christian, 2004). Consequently, this study selected the computer-based approach. Delbeq et al. (1975) revealed that computer capability takes a shorter turnaround time, allowing for more immediate feedback and ongoing interaction (Delbeq et al., 1975). Table 3.4 explains the organization of the Delphi process and result in eleven steps.*

Table 3.4 Delphi process of this study

Step	Procedure	Result
1	Create a list of potential panel members based on the area of expertise.	Panel Category and Potential expert list
2	Prepare TQIM-H questionnaires based on the knowledge from a literature review and case studies. - A 10-item open questionnaire asking for visions and missions about quality management and innovation management in healthcare. - Questionnaires aiming at measuring the importance and working performance level of TQIM-H affecting the healthcare performance.	1st round open-end questionnaire
3	Distribute the 1st round questionnaire to the experts Conduct an in-depth interview with the healthcare experts	1st round questionnaire results
4	Analyze the 1st round responses	The refined TQIM-H factor
5	Design a questionnaire based on the TQIM-H factor. Three questions that were very helpful in properly defining the TQIM-H procedure, have been prepared to send to 30 healthcare experts.	2nd round questionnaire based on TQIM-H factor from 1st round
6	Distribute the 2nd round questionnaire to the experts	Questionnaire via an in-depth interview
7	Summarize the feedback and develop a new TQIM-H procedure	The TQIM-H procedure
8	TRIZ team brainstormed to reinterpret and match the TQIM-H procedures with the TRIZ inventive principle based on text similarity and meaning similarity.	The mapping result of TQIM-H procedures and the TRIZ inventive principles
9	The 3rd round questionnaire was designed based on the correlation and the mapping result of TQIM-H procedures and the TRIZ inventive principle.	3rd round questionnaire
10	Distribute the 3rd round questionnaire	Questionnaire via email

11	Gain a consensus on the new TQIM-H inventive principle	The TQIM-H inventive principle

3.5.2 Selection of experts

Expert selection is an important process for Delphi studies. The selected experts in the Delphi panel are the perceived subject expertise, not for demographic representativeness. Scheele (1975) recommended the panel must be chosen from stakeholders who will be directly affected, experts with relevant background and experience, and facilitators in the field under study. Carman (1999) stated that the experts' criteria should be based on experience in related aspects. Linstone (1978) suggested that large panels have more difficulty in achieving agreement and are more difficult to manage the contribution. In addition, the accuracy of the developed conclusion is very slow with large numbers (Linstone, 1978; Scheele, 1975). The time consumption for the Delphi process can take around 30 to 45 days (Barnes, 1987). Normally, the response rates for the second round decrease, particularly in a paper-based method (Jillson, 1975). Computer-based techniques are far better than the paper-based approach. The utilization of email or internet-based methods has speeded up the process (Colton & Hatcher, 2004). Jillson (1975) stated that a Delphi study involved a multistage procedure, including the selection of panelists; the design of the questionnaire, and the provision of feedback. McKenna (1994) stated that the Delphi technique combines opinion into group consensus. According to the purpose of this research, the experts in a Delphi panel need to have practical experience in the healthcare quality and innovation area (Barnes, 1987; Carman, 1999; Fowles & Fowles, 1978; McKenna, 1994). Healthcare experts were selected based on the required qualification as shown in Table 3.5. They were directly contacted and asked for their consent to participate in this study. Thirty participants in this study were academic professionals, CEO/Directors, healthcare quality assurance specialists, innovation specialists in healthcare, project development specialists in healthcare from healthcare organizations in Thailand, Cambodia, and Indonesia. The average working time of the participants in the health sector is 16.5 years.

Table 3.5 Healthcare expert panel criteria

Expert Categories	**Required Qualification**	**No. of Participants**			**Overall % Response**
		1st Round	**2nd Round**	**3rd Round**	
Academics	More than 5 years of experience in the academic area with a Ph.D.	6	6	6	100%
CEO/Directors	Top management in healthcare and more than 5 years of experience in the healthcare position.	6	6	6	100%
Healthcare quality assurance specialist	Healthcare quality assurance specialist with the healthcare quality certification and more than 5 years of experience in the healthcare position.	6	6	6	100%

Innovation specialist in healthcare	Healthcare innovation specialist and more than 5 years of experience in the healthcare position.	6	6	6	100%
Project development specialist in healthcare	Project manager/technical specialist and more than 5 years of experience in the healthcare position.	6	6	6	100%
Total		30	30	30	100%

3.5.3 TRIZ team

The TRIZ team consisted of the invited TRIZ experts and the healthcare workers. We invited TRIZ experts who have had experience in TRIZ projects. In addition, most of the included inside workers were healthcare staff who had at least three years of experience in quality or/and innovation management in the healthcare context (Table 3.6) and were interested in TRIZ.

Table 3.6 TRIZ team criteria

Team categories	Required qualification	Number of the expert panel
TRIZ expert	More than 3 years of experience in TRIZ projects	1
Healthcare quality assurance specialist	Healthcare quality assurance specialist with healthcare quality certification and more than 3 years of experience in the healthcare position.	1
Innovation specialist in healthcare	Healthcare innovation specialist and more than 3 years of experience in the healthcare position.	1
Total		3

1st Round Delphi*:* *To refine and confirm the TQIM-H factor*

This stage aims to refine the TQIM-H factor by analyzing systematic reviews and case studies via in-depth interviews with healthcare experts. Healthcare experts can provide their opinions to develop quality and innovation management in healthcare through open questionnaires and provide scores with the ranges of level 1-9 to TQIM-H factors. The results from the questionnaire were analyzed using mean scores and IPA graphs to analyze TQIM-H factors affecting healthcare performance. Then, the results of an open questionnaire and IPA graphs were summarized and concluded to be the refined TQIM-H factor. In this round, the developed questionnaire consisted of two parts including Part A: Open questionnaire and Part B: The importance and working performance measurement questionnaire

Part A : Open questionnaire

In the first part, specific questions addressed in Part A indicate the area of expertise and experiences and the questions were open-ended and allowed participants to provide and express their opinions or add information freely about quality management and innovation management in healthcare. An in-depth interview with quality and innovation experts in healthcare by open questionnaires has four parts and is provided below.

Part 1: Quality Management

1. What attitudes or opinions do you hold regarding quality management?
2. What are the critical success factors that affect quality management in hospitals?

Part 2: Innovation Management

3. What attitudes or opinions do you hold regarding innovation management?
4. What are the critical success factors that affect innovation management in hospitals?

Part 3: Integrated Methodology

5. Do you think quality management and innovation management can be integrated?
6. How to integrate & What are the key Quality & Innovation Management dimensions?
7. What critical success factors do you think quality management and innovation management handle?
8. What are the risks of failure that occur in your setting when quality management and innovation management were integrated?
9. How do you approach conflicts arising from the integration of quality management and innovation management?

Part 4: Sustainability in Healthcare

10. What is your definition of sustainability in the hospital, what do you place importance on?

The authors collected the open questionnaire results from in-depth interviews with expert panels. Then, experts analyzed and extracted factors affecting quality management, innovation management, and healthcare sustainability and resubmitted the information to experts to check whether further corrections would be needed.

Part B : The importance and working performance measurement questionnaire

The questions in Part B aim at measuring the importance and working performance level affecting the performance in healthcare. This part aims to analyze importance levels and working performance levels of quality and innovation management in healthcare (TQIM-H) factors. The healthcare experts will provide scores with the ranges of level 1-9 to TQIM-H factors extracted from the literature review and case studies. The scores of Part B have been separated into 2 sub-parts including,

1) Importance levels that affect healthcare performance, Important Scoring (1= Unimportant, 9 =Very Important)

2) Performance levels that affect healthcare performance, Performance Scoring (1= Needs Development, 9 = Very Effective)

Step of 1st round

1. A group of experts was invited to provide opinions on the quality and innovation management in healthcare
2. The developed questionnaires were sent to healthcare experts.
3. The expert panels studied and reviewed to understand the characteristics of the quality and innovation management in healthcare
4. The healthcare expert was interviewed with the developed questionnaire consisted of two parts including:
   - Open questionnaire: The questions were open-ended and allowed participants to provide and express their opinions or add information freely about TQIM-H through 10 open questionnaires which were separated in four parts.
   - The importance and working performance measurement questionnaire: The healthcare experts provided scores with the ranges of level 1-9 to TQIM-H and healthcare performance that analyze and extract from the 1st round.
5. The results of the open questionnaire were analyzed and sent back to healthcare experts to confirm the information's accuracy.
6. The score results of TQIM-H factors have analyzed the importance and performance through IPA analysis.
7. The results of the open questionnaire were analyzed with the TQIM-H factor in the 1st and 2nd quadrant of the IPA graph to explain and present the refined TQIM-H factor which will be used in the 2nd round and 3rd round.

2nd Round Delphi*:* *To define the scope and extract the procedure of the TQIM-H with healthcare experts.*

In this round, we aimed to develop the methodology and procedure of ("how to achieve") the TQIM-H with a full description of thinking for solutions extracted from healthcare experts' opinions through in-depth interviews.

Questionnaire

In this round, a specific questionnaire was designed based on the TQIM-H factor which was summarized in 1st round (TQIM-H factor in quadrant 1 & quadrant 2 of IPA graph). Then, healthcare experts provide their opinions and methodologies to manage each TQIM-H factor. Three questions that were very helpful in properly defining the TQIM-H procedures included:

- In your opinion, what were the ideal description or characteristics of each TQIM-H factor?

- How to achieve this characteristic?

- What kind of resources could be used to construct the ideal characteristic?

***Step of* 2nd round**

1.) Clearly explaining the definitions of TQIM-H

2.) Designing a questionnaire based on TQIM-H.

3.) The 30 experts were asked for their opinions and ideas to create TQIM-H procedures through three questions by in-depth interviews.

4.) The results from each expert panel were analyzed and grouped by brainstorming among the TRIZ team. Consequently, the approach table for the TQIM-H procedure table was extracted.

3**rd Round Delphi*:*** To develop the TQIM-H inventive principle

In this round, TQIM-H procedures from experts' opinions were analyzed and mapped with the TRIZ inventive principle based on text similarity and meaning similarity by the TRIZ team. Then, the inventive principle mapping results of the TQIM-H were validated by 30 healthcare experts.

Questionnaire

After mapping the TQIM-H procedure and TRIZ inventive principle by the TRIZ team resulted in the TQIM-H inventive principle. The newly developed TQIM-H inventive principle was validated and confirmed by healthcare experts through 'Confirmed questionnaire'. The 'Confirmed questionnaire' was designed to provide healthcare experts with to select 'Agree' or 'Disagree' for each mapping result of TQIM-H procedures and the TRIZ inventive principles. The mapping results would be approved when the results were agreed upon by more than half of the total number of experts, i.e. more than 15 experts.

Step of 3rd round

The process to develop the TQIM-H inventive principle was divided into 2 parts that are Part A: Develop the TQIM-H inventive principle by the authors and TRIZ team and Part B: The applicability and reliability of the inventive principle mapping results were evaluated by a group of experts through 'Confirmed questionnaire'.

Part A : Develop the TQIM-H inventive principle.

1.) The authors and TRIZ team intensively reviewed 40 TRIZ inventive principles and TQIM-H procedures to understand their characteristics.

2.) TRIZ team brainstormed to reinterpret and match TQIM-H procedures from stage 1 with the TRIZ inventive principle based on text similarity and meaning similarity.

- Text similarity: It was the first stage of categorization and it focused on similarity between the inventive principle with each TQIM-H procedure identity. For instance, “Studying differences among the customer segment” had similarity in text information with principle #1- segmentation. Thus, this TQIM-H procedure was grouped under this TRIZ inventive principle.

- Meaning similarity: The second method looked for the meaning similarity between the procedure characteristic and each principle's information. For example, principle #2- Extraction, Taking out had a meaning related to the procedure characteristic “Considering a working process to eliminate irrelevant processes”, since it referred to eliminating certain processes. Likewise, it also resembled the TQIM-H procedure “Following complaints or acts that are out of line with the law or medical ethic for further improvement ”, which corresponded with inventive principle #22- Convert Harm Into Benefit.

Part B : The applicability and reliability of the inventive principle mapping results were evaluated by a group of experts by following the steps below:

1.) The ‘Confirmed questionnaire’ was designed based on the correlation of TQIM-H procedures and the TRIZ inventive principle.

2.) The 30 experts who participated in the in-depth interview in stage one were invited to answer the questionnaires. Before the experts began filling out the questionnaires, we clearly explained the definitions of the TQIM-H procedures, TRIZ inventive principle, and the reasons that were used for mapping the principles.

3.) Each expert indicated his/her opinion by selecting ‘Agree’ or ‘Disagree’ for each mapping result of TQIM-H procedures and the TRIZ inventive principles.

4.) The mapping results would be approved when the results were agreed upon by more than half of the total number of experts, i.e. more than 15 experts.

To confirm the consistency of the experts’ opinions on the parameter-corresponding results, the Cochran test was used to test the null hypothesis, and the following statements were hypothesized:

H_0: There are no differences among experts’ opinions on the effectiveness of the principle mapping results.

H_1: There is a difference among experts' opinions on the effectiveness of the principle mapping results. "Agree with the mapping result" was labeled as '1' and "Disagree with the mapping result" was labeled as '0'. The results were then tabulated with r rows representing the categories of determinants and c columns representing the c experts, with entries that were either zeros or ones. Let Ri represent the row totals, i = 1,2,....,r, and Cj represent the column totals, j = 1,2,....,c, with N representing the total number of ones in the table.

The test statistic was computed using the following equation:

$$T = c(c-1)\frac{\sum_{j=1}^{c}\left(c_j - \frac{N}{c}\right)^2}{\sum_{i=1}^{r} R_i\,(c - R_i)}$$

3.5 PHASE 4: THE VALIDATED TQIM-H INVENTIVE PRINCIPLE FROM 50 INNOVATION PROJECTS

This phase was designed to refine and validate the TQIM-H inventive principle through effective healthcare innovation projects in 50 healthcare innovation projects established during 2018-2020 from the largest hospital conglomerate in Southeast Asia which comprised of 47 hospitals in Thailand, Cambodia, and Indonesia. Each of the steps in this stage is presented below.

1.) Fifty impactful innovation projects established during 2018-2020 from selected hospital groups were selected as successful case studies. The case hospitals were selected if they:

- Were certified by JCI or/and HA with representing TQM practices.

- Specified the innovation-led vision and organizational strategy with tangible results in the organizational annual report.

2.) The project proposals were elaborately analyzed in every aspect including processes, methodologies, key success factors, and solutions by brainstorming among the authors and TRIZ team.

3.) Specific solutions were transformed to TQIM-H inventive principle developed in stage two.

4.) TQIM-H inventive principles of each innovation project were approved by the project owner. Then, the TQIM-H inventive principle table was constructed.

3.6 PHASE 5: A STRUCTURAL EQUATION MODELLING OF TQIM-H

In the previous phase, the study demonstrated the key procedures of TQIM-H but did not show the relationships among dimensions and the important level, that affected the development of sustainable innovation in the hospital, of each factor. The authors utilized SEM as the tool for analyzing the relationship between TQIM-H dimensions and sustainable innovation, and the important level of each TQIM-H dimension. Structural equation modeling (SEM) is a statistical modeling technique, related to the measuring of both independent and dependent variables. It has been widely used in econometrics, marketing, psychology, sociology, and education (Bollen, 1989). In effect, the SEM is considered as a much more comprehensive statistical analysis tool compared with multiple regression models and is more suitable for complicated models (Bollen & Long, 1992; Jiménez‑Jiménez & Martínez‑Costa, 2009; Jöreskog & Sörbom, 1993; Kline, 1998; Sekaran & Bougie, 2016). The primary objective of an SEM is to determine the ability of a predefined factor model to fit an observed set of data. We selected SEM as the tool for analysis based on three reasons:

1. It is a powerful tool that can provide direct and indirect analysis of a relationship in the model.

2. It can analyze multiple relationships concurrently.

3. Its CFA can be identified if the proposed model is fit.

SEM is identified as an appropriate statistical test particularly for the number of TQIM-H factors that are required to explain the inter-correlations among the variables. The TQIM-H factors that are precisely defined are tested. This involves selecting the number of factors and defining the nature of the loadings between the factors and the measures. In SEM, the structural relationship between the items (observed measures) and dimensions (latent variables or factors) are postulated a priori and then statistically tested. The objective of this phase is to examine the relationship among the TQIM-H factors and examine the impact of TQIM-H on sustainable innovation. The author needs to validate the TQIM-H model by using structural equation modeling (SEM), thus some variables will be grouped and some variables, which are not related to others, will be omitted. Additionally, this section is aimed to provide a weighting mechanism in each variable including the dominant characteristics of a variable and the variable group. As a result, it occurred to the relations between each variable and enables us to recognize the information structure and co-relate factor of variable including the weight of each component calculated from variable value as well.

3. Research model and proposed hypotheses

As discussed in the previous stage, the integration of TQIM-H is a key success factor to develop an effective innovation. However, to what extent does TQIM-H has positive effects on sustainable innovation. Thus, the authors aimed to study the direct and indirect effects of TQIM-H consisting of seven dimensions on sustainable innovation hypothesized the following:

H_1: Total quality and innovation management (TQIM-H) has a positive and significant impact on effective sustainable innovation.

The proposed model in Figure 3.4 presents the research framework under investigation.

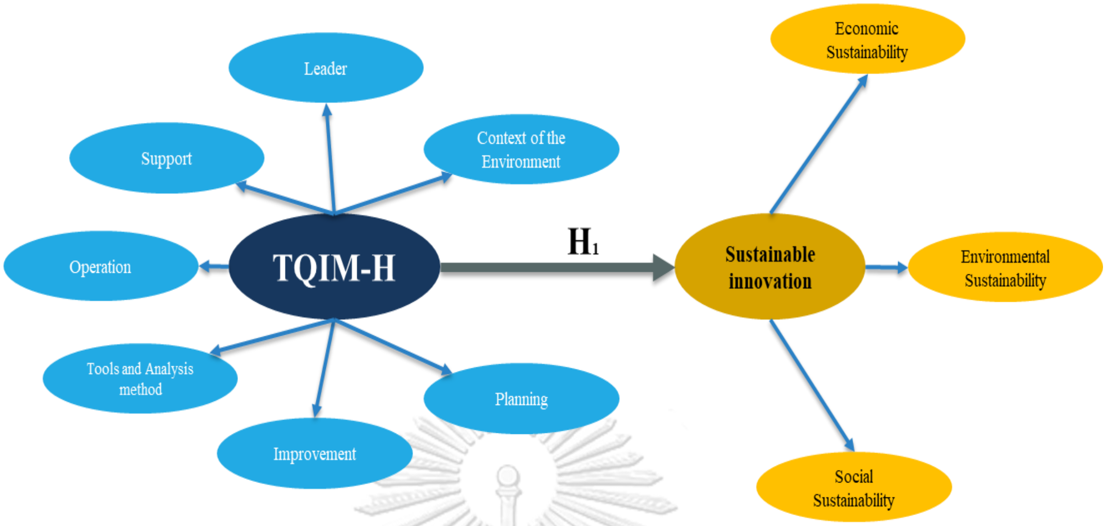


Figure 3.4 Theoretical frameworks of TQIM-H

Survey instrument

A draft questionnaire based on existing measurement scales for the research constructs was initially drafted. The participants rated the importance of each TQIM-H procedure component on the development of sustainable innovation. In addition, participants rated the importance of each sustainable innovation measurement component on the measurement of innovation project efficacy. The 1–10 Likert scale, which is a suitable tool for measuring ordinal data used to determine the construct validity (Afthanorhan, & Mamat 2016), was used to measure the TQIM-H constructs (1 = Not important; 10 = Very important). The respondents responded to the statements that closely represent their observations on how management in their organization was practiced (Appendix E: Table 1). Furthermore, the sustainable innovation project performance was also measured using the Likert scale (Appendix E: Table 2).

Pretesting

In this study, the draft questionnaire then was pretested with academics and practitioners to validate the content validity and terminology. To ensure that the instrument was accurate, valid, and reliable, a pretest was conducted using 40 questionnaires in the pilot analysis. Thus, Cronbach's alpha was used to measure the validity of the variables using the cut-off value suggested by Nunnally (1978), that is, 0.70. The results were then modified accordingly to provide their suitability and appropriateness for the target population before mailing.

Subject and data collection

The initial sample consisted of private and public hospitals in Southeast Asia that were operated under JCI or/and HA certified. The included 60 hospitals represented TQM practices and specified the innovation-led vision and organizational strategy with tangible results in the organizational annual report. The questionnaire was mailed to the healthcare member who related to quality and/or innovation in the hospitals including quality and/or innovation project owner, quality and/or innovation manager in the hospitals, and healthcare innovator (healthcare practitioners and healthcare workers who participated in innovation training courses). Regarding the sample size, as proposed by Roscoe (1975 cited in Sekaran and Bougie, 2016), the rules of thumb for determining sample size, sample size more than 30 and less than 500 are appropriate. Since the total number of individuals involved with healthcare innovation in Southeast Asia was not available, the largest proposed sample was 384 which was sufficient to achieve a confidence level of 0.05. The formula proposed by Aaker and Day (1986 cited in El-Gohary, 2012) also revealed the same figure (n = 384). Thus, the minimum sample size was then calculated to be 384

Data Analysis

SEM is generally selected to refine and validate the measurement scales (Al-Hawari et al., 2005). The data will be entered into the statistical software AMOS. Given the fact that the proposed model is based on logic, previous empirical research, and theoretical findings; the SEM approach is considered the most appropriate method to statistically confirm the proposed factors of the TQIM-H model. The conceptual model of TQIM-H contains the factors which are necessary to be grouped and does not contain the factors that are not involved with quality and innovation management systems affecting healthcare performance (Demirbag et al., 2006; El-Gohary, 2012; Fotopoulos & Psomas, 2009) The two-step data analysis will be employed such as step 1: the measurement models for each factor are tested using CFA to ascertain results in goodness-of-fit data and step 2: the association between TQIM-H integrated model and healthcare performance is measured using structural analysis.

Confirmatory Factor Analysis is performed for the TQIM-H to determine the validity of the constructs. According to Fornell and Larcker (1981), a more suitable indicator would be on composite reliability, as it takes into account the actual factor loadings rather than assuming that every item is equally weighted during composite load determination (Fuentes et al., 2006; Lin & Lee, 2004; Segars & Grover, 1998). According to Molina, et al., the minimum proposed value is 0.70, as this was obtained by calculating the Average Variance Extracted (AVE), which has a minimum suggested value of 0.5 (Fornell & Larcker, 1981; Molina et al., 2007).

According to Segars and Grover (1998), and Lin and Lee (2004), the measurement model can be measured for its goodness-of-fit based on eight common measures: ratio of $\chi 2$ statistics to the degree of freedom (df), Comparative Fit Index (CFI), Goodness-ofFit Index (GFI), Tucker Lewis Index (TLI), Adjusted Goodness-of-Fit Index (AGFI), Normed Fit Index (NFI), Standardized Root Mean Square Residual (SRMR), and Root Mean Square Error of Approximation (RMSEA).

3.7 PHASE 6: TQIM-H PROGRAM

The quantitative and qualitative analysis in the previous phase provided important information necessary to develop total quality and innovation management in hospital (TQIM-H). In addition, the importance of and relationship among each factor were also described. Thus, understanding the key characteristic in developing quality innovation in the hospital helps achieve acceptance and create value in the hospital effectively. However, the platform to develop the TQIM-H concretely and make TQIM-H development easier and more convenient was not available. This phase aimed to develop a web-based program to help healthcare organizations understand and make decisions concerning quality and innovation management in healthcare.

This chapter is divided into two phases:

1.) Development of the TQIM-H program concept

2.) Development of the TQIM-H program

Phase 1: Development of the TQIM-H program concept

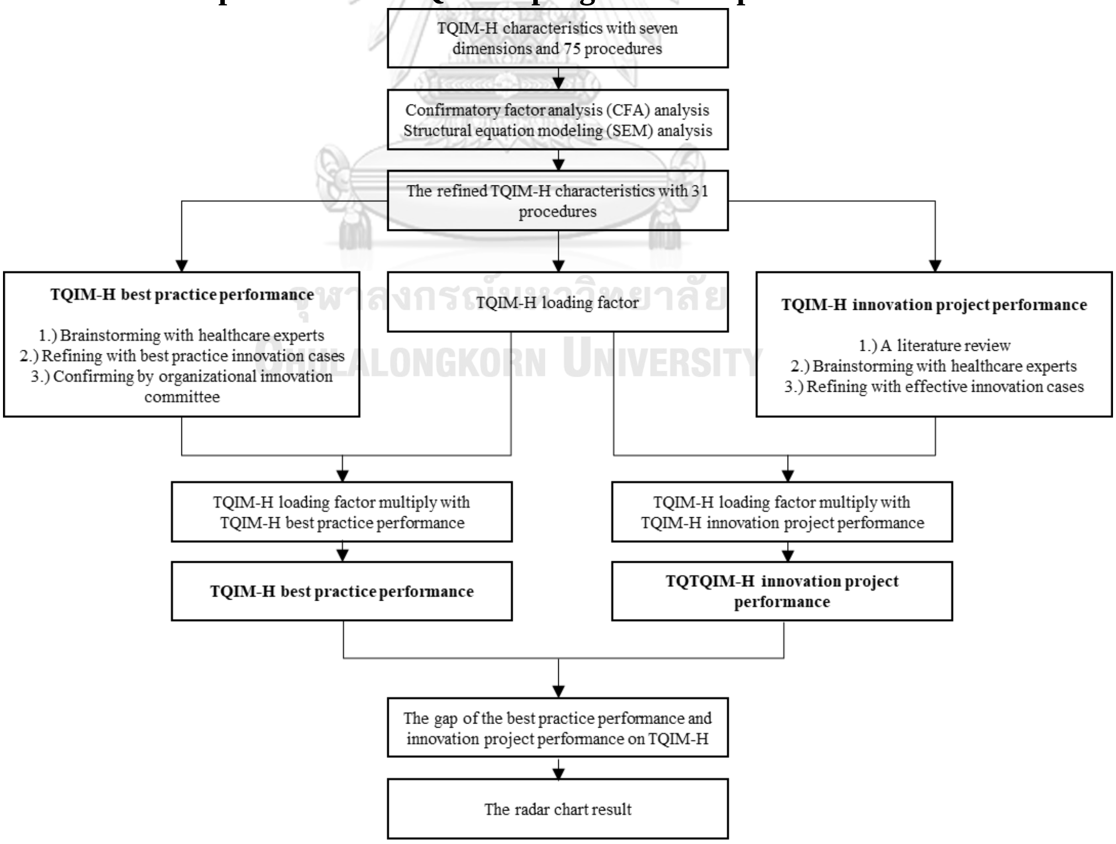


Figure 3.5 The concept to develop the TQIM-H program

The concept to develop the TQIM-H program was provided by the key characteristic of 31 TQIM-H procedures which had loading scores derived from the SEM analysis from the previous Chapter. The 31 factors of TQIM-H represented a key component to manage and establish quality innovation projects in healthcare. The 31 TQIM-H procedures with their loading score consisted of two main components.

1. TQIM-H innovation project performance: the key TQIM-H procedure with its loading score was multiplied with the TQIM-H measurement scale (1-3 level) to assess the innovation project performance from each user.

2. TQIM-H best practice performance: the key TQIM-H procedure with its loading score was multiplied with the best practice scale to provide the best practice TQIM-H score, a TQIM-H management standard.

Information from questionnaire output was presented as the best practice and innovation project performance score table. Then, the scores of these two components were analyzed and compared through a radar chart. Finally, the results of the radar graph were prioritized and the strengths and weaknesses of an innovation project were presented to suggest further performance development for project owners. The concept is shown in the flow chart in Figure 3.6.

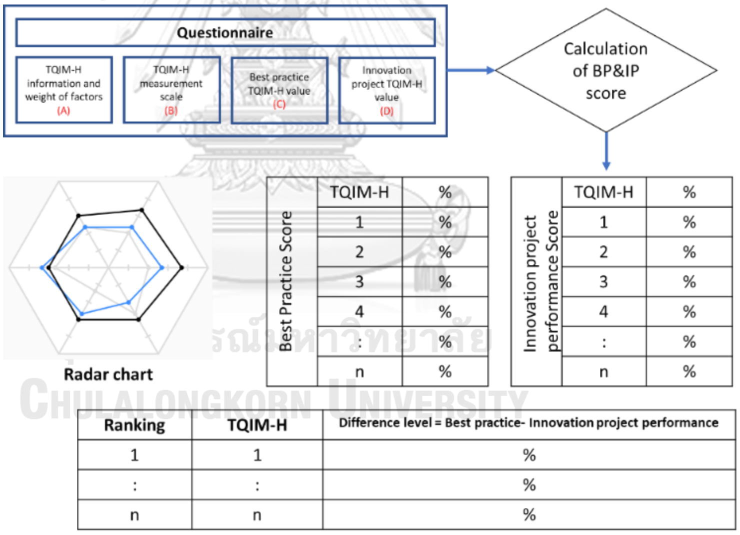


Figure 3.6 Flow of the development of the TQIM-H measurement concept

The development of the TQIM-H measurement concept in phase one was presented in four parts including:

Part 1: Providing the TQIM-H characteristic and weight of the TQIM-H factor

The quantitative analysis result with confirmatory factor analysis (CFA) and structural equation modeling (SEM) in the previous phase was able to identify seven dimensions or 31 procedures of the TQIM-H assessment criteria. These were taken as key elements in establishing the quality and innovation management in healthcare assessment criteria.

Part 2: Establishing the TQIM-H measurement scale

To measure the TQIM-H project performance of each innovation project, the importance loading level obtained from the SEM technique were multiplied by the measurement scale of each TQIM-H factor. The measurement scale was scored by healthcare innovators or healthcare innovation project owners. The TQIM-H measurement scale is very novel and unique, with different criteria for measuring each TQIM-H factor. Thus, the expert panels suggested that the measurement scale of each TQIM-H factor by its nature and the practical program should be developed. This part aimed to develop the measurement scale of each TQIM-H factor by using three methodologies as follows:

Table 3.7 The process of the TQIM-H measurement scale development

Step	Methodology	Objective	Process	Result
1.	A literature review	To define the scope and key factor of quality and innovation management measurement scale	Review literature of quality and innovation management measurement scale through an international database	The quality and innovation management in healthcare measurement methodology
2.	Brainstorming with healthcare experts	To contribute TQIM-H measurement scale	Brainstorm and develop a TQIM-H measurement scale	The measurement scale of each TQIM-H factor
3.	Refining by effective innovation cases	To refine and confirm the TQIM-H measurement scale	Review 50 effective innovation project reports and confirm the information with the owner of the innovation project.	The TQIM-H measurement scale

Stage 1: A literature Review

This study employed a literature review to define characteristics, scope, and factors involved in total quality and innovation management in hospital (TQIM-H) measurement scale from previous studies. The literature review consisted of five steps

1.) The review was limited to articles since 1985 as the quality management measurement scale and innovation management measurement scale emerged during that time. SCOPUS, MEDLINE, Web of Science, Google Scholar, Science Direct, and ABI/INFORM database were used.
2.) The initial keywords/phrases used to identify the relevant literature were quality and innovation management measurement scale relating with each TQIM-H dimension from the previous phase as they were deemed fit to mirror the scope of the review by the authors. These were targeted only in the 'title' and/or 'abstract' of the papers.
3.) The papers were screened to find articles linked to the quality and innovation management measurement scale, critical criteria of quality and innovation management, case studies illustrating the measurement methodology of managing quality and innovation.

4.) The full text of the final articles was reviewed. Measurement scale, criteria, and methodology for measuring the quality and innovation management in healthcare were extracted from the articles.
5.) Reporting the review findings and translating the research evidence into the quality and innovation management in the healthcare measurement scale table.

Stage 2: Brainstorming with healthcare experts

This stage aimed to contribute to the quality and innovation management in healthcare (TQIM-H) measurement scale which was extracted from a literature review. The experts' brainstorming process consisted of four steps

1.) A group of healthcare experts was invited to provide opinions on the measurement methodology of TQIM-H since in-depth knowledge and sound experience about TQIM-H measurement or criteria were required.
    The following criteria were devised to correctly identify eligible participants for this process.
    - Practitioners had extensive working experience in healthcare for more than 10 years.
    - Practitioners currently, recently, or directly involved in the management of healthcare.
    - Practitioners had detailed knowledge of quality management and innovation management.
2.) The expert panels studied and reviewed data collected from a literature review to understand the characteristics and area of quality and innovation management in the healthcare (TQIM-H) measurement scale.
3.) The healthcare experts brainstormed and provided their opinion to select the TQIM-H measurement scale in each TQIM-H factor ranging from 1 to 3.
    - "level 1" is a low level representing 0% of an actual performance

    - "level 2" is a medium level representing around 50% of an actual performance

    - "level 3" is a high level representing 100% of an actual performance

4.) Reporting the measurement scale of each TQIM-H factor.

Stage 3: Refine the TQIM-H measurement scale with effective innovation cases

This final stage aimed to refine the TQIM-H measurement scale by analyzing 50 effective innovation projects. The innovation projects were analyzed to confirm the TQIM-H measurement scale in two sections including:

Section 1: Review 50 effective innovation projects in healthcare presented in the project report. The process of this section consisted of six steps

1.) Impactful innovation projects that provided the organizational advantages from the selected hospital groups were selected as successful case studies. The case hospital was selected based on:
    - JCI or/and HA certified with representing TQM practices.
    - Innovation-led vision with tangible results.

    The selected project which represented the impactful and effective innovation project was chosen based on:

    - The innovation project provided the concept and business model accepted by the board of directors in an organization.
    - The marketable innovation projects with sales for more than a year.
2.) Three healthcare experts were invited to discuss the innovation projects to classify factors used in each project. Expert panels interviewed 50 effective innovation projects to extract the project's characteristics.
3.) The project proposal included background, characteristics, management factors used to develop a project, measurement method, project criteria, and results were presented to healthcare experts.
4.) Expert panels analyzed and extracted measurement scales from 50 projects by matching the TQIM-H measurement scale to the characteristic of each innovation project.
5.) The 1st refined TQIM-H measurement scale was compared with those formulated by three experts in terms of similarities and differences.
6.) Discrepancies were examined and analyzed before reaching a consensus.

Section 2: Confirm the accuracy of the TQIM-H measurement scale through the innovation project owners. The process of this section consisted of five steps

1.) The questionnaire was designed based on the TQIM-H measurement scale.
2.) The project owner of each innovation project was invited to confirm the accuracy of the TQIM-H measurement scale of his/her project.
3.) Before the project owner began filling out the questionnaires, the author clearly explained the definitions of the TQIM-H characteristics and the reasons that were used for establishing the TQIM-H measurement scale from their innovation project.
4.) Each project owner indicated his/her opinion by selecting 'Agree' or 'Disagree' for each mapping result of the TQIM-H measurement scale and their project.
5.) The mapping results were approved when the results were agreed upon by more than half of the total number of experts, i.e. more than 15 experts.

Part 3: The TQIM-H comparison of Innovation project and Best practice score

In this phase, the healthcare innovation project was evaluated for the TQIM-H performance level to present the performance in managing quality innovation projects using the performance level questionnaire. The innovation project owner could provide the performance management of his/her project in each TQIM-H factor following the measurement scale. Then, the TQIM-H performance level of the innovation project was calculated through the TQIM-H loading multiplied with the project performance measurement scale of each innovation project as shown in the equation below.

$$V(x) = \sum_{i=1}^{n} w_i v_i(x_i)$$

V(x) = TQIM-H performance level of innovation project

w_i = TQIM-H loading of the i^{th} factor (From structural equation analysis of TQIM-H)

v_i (xi)= the project performance measurement scale of the i^{th} factor (From the TQIM-H questionnaire provided by the innovation project owner)

i = factor; n = number of factors

Then, the best practice project was studied and provided the project standard that the innovator should follow during the development of an innovation project. The best practice innovation project was selected from the high-performance innovation project that provided good organizational sustainability outcomes and was accepted by the organizational innovation committee. The best practice innovation project's score that should have been in each TQIM-H factor was analyzed and provided by expert panels who had experience and were involved with best-practice innovation projects. Thus, the healthcare innovation project should follow the characteristic of the best practice innovation project following each TQIM-H score. The best practice TQIM-H score was calculated through the TQIM-H loading multiplied with the best practice score as shown in the equation below.

$$U(x) = \sum_{i=1}^{n} w_i u_i(x_i)$$

U(x) = TQIM-H performance level of best practice

w_i = TQIM-H loading of the i^{th} factor (From structural equation analysis of TQIM-H)

u_i (x_i) = the best practice score of the i^{th} factor (From best practice result provided by experts' analysis)

i = factor; n = number of factors

After considering and analyzing the results of the last two parts, part of the best practice project score and the innovation project performance score, a radar chart was used to present the related and different results. In addition, when considering radar chart results, the differences between the score of the best practice and actual performance were used as a guideline for guidance and improvement steps to develop a healthcare innovation project. The TQIM-H factor which has the greatest degree of difference of best practice and actual project*weight was prioritized first in the lead to the improvement. The equation of the difference score of the best practice and actual project was calculated from the best practice TQIM-H score minus the TQIM-H score of an innovation project as shown below.

$Z(x) = U(x) - V(x)$

$Z(x)$ = The difference score TQIM-H performance level of best practice and innovation project

$U(x)$ = TQIM-H performance level of best practice

$V(x)$ = TQIM-H performance level of innovation project

Phase 2: Development of the TQIM-H program

The developed TQIM-H program was established following the TQIM-H measurement concept development in part 1 for easy study and practical use. The development of this TQIM-H program uses the computer language PHP for importing data, data processing control, and displaying the results as desired by the user. In program assessment, users can use it through a web browser by typing the program name in the URL field: http://TQIM-H.com/ to go to the main screen of the program. The developed TQIM-H program was presented in two parts including Section 1: System design and Section 2: User interface design and prototyping.

3.8 PHASE 7: INVESTIGATING ACCEPTANCE OF THE TQIM-H PROGRAM THROUGH THE TECHNOLOGY ACCEPTANCE MODEL (TAM)

This study presents the concept of the Technology Acceptance Model (TAM) which was developed by David, Bagozzi and Warshaw (1989) to evaluate and predict the success and innovation of information system technology.

The purpose of acceptance testing TQIM-H program was as follows:

1. To understand the key factor and concepts that are essential to the development of quality and innovation in healthcare.

2. To test the ease of the TQIM-H program's use to develop a healthcare innovation project.

3. To show the acceptance level of TQIM-H program technology leading to the development of the quality innovation project in healthcare. The acceptance analysis was provided by the healthcare innovator or healthcare member related to healthcare innovation project development.

To study the TQIM-H system acceptance, the participant related to healthcare innovation project was invited to use and test the developed TQIM-H program. Then, the author surveyed the ability and efficiency of the TQIM-H program.

Participants

The participant is the healthcare innovator or healthcare member related to the healthcare innovation project development from the hospital having quality and innovation management background in Southeast Asia. The participant was invited to use and test the developed TQIM-H program. Then, he/she was asked about the program usability from his/her opinion via questionnaire.

Instruments

The questionnaire was designed by adaption from the technology acceptance concept. We provide the 35 questions corresponding to the effective implementation of the TQIM-H program, Ease of use, User Interface, and practical program to validate the program usability following the TAM concept. All the tested constructs, except objective usability, were measured using 5-point Likert-type scales ranging from "strongly disagree" to "strongly agree" as follows:

Table 3.8 The program acceptance level

Score	Level
1.00-1.80	Strongly disagree
1.81-2.60	Disagree
2.61-3.40	Nature
3.41-4.20	Agree
4.21-5.00	Strongly agree

Research methodology

A usability testing was conducted with the TQIM-H program which would help innovators in understanding key factors and the level of importance of each factor in the TQIM-H framework that would help guide innovation development. The process to test the program acceptance is shown below.

1. The tasks were designed according to test the usability of the TQIM-H program that healthcare innovators would perform with the developed program.
2. Before testing the TQIM-H program usability, the participant was invited to register to be a TQIM-H program member.
3. The participant was required to complete the TQIM-H measurement concept questionnaire about his/her innovation performance as quickly and successfully as possible.
4. The program analysis results were presented to the participant to understand the strengths and weaknesses of his/her project and compare his/her project performance with the best practice project via the radar chart diagram. The assessments enabled the development of innovative projects in the right direction and without errors.
5. After the testing task, the participant was asked to fill in a technology acceptance questionnaire to elicit their perceptions on variables in the TQIM-H program.

6. The analysis of TQIM-H program acceptance and utilization to develop a healthcare innovation project using average statistics and standard deviation. Convergent validity was verified if all item average scores of each question were greater than 2.5.

CHAPTER 4
DEVELOPING THE INTEGRATION OF TQIM-H

From the systematic review in Chapter 2 , we can specify key factors and characteristics of TQM and innovation management. We also found a positive relationship between TQM and innovation management. This suggests that quality management and innovation management should be performed simultaneously to enhance organizational performance. Thus, this chapter aims to develop the integrated framework of Total Quality and Innovation Management in Hospital (TQIM-H) affecting healthcare performance.

Table 4.1 Developing the integration of TQIM-H

Objective	Process	Result
To develop the integrated framework of TQM and Innovation in hospital	- TQM factors and innovation management factors from a systematic literature review were analyzed and combined based on ISO 56002 by 30 healthcare experts. The impactful innovation projects collected from the largest hospital conglomerate in Southeast Asia which comprised of 47 hospitals in Thailand, Cambodia, and Indonesia were used to study and to merge with the proposed TQIM-H factors from the systematic literature review.	The integrated framework of TQIM-H

TQM factors and innovation management factors from a systematic literature review were analyzed and combined based on ISO 56002, with dimensions of ISO

56002 as the core axis by 30 healthcare experts. This was undertaken in response to Rebelo, et al., who established that the integrated methodology should have used "management system standards" (Rebelo et al., 2016) as the core axis, an argument similarly found in research by several authors (Beckmerhagen et al., 2003; Jørgensen, 2006; Karapetrovic & Jonker, 2003; Pojasek, 2006), who have highlighted the efficiency of standards or awards. So, we decided to adopt ISO 56002 dimensions as the core axis in the process of integration, as ISO 56002 is a newly-established standard, modern, comprehensive, and is widely accepted in the management system sphere. The process of this phase was divided into two steps such as the TQIM-H integration step and the TQIM-H confirmation step using 50 innovation case studies.

The result in this chapter was derived from the exploration of a systematic literature review concerning the total quality and innovation management in hospital (TQIM-H). The impactful innovation projects collected from the largest hospital conglomerate in Southeast Asia which comprised of 47 hospitals in Thailand, Cambodia, and Indonesia were provided, analyzed, and compared. In addition, this part classified the quality and innovation management in healthcare (TQIM-H) factors and developed a new integrated model affecting healthcare performance. The process of this part consisted of four phases including:

Phase 1: The TQIM-H factors, which were the integration of TQM and innovation management factors from a systematic literature review by following ISO 56002, generating seven dimensions and 45 factors, were proposed.

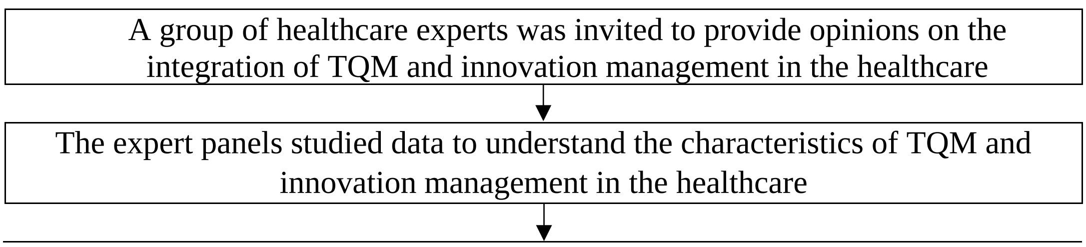
Phase 2: The refined TQIM-H factors were formulated by merging 50 impactful case study factors with the proposed TQIM-H factors from phase 1.

Phase 3: The content validity of the developed TQIM-H factor was verified using the Item-Objective Congruency index (IOC) by seven healthcare experts.

Phase 4: The TQIM-H conceptual framework was established by brainstorming and analyzing each TQIM-H factor by healthcare experts through characteristics and definitions of the new conceptual framework.

4.1 PHASE 1: THE INTEGRATION OF TQM AND INNOVATION MANAGEMENT IN HEALTHCARE

TQM factors and innovation management factors from a systematic literature review were analyzed and combined based on ISO 56002, with dimensions of ISO 56002 as the core axis by 30 healthcare experts as shown in Figure 4.1.



TQM and innovation management factors were categorized into the seven dimensions, according to iso 56002, and analyzed.

↓

The proposed TQIM-H factors were compared with those formulated by three experts in terms of similarities and differences.

↓

Discrepancies were examined and analyzed before reaching a consensus by a focusing group of experts.

Figure 4.1 The step of the integration of TQIM-H development

From the study, TQM and innovation management had a positive and direct relationship and foster healthcare performance. The authors presented the proposed TQIM-H conceptual framework which demonstrated the combination of two management philosophies, both central to healthcare performance at the present, including TQM in healthcare with six concerning dimensions and innovation management in healthcare with five concerning dimensions. A methodology for the integrated use of the proposed TQIM-H conceptual framework was proposed by ISO-56002, with dimensions of ISO 56002 as the core axis. TQM and innovation factors were later fused according to ISO 56002 dimensions. The integration of two management philosophies resulted in TQIM-H, which had seven concerning dimensions. TQIM-H affected healthcare performances which contained three concerning dimensions, as shown in Figure 4.1.

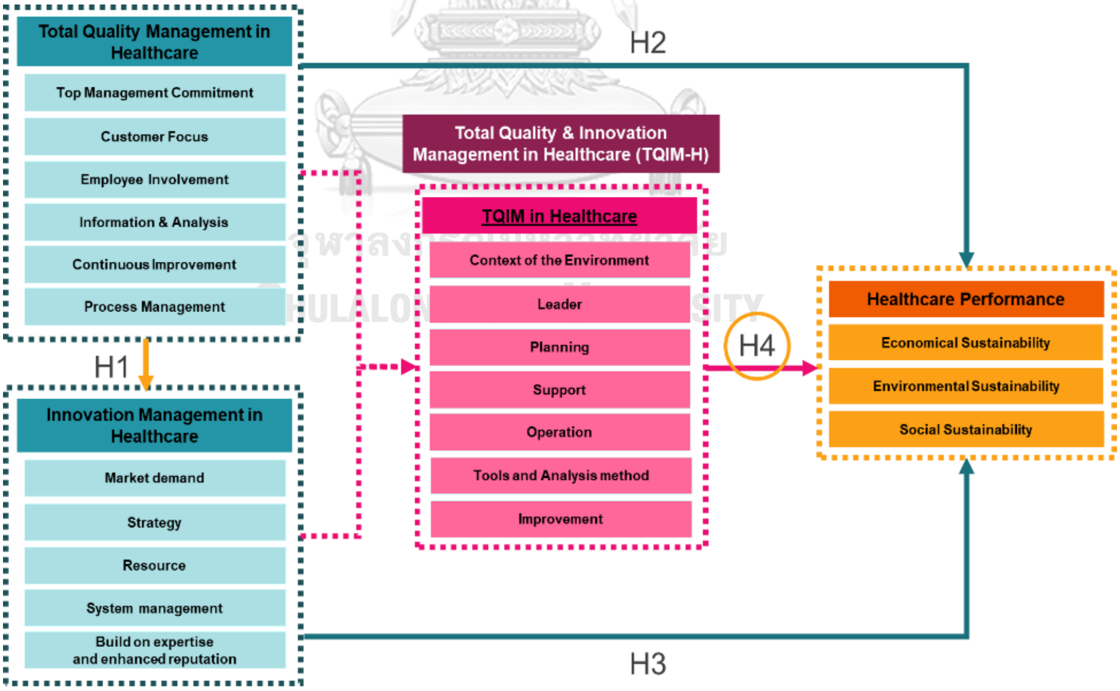


Figure 4.2 The proposed conceptual framework of TQIM-H

Table 4.1 shows the integrated part of TQM and innovation management factor based on ISO 56002 dimension, the result of which is TQIM-H factors. The first column shows the seven dimensions of ISO 56002 used as the core axis of our integrated framework. The second and third columns present the factors of TQM and innovation management in healthcare respectively that were analyzed from a literature systematic review and merged with ISO 56002 dimension by 30 healthcare experts. The last column was developed by merging the second and third columns by analyzing healthcare experts, resulting in TQIM-H factors. Therefore, the new 45 integrated factors in column four had the characteristics from both TQM and innovation management in healthcare.

Table 4.2 The proposed TQIM-H factors

Dimension	TQM in Healthcare factor	Innovation Management in Healthcare factor	Total Quality and Innovation Management in Healthcare (TQIM-H) factor
Context of the Environment (Internal & External)	A2.1 Customer (patient etc.) satisfaction A2.2 Solving the patient's complaints. A4.4 Informing the hospital's achievements A5.4 Litigation law refers to the rules and practices	B1.1 Country and culture B1.2 Customer segment and customer needs B.1.3 Competitors B.1.4 Technological change	A2.1 Customer (patient etc.) satisfaction A2.2 Solving the patient's complaints. A4.1 Informing the hospital's achievements A5.4 Litigation law refers to the rules and practices B.1.1 Country and culture B1.2 Customer segment and customer needs B.1.3 Competitors B1.4 Technological change
Leader	A1.1 Allocating resources. A.1.2 Leader vision, Policy A1.3 Assuming responsibility. A1.4 Supporting employees' suggestion	B2.2 Supporting from top management and leadership	A1.1 Allocating resources. A.1.2 Leader vision, Policy A1.3 Assuming responsibility. A1.4 B2.2 Supporting employees' suggestion
Planning	A5.1 Creating a strategic plan	B.2.1 Organizational strategy B.2.4 Innovation initiative with business needs and strategy B.2.5 Alignment of innovation	A5.1 Creating a strategic plan B.2.1 Organizational strategy B.2.4 Innovation initiative with business needs and strategy B.2.5 Alignment of innovation
Support	A4.2 Educating employee A4.5 Training programs	B3.1 Facilities e.g. laboratories, space, etc. B3.2 Budgets B.2.3 Establishing climate and environment in organization B3.3 Having knowledge and education B3.4 Human Resources	A4.2 Educating employee A4.5 Training programs B3.1 Facilities e.g. laboratories, space, etc. B3.2 Budgets B.2.3 Establishing climate and environment in organization B3.3 Having knowledge and education B3.4 Human Resources
Operation	A2.3 An effective system for patient's rights A2.4 Identifying Patients at Low Risk A4.1 Holding responsible for error-free output. A4.3 Decision-making to solve problems. A5.2 Monitoring and evaluation A5.3Amount of preventive equipment maintenance A5.5 Risk management	B4.1 Process management B4.2 Internal and External Networking B4.3 Knowledge Management B4.4 Portfolio Management B5.1 Building distinctive competencies and competitive advantage B5.2 Well-defined processes and formalized tools B5.3 Establishing an innovation award B5.4 Best practices documented and shared	A2.3 An effective system for patient's rights A2.4 Identifying Patients at Low Risk A4.1 Holding responsible for error-free output. A4.3 Decision-making to solve problems. A5.2 Monitoring and evaluation A5.3 Amount of preventive equipment maintenance A5.5 Risk management B4.1 Process management B4.2 Internal and External Networking B4.3 Knowledge Management B4.4 Portfolio Management B5.1 Building distinctive competencies and competitive advantage B5.2 Well-defined processes and formalized tools B5.3 Establishing an innovation award B5.4 Best practices documented and shared
Tools and Analysis method	A6.1 Information management A6.2 Data integrity and security A6.3 Data availability and accuracy	N/A	A6.1 Information management A6.2 Data integrity and security A6.3 Data availability and accuracy
Improvement	A3.1 Quality audits A3.2 Continuous solving A3.3 Improving product and process quality A3.4 Achieving quality standards	N/A	A3.1 Quality audits A3.2 Continuous solving A3.3 Improving product and process quality A3.4 Achieving quality standards

4.2 PHASE 2: THE REFINEMENT OF TQIM-H FACTOR BY CASE STUDIES

To refine and confirm the integrated framework of TQIM-H developed in the previous stage, we studied the impactful innovation case studies and extracted the key success factors used to manage each project. The three healthcare experts compared and merged the project’s key factors and TQIM-H factors to construct the new integrated conceptual framework.

The TQIM-H confirmation step using 50 innovation case studies

The integrated framework of TQIM-H developing in the previous stage was refined and confirmed through the healthcare innovation projects. The effective case studies which have been established and launched in 47 hospitals in Thailand, Cambodia, Indonesia during 2018-2020 were studied and analyzed. The factor used in these projects that correspond to the factors in the proposed TQIM-H was presented to confirm and define the TQIM-H framework. The process of the TQIM-H confirmation via 50 innovation projects is shown in Figure 4.3.

Impactful innovation projects from the selected hospital groups were selected as successful case studies.

↓

Three healthcare experts were invited to discuss the innovation projects to classify factors used in each project.

↓

The project proposal was presented to healthcare experts.

↓

Expert panels analyzed and extracted management factors affecting healthcare innovation in 50 projects.

↓

Factors from the innovation projects were matched with the proposed TQIM-H factors

↓

The refined TQIM-H factors were compared with those formulated by three experts in terms of similarities and differences.

↓

Discrepancies were examined and analyzed before reaching a consensus.

Figure 4.3 The TQIM-H confirmation step using innovation case studies

Table 4.3 shows the numbers of and types of TQIM-H which was used to manage each innovation project and healthcare sustainability factor. Experts analyzed stages and factors involved in developing each project and found that 45 factors of TQIM-H covered all issues of the management of 50 innovation projects and all 45 factors were used in creating projects. Moreover, the study shows that 33 healthcare sustainability in three parts (economic, environment, social) was used to evaluate the healthcare innovation project.

Table 4.3 The TQIM-H and healthcare sustainability factor

Dimension	Factor
Context of the Environment (Internal & External)	A2.1 Customer (patient etc.) satisfaction
	A2.2 Solving the patient's complaints.
	A4.1 Informing the hospital's achievements
	A5.4 Litigation law refers to the rules and practices
	B.1.4 Technological change
	B1.2 Customer segment and customer needs
Leader	A1.1B.2.2 Allocating resources.
	A.1.2 Leader vision, Policy
	A1.3 Assuming responsibility.
	A1.4B.2.2 Supporting employees' suggestion
Planning	A5.1 Creating a strategic plan
	B.2.1 Organizational strategy
	B.2.4 Innovation initiative with business needs and strategy
	B.2.5 Alignment of innovation
Support	A4.2A4.5 Educating employee and training programs.
	B.2.3 Establishing climate and environment in the organization
	B3.1 Facilities e.g. laboratories, space, etc.
	B3.2 Budgets
	B3.3 Having knowledge and education
	B3.4 Human Resources
Operation	A2.3 An effective system for patient's rights
	A4.3 Decision-making to solve problems.
	A5.2 A5.3 Monitoring and evaluation
	A2.4A4.1A5.5 Risk management
	B4.1 Process management
	B4.2 Internal and External Networking
	B4.3 Knowledge Management
	B4.4 Portfolio Management
	B5.1 Building distinctive competencies and competitive advantage
	B5.2 Well-defined processes and formalized tools
	B5.3 Establishing an innovation award
	B5.4 Best practices documented and shared
Tools and Analysis method	A6.1 Information management
	A6.2 Data integrity and security
	A6.3 Data availability and accuracy
Improvement	A3.1 Quality audits
	A3.2 Continuous solving
	A3.3 Improving product and process quality
	A3.4 Achieving quality standards
Economic Sustainability	C1.1 Cost in equipment and facilities
	C1.2 Long-term liability ratio
	C1.3 Utility (water /electricity)
	C1.4 Staff cost
	C1.5 Cost in pharmaceutical and medical materials
	C1.6 Marketing cost
	C1.7 Outsourcing cost (housekeeping/ Food)

Dimension	Factor
	C1.8 Debt-to-assets ratio
	C1.9 The growth rate in revenue
	C1.10 Revenue
	C1.11 Net profit rate
	C1.12 Investment
Environmental Sustainability	C2.1 Energy from renewable
	C2.2 Energy from nonrenewable
	C2.3 Energy regulations/certifications
	C2.4 Natural resource
	C2.5 Gaseous emissions
	C2.6 Solid waste
	C2.7 Liquid waste
	C2.8 Other waste and emissions
	C2.9 Waste management regulations/certification
	C2.10 Recycled wastes use
	C2.11 Hazardous wastes
Social Sustainability	C3.1 Efficiency, Quality of care
	C3.2 Facility
	C3.3 Technology
	C3.4 Speed of time
	C3.5 Safety
	C3.6 Health
	C3.7 Customer need
	C3.8 Employee engagement
	C3.9 Training
	C3.10Ethic

However, each of the TQIM-H and healthcare sustainability factors was used in managing each project at different frequencies. This difference in frequency in each factor suggested differences in the significance of the healthcare project in order. The higher the frequency was, the higher the priority the factor was placed on managing healthcare projects. This study found three main factors used in all of the projects. The first was facility support for project management including tools, sandbox, time, human labor. The second was the management of the budget received from research funding from leaders. The third was, continuous solving, referring to how goals were being developed constantly to keep pace with new needs and global changes.

Table 4.4 The refinement of TQIM-H factor from 50 innovation projects

		Factor	Case study project																																																	Sum
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	
Total Quality and Innovation Management in Healthcare (TQIM-H)	Context of the Environment	A2.1 Customer (patient etc.) satisfaction	/		/	/	/	/	/	/	/	/	/	/	/		/	/		/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/		/	/		/	/	/		/	/	/	/	/	/	/	43
		A2.2 Solving the patient's complaints.	/	/	/	/				/		/	/	/	/	/		/	/	/			/					/		/			/		/			/				/	/		/	/	/	/	/	/	/		29
		A4.1 Informing the hospital's achievements	/			/	/		/				/	/	/		/			/	/		/	/	/		/	/	/	/				/	/		/		/	/	/			/			/		/	/		/	28
		A5.4 Litigation law refers to the rules and practices	/		/	/		/		/	/	/	/	/	/		/		/		/			/	/	/	/	/	/	/	/			/	/					/	/						/			/	/		28
		B.1.1 Country and culture		/						/												/												/								/		/								/	7
		B.1.2 Customer segment and customer needs	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/			/	/	/	/	/	/		/	/			/	/	/	/	/	/	/	/	/		/	/	/	/	42
		B.1.3 Competitors																																							/							/					2
		B.1.4 Technological change	/	/	/		/	/			/		/	/			/			/	/	/	/	/	/	/	/		/	/			/		/	/	/		/	/	/		/		/	/	/	/	/	/			33
	Leader	A1.1 Allocating resources.	/	/	/			/	/	/	/		/	/		/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/			/	/	/	/	/	/	/	/	/	/	/	/	/	/	43
		A.1.2 Leader vision, Policy	/		/	/				/		/		/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	43
		A1.3 Assuming responsibility.	/			/	/	/	/	/			/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	45
		A1.4 Supporting employees' suggestion		/			/	/	/	/		/	/	/	/	/			/		/			/					/		/		/							/			/									/	19
		B.2.2 Supporting from top management and leadership	/	/	/	/	/	/	/	/	/	/	/	/				/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	47
	Planning	A5.1 Creating a strategic plan	/	/		/	/	/			/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	46
		B.2.1 Organizational strategy			/	/		/		/		/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	44
		B.2.4 Innovation initiative with business needs and strategy			/	/				/		/		/		/			/	/			/	/	/					/						/			/	/		/	/						/				32
		B.2.5 Alignment of innovation	/		/					/	/			/		/					/				/					/	/		/		/	/	/		/	/	/	/	/				/	/	/				28
	Support	A4.2 Educating employee	/	/	/	/	/	/	/	/	/	/		/			/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/		/	/	/	/	/	/	/	/	/	/	44
		A4.5 Training programs.	/	/		/		/		/		/	/		/		/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/		/	/	/	/	/	/	/	/	/	/	41
		B.2.3 Establishing climate and environment in organization	/	/		/	/	/	/	/	/	/	/		/	/					/			/							/		/			/			/		/		/			/	/		/			/	24
		B3.1 Facilities e.g. laboratories, space, etc.	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	50
		B3.2 Budgets	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	50
		B3.3 Having knowledge and education	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/		/	/	/	/	/	/	/	/	/	/	47
		B3.4 Human Resources	/	/	/	/	/	/	/	/	/	/		/	/			/	/	/	/	/	/	/	/			/	/	/	/	/	/	/	/	/		/	/		/	/	/	/	/	/	/	/	/	/	/	/	43
	Operation	A2.3 An effective system for patient's rights	/		/	/				/		/	/		/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	44
		A2.4 Identifying Patients at Low Risk		/		/				/		/		/			/	/	/					/	/			/	/	/	/	/	/	/	/			/	/	/	/		/	/	/	/	/	/	/	/	/		31
		A4.1 Holding responsible for error-free output.		/				/			/		/	/	/		/	/	/					/	/			/	/	/	/	/	/	/	/			/	/	/	/		/	/	/	/	/				/		29
		A4.3 Decision-making to solve problems.		/	/	/	/	/	/	/			/	/		/			/					/	/	/	/	/	/	/	/		/	/	/	/			/	/	/		/	/	/	/	/	/		/			33
		A5.2 Monitoring and evaluation	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	49
		A5.3 Amount of preventive equipment maintenance		/	/					/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/						/					/	/		/				/	/	/	/	/		30
		A5.5 Risk management	/	/	/	/				/		/	/	/	/		/	/		/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/			/	/	/	/		/	/	/	/	/	/	/	/	/		39
		B4.1 Process management	/	/	/	/	/	/	/	/	/	/					/			/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	43
		B4.2 Internal and E/ternal Networking				/	/	/		/	/						/	/						/			/						/	/	/	/	/			/		/		/				/			/		/	20
		B4.3 Knowledge Management	/	/	/	/				/	/	/					/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/		/	/	/	/	/	/		/	/	/	/	/	/	/		/	39
		B4.4 Portfolio Management	/	/		/				/										/			/				/	/							/		/		/										/				12
		B5.1 Building distinctive competencies and competitive advantage		/		/						/		/																						/	/		/	/	/												9
		B5.2 Well-defined processes and formalized tools			/				/						/					/								/									/													/				7
		B5.3 Establishing an innovation award											/									/														/	/		/		/		/			/	/		/				10
		B5.4 Best practices documented and shared				/					/						/								/											/	/												/				7
	Method	A6.1 Information management	/	/	/		/	/	/	/	/	/	/				/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/		/	45
		A6.2 Data integrity and security			/	/				/		/	/								/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/		/	37
		A6.3 Data availability and accuracy	/	/	/		/	/	/	/	/	/	/				/	/			/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/		/	43
	Improvement	A3.1 Quality audits		/	/	/				/		/		/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	44
		A3.2 Continuous solving	/	/			/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	48
		A3.3 Improving product and process quality	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	50
		A3.4 Achieving quality standards		/		/				/		/	/	/		/	/	/		/			/		/		/	/	/	/	/	/	/	/	/		/	/		/	/						/				/		27

Table 4.4 shows the successful results of 50 projects that affected healthcare performance in terms of sustainability three dimensions, amounting to 33 factors. After a close follow-up of the performance results of these 50 projects for one year, each project could positively increase its healthcare performance in each aspect according to its objectives. Overall, most projects focused on social sustainability. Since healthcare was directly related to human life, management of quality of care, customer need, staff health, patient safety, facility management, new technology, medical ethic, and speed of time was what over 40 projects place importance on and wanted to develop further. In terms of economic sustainability, a calculation revealed that in just one year, 50 projects could decrease costs such as equipment and facility cost, staff cost, utility cost, and also increase sales from merchandise and service. Finally, in terms of environmental sustainability, few projects focused on this aspect because hospitals were an industry that created fewer adverse effects on the environment than other industries. Moreover, the use of energy could not be reduced as it would have affected treatment effectiveness, which was paramountcy important. Still, they focused on how to manage waste effectively.

Table 4.5 The refinement of healthcare performance from 50 innovation projects

		Factors	Case study project																																																	
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	Sum
Healthcare Performance	Economic Sustainability	Cost in equipment and facilities	/	/	/		/		/	/	/	/		/					/			/					/																/				/		/	/	/		17
		Long-term liability ratio		/	/		/			/		/		/								/																					/						/		/		10
		Utility (water /electricity)	/		/		/		/		/			/								/																					/						/		/		10
		Staff cost	/		/		/	/													/		/			/																/				/		/		/	/	12
		Cost in pharmaceutical and medical materials		/					/		/	/							/			/					/																/	/					/		/		11
		Marketing cost																				/																																1
		Outsourcing cost (housekeeping/ Food)																																																			0
		Debt-to-assets ratio													/																												/										2
		The growth rate in revenue			/	/					/					/			/	/	/		/				/											/	/	/	/	/			/		/	/	/	/					19
		Revenue			/	/					/					/			/	/	/		/				/											/	/	/	/	/			/		/	/	/	/					19
		Net profit rate			/	/					/					/			/	/	/		/				/											/	/	/	/	/			/		/	/	/	/					19
		Investment				/									/			/	/	/		/	/													/				/	/		/											11
	Environmental Sustainability	Energy from renewable																																																			0
		Energy from nonrenewable																									/																										1
		Energy regulations/certifications																																																			0
		Natural resource																																																			0
		Gaseous emissions														/																																				1
		Solid waste		/			/		/							/						/						/		/																								7
		Liquid waste								/												/								/																								3
		Other waste and emissions																																																			0
		Waste management regulations/certification																																																			0
		Recycled wastes use																																																			0
		Hazardous wastes		/					/	/												/					/	/		/			/							/			/								/		11
	Social Sustainability	Efficiency, Quality of care	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/		48
		Facility	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/		/	/	/		/		/	/	/	/	/	/	/		/	/	/		/	/	/	/	/		/	/	/	/	/		/	/	43
		Technology	/	/	/	/	/		/	/	/	/	/	/			/		/	/	/		/		/		/	/		/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	41
		Speed of time	/	/	/	/	/		/	/	/	/	/	/			/		/		/		/		/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/		/	40
		Safety	/	/	/	/	/	/	/	/		/	/	/	/		/	/	/		/	/	/	/	/	/	/	/	/	/	/	/		/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		44
		Health	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/			/	/	/	/	/	/	/	/	/	/	/		/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	45
		Customer need	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/			/	/	/	/	/	/	/	46
		Employee engagement		/	/	/	/	/				/	/	/			/		/				/	/											/				/		/		/								/	17
		Training		/	/	/		/		/		/	/	/			/		/		/			/							/				/				/		/		/		/								18
		Ethic	/	/	/	/		/	/	/		/	/	/	/		/		/		/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/		42

Table 4.5 shows the successful results of 50 projects that affected healthcare performance in terms of sustainability three dimensions, amounting to 33 factors. After a close follow-up of the performance results of these 50 projects for one year, each project could positively increase its healthcare performance in each aspect according to its objectives. Overall, most projects focused on social sustainability. Since healthcare was directly related to human life, management of quality of care, customer need, staff health, patient safety, facility management, new technology, medical ethic, and speed of time was what over 40 projects place importance on and wanted to develop further. In terms of economic sustainability, a calculation revealed that in just one year, 50 projects could decrease costs such as equipment and facility cost, staff cost, utility cost, and also increase sales from merchandise and service. Finally, in terms of environmental sustainability, few projects focused on this aspect because hospitals were an industry that created fewer adverse effects on the environment than other industries. Moreover, the use of energy could not be reduced as it would have affected treatment effectiveness, which was paramountcy important. Still, they focused on how to manage waste effectively.

4.3 PHASE 3: THE CONTENT VALIDITY OF DEVELOPED TQIM-H FACTORS

To verify the preciseness using the Item-Objective Congruency index (IOC) by seven healthcare experts. Each of the refined TQIM-H factors was rated as -1, 0, and +1 representing disagreement, uncertainty, and agreement, respectively. IOC index of at least 0.5 is considered acceptable. From brainstorming and analyzing average IOC scores in each factor with seven healthcare experts through characteristics and definitions of the refined conceptual framework of TQIM-H.

The Total Quality and Innovation Management in Hospital (TQIM-H) factors were verified using the Item-Objective Congruency index (IOC) by seven healthcare experts as shown in Table 4.6.

Table 4.6 The average IOC scores

Dimension	Factor	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7	Score	Results
Context of the Environment (Internal & External)	A2.1 Customer (patient etc.) satisfaction	1	1	0	1	1	1	1	0.86	YES
	A2.2 Solving the patient's complaints.	1	1	1	-1	1	0	1	0.57	YES
	A4.1 Informing the hospital's achievements	1	1	1	1	-1	1	0	0.57	YES
	A5.4 Litigation law refers to the rules and practices	1	1	1	1	1	1	1	1.00	YES
	B.1.4 Technological change	0	1	0	1	1	1	1	0.71	YES
	B1.2 Customer segment and customer needs	1	1	1	1	0	1	1	0.86	YES
Leader	A1.1B.2.2 Allocating resources.	1	1	1	0	1	1	1	0.86	YES
	A.1.2 Leader vision, Policy	1	1	1	1	1	1	1	1.00	YES
	A1.3 Assuming responsibility.	1	0	1	1	1	0	0	0.57	YES
	A1.4B.2.2 Supporting employees' suggestion	0	1	0	0	-1	0	1	0.14	NO
Planning	A5.1 Creating a strategic plan	1	1	1	1	1	1	1	1.00	YES
	B.2.1 Organizational strategy	1	1	0	1	1	1	1	0.86	YES
	B.2.4 Innovation initiative with business needs and strategy	1	1	1	1	-1	1	1	0.71	YES
	B.2.5 Alignment of innovation	1	1	0	1	1	0	1	0.71	YES
Support	A4.2A4.5 Educating employee and training programs.	1	1	1	1	1	1	1	1.00	YES
	B.2.3 Establishing climate and environment in organization	0	0	1	1	1	-1	0	0.29	NO
	B3.1 Facilities e.g. laboratories, space, etc.	1	0	1	1	1	1	1	0.86	YES
	B3.2 Budgets	1	1	1	1	1	1	1	1.00	YES
	B3.3 Having knowledge and education	1	1	1	1	1	1	1	1.00	YES
	B3.4 Human Resources	1	1	1	1	1	1	1	1.00	YES
Operation	A2.3 An effective system for patient's rights	1	1	1	1	1	1	1	1.00	YES
	A4.3 Decision-making to solve problems.	1	1	1	0	1	1	1	0.86	YES
	A5.2 A5.3 Monitoring and evaluation	1	1	1	1	1	1	1	1.00	YES
	A2.4A4.1A5.5 Risk management	1	1	1	1	1	1	1	1.00	YES
	B4.1 Process management	1	1	1	1	1	1	1	1.00	YES
	B4.2 Internal and External Networking	1	1	-1	1	0	1	1	0.57	YES
	B4.3 Knowledge Management	1	1	1	1	1	1	1	1.00	YES
	B4.4 Portfolio Management	1	1	-1	1	1	0	1	0.57	YES
	B5.1 Building distinctive competencies and competitive advantage	1	-1	1	1	1	1	1	0.71	YES
	B5.2 Well-defined processes and formalized tools	1	1	0	1	1	0	1	0.71	YES
	B5.3 Establishing an innovation award	1	-1	1	0	1	1	1	0.57	YES
	B5.4 Best practices documented and shared	0	1	1	1	-1	1	1	0.57	YES
Tools and Analysis method	A6.1 Information management	1	1	1	1	1	1	1	1.00	YES
	A6.2 Data integrity and security	1	1	1	1	1	1	1	1.00	YES
	A6.3 Data availability and accuracy	1	1	1	1	1	1	1	1.00	YES
Improvement	A3.1 Quality audits	1	0	1	1	0	1	0	0.57	YES
	A3.2 Continuous solving	1	0	1	1	1	1	1	0.86	YES
	A3.3 Improving product and process quality	1	1	1	0	1	1	1	0.86	YES
	A3.4 Achieving quality standards	1	0	1	1	1	0	0	0.57	YES
Economic Sustainability	C1.1 Cost in equipment and facilities	1	0	1	1	1	1	1	0.86	YES
	C1.2 Long-term liability ratio	0	1	-1	1	1	0	0	0.29	NO
	C1.3 Utility (water /electricity)	1	1	1	1	1	1	1	1.00	YES
	C1.4 Staff cost	1	1	1	1	1	1	1	1.00	YES
	C1.5 Cost in pharmaceutical and medical materials	1	1	1	0	0	1	1	0.71	YES
	C1.6 Marketing cost	1	1	0	1	1	0	0	0.57	YES
	C1.7 Outsourcing cost (housekeeping/ Food)	1	0	1	1	1	0	1	0.71	YES
	C1.8 Debt-to-assets ratio	0	1	0	1	0	-1	1	0.29	NO
	C1.9 The growth rate in revenue	1	0	1	1	1	1	1	0.86	YES
	C1.10 Revenue	1	0	1	1	1	1	1	0.86	YES
	C1.11 Net profit rate	1	1	0	1	1	1	1	0.86	YES
	C1.12 Investment	0	1	1	0	1	0	1	0.57	YES
Environmental Sustainability	C2.1 Energy from renewable	-1	1	0	1	0	-1	1	0.14	NO
	C2.2 Energy from nonrenewable	0	1	-1	-1	1	1	1	0.29	NO
	C2.3 Energy regulations/certifications	1	1	-1	0	1	0	0	0.29	NO
	C2.4 Natural resource	1	0	0	1	-1	1	-1	0.14	NO
	C2.5 Gaseous emissions	-1	1	1	-1	0	1	1	0.29	NO
	C2.6 Solid waste	1	1	0	1	1	1	1	0.86	YES
	C2.7 Liquid waste	1	1	1	1	1	1	1	1.00	YES
	C2.8 Other waste and emissions	0	1	1	-1	1	0	0	0.29	NO
	C2.9 Waste management regulations/certification	1	0	1	1	0	1	1	0.71	YES
	C2.10 Recycled wastes use	-1	1	1	0	1	0	0	0.29	NO
	C2.11 Hazardous wastes	1	1	1	1	1	1	1	1.00	YES
Social Sustainability	C3.1 Efficiency, Quality of care	1	1	1	1	1	1	1	1.00	YES
	C3.2 Facility	0	1	1	0	1	1	1	0.71	YES
	C3.3 Technology	1	1	0	1	1	1	1	0.86	YES
	C3.4 Speed of time	1	1	1	1	0	1	0	0.71	YES
	C3.5 Safety	1	1	1	1	1	1	1	1.00	YES
	C3.6 Health	1	1	0	1	1	1	1	0.86	YES
	C3.7 Customer need	1	1	1	1	0	1	1	0.86	YES
	C3.8 Employee engagement	1	1	1	1	0	1	1	0.86	YES
	C3.9 Training	1	1	0	1	1	1	1	0.86	YES
	C3.10Ethic	1	1	1	1	1	1	1	1.00	YES

Each of the refined TQIM-H factors was rated as -1, 0, and +1 representing disagreement, uncertainty, and agreement, respectively. IOC index of at least 0.5 was considered acceptable. Table 3.3 shows the average IOC scores. The factors with IOC below 0.5 were removed or revised. From the experts' viewpoint, they provide the argument including:

Each of the refined TQIM-H factors was rated as -1, 0, and +1 representing disagreement, uncertainty, and agreement, respectively. IOC index of at least 0.5 was considered acceptable. Table 3.3 shows the average IOC scores. The factors with IOC below 0.5 were removed or revised. From the experts' viewpoint, they provide the argument including:

A1.4B.2.2 Factors suggested by supporting employees: Healthcare experts believed that this factor did not relevant to the hospital management system because the hospital was an organization with multiple departments and each department had staff or specialists with specific knowledge. So, the suggestion from top management rarely affected hospital management and healthcare performance.

B.2.3 Established climate and environment in the organization: The panel experts suggested that this factor resembled organizational strategy in the planning dimension, Also, this factor should also be combined with B.2.1.

C1 . 2 Long-term liability ratio: This part did not relate to economical sustainability and organizational performance in the hospital context.

C1 .8 Debt-to-assets ratio: Total-debt-to-total-assets was a leverage ratio that defines the total amount of debt relative to assets owned by a company but this part was rarely implicated with healthcare management.

C2 .1 Energy from renewable, C2 .2 Energy from nonrenewable and C2 .4 Natural resource: Deployment of healthcare management had traditionally focused on the important role of patient safety. So, energy management was controlled by safety standards and legislation.

C2.3 Energy regulations/certifications: Energy certifications had never been in place in ASEAN. The experts, therefore, suggested removing this factor.

C2.5 Gaseous emissions C2.8 Other waste and emissions: Most of the waste produced by the healthcare industry were solid, liquid, and infectious wastes. Healthcare was a lesser source of greenhouse gases relative to other sectors.

C2 . 1 0 Recycled wastes use: The process of patient care involved contamination and infectious activities. It was important to sterilize equipment or medical instruments. Therefore, the use of recycled waste could increase patient risk, which became a problem with the system.

4.4 PHASE 4: THE REFINED TQIM-H CONCEPTUAL FRAMEWORK

The refined TQIM-H conceptual framework which was developed through three research methods consists of seven dimensions, which were, Context of the Environment (Internal & External), Leader, Support, Planning, Operation, Tools, and Analysis method, and Improvement, all of which results in positive healthcare performance including three sustainability impacts: economic, environmental, and social dimension as shown in figure 4.4.

Dimension	Factor
Context of the Environment (Internal & External)	A2.1B.1.2 Customer (patient etc.) satisfaction and customer needs
	A2.2 Solving the patient's complaints.
	A4.1 Informing the hospital's achievements
	A5.4 Litigation law refers to the rules and practices
	B.1.4 Technological change
Leader	A1.1B.2.2 Allocating resources.
	A.1.2 Leader vision, Policy
	A1.3 Assuming responsibility.
	A1.4B.2.2 Supporting employees' suggestion
Planning	A5.1 Creating a strategic plan
	B.2.1 Organizational strategy
	B.2.4 Innovation initiative with business needs and strategy
	B.2.5 Alignment of innovation
Support	A4.2A4.5 Educating employee and training programs.
	B.2.3 Establishing climate and environment in organization
	B3.1 Facilities e.g. laboratories, space, etc.
	B3.2 Budgets
	B3.3 Having knowledge and education
	B3.4 Human Resources
Operation	A2.3 An effective system for patient's rights
	A4.3 Decision-making to solve problems.
	A5.2 A5.3 Monitoring and evaluation
	A2.4A4.1A5.5 Risk management
	B4.1 Process management
	B4.2 Internal and External Networking
	B4.3 Knowledge Management
	B4.4 Portfolio Management
	B5.1 Building distinctive competencies and competitive advantage
	B5.2 Well-defined processes and formalized tools
	B5.3 Establishing an innovation award
	B5.4 Best practices documented and shared
Tools and Analysis method	A6.1 Information management
	A6.2 Data integrity and security
	A6.3 Data availability and accuracy
Improvement	A3.1 Quality audits
	A3.2 Continuous solving
	A3.3 Improving product and process quality
	A3.4 Achieving quality standards

Dimension	Factor
Economic Sustainability	Cost in equipment and facilities
	Long-term liability ratio
	Utility (water /electricity)
	Staff cost
	Cost in pharmaceutical and medical materials
	Marketing cost
	Outsourcing cost (housekeeping/ Food)
	Debt-to-assets ratio
	The growth rate in revenue
	Revenue
	Net profit rate
	Investment
Environmental Sustainability	Energy from renewable
	Energy from nonrenewable
	Energy regulations/certifications
	Natural resource
	Gaseous emissions
	Solid waste
	Liquid waste
	Other waste and emissions
	Waste management regulations/certification
	Recycled wastes use
	Hazardous wastes
Social Sustainability	Efficiency, Quality of care
	Facility
	Technology
	Speed of time
	Safety
	Health
	Customer need
	Employee engagement
	Training
	Ethic

Figure 4.4 The refined TQIM-H conceptual framework

The refined TQIM-H conceptual framework consists of seven dimensions and impacted three healthcare performances which were,

1.) Context of the Environment (Internal & External): This was the study of factors required to create and develop products and services, taking internal and external contexts into account. For external contexts, they were customers' demand, their complaints, and the changing environment of rivals in the same market. For internal contexts, they were the vision and mission of an organization. These two contexts facilitated designs of products and services in a way that satisfied customers, resulting in success.

2.) Leader: This was the crucial factor in the management that drove the organization forwards because the top management role was more crucial than other service industries and was responsible for the quality of care and overall hospital system. Leaders also had to encourage the rest to contribute to organizational success. The organization leaders' visions were thus crucial for driving quality and innovation systems. Most vital was their role in allocating budgets and facilities needed to develop new systems.

3.) Support: Support came in a variety of aspects, for example, knowledge, financial support, facilities. It was a very crucial factor that drove innovation and equipped personnel in the organization with tools. Also, the organization with flourishing innovation was the one that had human resource management, which led to effective collaboration with the organization.

4.) Planning: Health planning represented the first step in an orderly process to accomplish things necessary to improve the health status of individuals and populations. The planning and evaluation cycle, however, was structured, allowing us to succeed in identifying and solving health problems.

5.) Operation: Hospitals had various components and were diverse. The hospital was an organization that was highly complex in terms of personnel, knowledge from different fields, working processes, management of confidential patients' data, and their rights. Also, the risk was less tolerable in the hospital than in any other service industry. Comprehensive development and operation would create effectiveness in service and customers' satisfaction and they should have been in line with fundamental laws governing hospitals.

6.) Tools and Analysis method: Data analysis in the hospital was far more complex and crucial, as it involved the matters of life and death. The risks stemmed from managing a large amount of complex and confidential data. These factors should be attended to because they concerned the performance and credibility of the organization in the long run.

7.) Improvement: Continuous improvement was significant for the operation of the hospital, as it increased personnel's effective performance and capabilities of curing patients. Also, it would boost the performance of tackling newly-found diseases, namely incorporating new technologies to assist in taking care of patients with greater effectiveness and capability for competition.

The healthcare performance factors were summarized and analyzed such that the definition of each factor was established with healthcare experts. They were

1.) Economical dimensions: Healthcare finance was an important factor indicating the effectiveness of management and the organization's success because it was the factor crucial for the survival of a hospital and its continuation of the business and health service. Financial management was grouped into two parts: decreasing costs and increasing revenue. Cost management and cost control were important factors in maintaining and growing healthcare performance. Staff cost was the biggest expenditure organization paid because in the medical service, a large number of experts e.g. doctors, nurses, and general officers, were needed. Moreover, the cost in equipment, utility cost, and cost in medical materials were defrayed since the treatment process required efficient tools and facilities, some of which were costly and not omittable. Additionally, the long-term debt-to-total-assets ratio was a coverage or solvency ratio used to calculate the amount of a hospital's leverage. Income and growth dimension consisted of net patient revenue which was total patient revenue minus contractual allowances and discounts on patients' accounts and it could be considered in the growth rate of profitability. The net profit margin was equal to how much net income or profit was generated as a percentage of revenue. Furthermore, the important part was the healthcare investment which was the act of putting money to expand a business or the purchase of an asset.

2.) Environmental dimension: The hospitals intended to manage waste, both in solid and liquid forms, and infectious waste produced by internal processes in the hospitals. Furthermore, waste management was regulated by laws and the hospitals also attended to the use of energy, which affected the effectiveness of treatment and care. Decreasing energy use and using the natural energy source in healthcare have never been discussed because it was vital for the patient care process and it affected patient risk.

3.) Social dimension: The hospitals place most emphasis on this aspect, highlighting individuals. Social dimensions had two parts, external social (patients) and internal social which referred to personnel working in the hospital. The external social was patients or customers attending healthcare services. Since healthcare was an industry concerning humans and the matter of life and death, human is given such importance. Thus, the factor that all hospitals attend to, especially in the aspect of quality of care, which was the ability to take care of patients and cure them of illnesses safely and is at the center of concern. Also, hospitals prioritized the readiness of facilities, technologies, modern treatment, and service. The service had to be quick and safe because patients were already vulnerable. Last, the healthcare business also operated its service based on ethics within the organization and personnel. On the other hand, internal social was healthcare staff or persons in the healthcare system. They were a critical factor in determining the quality of care in hospitals and the nature of patient outcomes. So, healthcare staff should have been provided the safety and health from their work because it affected treatment outcomes and healthcare performance.

It indicated that the refined TQIM-H conceptual framework has applied both characteristics of innovation and quality management affecting healthcare sustainability. Innovation management is processes and patterns with new technologies to enhance effectiveness in treatment. Quality management concerns human life and working performance in line with medical standards and, law. Thus, this conceptual framework was useful for healthcare aiming at creating innovative projects in healthcare, since this framework represented important characteristics, key success factors, scope needed to design innovation projects. The innovative projects needed concentration and focus so that projects could be achieved smoothly and effectively and receive recognition from organization members and the markets.

In conclusion, this Chapter integrated TQM and innovation management in hospitals by analyzing/conducting a systematic literature review with three experts. The result was confirmed through SEA innovation case studies, extending the work from Prajogo & Sohal in 2003 which integrated TQM and innovation management in manufacturing, and applying the work of Rebelo, et al. (2006) by using ISO 56002. The result of the study was TQIM-H which consisted of seven dimensions (Context of the Environment (Internal & External), Leader, Support, Planning, Operation, Tools and Analysis method, and Improvement). These factors were important key factors for the development of implementable innovation that could be used sustainably. The characteristics of the factors also suited with health organization management because they agreed with healthcare cultures including medical regulation. However, we only knew the seven factors but did not know the procedure or how to manage each TQIM-H factor. The lack of such knowledge would lead to the misuse of the TQIM-H. Therefore, the next Chapter aimed to develop the TQIM-H inventive principle which had a procedure like characteristic and could be used for the management of each TQIM-H.

CHAPTER 5
THE DEVELOPMENT OF TQIM-H INVENTIVE PRINCIPLE BY DELPHI STUDY

From the previous Chapter, the TQIM-H framework, which was a key factor for the sustainable development of innovation in hospitals, was created. However, the procedure and how to manage according to the framework has not been established, applying the framework effectively and accurately was not possible. Therefore, this Chapter aimed to develop the TQIM-H inventive principle, which was procedures and processes for management according to the TQIM-H framework. The principle would be developed based on TRIZ inventive principle, an engineering tool developed by Altashuler the Russian. The integration of the TQIM-H framework and TRIZ inventive principle by the Delphi method yielded the TQIM-H inventive principle.

Table 5.1 The development of TQIM-H inventive principle by Delphi study

Objective	Process	Result
To develop the TRIZ inventive principle to provide practitioners with an effective procedure to manage quality and innovation management systems in hospital (TQIM-H) through Delphi method.	A Delphi survey on TQIM-H issues with 30 experts in five related areas of expertise in quality management and innovation management in the hospital was conducted in three rounds to gain a further consensus. 1st round: In-depth interview with 30 healthcare experts in two parts including open questionnaire and importance and working performance questionnaire. Then, the results were analyzed through the IPA method. 2nd round: The methodology and procedure of ("how to achieve") the TQIM-H was established by in-depth interview and brainstorming with 30 healthcare experts. 3rd round: TRIZ and TQIM-H procedure were integrated through text and meaning similarity analysis by experts' brainstorming. Then, the Cochran test was used to confirm the developed TQIM-H inventive principle.	The TQIM-H inventive principle

The TRIZ methodology

The TRIZ methodology is a well-structured inventive problem-solving process whose application of thinking tools in diverse industries successfully replaces the unsystematic trial-and-error method used in the search for solutions to the everyday lives of engineers and developers (Ruchti & Livotov, 2001). Altshuller, the proponent of the TRIZ method, analyzed thousands of worldwide patents from leading engineering fields, and categorized these patents in a novel way by removing the subject matter to identify the problem-solving processes instead of classifying the patents by industry. From this, he found that the same problems were often solved repeatedly using only 40 fundamental inventive principles.

In this respect, Domb et al. (1998) indicated that TRIZ researchers have encapsulated the principles of good inventive practice and set them onto a general problem-solving structure. The general model for TRIZ problem solving is shown in Figure 5.1. Loebmann (2002) explained the general process by which the TRIZ method overcomes the psychological inertia barrier, and this is through the generalization of the specific problem to an analogous TRIZ generic problem. Consequently, through the comparison of this generic TRIZ problem with the analogous generic TRIZ solution in the knowledge database obtained from scientific effects and patents research, one can generate the solutions for a specific problem. TRIZ helps avoid an inefficient route for problem-solving, and instead provides a systematic and efficient way to solve problems. Hence, it is a reliable process that results in systematic innovation.

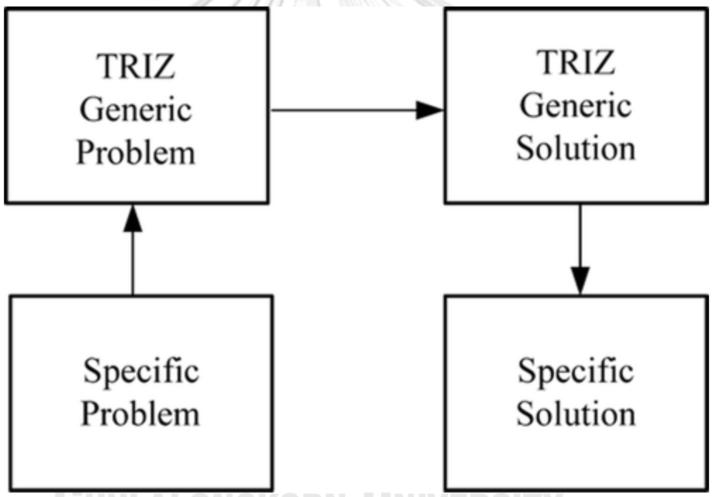


Figure 5.1 The general TRIZ process (Domb et al., 1998)

In the TRIZ methodology, the fundamental idea in the conceptual framework is the extraction of the essential conflicts from the problems and the eventual resolution of the conflicts. Altshuller asserted that an invention frequently appears when a contradiction between the engineering parameters is resolved. The contradictions can either be technical contradictions in the form of two mutually conflicting parameters within a system, or physical contradictions that are the direct opposite of two values for a parameter formulated by the same system.

Concerning resolving contradictions within a system, one of the most popular tools of TRIZ is the contradiction matrix. This matrix comprises 39 engineering parameters and 40 types of inventive principles. The 39 engineering parameters are defined as the behavior or state of a technological system, and most of the engineering products are a compromise between competing features, that is, trying to improve one feature often degrades another. Altshuller arranged these 39 features in each side of a two-dimensional matrix, and at each intersection, some inventive principles are indicated as a reference to resolve the contradictions between these denoted competing features. The 40 inventive principles currently contained within the TRIZ methodology present complete descriptions of the detailed solution thinking contained in each principle, and a few samples of how other problem solvers have used a particular principle to resolve a given situation involving a contradiction. A sample selection from the TRIZ contradiction matrix is shown in Figure 5.2. It can be seen that each of the parameters could either be an improvement or a worsening feature. For instance, if one of the improving features of a specified system is strength (14), which is achieved at the expense of a worsening feature with regard to the weight of a moving object (1), then the inventive principles No. 1 ('segmentation'), No. 8 ('anti-weight'), No. 40 ('composite material'), and No. 15 ('dynamics') might be the applicable suggestions.

Domb et al. (1998) described that one barrier in the application of the contradiction matrix in the TRIZ process is the very brief statement of the lists of improving and worsening features. Thus, in their study, they derived an expanded explanation of the 39 features of the contradiction matrix by comparing several different translations for convenience in using the matrix. Furthermore, in expanding the use of the 39 engineering parameters of the contradiction matrix, Liu and Chen (2001) tried to develop a green innovation design method by using TRIZ inventive principles without contradiction information and examining the relationships between the 39 engineering parameters of TRIZ and each of the major elements of eco-efficiency in the development of non-impacted environmental products or processes for the company. Hasan et al. (2004) considered the correspondence between safety standards and contradiction resolution by means of the TRIZ to come up with various resolution principles to assist the equipment or machine designer in his/her task and to take into account safety as soon as possible. However, there is limited literature discussing the 39 engineering parameters in the TRIZ contradiction matrix, more especially for service areas, and there is also the lack of an effective method to analyze the analogical relationship between the 39 TRIZ engineering parameters and the characteristic features of individual service sectors. Hence, an efficient way of correlating the 39 TRIZ engineering parameters and the service determinants of individual service sectors is developed in our systematic process, and the inventive results are effectively obtained.

Improving feature ↓ / Worsening feature →		Weight of moving object	Weight of stationary object	Strength	Loss of information	Ease of repair
		1	2	14	24	34
1	Weight of moving object			28 27 18 40	10 24 35	2 27 28 11
2	Weight of stationary object			28 2 10 27	10 15 35	2 27 28 11
14	Strength	1 8 40 15	40 26 27 1			27 11 3
24	Loss of information	10 24 35	10 35 5			
34	Ease of repair	2 27 35 11	2 27 35 11	11 1 2 9		

Figure 5.2 A partial contradiction matrix with suggested inventive principles.

Delphi Method

The Delphi study was originally developed by the RAND Corporation in California in the 1950s and 1960s to elicit expert opinions (Woudenberg, 1991). The Delphi is a tool for discovering agreement and consensus by sharing the criticism (Buckley, 1995; Delbecq, Van de Ven, & Gustafson, 1975). Delbecq et al. (1975) describe the Delphi process as the approach that contains a survey conducted in two or more rounds and provides the experts in the second round with the feedback of the previous round then adjusts the original assessments. The same experts assess the specific topic in two or more rounds and the result of the next round was influenced by the opinions of the other experts(Linstone & Turoff, 1975). Linstone and Turoff (1975) stated that the method requires expert contributors submitted separate responses to questions to a central coordinator. Delphi method is suitable for experts in different locations and if there are political issues among a group. The benefits of the Delphi technique are the potential for anonymity, the ability to equalize participants, and the ability to remove personality factors from the process (Howze & Dalrymple, 2004). The sample size of the Delphi study should be a sufficient number of experts. In addition, experts should be willing to complete the entire study and provide enough information.

The rationale for the use of the Delphi approach for TQIM-H research and evaluation was several. First, it is a good research method for deriving consensus among a group of experts on complex and subjective topics (Linstone & Turoff, 1975). Second, participants are separated by physical distance, so the information can derive from various companies without any political barrier. Last but not least, the Delphi approach is well known and accepted in several areas. Christian (2004) supported that Delphi was studied more than 612 articles in many research areas including information management, healthcare, banking, and quality management. However, the Delphi approach is time-consuming (Christian, 2004). Consequently, this study selected the computer-based approach. Delbeq et al. (1975) revealed that computer capability takes a shorter turnaround time, allowing for more immediate feedback and ongoing interaction (Delbeq et al., 1975).

The methodology of this study was a Delphi survey on TQIM-H issues which was conducted in three rounds to gain a further consensus. Developing an effective TQIM-H inventive principle would lead to the ability to create innovative projects in hospitals, thus improving the potential of the hospitals. In the first round, the study started with refining the TQIM-H factor through in-depth interviews with 30 healthcare experts using importance and performance analysis (IPA). Then, the second round is to develop the TQIM-H procedure or (How to achieve) TQIM-H via an in-depth interview with healthcare experts. Finally, the third round is to establish TQIM-H inventive principle through integrating the TQIM-H procedure and TRIZ inventive principle by analyzing and brainstorming among the TRIZ team. Then, the correlation of TQIM-H procedures and the TRIZ inventive principle was confirmed and approved by 30 expert panels via questionnaire.

Table 5.2 Three rounds of Delphi methodology

Delphi	Objective	Method	Tool	Result
1^{st} round	To refine the TQIM-H factor	- In-depth interview - Importance performance analysis	- Open questionnaire - Importance performance scale questionnaire	The refined TQIM-H factor
2^{nd} round	To develop the TQIM-H procedure	- In-depth interview - Brainstorming	- Open questionnaire	TQIM-H procedure
3^{rd} round	To develop the TQIM-H inventive principle	- In-depth interview - Text and meaning similarity analysis - Brainstorming	- Questionnaire - The Cochran test	TQIM-H inventive principle

1^{st} Round Delphi: The refinement and confirmation of the TQIM-H factor

This stage aims to refine the TQIM-H factor by analyzing systematic reviews and case studies via in-depth interviews with healthcare experts.

Table 5.3 The refinement and confirmation of the TQIM-H factor

Objective	**Method**	**Tool**	**Result**
This stage aims to refine the TQIM-H factor by analyzing literature reviews and case studies via in-depth interviews with healthcare experts.	<u>In-depth interview with healthcare experts</u> Healthcare experts can provide their opinions to develop quality and innovation management in healthcare through open questionnaires and provide scores with the ranges of level 1-9 to TQIM-H factors <u>Importance performance analysis</u> The results from the questionnaire were analyzed using mean scores and IPA graphs to analyze TQIM-H factors affecting healthcare performance.	<u>- Questionnaires</u> Part 1:Open questionnaire Part 2:Importance performance scale questionnaire with the ranges of level 1-9 to TQIM-H factors <u>- Importance performance analysis method</u>	TQIM-H factor

Healthcare experts can provide their opinions to develop quality and innovation management in healthcare through open questionnaires and provide scores with the ranges of level 1-9 to TQIM-H factors. The results from the questionnaire were analyzed using mean scores and IPA graphs to analyze TQIM-H factors affecting healthcare performance. Then, the results of an open questionnaire and IPA graphs were summarized and concluded to be the refined TQIM-H factor. In this round, the developed questionnaire consisted of two parts including Part A: Open questionnaire and Part B: The importance and working performance measurement questionnaire. The step of Delphi's 1st round is shown below.

A group of experts was invited to provide opinions on the quality and innovation management in healthcare

↓

The developed questionnaires were sent to healthcare experts.

↓

The expert panels studied to understand the characteristics of the quality and innovation management in healthcare

↓

The healthcare expert was interviewed with the developed questionnaire consisted of two parts including an open questionnaire and the importance and working performance measurement questionnaire

↓

The results of the open questionnaire were analyzed and sent back to healthcare experts to confirm the information's accuracy.

↓

The score results of TQIM-H factors have analyzed the importance and performance through IPA analysis.

↓

The results of the open questionnaire were analyzed with the TQIM-H factor in the 1st and 2nd quadrant of the IPA graph to explain and present the refined TQIM-H factor which will be used in the 2nd round and 3rd round.

Figure 5.3 The step to refine and confirm the TQIM-H factor

The results from the questionnaire were analyzed using mean scores and IPA graphs to analyze TQIM-H factors affecting healthcare performance. Then, the results of an open questionnaire and IPA graphs were summarized and concluded to be the refined TQIM-H factor.

Table 5.4 Total Quality and Innovation Management in Hospital analysis

TQIM-H	Importance level		Performance level		Quadrant
	Mean	SD	Mean	SD	
A2.1 Customer (patient etc.) satisfaction	8.67	0.55	7.83	0.91	Q2
A2.2 Solving the patient’s complaints.	7.37	1.27	6.77	0.86	Q3
A4.1 Informing the hospital’s achievements	6.90	1.58	7.10	1.03	Q4
A5.4 Litigation law refers to the rules and practices	8.67	0.71	8.23	1.04	Q2
B1.1 Technological change	8.03	0.76	7.10	1.47	Q2
B1.2 Customer segment and customer needs	7.37	1.03	7.40	0.97	Q4
A1.1 Allocating resources.	8.57	0.63	6.83	1.02	Q1
A1.2 Leader vision, Policy	8.27	0.69	7.37	1.07	Q2
A1.3 Assuming responsibility.	7.37	1.22	7.47	1.28	Q4
A1.4 Supporting employees' suggestion	6.97	1.40	6.37	1.22	Q3
A5.1 Creating a strategic plan	8.33	0.88	6.87	1.17	Q1
B2.1 Organizational strategy	7.30	1.02	6.83	0.87	Q3
B2.2 Alignment of innovation	8.10	0.80	6.17	0.91	Q1
B2.3 Innovation initiative with business needs and strategy	7.17	1.42	6.00	0.95	Q3
A4.2 Educating employee and training programs	8.60	0.56	6.53	1.20	Q1
B3.1 Facilities e.g. laboratories, space, etc.	8.33	0.76	6.37	1.35	Q1
B3.2 Budgets	8.40	0.86	6.37	1.25	Q1
B3.3 Having knowledge and education	7.33	0.96	6.20	0.89	Q3
B3.4 Human Resources	7.23	1.01	6.33	1.15	Q3
A2.3 An effective system for patient’s rights	7.30	1.06	7.93	1.14	Q4
A4.3 Decision-making to solve problems.	7.20	1.58	6.13	1.25	Q3
A5.2 Monitoring and evaluation	8.10	0.71	7.03	1.19	Q2
A5.5 Risk management	8.50	0.63	7.53	0.90	Q2
B4.1 Process management	8.50	0.51	6.87	0.97	Q1
B4.2 Internal and External Networking	8.13	0.82	7.10	1.37	Q2
B4.3 Knowledge Management	8.47	0.57	6.63	1.30	Q1
B4.4 Portfolio Management	7.13	1.01	5.70	1.21	Q3

TQIM-H	Importance level		Performance level		Quadrant
	Mean	SD	Mean	SD	
B5.1 Building distinctive competencies and competitive advantage	8.17	0.75	6.13	1.43	Q1
B5.3 Establishing an innovation award	8.00	0.74	6.90	1.16	Q2
B5.4 Best practices documented and shared	7.33	1.03	5.97	1.10	Q3
A6.1 Information management	8.43	0.77	7.27	1.11	Q2
B5.2 Well-defined processes and formalized tools	8.00	0.95	6.40	1.04	Q1
A6.2 Data integrity and security	8.47	0.82	7.43	1.50	Q2
A6.3 Data availability and accuracy	8.53	0.78	7.50	1.04	Q2
A3.1 Quality audits	8.17	0.83	7.33	1.06	Q2
A3.2 Continuous solving	8.13	0.73	7.10	0.84	Q2
A3.3 Improving product and process quality	7.40	0.81	7.27	1.14	Q4
A3.4 Achieving quality standards	8.03	0.89	7.73	1.08	Q2

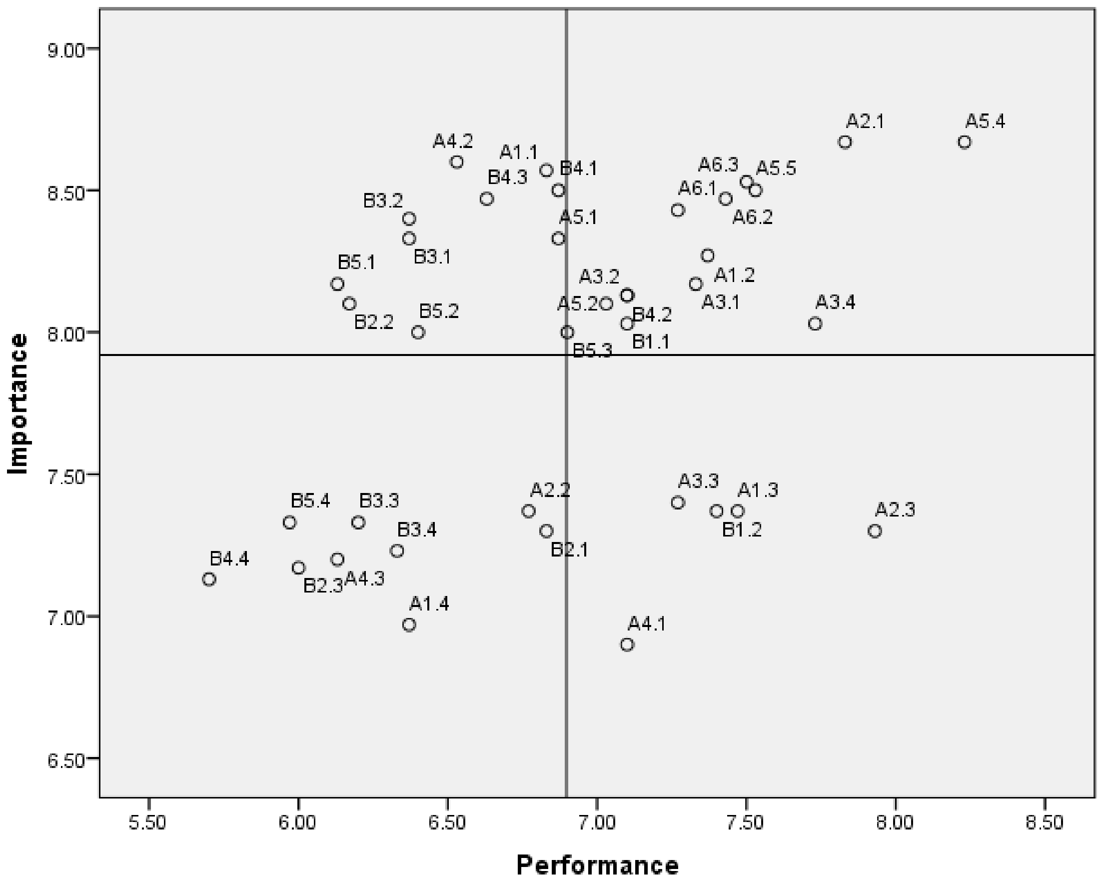


Figure 5.4 IPA of Total Quality and Innovation Management in Hospital

Figure 5.4 shows the analysis of the importance and working performance level of the TQIM-H factor through the IPA graph. The X-axis provides the performance level of each TQIM-H factor scored by 30 healthcare experts. On the other hand, the Y-axis shows the importance level of each TQIM-H factor provided by 30 expert panels.

Tontini et al. (2014) found that IPA is a tool that can be used to assist in omitting factors because IPA categorizes factors according to their importance and performance level scores. It also hints at the characteristics of the factors, facilitating the further application of the factors (Tontini & Picolo, 2014; Tontini et al., 2014).Several studies found that using the mean for categorization resulted in the best cut-off power since factors with values under the mean are omitted. This allows the elimination of 50% of the factors (Azzopardi & Nash, 2013; Chen et al., 2016; Sever, 2015) Several studies used IPA with the mean as a cut-off to categorize factors and yielded good results (Bacon, 2003; Boley et al., 2017; Matzler et al., 2004). In this study, we used IPA with the mean score as a cut-off since the experts from the first round Delphi suggested that there were too many factors, some had a very low impact. They also suggested that 30%-50% of the factors could be ignored.

Then, the author and healthcare experts have brainstormed and summarized that TQIM-H factors in quadrant 1 and quadrant 2 will be used to develop the TQIM-H system because the 1st and 2nd quadrant are important factors to manage healthcare quality and innovation. On the other hand, TQIM-H factors in quadrant 3 and quadrant 4 will be deleted because there is unimportance to manage a healthcare innovative system. Thus, in this study, TQIM-H factors in quadrant 1 and quadrant were used to analyze and provide their procedure in the future round. From the IPA results, the author analyzed the TQIM-H factor by separating in four quadrants including:

Quadrant 1: “Concentrate here” (high importance and low performance). This quadrant shows that a company’s performance does not meet the importance level of its products and services. Therefore, management needs to focus on improving current products and services performance. The 2nd quadrant has 14 TQIM-H factors including A2.1: Customer (patient etc.) satisfaction, A5.4: Litigation law refers to the rules and practices, B1.1: Technological change, A1.2: Leader vision, Policy, A5.2: Monitoring and evaluation, A5.5: Risk management, B4.2: Internal and External Networking, B5.3: Establishing an innovation award, A6.1: Information management, A6.2: Data integrity and security, A6.3: Data availability and accuracy, A3.1: Quality audits, A3.2: Continuous solving, and A3.4: Achieving quality standards.

From analyzing the TQIM-H factor, the author found high importance levels but low-performance levels in the 1st quadrant because all of these factors did not have the organizational regulation and KPI that was measured the tangible performance. Thus, healthcare workers did not give priority to improving and provideing effective management. In addition, the organization did not have a policy and action plan on these factors. However, expert panels recommended that organizations should focus and emphasize TQIM-H factors in quadrant 1 since the factor in 1st quadrant may be the key success factor in managing an effective quality and innovation in healthcare. To achieve high organizational performance, hospitals should provide the organizational strategy and planning to efficiently manage these factors.

Quadrant 2: “Keep up the good work” presented high importance and high performance of each TQIM-H factor. Attributes plotted in this area show that the hospital must continue to perform well, as the attributes are considered important. The attributes in this quadrant may be viewed as a set of opportunities to continue doing a good job over competitors. The 1st quadrant has 10 TQIM-H factors including A1.1: Allocating resources, A5.1: Creating a strategic plan, B2.2: Alignment of innovation, A4.2: Educating employee and training programs, B3.1: Facilities e.g. laboratories, space, etc., B3.2: Budgets, B4.1: Process management, B4.3: Knowledge Management, B5.1: Building distinctive competencies and competitive advantage, and B5.2: Well-defined processes and formalized tools.

After analyzing TQIM-H factors in the second quadrant, the author and expert panels found that these factors were important and had high performance because all of these factors were used as criteria and Key Performance Indicator (KPI) of an organization. Moreover, some factors in this quadrant represented medical regulation and quality standards, thus, the organization and healthcare workers paid attention to these factors and performed well. Therefore, such attributes must be maintained and exploited to achieve organizational maximum benefits as a potential competitive advantage. At this point, the factor in the second quadrant is important to sustain an optimum level of resources to suffice healthcare maximum benefits.

Quadrant 3: “Low priority” (low importance and low performance). Customers perceive attributes in this area as unimportant and are communicating that the company is not performing well. The 3rd quadrant has 9 TQIM-H factors including A2.2 Solving the patient’s complaints, A1.4 supporting employees' suggestion, B2.1 Organizational strategy, B2.3 Innovation initiative with business needs and strategy, B3.3 Having knowledge and education, B3.4 Human Resources, A4.3 Decision-making to solve problems, B4.4 Portfolio Management, and B5.4 Best practices documented and shared.

Quadrant 4: “Possible overkill” (low importance and high performance). For each attribute in this area, customers evaluate its performance as exceeding its importance. Therefore, much attention to this area could represent overkill concerning the use of resources that could be better directed to other areas, although high performance on an attribute in this area could be considered a strength in that it may enable the company to attract new customers (Gates & Amarani, 1992). The 4th quadrant has 5 TQIM-H factors including A4.1 Informing the hospital’s achievements, B1.2 Customer segment, and customer needs, A1.3 Assuming responsibility, A2.3 An effective system for patient’s rights, and A3.3 Improving product and process quality.

From brainstorming and analysis among the author and expert panels, the attribute situated in quadrant three and quadrant four have low importance. The attribute was successfully performed but unfortunately deemed irrelevant to the management of quality and innovation in healthcare. As such, there is no need for any changes in the efforts or resources allocated. On the other hand, perhaps it is more beneficial to curtail the resource allocation and redeploy the efforts to the other attribute that needs immediate action. Thus, in this study, the TQIM-H factor in quadrant three and quadrant four were omitted. The factor in quadrant 1 and quadrant 2 would be used in the next round. So, TQIM-H factors were reduced from 38 factors to 23 factors.

Table 5.5 Healthcare Performance analysis

Sustainability	Importance level		Performance level		Quadrant
	Mean	SD	Mean	SD	
C.1.1 Cost management	8.17	0.87	7.33	0.96	Q1
C.1.3 Net profit rate	8.30	0.75	7.40	1.33	Q2
C.1.5 Growth rate in revenue	6.57	1.07	7.20	1.21	Q3
C.1.6 Dept-to-assets ratio	6.03	1.16	6.83	1.62	Q3
C.1.7 Investment	7.18	0.81	7.57	0.93	Q4
C.2.1 Energy management	8.00	0.74	7.07	0.87	Q1
C.2.2 Natural resource management	6.20	0.89	6.77	1.57	Q3
C.2.3 Waste management	8.03	0.93	8.00	0.95	Q2
C.2.4 Recycle management	6.10	1.03	7.87	0.90	Q4
C.3.1 Internal customer	8.37	0.67	6.97	1.38	Q1
C.3.2 External customer	8.53	0.63	8.27	0.83	Q2

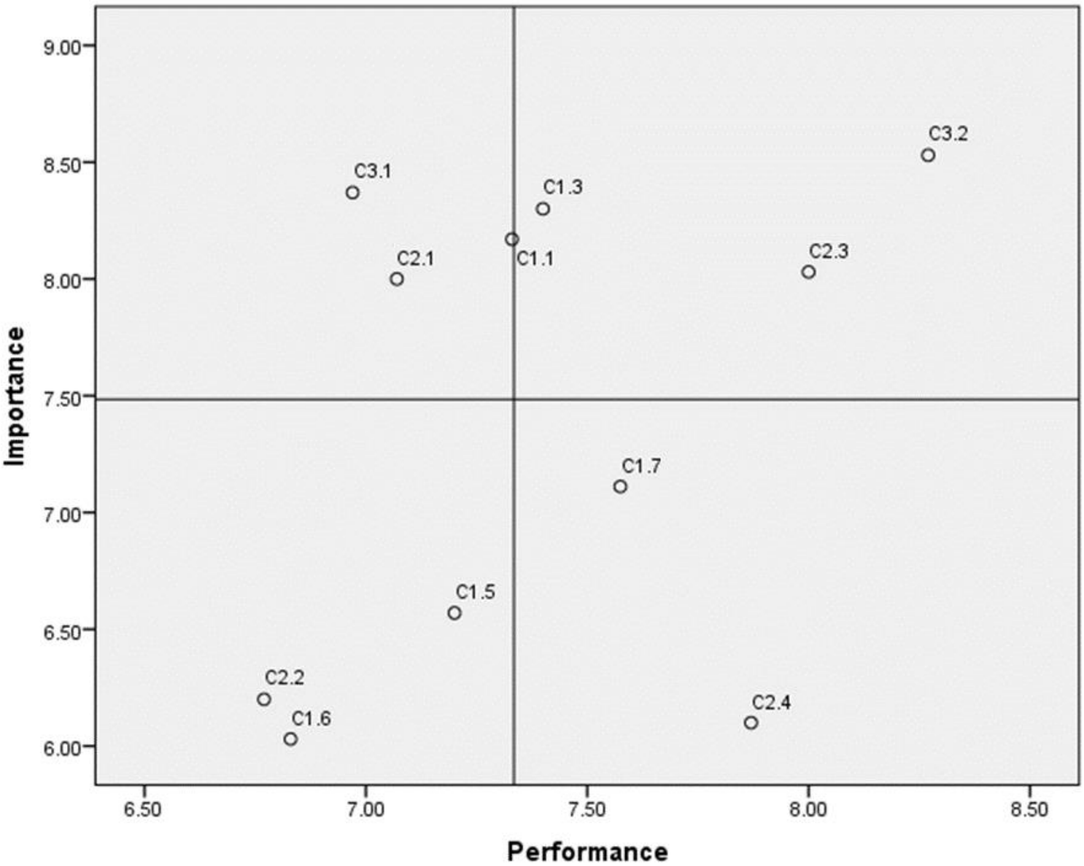


Figure 5.5 IPA of Performance

Figure 5.5 shows the IPA of organizational performance measurement factor result. The data provides the prioritization of each performance measurement factor that healthcare should focus on and follow to measure the success of each innovation project. The X-axis shows the performance level of each organizational performance measurement factor scored by 30 healthcare experts. On the other hand, the Y-axis shows the importance level of each organizational performance measurement factor provided by 30 expert panels. For summarizing healthcare performance measurement, the results of the hospital importance and working performance were analyzed through IPA methodology and presented via IPA graph. The author and healthcare experts chose the measurement factors in quadrant 1 and quadrant 2 because there are important to measure organizational performance.

IPA shows that the performance measurement factor in quadrant second was important and had high performance. This is because the factor in quadrant second has related to organizational policy and KPI. Thus, an organization and healthcare workers nurtured all of these factors and monitored the performance of these factors.

The 1st quadrant has three performance measurement factors including C.1.1 Cost management, C.2.1 Energy management, and C.3.1 Internal customer. performance measurement factors in the 1st quadrant were very important attributes to quality and innovation management in healthcare. However, the performance of the institution is low. Because these factors did not relate to organizational policy and regulations, they were neglected. Since these attributes are major weaknesses of the institution, and they necessitate instant improvement intervention, it demands the highest prioritization in terms of allocation of resources and effort to achieve higher healthcare performance.

Factors in the third and fourth quadrants were performance measurement factors with low importance levels, thus posing no threat to the organizations. These factors were omitted in this round. The 3rd quadrant has three performance measurement factors including C.1.5 Growth rate in revenue, C.1.6 Dept-to-assets ratio, and C.2.2 Natural resource management. The 4th quadrant has two performance measurement factors including C.1.7 Investment, and C.2.4 Recycle management.

From the IPA analysis of TQIM-H and performance measurement as shown in Figure 5.1 and Figure 5.2, the quadrants labels of the IPA grid indicate where the institution should develop its performance (“Concentrate Here”) and where to be maintained (“Keep Up the Good Work”) and where to be reduced (“Possible Overkill” and “Low Priority”). Accordingly, the institution can determine the best strategy for the optimization of its performance in producing a certain healthcare attribute. From analyzing and brainstorming among the author and healthcare experts, TQIM-H and performance measurement factors in quadrant 1and quadrant 2 were used to develop the methodology and procedure of (“how to achieve”) the TQIM-H and performance measurement. But TQIM-H and performance measurement factors in quadrant 3 and quadrant 4 were eliminated.

2nd Round Delphi: The scope and the procedure of the TQIM-H

In this round, we aimed to develop the methodology and procedure of (“how to achieve”) the TQIM-H with a full description of thinking for solutions extracted from healthcare experts’ opinions through in-depth interviews.

Table 5.6 The scope and the procedure of the TQIM-H

Objective	Method	Tool	Result

This stage aims to develop the methodology and procedure of ("how to achieve") the TQIM-H with a full description of thinking for solutions extracted from experts' opinions through in-depth interviews.	In-depth interview with healthcare experts Healthcare experts can provide their opinions to develop to create TQIM-H procedures through three questions by in-depth interviews. Brainstorming The results from each expert panel were analyzed and grouped by brainstorming among the TRIZ team. Consequently, the approach table for the TQIM-H procedure table was extracted.	- Questionnaires Very helpful questionnaires in properly defining the TQIM-H procedures - Brainstorming	TQIM-H procedure

A group of experts was invited to provide opinions on the quality and innovation management in healthcare

↓

The expert panels studied to understand the definitions of TQIM-H

↓

The 30 experts were asked for their opinions and ideas to create TQIM-H procedures through three questions by in-depth interviews.

↓

The results from each expert panel were analyzed and grouped by brainstorming among the TRIZ team.

↓

The results of the TQIM-H procedures were analyzed and sent back to healthcare experts to confirm the information's accuracy.

↓

The results of the TQIM-H were summarized and presented as the TQIM-H procedure table

Figure 5.6 The step to develop scope and procedure of the TQIM-H

As a result, a full description of thinking for solutions extracted from 30 healthcare experts' opinions through in-depth interviews about the procedure or "how to achieve each TQIM-H factor" was extracted and brainstormed among the author and healthcare experts. Then, the TQIM-H procedure result from each expert's opinion was summarized and sent back to each expert panel to confirm the accuracy of the TQIM-H procedure. Finally, the TQIM-H procedure from each expert was summarized and grouped based on text similarity and meaning similarity.

Procedures or "how to achieve each TQIM-H factor", which derived from 30 experts' opinions, summarized 85 procedures which were grouped into 7 dimensions and 25 factors, as presented in Table 5.3.

Table 5.7 The TQIM-H procedures

Dimension	Factors & Definitions	Procedures (How to achieve each TQMH factor)	Expert
Context of the Environment (Internal & External)	**1.1 Customer (patient etc.) needs:** The hospital places importance on customers' satisfaction with the service. Keeping abreast of the market's situation and patient's needs is essential to increase the potential for competition.	1.1.1 Examining cases of complaints from customers for further improvement.	[2], [3], [6], [7], [9], [10], [13], [14], [16], [21], [23], [25], [27], [28], [29], [30]
		1.1.2 Observing trends that reflect needs from both customers and the markets.	[1], [3], [4], [7], [8], [14], [18], [19], [20], [23], [28],
		1.1.3 Studying tangible and intangible differences among the customer segment in terms of, for example, age, race.	[4], [6], [8], [9], [12], [13], [14], [17], [18], [20], [23], [24], [26], [27], [28], [30]
		1.1.4 Prioritizing according to important customer needs and demands.	[1], [5], [6], [8], [9], [11], [12], [[15], [16], [18], [21], [22], [23], [24], [25], [26], [27], [30]
	1.2 Litigation law refers to the rules and practices: Law is important because it is the basis of all operations and covers medical ethics and patient rights.	1.2.1 Complying with laws, hospital standards, and medical ethics.	[1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [12], [13], [16], [17], [18], [19], [20], [22], [23], [24], [25], [26], [27], [28], [29], [30]
		1.2.2 Setting up a control system that monitors and audits each department.	[1], [2], [4], [5], [8], [9], [10], [12], [14], [18], [19], [23], [24], [25], [26]
		1.2.3 Annexing regulations into part of the hospital's strategies.	[1], [2], [3], [4], [6], [7], [8], [9], [10], [14], [15], [16], [19], [20], [21], [22], [24], [25], [26], [27], [28], [29], [30]
		1.2.4 Seeking to be recognized by standards e.g. HA, JCI.	[1], [2], [4], [5], [7], [8], [11], [12], [13], [14], [15], [17], [18], [20], [21], [23], [25], [26], [27], [28]
		1.2.5 Following complaints or acts that do not comply with the law or medical ethics for further improvement.	[1], [2], [4], [5], [6], [11], [12], [16], [17], [18], [21], [22], [25], [26], [28], [30]
	1.3 Technological change: Technological changes affect an organization's development by superseding some processes. Technology can enhance working performance and streamline the process by removing irrelevant parts, resulting in increasing capability for competition in the healthcare market and augment customers' trust.	1.3.1 Studying technological changes, medical innovative technologies, and emergent innovations and applying them in the hospital.	[1], [4], [5], [7], [9], [13], [18], [20], [21], [25], [28], [29]
		1.3.2 Adopting cross-industry innovation by studying trends of changes and adaptation of other businesses; and applying the knowledge to the healthcare business.	[1], [3], [4], [5], [8], [12], [14], [17], [20], [22], [23], [25], [26], [27], [28], [29]
		1.3.3 Collaborating with universities to conduct research that creates or imports technologies to the hospital.	[2], [7], [11], [21], [22], [23], [27], [28], [29], [30]
		1.3.4 Using technology and innovation as a tool to build trust between personnel and customers.	[1], [5], [9], [10], [12], [16], [17], [18], [20], [21], [24], [26]
Leadership	**2.1 Leader vision:** Leaders' visions and attitudes are significant for the creation of innovation and quality, as leaders are in charge of steering the direction of the management and organizational structures.	2.1.1 Acknowledging the importance of innovation and having a vision about developing innovation and quality in the hospital.	[1], [2], [3], [5], [10], [11], [12], [13], [15], [16], [17], [19], [22], [25], [26], [27], [29], [30]
		2.1.2 Proposing policies on quality and innovation as the main goals of the organization, with specified related KPIs.	[1], [2], [3], [4], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29]
		2.1.3 Setting up a committee that monitors the results continuously.	[1], [2], [4], [5], [6], [9], [10], [13], [15], [16], [18], [20], [24], [25], [26 [29], [30]
		2.1.4 Joining the development of projects as examples.	[4], [[7], [13], [20], [24], [27]
		2.1.5 Creating an atmosphere that encourages learning and experiments.	[1], [3], [4], [7], [9], [13], [16], [17], [20], [22], [25], [26], [28], [29]
	2.2 Resources allocation: Resources e.g. time, personnel, budgets, etc is important. Allocating the resource is an essential task that enables leaders to manage the hospital.	2.2.1 Including time used for creating innovation into working hours.	[5], [6], [9], [13], [15], [16], [19], [20], [21], [25], [26], [28], [30]
		2.2.2 Allowing everyone to express equal and unlimited opinions.	[1], [2], [5], [6], [8], [9], [10], [12], [17], [18], [21], [24], [25], [26], [27], [29], [30]
		2.2.3 Punishing for mistakes that occur after any design or experiment is prohibited.	[3], [4], [5], [6], [7], [10], [12], [15], [18], [19], [21], [23], [26], [27], [28], [30]
		2.2.4 Allowing workers to consult leaders for advice when facing problems and to report progress periodically.	[1], [2], [4], [5], [6], [8], [11], [14], [15], [16], [19], [21], [22], [24], [29], [30]
		2.2.5 Supporting and allocating resources need for the development of innovation including time, personnel, tools, training sessions, and money, all handled appropriately.	[1], [2], [3], [4], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30]
Planning	**3.1 Strategic plan development:** Implementation of organizational policies and planning direction in the management of the organization, together with quality and innovation management, can drive working processes toward success.	3.1.1 Specifying strategic plans that lead to conducting innovation and quality.	[1], [2], [3], [6], [7], [8], [9], [10], [11], [14], [15], [16], [18], [19], [20], [21], [23], [24], [25], [26], [27], [28],
		3.1.2 Integrating quality and innovation in the hospital into part of organizational vision and structures.	[1], [4], [5], [6], [8], [9], [12], [13], [15], [16], [17], [18], [21], [22], [25], [26], [27], [28], [30]
		3.1.3 Effectively practicing organizational policies and visions that are in line with changes.	[1], [3], [6], [7], [8], [9], [10], [13], [16], [17], [20], [21], [22], [28], [29]
		3.1.4 Assessing the results to evaluate the conducting of quality and innovation.	[3], [5], [8], [13], [15], [20], [23], [26], [30]
	3.2 Alignment of innovation: Making innovation part of the organization's strategies and part of each member's work catalyzes innovation and generates innovation recognition from the organization's members, resulting in sustainability.	3.2.1 Creating an organizational action plan that is consistent with the strategic plan.	[1], [5], [6], [7], [10], [13], [15], [16], [19], [20], [21], [27], [28], [30]
		3.2.2 Establishing KPIs for innovation in all activities in the organization to evaluate and pursue innovation.	[1], [2], [3], [4], [8], [9], [10], [11], [12], [14], [17], [18], [20], [21], [22], [24], [25], [29], [30]
Sup	**4.1 Employee education and**	4.1.1 Planning a training session that encourages quality	[2], [3], [5], [6], [9], [10], [12], [14], [17], [18], [21], [24], [27], [30]

Dimension	Factors & Definitions	Procedures (How to achieve each TQMH factor)	Expert
	training programs: Healthcare programs are intended for equipping staff with the knowledge of working systems internal to the hospital so they can all work in the same direction. Further, cultivating critical thinking is very important to develop innovative projects in the hospital.	and innovation.	
		4.1.2 Providing mandatory training courses for new personnel so that they work in the same direction.	[1], [2], [6], [8], [11], [14], [16], [19], [20], [23], [24], [25], [29], [30]
		4.1.3 Creating a handbook for new personnel.	[1], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [15], [16], [17], [18], [19], [20], [22], [23], [25], [26], [27], [28], [29], [30]
		4.1.4 Auditing healthcare staff working knowledge periodically.	[1], [2], [3], [6], [7], [8], [9], [10], [12], [13], [14 [17], [18], [19], [20], [21], [23], [24], [25], [26], [27], [28], [29], [30]
		4.1.5 Providing courses that aim to create innovative thinking and a critical thinking mindset to cultivate innovators.	[1], [3], [5], [6], [7], [11], [12], [14], [15], [16], [19], [20], [21], [22], [25], [26], [27], [28], [30]
		4.1.6 Providing space or time for opinion exchanges. Problems should be also discussed so knowledge for further development can be exchanged.	[1], [4], [8], [9], [13], [15], [16], [18], [21], [23], [25], [27]
	4.2 Facilities e.g. laboratories, space, etc.: Facilities constitute a factor that drives the organization towards development. There are two dimensions to facilities: intangible dimension and tangible dimension. The first one includes time, opportunity, trust, and knowledge. The second includes tools, apparatus, technology, human resources, and sandbox.	4.2.1 Creating a space or hub where innovators can exchange ideas and brainstorm to develop projects in the hospital.	[4], [7], [8], [10], [11], [12], [15], [16], [19], [20], [21], [22], [24], [25], [30]
		4.2.2 Providing "sandbox" or "simulative model" to experiment with projects or inventions developed in the hospital before their real use so risks can be predicted and minimized.	[1], [3], [4], [8], [9], [12], [13], [16], [18], [19], [22], [23], [24], [25], [27], [28], [29], [30]
	4.3 Budgets: Money is a crucial factor for the success of all activities in the hospital.	4.3.1 Setting up a funding budget for quality and innovation projects for suitable periods.	[1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30]
Operation	**5.1 Process management:** Management and operating processes are considered significant for effective performance. Process management can reduce organizational resources and risks, and can increase working performance in the hospital.	5.1.1 Creating a management system and a plan that provide the whole picture of the organization.	[1], [2], [3], [4], [5], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30]
		5.1.2 Creating a management system and a plan for each department with its specificity.	[1], [3], [4], [6], [7], [10], [11], [12], [13], [15], [16], [18], [19], [20], [21], [22], [23], [24], [25], [30]
		5.1.3 Auditing and evaluating performance periodically to maintain standards and working potential.	[1], [2], [4], [6], [13], [14], [18], [21], [23], [25], [27],
		5.1.4 Considering a working process to eliminate irrelevant processes.	[3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [15], [16], [17], [18], [19], [20], [22], [23], [24], [25], [28], [29], [30]
	5.2 Monitoring and evaluation: Monitoring and evaluating working processes eliminate pain points and increase the working potential that helps the organization achieve its goals.	5.2.1 Creating a monitoring system that follows up projects in the hospital to evaluate and report their progress.	[1], [2], [4], [5], [6], [7], [9], [11], [13], [14], [16], [17], [18], [20], [21], [23], [24], [25], [28], [30]
		5.2.2 Specifying clear scopes of progress in each period as guiding principles.	[3], [5], [6], [9], [10], [13], [15], [16], [21], [22], [25], [26], [27]
		5.2.3 Using effective tools to evaluate working processes and constantly adapting the process to remain under established goals.	[1], [2], [4], [7], [11], [14], [16], [17], [20], [21], [24], [25], [26], [29], [30]
	5.3 Risk management: Risk management is the process of analyzing processes and practices that are in the hospital, identifying risk factors, and implementing procedures to address those risks.	5.3.1 Creating a system that assesses risks, planing precautious measures against potential risks, and putting system and plan to use.	[1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30]
		5.3.2 Creating a system that predicts risks and precautious processes against risks in the organization.	[3], [4], [8], [11], [12], [15], [16], [17], [20], [24], [26], [27],
		5.3.3 Studying risks that have taken place as a model for further development of the system.	[5], [9], [14], [18], [25], [27], [30]
	5.4 Decision-making to solve problems: The decision-making system is a significant part of the hospital, as patient treatment requires informed and quick decisions that create the minimum risks to patients.	5.4.1 Having a reliable database that is adequate for decision-making.	[1], [3], [6], [7], [13], [16], [17], [18], [22], [25], [28], [30]
		5.4.2 Having systems and technology that can make accurate decisions such as AI Robots.	[1], [2], [3], [5], [6], [10], [11], [12], [13], [14], [15], [17], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29]
		5.4.3 Prioritizing work according to its importance to help with decision-making processes.	[3], [4], [7], [9], [10], [11], [13], [14], [17], [19], [21], [23], [24], [26], [27], [28],
		5.4.4 Providing a system that furnishes decision-making.	[3], [4], [5], [8], [12], [15], [16], [20], [22], [25], [26], [30]
	5.5 Internal and external networking: Internal and external networking and collaboration from diverse sections increase the effectiveness in the development of the organization and working processes in the hospital.	5.5.1 Seeking alliances or networks with other organizations to develop between-organization or between-department innovation projects.	[1], [2], [3], [4], [5], [6], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30]
		5.5.2 Signing business treaties that are beneficial to creating a positive image and building trust.	[1], [3], [4], [8], [9], [13], [15], [16], [17], [18], [19], [20], [23], [24], [26], [27], [28],
		5.5.3 Collaborating with a network of partners to create new business models.	[4], [6], [7], [8], [10], [11], [14], [15], [16], [17], [18], [19], [21], [22], [23], [25], [26], [29], [30]
	5.6 Knowledge management: Knowledge management is to collect and present knowledge necessary for effective organizational development.	5.6.1 Collecting knowledge necessary for developing management processes in the hospital for further research and access by interested personnel.	[1], [2], [3], [4], [5], [6], [9], [10], [11], [12], [14], [15], [16], [17], [19], [20], [23], [24], [25], [26], [28], [29], [30]
		5.6.2 Collecting previous projects as models for further development and expansion in the future.	[3], [4], [5], [7], [8], [10], [11], [12], [14], [15], [18], [19], [20], [21], [22], [23], [25], [26], [27], [30]
		5.6.3 Presenting factors contributing to the success in detail	[1], [2], [4], [6], [8], [9], [14], [16], [17], [20], [21], [26], [27], [28], [30]

Dimension	Factors & Definitions	Procedures (How to achieve each TQMH factor)	Expert
	Knowledge management includes professional knowledge and critical thinking.	as a model for knowledge generation and development.	
		5.6.4 Providing activities involving knowledge-seeking or seminars led by experienced individuals from both inside and outside of the organization to obtain new bodies of knowledge.	[1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [27], [28], [29], [30]
	5.7 Building distinctive competencies and competitive advantage: Examining competitor's potential in the market can help create effective development in the hospital. Moreover, studying other competitors' weaknesses and strengths helps identify new opportunities for development in the organization.	5.7.1 Studying and comparing competitors in the market to increase potential in selling and treatment.	[1], [4], [5], [6], [7], [9], [10], [11], [15], [16], [17], [18], [21], [27]
		5.7.2 Studying uncharted territory in the market and create values out of those gaps.	[1], [2], [3], [4], [7], [8], [9], [10], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [28], [29], [30]
	5.8 Establishing an innovation award: Awards granted to successful projects support and encourage personnel to improve their quality and innovation projects within the organization. Also, awards are one of the factors that stimulate healthcare workers to forge organizational development.	5.8.1 Promoting awarded projects and implementing them in the organization as examples.	[3], [4], [5], [6], [7], [10], [12], [13], [14], [16], [17], [18], [19], [20], [21], [23], [24], [25], [26], [27], [28],
		5.8.2 Providing prizes or increasing salaries to the winning team to motivate other personnel.	[1], [2], [3], [6], [7], [9], [10], [11], [13], [14], [15], [16], [17], [18], [20], [21], [22], [23], [24], [25], [26], [27], [28], [30]
		5.8.3 Using awarded projects as learning examples.	[1], [4], [5], [9], [13], [15], [18], [20], [22], [25], [26], [29], [30]
Tools and Analysis method	**6.1 Well-defined processes and formalized tools:** Using the right tools and system patterns ensures the effectiveness of working processes, minimizes risks, and creates trust between personnel and patients.	6.1.1 Collecting quality-and-innovation-related apparatus for organizational use.	[1], [2], [3], [5], [6], [9], [10], [11], [12], [14], [15], [16], [17], [19], [20], [21], [23], [24], [25], [26], [27], [30]
		6.1.2 Developing an accessible database system that gather knowledge and tools used in quality improvement and innovation.	[3], [5], [8], [9], [11], [14], [17], [22], [25], [28], [29]
		6.1.3 Rechecking tools' perfection.	[1], [2], [5], [6], [7], [8], [10], [11], [12], [13], [15], [16], [17], [20], [21], [23], [24], [25], [26], [27], [28], [29]
	6.2 Information management: Management of internal information is significant and complicated, so appropriate and accurate management, which is essential to the hospital, is required.	6.2.1 Managing information within the organization that is connected across departments.	[1], [3], [4], [5], [9], [11], [12], [13], [14], [15], [16], [17], [18], [19], [22], [23], [25], [26], [27], [29], [30]
		6.2.2 Providing information that is available for retrieval at any time; is reliable; and, is ready to be used.	[1], [2], [5], [6], [10], [13], [16], [17], [18], [24], [30]
		6.2.3 Collecting information and using statistical prediction is performed so weaknesses can be spotted. Overcoming the identified weakness can improve the organization.	[4], [5], [6], [7], [8], [9], [10], [12], [13], [14], [15], [19], [20], [21], [22], [25], [27], [28],
	6.3 Data integrity and security: Keeping medical information confidential is bound by the law and medical ethics. Therefore, data safety and confidentiality must be managed effectively.	6.3.1 Creating effective and secure information retrieval processes e.g. the process that requires identification of users.	[1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [25], [26], [27], [28], [29], [30]
	6.4 Data availability and accuracy: Accuracy in the hospital's information is highly significant since it is directly relevant to medical information and patients' lives. The information must be up-to-date throughout the treatment duration so that effectiveness is brought to treatment processes.	6.4.1 Managing information that is brought into the system with clarity and accuracy.	[1], [3], [4], [5], [6], [8], [9], [11], [12], [14], [16], [18], [19], [21], [22], [24], [25], [26], [27], [28], [29]
		6.4.2 Updating the information constantly according to the patient status that is changing throughout the treatment process.	[1], [2], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [19], [20], [22], [23], [24], [25], [26], [30]
		6.4.3 Managing information that is audited so that the accuracy of information is confirmed.	[2], [3], [4], [8], [9], [10], [11], [12], [13], [16], [17], [20], [21], [23], [24], [26], [27], [28], [30]
Improvement	**7.1 Quality audits:** To keep healthcare management effective and to minimize errors, auditors observe the process to maintain working efficiency and to stimulate personnel to remain in line with working standards.	7.1.1 Creating an audit system that is periodically initiated by internal agencies.	[1], [2], [3], [5], [6], [7], [8], [9], [12], [13], [14], [17], [19], [20], [21], [22], [23], [24], [26], [27], [28], [29], [30]
		7.1.2 Establishing clear KPIs to develop and maintain working effectiveness.	[1], [2], [3], [4], [5], [6], [8], [9], [10], [11], [12], [13], [15], [16], [17], [19], [20], [23], [24], [25], [28], [29], [30]
		7.1.3 Having external agencies auditing the system periodically.	[1], [2], [3], [4], [7], [8], [9], [10], [12], [13], [14], [16], [18], [21], [22], [23], [24], [27], [28], [29], [30]
		7.1.4 Applying results from auditing for further development or future models.	[3], [4], [9], [12], [13], [17], [22], [24], [26], [28]
	7.2 Continuous solving: Continuous solving involves the improvement of the process after the weakness identification. Newly designed processes increase working potential, resulting in	7.2.1 Evaluating working performance regularly to seek tools and methods that can develop the system continuously.	[3], [4], [5], [6], [7], [8], [9], [10], [11], [12], [13], [14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [26], [27], [28], [29], [30]
		7.2.2 Providing a system or experts who can advise and support system development.	[1], [4], [6], [9], [10], [12], [13], [16], [21], [24], [26], [29]
		7.2.3 Designing and seek new ways to develop continuously in place of old, existing processes.	[1], [2], [5], [6], [7], [8], [10], [11], [14], [16], [17], [18], [20], [21], [22], [23], [24], [27], [30]

Dimension	Factors & Definitions	Procedures (How to achieve each TQMH factor)	Expert
	the ability to adapt to the ever-changing environment.		
	7.3 Achieving quality standards: Implementing quality standards, having clear working criteria, and gaining trust from customers can increase the working potential to the level of international standards.	7.3.1 Incorporating standardized regulations as part of organizational policies.	[1], [2], [5], [6], [7], [8], [10], [11], [12], [15], [17], [19], [21], [22], [24], [25], [27], [28]
		7.3.2 Setting annual goals as reaching quality standards.	[3], [9], [11], [15], [21], [22], [24], [25], [30]
		7.3.3 Creating a system that encourages knowledge sharing and that points to the significance of quality standards.	[1], [2], [4], [7], [8], [11], [12], [13], [14], [17], [18], [20], [21], [23], [24], [25], [26], [27], [28], [29]
		7.3.4 Building customers' trust toward the organization through organizational standards.	[3], [6], [9], [14], [16], [18], [23], [25], [30]

BSR: Body shape rating, COVID-19: Coronavirus disease, ECMO: Extracorporeal membrane oxygenation, FDA: Food and drug administration, IPD: In-patient department, JCI: Joint commission international, KPI: Key Performance index, NOACs: Non-vitamin K antagonist oral anticoagulants, NSAIDs: Non-steroidal anti-inflammatory drugs, OPD: Out-patient department, R&D: Research and development, SOPs: standard operating procedures

Table 5.3. displays components and characteristics of TQIM-H. The first and the second columns show seven dimensions of TQIM-H with their 25 factors, all of which were considered critical success factors in creating innovation under the quality medical standards proposed in the previous study (Tonjang & Thawesaengskulthai, 2020). The third column demonstrates the procedures, which were gathered from 30 experts' opinions via an in-depth interview, to achieve each TQIM-H factor. Each TQIM-H factor could have more than one procedure. Thus, 85 TQIM-H procedures were developed for managing quality innovation projects in hospitals. The last column shows 30 expert panels, [1]-[30], who provided opinions on each of the TQIM-H procedures (How-to).

3rd Round Delphi: The TQIM-H inventive principle

In this round, TQIM-H procedures from experts' opinions were analyzed and mapped with the TRIZ inventive principle based on text similarity and meaning similarity by the TRIZ team. Then, the inventive principle mapping results of the TQIM-H were validated by 30 healthcare experts.

Table 5.8 The TQIM-H inventive principle

Objective	**Method**	**Tool**	**Result**
This stage aims to analyze and map the TQIM-H procedure from experts' opinions with the TRIZ inventive principle based on text similarity and meaning similarity resulting in the TQIM-H inventive principle	- In-depth interview with healthcare experts Brainstorming to reinterpret and match TQIM-H procedures with the TRIZ inventive Principle-based on text and meaning similarity - Questionnaire The 'Confirmed question naire' was designed to provide healthcare experts to select 'Agree' or 'Disagree' for each mapping result of TQIM-H procedures and the TRIZ inventive principles. Then, the Cochran test was used to test the null hypothesis	- Brainstorming - Confirmed questionnaire Part 1: Open questionnaire Part 2: Importance of perf ormance scale questionnaire with the ranges of level 1-9 to TQIM-H factors - The Cochran test	TQIM-H inventive principle

The process to develop the TQIM-H inventive principle was divided into two parts that are Part A: Develop the TQIM-H inventive principle by the authors and TRIZ team and Part B: The applicability and reliability of the inventive principle mapping results were evaluated by a group of experts through 'Confirmed questionnaire'.

Part A : Develop the TQIM-H inventive principle.

In this round, TQIM-H procedures from experts' opinions were analyzed and mapped with the TRIZ inventive principle based on text similarity and meaning similarity by the TRIZ team. Then, the inventive principle mapping results of the TQIM-H were validated by 30 healthcare experts.

The authors and TRIZ team intensively reviewed 40 TRIZ inventive principles and TQIM-H procedures to understand their characteristics

↓

TRIZ team brainstormed to reinterpret and match TQIM-H procedures with the TRIZ inventive principle based on text similarity and meaning similarity

↓

The proposed mapping results of TQIM-H procedures with the TRIZ inventive principle were compared with those formulated in terms of similarities and differences

↓

Discrepancies were examined and analyzed before reaching a consensus by a focusing group of the TRIZ team

The 'Confirmed questionnaire' was designed based on the correlation of TQIM-H procedures and the TRIZ inventive principle

The 30 experts were invited to answer the questionnaires

Each expert indicated his/her opinion by selecting 'Agree' or 'Disagree' for each mapping result of TQIM-H procedures and the TRIZ inventive principles

The mapping results would be approved when the results were agreed upon by more than half of the total number of experts, i.e. more than 15 experts

To confirm the consistency of the experts' opinions on the parameter-corresponding results, the Cochran test was used to test the null hypothesis

The results of the TQIM-H inventive principles were analyzed and sent back to healthcare experts to confirm the information accuracy

The results of the TQIM-H inventive principles were summarized and presented as the TQIM-H inventive principles table

Figure 5.7 The step to develop the TQIM-H inventive principle.

The TQIM-H inventive principle development result

The results of the TQIM-H inventive principle which were developed from mapping TQIM-H procedures TRIZ inventive principle through text similarity and meaning similarity are shown in Table 5.9. Then, the 85 pairs mapping of TRIZ inventive principle and TQIM-H procedure was validated by opinions from 30 healthcare experts. Thirteen mapping results were eliminated, and 72 results were approved by more than half of the total number of experts (15 experts). For instance, principle #5- Consolidation/Merging matched with "4.1.1. Planning a training session that encourages quality and innovation" and "5.1.1. Creating a management system and a plan that provide a complete picture of the organization", since they both suggested unifying systems into one. After analyzing and brainstorming among the TRIZ team, four TRIZ inventive principles were omitted due to their incompatibility with the TQIM-H procedure. The eliminated principles include #16- Partial or Excessive Action, #18- Mechanical Vibration, #21- Rushing Through, #34- Regenerating Parts. Furthermore, principle #41- Reinforcement was recommended to be added to the invention principle matrix because Reinforcement was related to resource allocation which was essential in developing successful innovation projects.

Table 5.9 The mapping of TQIM-H procedures and TRIZ inventive principle

No.	TRIZ inventive principles	Procedure (How to achieve each TRIZ principle)
1	Segmentation	1.1.3 Studying tangible and intangible differences among the customer segment in terms of, for example, age, race.
2	Extraction, Taking out	5.1.4 Considering a working process to eliminate irrelevant processes.
3	Local Quality	6.4.1 Managing information that is brought into the system with clarity and accuracy.
4	Asymmetry	5.1.2 Creating a management system and a plan for each department with its specificity.
5	Consolidation / Merging	4.1.1 Planning a training session that encourages quality and innovation.
		5.1.1 Creating a management system and a plan that provide the whole picture of the organization.
6	Universality	6.1.1 Collecting quality-and-innovation-related apparatus for organizational use.
7	Nesting	1.2.3 Annexing regulations into part of the hospital's strategies.
		3.1.2 Integrating quality and innovation in the hospital into part of organizational vision and structures.
		7.3.1 Incorporating standardized regulations as part of organizational policies.
8	Counterweight	1.3.2 Adopting cross-industry innovation by studying trends of changes and adaptation of other businesses; and applying the knowledge to the healthcare business.
		1.3.3 Collaborating with universities to conduct research that creates or imports technologies to the hospital.
		5.5.1 Seeking alliances or networks with other organizations to develop between-organization or between-department innovation projects.
9	Prior Counteraction	4.2.2 Providing "sandbox" or "simulative model" to experiment with projects or inventions developed in the hospital before their real use so risks can be predicted and minimized.
10	Prior Action	1.1.4 Prioritizing according to important customer needs and demands.
		2.1.1 Acknowledging the importance of innovation and having a vision about developing innovation and quality in the hospital.
		3.2.1 Creating an organizational action plan that is consistent with the strategic plan.
		5.4.3 Prioritizing work according to its importance to help with decision-making processes.
11	Cushion in Advance	5.3.2 Creating a system that predicts risks and precautious processes against risks in the organization.
		5.4.1 Having a reliable database that is adequate for decision-making.
		6.1.3 Rechecking tools' perfection.
		6.2.2 Providing information that is available for retrieval at any time; is reliable; and, is ready to be used.
12	Equipotentiality	2.2.2 Allowing everyone to express equal and unlimited opinions.
13	Inversion Thinking:	4.1.5 Providing courses that aim to create innovative thinking and a critical thinking mindset to cultivate innovators.
14	Spheroidicity	6.4.3 Managing information that is audited so that the accuracy of information is confirmed.
15	Dynamicity	5.2.1 Creating a monitoring system that follows up projects in the hospital to evaluate and report their progress.
		6.4.2 Updating the information constantly according to the patient status that is changing throughout the treatment process.
17	Transition Into a New Dimension	5.5.3 Collaborating with a network of partners to create new business models.
		5.6.4 Providing activities involving knowledge-seeking or seminars led by experienced individuals from both inside and outside of the organization to obtain new bodies of knowledge.
19	Periodic Action	5.2.2 Specifying clear scopes of progress in each period as guiding principles.
		7.1.3 Having external agencies auditing the system periodically.
20	Continuity of Useful Action	2.1.3 Setting up a committee that monitors the results continuously.
		7.2.1 Evaluating working performance regularly to seek tools and methods that can develop the system continuously.
22	Convert Harm Into Benefit	1.1.1 Examining cases of complaints from customers for further improvement.
		1.2.5 Following complaints or acts that do not comply with the law or medical ethics for further improvement.
		5.3.3 Studying risks that have taken place as a model for further development of the system.
		6.2.3 Collecting information and using statistical prediction is performed so weaknesses can be spotted. Overcoming the identified weakness can improve the organization.
23	Feedback	1.2.2 Setting up a control system that monitors and audits each department.
		3.1.4 Assessing the results to evaluate the conduction of quality and innovation.
		3.2.2 Establishing KPIs for innovation in all activities in the organization to evaluate and pursue innovation.
		4.1.4 Auditing healthcare staff working knowledge periodically.
		5.1.3 Auditing and evaluating performance periodically to maintain standards and working potential.
		5.2.3 Using effective tools to evaluate working processes and constantly adapting the process to

No.	TRIZ inventive principles	Procedure (How to achieve each TRIZ principle)
		remain under established goals.
		7.1.2 Establishing clear KPIs to develop and maintain working effectiveness.
24	Intermediary	4.2.1 Creating a space or hub where innovators can exchange ideas and brainstorm to develop projects in the hospital.
25	Self-service	5.4.2 Having systems and technology that can make accurate decisions such as AI Robots.
		5.6.1 Collecting knowledge necessary for developing management processes in the hospital for further research and access by interested personnel.
		6.1.2 Creating a system aimed at learning and tool use that can be personally accessed.
		7.1.1 Creating an audit system that is periodically initiated operation by internal agencies.
26	Copying	1.2.1 Complying with laws, hospital standards, and medical ethics.
		1.2.4 Seeking to be recognized by standards e.g. HA, JCI.
		5.6.3 Presenting factors contributing to the success in detail as a model for knowledge generation and development.
		5.8.3 Using awarded projects as learning examples.
27	Cheap short-living objects:	4.1.3 Creating a handbook for new personnel.
28	Replacement of Mechanical System	7.2.3 Designing and seeking new ways to develop continuously in place of old, existing processes.
29	Pneumatic or Hydraulic Constructions (Intangibility)	1.3.4 Using technology and innovation as a tool to build trust between personnel and customers.
		5.5.2 Signing business treaties that are beneficial to creating a positive image and building trust.
		7.3.4 Building customers' trust toward the organization through organizational standards.
30	Flexible Membranes or Thin Films	6.3.1 Creating effective and secure information retrieval processes e.g. the process that requires identification of users.
31	Porous Material	5.3.1 Creating a system that assesses risks, planning precautious measures against potential risks, and implementing the system and plan.
		5.7.2 Studying uncharted territory in the market and creating values out of those gaps.
32	Changing the Color	1.1.2 Observing trends that reflect needs from both customers and the markets.
		1.3.1 Studying technological change, medical innovative technologies, and emergent innovations and applying them in the hospital.
		5.7.1 Studying and comparing competitors in the market to increase potential in selling and treatment.
33	Homogeneity	4.1.2 Providing mandatory training courses for new personnel so that they work in the same direction.
		6.2.1 Managing information within the organization that is connected across departments.
35	Transformation of Properties	3.1.1 Specifying strategic plans that lead to conducting innovation and quality.
36	Phase Transition	3.1.3 Effectively practicing organizational policies and vision that are in line with changes.
37	Thermal Expansion	5.6.2 Collecting previous projects as models for further development and expansion in the future.
		5.8.1 Promoting awarded projects and implementing them in the organization as examples.
		7.1.4 Applying results from auditing for further development or future models.
38	Accelerated Oxidation	2.1.2 Proposing policies on quality and innovation as the main goals of the organization, with specified related KPIs.
		2.1.4 Leaders join the development of projects as examples.
		5.8.2 Providing prizes or increasing salaries to the winning team to motivate other personnel.
		7.3.2 Setting annual goals as reaching quality standards.
		7.3.3 Creating a system that encourages knowledge sharing and that points to the significance of quality standards.
39	Inert Environment	2.1.5 Creating an atmosphere that encourages learning and experiments.
40	Composite Materials	2.2.3 Punishing for mistakes that occur after any design or experiment is prohibited.
		2.2.4 Allowing workers to consult leaders for advice when facing problems and to report progress periodically.
41	Reinforcement	2.2.1 Including time used for creating innovation into working hours.
		2.2.5 Leaders support and allocate resources needed to develop innovation including time, personnel, tools, training sessions, and money, all handled appropriately.
		4.1.6 Providing space or time for opinion exchanges. Problems should be also discussed so knowledge for further development can be exchanged.
		4.3.1 Setting up a funding budget for quality and innovation projects for suitable periods.
		5.4.4 Providing a system that furnishes decision-making.
		7.2.2. Providing a system or experts who can advise and support system development.

Furthermore, to confirm the consistency of the experts' opinions on the parameter-corresponding results, the Cochran test was used to test the null hypothesis,

$$T = 30(30-1)\frac{\sum_{j=1}^{30}\left(c_j - \frac{1743}{30}\right)^2}{\sum_{i=1}^{72} R_i\,(30 - R_i)} \;=\; 30 \times 29\; \times \frac{222}{8450} = 22.81$$

The exact distribution of T was difficult to tabulate, thus a large sample approximation was instead used. The number of blocks r was assumed to be large. The critical region of an approximate size 0.05 (alpha) then corresponded to all values of T that were greater than 42.557 and was 0.95 (1-alpha) quantile of a chi-square random variable with 29 degrees of freedom (the Chi-square Table). The calculated statistic value of T, which was 22.81, was smaller than the critical value of 42.557, meaning that the p-value was not less than 0.05. Therefore, the null hypothesis H_0 could not be rejected, i.e., no significant difference among the experts' opinions was detected.

Table 5.10 The TRIZ inventive principle corresponding to TQIM-H procedures.

No.	TRIZ inventive principles	Procedure (How to achieve each TRIZ principle)	Expert panel																													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	Segmentation	1.1.3 Studying tangible and intangible differences among the customer segment in terms of, for example, age, race.	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
2	Extraction, Taking out	5.1.4 Considering a working process to eliminate irrelevant processes.	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1
3	Local Quality	6.4.1 Managing information that is brought into the system with clarity and accuracy.	1	1	1	0		0	0	1	1	1	1	0	1	0	1	0	1	1	0	1	1	1	0	0	0	1	1	0	1	1
4	Asymmetry	5.1.2 Creating a management system and a plan for each department with its specificity.	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	0	1	1	0	1	1	1	1	1	1	1	1	1
5	Consolidation / Merging	4.1.1 Planning a training session that encourages quality and innovation.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		5.1.1 Creating a management system and a plan that provide the whole picture of the organization.	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
6	Universality	6.1.1 Collecting quality-and-innovation-related apparatus for organizational use.	1	1	0	1	1	1	1	1	1	0	0	1	1	1	0	1	1	1	1	0	1	0	1	1	1	1	1	1	1	1
7	Nesting	1.2.3 Annexing regulations into part of the hospital’s strategies.	1	0	1	1	1	1	0	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0
		3.1.2 Integrating quality and innovation in the hospital into part of organizational vision and structures.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	0	0	1	1	1	1	1
		7.3.1 Incorporating standardized regulations as part of organizational policies.	1	0	0	1	1	0	1	1	1	1	0	1	1	1	0	1	0	1	1	1	0	1	0	1	1	1	1	1	1	1
8	Counterweight	1.3.2 Adopting cross-industry innovation by studying trends of changes and adaptation of other businesses; and applying the knowledge to the healthcare business.	0	0	1	1	0	1	0	1	0	0	0	0	1	1	1	1	1	1	0	0	1	1	0	1	1	1	1	1	1	0
		1.3.3 Collaborating with universities to	1	1	0	1	0	1	1	0	1	1	1	1	0	1	1	1	0	1	0	1	0	1	1	1	1	1	1	1	1	1

No.	TRIZ inventive principles	Procedure (How to achieve each TRIZ principle)	Expert panel 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		conduct research that creates or imports technologies to the hospital.																														
		5.5.1 Seeking alliances or networks with other organizations to develop between-organization or between-department innovation projects.	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1
9	Prior Counteraction	4.2.2 Providing “sandbox” or “simulative model” to experiment with projects or inventions developed in the hospital before their real use so risks can be predicted and minimized.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
10	Prior Action	1.1.4 Prioritizing according to important customer needs and demands.	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		2.1.1 Acknowledging the importance of innovation and having a vision about developing innovation and quality in the hospital.	1	0	1	0	0	1	1	1	1	0	1	1	0	1	0	0	1	0	1	1	0	1	0	1	1	0	0	1	1	0
		3.2.1 Creating an organizational action plan that is consistent with the strategic plan.	1	0	0	1	0	1	0	1	1	0	1	0	1	0	0	0	1	1	0	1	0	1	0	0	0	1	0	0	0	0
		5.4.3 Prioritizing work according to its importance to help with decision-making processes.	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
11	Cushion in Advance	5.3.2 Creating a system that predicts risks and precautious processes against risks in the organization.	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1
		5.4.1 Having a reliable database that is adequate for decision-making.	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	0	0	1	1	1
		6.1.3 Rechecking tools’ perfection.	1	1	0	1	0	1	1	1	1	1	1	0	1	0	1	1	1	1	0	1	1	0	0	1	1	1	0	0	1	0
		6.2.2 Providing information that is available for retrieval at any time; is reliable; and, is ready to be used.	0	1	1	0	1	1	0	1	0	0	0	0	0	1	1	1	0	1	1	0	1	0	1	0	1	0	0	0	1	0
12	Equipotentiality	2.2.2 Allowing everyone to express equal and unlimited opinions.	1	0	1	1	1	1	1	1	1	0	1	1	1	1	0	1	0	0	1	1	1	1	0	1	1	1	1	1	0	1

No.	TRIZ inventive principles	Procedure (How to achieve each TRIZ principle)	Expert panel																													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
13	Inversion Thinking:	4.1.5 Providing courses that aim to create innovative thinking and a critical thinking mindset to cultivate innovators.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
14	Spheroidicity	6.4.3 Managing information that is audited so that the accuracy of information is confirmed.	0	0	1	0	1	1	1	1	1	0	0	1	1	0	0	1	1	1	0	1	1	1	0	1	1	0	1	0	1	1
15	Dynamicity	5.2.1 Creating a monitoring system that follows up projects in the hospital to evaluate and report their progress.	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	1	0	1	1	1	0	1
		6.4.2 Updating the information constantly according to the patient status that is changing throughout the treatment process.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
17	Transition Into a New Dimension	5.5.3 Collaborating with a network of partners to create new business models.	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1
		5.6.4 Providing activities involving knowledge-seeking or seminars led by experienced individuals from both inside and outside of the organization to obtain new bodies of knowledge.	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1
19	Periodic Action	5.2.2 Specifying clear scopes of progress in each period as guiding principles.	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1
		7.1.3 Having external agencies audit the system periodically.	0	1	1	1	1	1	0	1	1	0	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	1	1	1	0	1
20	Continuity of Useful Action	2.1.3 Setting up a committee that monitors the results continuously.	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1
		7.2.1 Evaluating working performance regularly to seek tools and methods that can develop the system continuously.	1	0	1	1	1	0	1	0	1	1	1	0	0	1	1	1	1	1	0	1	1	1	0	0	1	1	0	1	0	1
22	Convert Harm Into Benefit	1.1.1 Examining cases of complaints from customers for further improvement.	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
		1.2.5 Following complaints or acts that	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	0	1	1	1	1	1

No.	TRIZ inventive principles	Procedure (How to achieve each TRIZ principle)	Expert panel 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		do not comply with the law or medical ethics for further improvement.																														
		5.3.3 Studying risks that have taken place as a model for further development of the system.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		6.2.3 Collecting information and using statistical prediction is performed so weaknesses can be spotted. Overcoming the identified weakness can improve the organization.	1	0	1	0	1	0	0	0	1	0	1	1	1	1	0	0	1	1	0	1	0	1	0	0	1	1	0	1	0	0
23	Feedback	1.2.2 Setting up a control system that monitors and audits each department.	0	1	1	1	0	0	1	1	1	0	1	0	0	0	0	1	0	1	0	0	1	0	0	1	0	1	0	1	0	0
		3.1.4 Assessing the results to evaluate the conduction of quality and innovation.	1	0	0	1	1	1	0	0	0	0	0	1	0	1	1	0	1	0	0	1	0	1	1	0	0	1	1	0	0	1
		3.2.2 Establishing KPIs for innovation in all activities in the organization to evaluate and pursue innovation.	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		4.1.4 Auditing healthcare staff working knowledge periodically.	1	1	1	0	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1
		5.1.3 Auditing and evaluating performance periodically to maintain standards and working potential.	0	1	0	0	0	1	1	0	1	0	0	1	0	1	0	1	0	1	0	0	1	0	1	0	1	0	1	0	0	0
		5.2.3 Using effective tools to evaluate working processes and constantly adapting the process to remain under established goals.	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1
		7.1.2 Establishing clear KPIs to develop and maintain working effectiveness.	0	0	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1
24	Intermediary	4.2.1 Creating a space or hub where innovators can exchange ideas and brainstorm to develop projects in the hospital.	1	1	1	1	0	1	1	0	1	1	1	1	0	1	1	1	0	1	1	0	0	0	1	1	1	1	0	1	1	0
25	Self-service	5.4.2 Having systems and technology	0	1	0	1	0	1	1	1	0	1	1	0	1	1	0	1	1	1	0	1	1	1	1	0	1	0	0	1	1	1

No.	TRIZ inventive principles	Procedure (How to achieve each TRIZ principle)	Expert panel																													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		that can make accurate decisions such as AI Robots.																														
		5.6.1 Collecting knowledge necessary for developing management processes in the hospital for further research and access by interested personnel.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
		6.1.2 Creating a system aimed at learning and tool using that can be personally accessed.	0	0	1	0	1	0	0	1	0	1	0	0	1	0	1	0	0	0	0	1	1	1	1	0	1	0	1	0	0	0
		7.1.1 Creating an audit system that is periodically initiated operation by internal agencies.	1	1	1	1	0	1	1	0	1	1	1	1	0	1	1	1	1	1	0	1	0	1	1	1	0	0	1	1	0	1
26	Copying	1.2.1 Complying with laws, hospital standards, and medical ethics.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		1.2.4 Seeking to be recognized by standards e.g. HA, JCI.	0	1	1	0	1	1	1	0	0	1	1	1	1	1	1	0	1	1	0	1	1	1	0	1	0	1	1	0	0	1
		5.6.3 Presenting factors contributing to the success in detail as a model for knowledge generation and development.	1	0	0	1	1	0	1	0	0	0	0	1	1	0	1	1	1	1	0	1	0	0	1	0	1	0	1	0	0	1
		5.8.3 Using awarded projects as learning examples.	0	1	1	0	1	0	0	1	1	0	1	0	1	0	1	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0
27	Cheap short-living objects:	4.1.3 Creating a handbook for new personnel.	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
28	Replacement of Mechanical System	7.2.3 Designing and seeking new ways to develop continuously in place of old, existing processes.	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1	0	1	1	1	0	1	1	1	1
29	Pneumatic or Hydraulic Constructions (Intangibility)	1.3.4 Using technology and innovation as a tool to build trust between personnel and customers.	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	0	1	1
		5.5.2 Signing business treaties that are beneficial to creating a positive image and building trust.	0	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1	1	0	1	0	1	1	0
		7.3.4 Building customers' trust toward the organization through organizational	0	0	0	0	1	0	1	1	1	0	1	0	1	0	1	0	1	0	0	0	1	1	0	0	0	1	0	0	0	0

No.	TRIZ inventive principles	Procedure (How to achieve each TRIZ principle)	Expert panel																													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		standards.																														
30	Flexible Membranes or Thin Films	6.3.1 Creating effective and secure information retrieval processes e.g. the process that requires identification of users.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	1	1	1	1	1
31	Porous Material	5.3.1 Creating a system that assesses risks, planning precautious measures against potential risks, and implementing the system and plan.	1	1	1	1	0	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1
		5.7.2 Studying uncharted territory in the market and creating values out of those gaps.	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	0	0	1	1
32	Changing the Color	1.1.2 Observing trends that reflect needs from both customers and the markets.	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
		1.3.1 Studying technological change, medical innovative technologies, and emergent innovations and applying them in the hospital.	1	1	1	1	0	1	1	1	1	1	0	1	1	1	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1	1
		5.7.1 Studying and comparing competitors in the market to increase potential in selling and treatment.	0	1	0	1	0	1	0	0	1	1	1	0	1	0	0	1	1	1	1	0	0	1	1	0	1	0	0	1	1	1
33	Homogeneity	4.1.2 Providing mandatory training courses for new personnel so that they work in the same direction.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		6.2.1 Managing information within the organization that is connected across departments.	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
35	Transformation of Properties	3.1.1 Specifying strategic plans that lead to conducting innovation and quality.	1	0	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	0	1	1	0	0	1	1	1
36	Phase Transition	3.1.3 Effectively practicing organizational policies and vision that are in line with changes.	1	1	0	0	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
37	Thermal Expansion	5.6.2 Collecting previous projects as models for further development and	1	1	1	1	0	1	1	1	1	1	1	0	1	1	1	0	0	1	1	1	1	1	1	0	0	1	1	1	1	0

No.	TRIZ inventive principles	Procedure (How to achieve each TRIZ principle)	Expert panel 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		expansion in the future.																														
		5.8.1 Promoting awarded projects and implementing them in the organization as examples.	0	1	1	1	1	1	0	1	0	1	1	1	1	0	0	1	1	1	1	1	0	1	0	1	1	0	1	0	0	1
		7.1.4 Applying results from auditing for further development or future models.	0	1	0	1	1	0	0	0	1	1	1	0	0	1	1	0	1	0	0	1	0	1	0	1	0	1	1	0	0	0
38	Accelerated Oxidation	2.1.2 Proposing policies on quality and innovation as the main goals of the organization, with specified related KPIs.	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
		2.1.4 Leaders join the development of projects as examples.	1	0	1	1	1	1	0	0	1	1	0	1	1	1	1	0	1	1	1	1	0	1	0	1	1	1	0	1	1	1
		5.8.2 Providing prizes or increasing salaries to the winning team to motivate other personnel.	1	1	1	1	0	1	1	1	1	1	1	1	0	1	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
		7.3.2 Setting annual goals as reaching quality standards.	0	1	0	0	1	0	1	0	1	0	0	0	0	1	1	0	1	0	0	1	1	0	1	0	0	1	0	1	0	0
		7.3.3 Creating a system that encourages knowledge sharing and that points to the significance of quality standards.	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1	1	0	1	0	1	1	1	1
39	Inert Environment	2.1.5 Creating an atmosphere that encourages learning and experiments.	1	1	0	1	0	1	1	0	1	1	1	0	1	1	0	1	1	1	0	1	1	1	1	1	0	1	1	1	0	1
40	Composite Materials	2.2.3 Punishing for mistakes that occur after any design or experiment is prohibited.	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1
		2.2.4 Allowing workers to consult leaders for advice when facing problems and to report progress periodically.	1	0	1	1	0	1	1	1	1	1	0	1	1	0	0	1	0	1	1	1	1	1	0	0	1	1	0	1	1	1
41	Reinforcement	2.2.1 Including time used for creating innovation into working hours.	0	1	0	1	1	0	1	1	0	1	1	1	1	0	1	1	1	0	0	1	1	0	1	0	0	1	0	1	1	0
		2.2.5 Leaders support and allocate resources needed to develop innovation including time, personnel, tools, training sessions, and money, all handled	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1

No.	TRIZ inventive principles	Procedure (How to achieve each TRIZ principle)	Expert panel																													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		appropriately.																														
		4.1.6 Providing space or time for opinion exchanges. Problems should be also discussed so knowledge for further development can be exchanged.	1	0	0	1	1	0	0	0	1	1	0	1	1	0	0	1	0	0	0	1	0	1	0	1	0	1	0	0	1	1
		4.3.1 Setting up a funding budget for quality and innovation projects for suitable periods.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
		5.4.4 Providing a system that furnishes decision-making.	0	0	1	1	0	1	0	1	0	0	0	1	0	0	0	1	0	1	0	1	1	0	1	1	0	1	0	1	0	0
		7.2.2. Providing a system or experts who can advise and support system development.	1	1	0	0	0	1	0	0	1	0	0	0	1	1	0	1	0	0	1	1	0	0	0	0	1	1	0	0	0	1

The 72 pairs of mapped principles were formulated as the content of the principle corresponding table, which was then used in the following problem-solving process as shown in Table 5.11.

Table 5.11 The refined TQIM-H inventive principle

No.	TRIZ inventive principles	Procedure (How to achieve each TRIZ principle)
1	Segmentation	1.1.3 Studying tangible and intangible differences among the customer segment in terms of, for example, age, race.
2	Extraction, Taking out	5.1.4 Considering a working process to eliminate irrelevant processes.
3	Local Quality	6.4.1 Managing information that is brought into the system with clarity and accuracy.
4	Asymmetry	5.1.2 Creating a management system and a plan for each department with its specificity.
5	Consolidation / Merging	4.1.1 Planning a training session that encourages quality and innovation.
		5.1.1 Creating a management system and a plan that provide the whole picture of the organization.
6	Universality	6.1.1 Collecting quality-and-innovation-related apparatus for organizational use.
7	Nesting	1.2.3 Annexing regulations into part of the hospital's strategies.
		3.1.2 Integrating quality and innovation in the hospital into part of organizational vision and structures.
		7.3.1 Incorporating standardized regulations as part of organizational policies.
8	Counterweight	1.3.2 Adopting cross-industry innovation by studying trends of changes and adaptation of other businesses; and applying the knowledge to the healthcare business.
		1.3.3 Collaborating with universities to conduct research that creates or imports technologies to the hospital.
		5.5.1 Seeking alliances or networks with other organizations to develop between-organization or between-department innovation projects.
9	Prior Counteraction	4.2.2 Providing "sandbox" or "simulative model" to experiment with projects or inventions developed in the hospital before their real use so risks can be predicted and minimized.
10	Prior Action	1.1.4 Prioritizing according to important customer needs and demands.
		2.1.1 Acknowledging the importance of innovation and having a vision about developing innovation and quality in the hospital.
		5.4.3 Prioritizing work according to its importance to help with decision-making processes.
11	Cushion in Advance	5.3.2 Creating a system that predicts risks and precautious processes against risks in the organization.
		5.4.1 Having a reliable database that is adequate for decision-making.
		6.1.3 Rechecking tools' perfection.
12	Equipotentiality	2.2.2 Allowing everyone to express equal and unlimited opinions.
13	Inversion Thinking:	4.1.5 Providing courses that aim to create innovative thinking and a critical thinking mindset to cultivate innovators.
14	Spheroidicity	6.4.3 Managing information that is audited so that the accuracy of information is confirmed.
15	Dynamicity	5.2.1 Creating a monitoring system that follows up projects in the hospital to evaluate and report their progress.
		6.4.2 Updating the information constantly according to the patient status that is changing throughout the treatment process.
17	Transition Into a New Dimension	5.5.3 Collaborating with a network of partners to create new business models.
		5.6.4 Providing activities involving knowledge-seeking or seminars led by experienced individuals from both inside and outside of the organization to obtain new bodies of knowledge.
19	Periodic Action	5.2.2 Specifying clear scopes of progress in each period as guiding principles.
		7.1.3 Having external agencies audit the system periodically.
20	Continuity of Useful Action	2.1.3 Setting up a committee that monitors the results continuously.
		7.2.1 Evaluating working performance regularly to seek tools and methods that

No.	TRIZ inventive principles	Procedure (How to achieve each TRIZ principle)
		can develop the system continuously.
22	Convert Harm Into Benefit	1.1.1 Examining cases of complaints from customers for further improvement.
		1.2.5 Following complaints or acts that do not comply with the law or medical ethics for further improvement.
		5.3.3 Studying risks that have taken place as a model for further development of the system.
		6.2.3 Collecting information and using statistical prediction is performed so weaknesses can be spotted. Overcoming the identified weakness can improve the organization.
23	Feedback	3.2.2 Establishing KPIs for innovation in all activities in the organization to evaluate and pursue innovation.
		4.1.4 Auditing healthcare staff working knowledge periodically.
		5.2.3 Using effective tools to evaluate working processes and constantly adapting the process to remain under established goals.
		7.1.2 Establishing clear KPIs to develop and maintain working effectiveness.
24	Intermediary	4.2.1 Creating a space or hub where innovators can exchange ideas and brainstorm to develop projects in the hospital.
25	Self-service	5.4.2 Having systems and technology that can make accurate decisions such as AI Robots.
		5.6.1 Collecting knowledge necessary for developing management processes in the hospital for further research and access by interested personnel.
		7.1.1 Creating an audit system that is periodically initiated operation by internal agencies.
26	Copying	1.2.1 Complying with laws, hospital standards, and medical ethics.
		1.2.4 Seeking to be recognized by standards e.g. HA, JCI.
		5.6.3 Presenting factors contributing to the success in detail as a model for knowledge generation and development.
27	Cheap short-living objects:	4.1.3 Creating a handbook for new personnel.
28	Replacement of Mechanical System	7.2.3 Designing and seeking new ways to develop continuously in place of old, existing processes.
29	Pneumatic or Hydraulic Constructions (Intangibility)	1.3.4 Using technology and innovation as a tool to build trust between personnel and customers.
		5.5.2 Signing business treaties that are beneficial to creating a positive image and building trust.
30	Flexible Membranes or Thin Films	6.3.1 Creating effective and secure information retrieval processes e.g. the process that requires identification of users.
31	Porous Material	5.3.1 Creating a system that assesses risks, planning precautious measures against potential risks, and implementing the system and plan.
		5.7.2 Studying uncharted territory in the market and creating values out of those gaps.
32	Changing the Color	1.1.2 Observing trends that reflect needs from both customers and the markets.
		1.3.1 Studying technological change, medical innovative technologies, and emergent innovations and applying them in the hospital.
		5.7.1 Studying and comparing competitors in the market to increase potential in selling and treatment.
33	Homogeneity	4.1.2 Providing mandatory training courses for new personnel so that they work in the same direction.
		6.2.1 Managing information within the organization that is connected across departments.
35	Transformation of Properties	3.1.1 Specifying strategic plans that lead to conducting innovation and quality.
36	Phase Transition	3.1.3 Effectively practicing organizational policies and vision that are in line with changes.
37	Thermal Expansion	5.6.2 Collecting previous projects as models for further development and expansion in the future.
		5.8.1 Promoting awarded projects and implementing them in the organization as examples.
38	Accelerated Oxidation	2.1.2 Proposing policies on quality and innovation as the main goals of the

No.	TRIZ inventive principles	Procedure (How to achieve each TRIZ principle)
		organization, with specified related KPIs.
		2.1.4 Leaders join the development of projects as examples.
		5.8.2 Providing prizes or increasing salaries to the winning team to motivate other personnel.
		7.3.3 Creating a system that encourages knowledge sharing and that points to the significance of quality standards.
39	Inert Environment	2.1.5 Creating an atmosphere that encourages learning and experiments.
40	Composite Materials	2.2.3 Punishing for mistakes that occur after any design or experiment is prohibited.
		2.2.4 Allowing workers to consult leaders for advice when facing problems and to report progress periodically.
41	Reinforcement	2.2.1 Including time used for creating innovation into working hours.
		2.2.5 Leaders support and allocate resources needed to develop innovation including time, personnel, tools, training sessions, and money, all handled appropriately.
		4.3.1 Setting up a funding budget for quality and innovation projects for suitable periods.

TRIZ inventive principle is an engineering tool that is widely accepted as a tool for designing innovative processes and fixing new unsolved problems. The integration of TQIM-H and TRIZ inventive principle using the Delphi study resulted in the TQIM-H inventive principle, which consists of four elements (as shown in Table 5.6): the first and second columns depict the TQIM-H inventive principle, including all 37 dimensions. The third column shows the details and characteristics of each TQIM-H inventive principle. TQIM-H inventive principle, which contained processes and procedures for innovation management in hospitals, could be applied to assist healthcare innovators in designing innovations. The next step in the development of the TQIM-H inventive principle would be applying the principle to the effective innovation projects which had impacts on healthcare sustainability. This would allow the calibration of the principle.

CHAPTER 6
THE VALIDATED TQIM-H INVENTIVE PRINCIPLE FROM 50 INNOVATION PROJECTS

This chapter was designed to refine and validate the TQIM-H inventive principle, which was developed from Chapter 5, through 50 effective healthcare innovation projects that were created during 2018-2020 in the largest hospital conglomerate in Southeast Asia (n = 47 hospitals).

Table 6.1 The validated TQIM-H inventive principle from 50 innovation projects

Objective	Process & Information	Result
To refine and confirm the TQIM-H inventive principle	50 healthcare innovation projects established during 2018-2020 from the largest hospital conglomerate in Southeast Asia which comprised of 47 hospitals were elaborately analyzed in every aspect to refine and validate the TQIM-H inventive principle.	The refined TQIM-H inventive principle

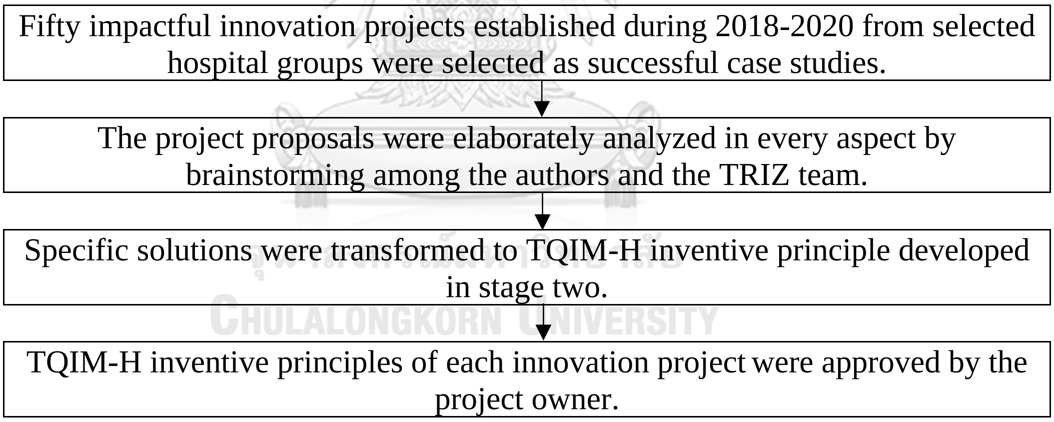


Figure 6.1 The step to validate the TQIM-H inventive principle via 50 innovation projects

The innovation projects in the hospitals' case studies consisted of 35 product innovations, 11 process innovations, and 4 business model innovations. All these projects were practically actualized and resulted in positive healthcare performance, which was the organizational sustainability which included three sustainability impacts: economic, environmental, and social dimension as shown in Table 6.1.

Table 6.2 The list of 50 innovations with associated TQIM-H inventive principles

Code project	**Title project**	**Innovation type**	**No. of Inventive principle**	**Healthcare Performance**
PJ01	Rehabilitation M-O-V-E-O-N	Process Innovation	3 Local Quality 10 Prior Action 13 Inversion Thinking: 20 Continuity of Useful Action 28 Replacement of Mechanical System 39 Inert Environment	Social sustainability
PJ02	Evaluation of Self-awareness and Reduce of Medication Error by Simulation Program	Process Innovation	3 Local Quality 10 Prior Action 11 Cushion in Advance 13 Inversion Thinking 22 Convert Harm Into Benefit 31 Porous Material 41 Reinforcement	Social sustainability
PJ03	Data Visualization in Business Intelligence	Process Innovation	5 Consolidation / Merging 14 Spheroidicity 23 Feedback 30 Flexible Membranes or Thin Films 33 Homogeneity 39 Inert Environment 41 Reinforcement	Social sustainability
PJ04	Multidisciplinary Team Breast Cancer: MDT Breast Cancer	Process Innovation	3 Local Quality 13 Inversion Thinking: 15 Dynamicity 20 Continuity of Useful Action 38 Accelerated Oxidation 40 Composite Materials	Social sustainability
PJ05	Auto notifying repair system with LINE notification	Process Innovation	8 Counterweight 11 Cushion in Advance 23 Feedback 24 Intermediary 25 Self-service	Social sustainability
PJ06	New Employee Onboarding Guide Program	Process Innovation	1 Segmentation 10 Prior Action 12 Equipotentiality 23 Feedback 27 Cheap short-living objects 33 Homogeneity 40 Composite Materials $	Social sustainability
PJ07	Reduce the film waste using NH application	Product Innovation	2 Extraction, Taking out 7 Nesting 9 Prior Counteraction 17 Transition Into a New Dimension 28 Replacement of Mechanical System 36 Phase Transition	Environmental sustainability
PJ08	ECMO cannula robotic model	Product Innovation	1 Segmentation 3 Local Quality 9 Prior Counteraction 10 Prior Action 14 Spheroidicity 23 Feedback 28 Replacement of Mechanical System 41 Reinforcement	Economical sustainability
PJ09	N Health system	Process Innovation	4 Asymmetry 8 Counterweight 20 Continuity of Useful Action	Economical sustainability

Code project	Title project	Innovation type	No. of Inventive principle	Healthcare Performance
			24 Intermediary 28 Replacement of Mechanical System 32 Changing the Color 37 Thermal Expansion 41 Reinforcement	
PJ10	ECMO Rota flow Technique for moving and handling people	Product Innovation	3 Local Quality 5 Consolidation / Merging 10 Prior Action 26 Copying 28 Replacement of Mechanical System 39 Inert Environment 41 Reinforcement	Social sustainability
PJ11	Dr.Mobile	Process Innovation	1 Segmentation 3 Local Quality 6 Universality 15 Dynamicity 22 Convert Harm Into Benefit 25 Self-service 32 Changing the Color 38 Accelerated Oxidation	Economical sustainability
PJ12	BI Stat Process	Process Innovation	5 Consolidation / Merging 7 Nesting 12 Equipotentiality 13 Inversion Thinking: 23 Feedback 25 Self-service 35 Transformation of Properties	Social sustainability
PJ13	Innovation SAI " Salt Baht"	Product Innovation	3 Local Quality 9 Prior Counteraction 12 Equipotentiality 29 Pneumatic or Hydraulic Constructions (Intangibility) 35 Transformation of Properties 41 Reinforcement	Economical sustainability
PJ14	PM 2.5 measuring device	Product Innovation	6 Universality 11 Cushion in Advance 13 Inversion Thinking: 17 Transition Into a New Dimension 22 Convert Harm Into Benefit 36 Phase Transition 41 Reinforcement	Environmental sustainability
PJ15	DO NOACs, DO NO HARM	Process Innovation	2 Extraction, Taking out 13 Inversion Thinking 19 Periodic Action 30 Flexible Membranes or Thin Films 37 Thermal Expansion 40 Composite Materials	Social sustainability
PJ16	Sherbet Energy Plus (SEP) Dietary Supplements	Product Innovation	1 Segmentation 3 Local Quality 13 Inversion Thinking 20 Continuity of Useful Action 23 Feedback 36 Phase Transition 41 Reinforcement	Economical sustainability
PJ17	Smart Jacket for a pregnant	Product Innovation	1 Segmentation 3 Local Quality 6 Universality 12 Equipotentiality	Economical sustainability

Code project	Title project	Innovation type	No. of Inventive principle	Healthcare Performance
			23 Feedback 24 Intermediary 41 Reinforcement	
PJ18	Miracle Banana Blossom	Business Model Innovation	5 Consolidation / Merging 8 Counterweight 12 Equipotentiality 13 Inversion Thinking 23 Feedback 32 Changing the Color 38 Accelerated Oxidation	Economical sustainability
PJ19	Safety & Easy with E-MEWS	Process Innovation	2 Extraction, Taking out 7 Nesting 9 Prior Counteraction 11 Cushion in Advance 14 Spheroidicity 19 Periodic Action 22 Convert Harm Into Benefit 39 Inert Environment 41 Reinforcement	Social sustainability
PJ20	Healthy smart system for IPD	Process Innovation	3 Local Quality 8 Counterweight 12 Equipotentiality 13 Inversion Thinking 15 Dynamicity 17 Transition Into a Dimension 25 Self-service 28 Replacement of Mechanical System 41 Reinforcement	Social sustainability
PJ21	First Class Case Cart New Service Project	Product Innovation	10 Prior Action 14 Spheroidicity 15 Dynamicity 23 Feedback 24 Intermediary 31 Porous Material 33 Homogeneity	Economical sustainability
PJ22	Run to Real	Process Innovation	3 Local Quality 10 Prior Action 15 Dynamicity 24 Intermediary 26 Copying & 30 Flexible Membranes or Thin Films 38 Accelerated Oxidation	Social sustainability
PJ23	E chemo order	Process Innovation	4 Asymmetry 10 Prior Action 15 Dynamicity 23 Feedback 27 Cheap short-living objects 28 Replacement of Mechanical System 36 Phase Transition	Social sustainability
PJ24	Automated–inappropriate admission detector	Process Innovation	3 Local Quality 6 Universality 11 Cushion in Advance 14 Spheroidicity 17 Transition Into a New Dimension 36 Phase Transition 38 Accelerated Oxidation	Social sustainability
PJ25	Save Dose Save Life	Process	3 Local Quality	Social

Code project	Title project	Innovation type	No. of Inventive principle	Healthcare Performance
	(Brain Protocol)	Innovation	7 Nesting 13 Inversion Thinking: 19 Periodic Action 23 Feedback 35 Transformation of Properties 41 Reinforcement	sustainability
PJ26	The Care and Handling of Surgical Instruments process	Process Innovation	3 Local Quality 6 Universality 11 Cushion in Advance 12 Equipotentiality 22 Convert Harm Into Benefit 26 Copying 41 Reinforcement	Social sustainability
PJ27	Prestige Innovation Parkinson Service	Process Innovation	1 Segmentation 4 Asymmetry 11 Cushion in Advance 13 Inversion Thinking 15 Dynamicity 23 Feedback 31 Porous Material	Economical sustainability
PJ28	Medical Error Prevention program	Process Innovation	3 Local Quality 9 Prior Counteraction 10 Prior Action 22 Convert Harm Into Benefit 37 Thermal Expansion	Social sustainability
PJ29	Counseling and Monitoring ADR Chemotherapy regimen in Colorectal Cancer by Care map for Pharmacist	Process Innovation	4 Asymmetry 10 Prior Action 15 Dynamicity 25 Self-service 31 Porous Material 41 Reinforcement	Social sustainability
PJ30	Quality of life in Colorectal Cancer Patient with Counseling and Monitoring ADR Chemotherapy regimen by Care map for Pharmacist)	Process Innovation	1 Segmentation 20 Continuity of Useful Action 23 Feedback 32 Changing the Color 37 Thermal Expansion	Social sustainability
PJ31	Hematoma management system	Business Model Innovation	3 Local Quality 10 Prior Action 11 Cushion in Advance 17 Transition Into a New Dimension 24 Intermediary 28 Replacement of Mechanical System	Social sustainability
PJ32	NSAIDs drug-using Program	Process Innovation	6 Universality 14 Spheroidicity 23 Feedback 24 Intermediary 28 Replacement of Mechanical System 41 Reinforcement	Social sustainability
PJ33	An Infection Prevention and Control (IPC) program	Process Innovation	11 Cushion in Advance 14 Spheroidicity 22 Convert Harm Into Benefit 24 Intermediary 30 Flexible Membranes or Thin	Social sustainability

Code project	Title project	Innovation type	No. of Inventive principle	Healthcare Performance
			Films 37 Thermal Expansion	
PJ34	BHQ My B+	Process Innovation	3 Local Quality 5 Consolidation / Merging 13 Inversion Thinking 25 Self-service 28 Replacement of Mechanical System 41 Reinforcement	Economical sustainability
PJ35	Want Wow Project for Beyond Patient Experience	Process Innovation	1 Segmentation 10 Prior Action 13 Inversion Thinking 23 Feedback 29 Pneumatic or Hydraulic Constructions (Intangibility) 32 Changing the Color	Social sustainability
PJ36	3A in ER	Process Innovation	3 Local Quality 6 Universality 9 Prior Counteraction 15 Dynamicity 23 Feedback 28 Replacement of Mechanical System	Social sustainability
PJ37	Predicting Center	Process Innovation	4 Asymmetry 11 Cushion in Advance 19 Periodic Action 24 Intermediary 31 Porous Material 35 Transformation of Properties	Social sustainability
PJ38	Safety protocol for Safety experience from BHQ radiology to BDMS and National standard	Business Model Innovation	5 Consolidation / Merging 15 Dynamicity 26 Copying 27 Cheap short-living objects 35 Transformation of Properties	Social sustainability
PJ39	Mobile ECMO program	Product Innovation	3 Local Quality 4 Asymmetry 13 Inversion Thinking 17 Transition Into a New Dimension 25 Self-service 41 Reinforcement	Social sustainability
PJ40	Empathic Women's Dress	Product Innovation	1 Segmentation 8 Counterweight 12 Equipotentiality 23 Feedback 24 Intermediary 39 Inert Environment	Economical sustainability
PJ41	Healthy robot	Business Model Innovation	3 Local Quality 6 Universality 13 Inversion Thinking: 24 Intermediary 41 Reinforcement	Economical sustainability
PJ42	Pharm care determine NSAIDs	Process Innovation	3 Local Quality 8 Counterweight 10 Prior Action 17 Transition Into a New Dimension 23 Feedback 26 Copying	Social sustainability
PJ43	To evaluate the Clinical outcomes and Quality Of Life	Process Innovation	3 Local Quality 7 Nesting 11 Cushion in Advance	Social sustainability

Code project	Title project	Innovation type	No. of Inventive principle	Healthcare Performance
	in Epilepsy patients at Bangkok Hospital		22 Convert Harm Into Benefit 38 Accelerated Oxidation	
PJ44	Pregnant application preventing diabetes	Process Innovation	6 Universality 9 Prior Counteraction 11 Cushion in Advance 25 Self-service 31 Porous Material	Social sustainability
PJ45	Drip and ship innovation for the emergent referral process	Process Innovation	2 Extraction, Taking out 10 Prior Action 11 Cushion in Advance 13 Inversion Thinking 36 Phase Transition	Social sustainability
PJ46	Smart cold chain	Product Innovation	8 Counterweight 23 Feedback 32 Changing the Color 39 Inert Environment 40 Composite Materials	Economical sustainability
PJ47	Dashboard of Medical Equipment Utilization	Process Innovation	3 Local Quality 6 Universality 14 Spheroidicity 17 Transition Into a New Dimension 28 Replacement of Mechanical System 41 Reinforcement	Social sustainability
PJ48	N Linen 4.0	Process Innovation	8 Counterweight 13 Inversion Thinking: 17 Transition Into a New Dimension 28 Replacement of Mechanical System 41 Reinforcement	Economical sustainability
PJ49	Endoscope Total service Solution	Process Innovation	3 Local Quality 6 Universality 24 Intermediary 26 Copying 41 Reinforcement	Social sustainability
PJ50	BSR Morning Brief Dashboard	Process Innovation	14 Spheroidicity 23 Feedback 28 Replacement of Mechanical System 33 Homogeneity 38 Accelerated Oxidation	Social sustainability

Table 6.3 Interpreting TQIM-H inventive principle for performing innovation

No	IPs	Definition	Goal	Examples
1	Segmentation	The categorization of processes in hospital administration by characteristics	To isolate a beneficial or harmful function, allowing the organization to see characteristic activity, customer needs, or goals of each different process	PJ35: A survey that evaluates the difference in needs among patients of different ethnicities is conducted and used to improve customer service. PJ40: A survey that evaluates the needs of different segments of patients is conducted to gain insight into the products and services that are specific to each segment. PJ06: Job classification is set so the personal training is aligned to the goal of the pediatric ward.
2	Extraction, Taking out	The omission or elimination of the process that does not create value	To remove irrelevant processes and decrease costs which are facility, time, and personnel	PJ07: Radiotherapy is designed via an online application so the number of the working process, waiting time, and the number of films is minimized. PJ45: An emergent referral process is analyzed so

No	IPs	Definition	Goal	Examples
				the unimportant bottleneck process that does not create value is optimized to allow fast referrals with fewer persons.
3	Local Quality	The management of data or working process for quality	To effectively manage healthcare systems that can improve customer satisfaction and reduce complaints	PJ04: A caring system is designed to best suit patients suffering from breast cancer. PJ25: A dispensing program is developed to facilitate fast and accurate dispensing with minimum errors.
4	Asymmetry	The design of the working process by considering characteristics and specifications of the job	To design and modify specific responsibilities of each performance to bring values to the organization and patients	PJ37: An annual physical check is designed by analyzing individual symptoms, risk factors, and laboratory data. PJ27: An innovative process is developed to take care of and monitor patients with Parkinson’s disease.
5	Consolidation / Merging	The act of combining processes or hospital management	To develop novel integrated methods or services that increase management potential and provide strength in each process in the hospital	PJ38: Hospitals within the same network collaborate to manage risks, resulting in working processes that are safe for patients and personnel. PJ34: An application that is used to collect data and all working processes in the hospital is developed to allow access by hospital personnel.
6	Universality	The multifunctionalization of processes	To eliminate redundancy, optimize resource consumption, and increase the effectiveness of working processes in the healthcare organization	PJ17: Multifunctional innovative pregnant dresses that can monitor the progression of pregnancy and fetal development are designed. PJ47: An innovative machine that facilitates the management system for medical equipment is developed to assist the users.
7	Nesting	The merging of a process to a part of a major process	To generate policies and guiding principles that create a consistent structure where work is harmoniously performed across departments in the hospital, making a system easier for improvement and development	PJ43: Quality management is specified as a part of work and KPIs are defined to evaluate the quality management-related tasks.
8	Counterweight	Co-working with others to brainstorm ideas and develop the balanced working process	To collaborate with other departments or external organizations to compensate for the resources or expertise that the hospital lacks	PJ18: A hospital collaborates with academia to develop aromatherapy that helps relax patients after surgery. PJ46: A hospital collaborates with a faculty of Engineering to develop equipment that provides post-operative care.
9	Prior Counteraction	Vigilance or preparation to avoid mistakes	To eliminate or diminish any possibility of risk by using preliminary anti-actions such as sandbox and simulative model	PJ08: A sandbox to test the ECMO cannula robot that is used to assist with surgery is used to reveal the risk of using the robot so that the risk can be mitigated before the implementation of the robot to the real surgery. PJ36: A simulation model that is used to evaluate the functions and accuracy of surgery robots is designed and used before the implementation of the robot to the surgery.
10	Prior Action	The prioritization of the issue or working process	To fabricate, prioritize, and implement the plan sequentially, creating values and positive results for the hospital’s managerial processes	PJ10: Each patient transportation process is designed sequentially by its importance to reduce risks. PJ23, PJ29: Cancer patients are categorized by their disease severity so that the category is used to maximize patient care and optimize patient traffic in the hospital.
11	Cushion in Advance	The preparation for backup measures or methods to prevent	To protect and tackle problems or risks in the hospital management	PJ02: A program that is designed to prevent dispensing errors is developed. PJ05: A hospital application is set to send

No	IPs	Definition	Goal	Examples
		errors	processes	reminders to patients to notify them of the upcoming follow-up. PJ33: An innovative process is developed to observe and monitor infections in in-patient wards.
12	Equipoten-tiality	The permission that allows hospital personnel to raise their opinion equally	To draw out healthcare workers' potential and stimulate their critical thinking and innovative ideas	PJ20: Physicians and nurse practitioners are gathered in a conference room to express their opinions and concerns on the patient care system and suggest solutions for the existing challenges. PJ16: Nutritionists express their opinions on nutritional concerns in patients and design new nutritious food formulas that help fix the problems.
13	Inversion Thinking	The thinking process that is opposite or different from the standard or pattern currently used in the hospital	To cultivate healthcare innovators who have a critical thinking mindset, are key success persons, and drive a hospital toward success	PJ15: A course for critical thinking and out-of-the-box thinking is provided to hospital pharmacists.
14	Spheroidicity	Validation by repeating or auditing the repeated process	To increase accuracy and efficacy in working processes, decreasing risks, and errors in the healthcare organization	PJ19, PJ24: A verification system for patient profile and status is implemented to reduce errors and lawsuits.
15	Dynamicity	The adjustment for the continuous development of hospital management	To render the effective system more movable, flexible, and adaptable to different situations	PJ20: Patient care in IPD is continuously improved by using technologies to increase efficiency and reduce medical waste. PJ27: A monitoring program for patients with Parkinson's disease is used to formulate treatment plans and evaluate the effectiveness of the treatment.
17	Transition Into a New Dimension	The designing of hospital administration or process to create innovation	To create values that are differentiated and add a new concept or a new business model for increasing the healthcare performance	PJ14: The goal of collaboration between a hospital and the Ministry of Natural Resource and Environment is to develop robots that can measure and improve air quality. PJ39: Collaboration with a software developer enables the development of a program that analyzes the performance of ECMO.
19	Periodic Action	The monitoring of the working process periodically	To monitor working performance, risks, and resource utilization sporadically to minimize losses if mistakes occur	PJ25: Pharmacy department monitor and evaluate its dispensing practice periodically to reduce medication error. P37: Periodic health checkup plan is designed to detect risks in patients.
20	Continuity of Useful Action	The development of working process or management of the hospital constantly	To continually improve the working potentials and ability to compete	PJ01: Rehabilitation is monitored and evaluated continuously to improve the efficiency of patient care. PJ30: A program that continuously monitors and evaluates treatment and safety outcomes in cancer patients after receiving chemotherapy is used to improve treatment quality.
22	Convert Harm Into Benefit	The change of weaknesses or risks to strengths or opportunities	To improve healthcare processes and sustainably create new value for customers and the organization	PJ26: Patient complaints about medical equipment that is left in patients during surgery are used to create systems that reduce such incidences. PJ28: Dispensing errors are collected and used to design a dispensing program that has improved performance and can reduce errors.
23	Feedback	The evaluation of hospital managerial outcomes	To assess working processes and inform the hospital about the future direction for hospital development	PJ12: Data from each working procedure in the hospital is statistically analyzed so the output is objective. Results from the analysis are used to improve the procedure. PJ35: Customer complaint is used to improve customer service.
24	Intermediary	The provision of areas or opportunities	To cultivate development through	PJ09: A meeting session between healthcare professionals and R&D allows knowledge

No	IPs	Definition	Goal	Examples
		for innovators or startups to meet	brainstorming from each department or other hospitals that have different expertise, and allow the broad open exchange of knowledge to facilitate innovative ideas	exchange and brainstorming which is critical for the development of the N system for patient care. PJ31: A medical hub for the assembly of startups facilitates the design of the Hematoma Management System for patient care.
25	Self-service	The act that allows patients to access healthcare by themselves or allows healthcare providers to develop the working process by themselves	To develop the healthcare system that customers or workers select processes that fit their needs by themselves	PJ11: A mobile application is designed in a way that allows patients to be able to access their health information and examination results. PJ20: Healthy smart system for IPD is designed by healthcare professionals in the IPD.
26	Copying	The application of rules or good practices in hospital administration	To increase the chance of success and minimize error-related risks by the best practice or regulation	PJ22: A modified JCI medical standard is used as KPIs in OPD. PJ42: Drug Act BE. 2510 and FDA guidelines are used as a protocol to develop SOPs for the dispensing of NSAIDs. PJ49: The JCI requirements are integrated into endoscopic ultrasound procedures.
27	Cheap short-living objects	The availability of manual or guidance for effective working that align with the objective of processes	To control, guide, and provide a framework that aims to increase efficacy and minimize risks from mistakes for practitioners	PJ06: A guideline and standard operating procedures that are aligned with the direction and standard of the hospital are created for new employees. PJ23: A manual explaining treatment procedures and post-chemotherapy care is created to improve patient comprehension and assist patient care.
28	Replacement of Mechanical System	The application of technology or innovation in working processes	To create values for both customers and the hospital in every respect continuously and sustainably	PJ32: The current monitoring practice that is paper-based is replaced by a program that monitors the dispensing so the use of NSAIDs in patients is better monitored. PJ48: A program that monitors signs and symptoms in IPD patients replaced the current paper-based practice to improve patient care.
29	Pneumatic or Hydraulic Constructions (Intangibility)	The building of belief or trust in the hospital	To build trust and organizational royalty in the long run	PJ13: The innovative products for postoperative wound care increase the quality of life of patients, gaining their trust in the hospital. PJ35: A team for pre-and postoperative care is built to provide better care to the patients.
30	Flexible Membranes or Thin Films	The availability of walls or systems that screen or prevent access to data or processes	To reduce the risks in the following processes: patient treatment, data generation and storage, and other processes relating to patient well-being and rights	PJ03, PJ15, PJ33: A system that monitors the access to patients requires the identification of the users and allows the different users to access diffident levels of the data.
31	Porous Material	The searching for loopholes or gaps in hospital management and administration The identification for new markets	To improve the organizational system, create new opportunities, increase the ability to compete, and expand the healthcare business into other areas	PJ21: Business gaps in the health market are studied to deliver a new health check-up package that is specific to patient need. PJ44: A risk assessment for pregnant women by using simulation application to simulate an optimized program for preventing diabetes mellitus is conducted.
32	Changing the Color	The change of direction or pattern in hospital management and administration according to technology or social needs	To serve both customers and society in a way that satisfies both customers and social needs	PJ09: Healthcare-related products are designed according to the current market trend. PJ49: Products for rehabilitated patients are designed according to the current technology.

No	IPs	Definition	Goal	Examples
33	Homogeneity	The harmonization of the working process in the hospital to render the system the same working pattern	To understand the characteristics and optimize the working performance of the healthcare system	PJ06: A training for new staff is arranged so the staff understands the culture and direction of the organization. PJ50: The data from all departments in the hospital are connected, resulting in a data network that allows the real-time monitoring of patients.
35	Transforma-tion of Properties	The changing in pattern and strategy in hospital management	To consider a new management system or add value to current management that responds to changes in demand	PJ12: The surgery method is changed according to statistically analyzed information to improve treatment outcomes. PJ38: The policy on patient safety is created to scope the work, leading to the development of innovation that increases safety and reduces risk from hospital work.
36	Phase Transition	The implementation of the developed working process in the hospital	To increase the chance of success and continual improvement for higher organizational performance	PJ07: A tested and validated program for X-ray film reading that has been developed in the hospital is implemented. PJ16: High nutrition food for inpatients is developed and modified according to feedback from users.
37	Thermal Expansion	The use of a model to improve working processes	To attract opportunities for hospital growth in quality and innovation	PJ23: The program that is successfully and effectively used to manage patient queue in a cancer patient ward is also implemented in other wards. PJ45: The protocol to refer patients from traffic accidents is extended to cover the patients with accidents from the ground ambulance, hydro lance, and air ambulance.
38	Accelerated Oxidation	The stimulation and expedition of the development of working processes	To change the direction of the healthcare management and set the goal at continuous and sustainable development	PJ22: Key leaders are involved in the OPD improvement project to stimulate improvement in other departments. PJ50: BSR Morning Brief Dashboard is nominated for Innovation Contest to motivate the improvement of other programs and systems.
39	Inert Environment	The creation of a good working environment	To foster a healthcare innovative culture that promotes creativity and critical thinking mindset of healthcare workers	PJ03: Access to in-depth data is allowed so the data can be used for root-cause analysis. PJ46: Various types of smart cold chains are developed and the best one is selected for implementation.
40	Composite Materials	The formation of working patterns and structures that are flexible and free from punishment when the error occurs	To support personnel in improving the healthcare system and equipping them with innovative thinking that leads to increased healthcare performance	PJ06: Hospital staff is allowed to raise their concerns and solutions. PJ15: A dispensing system is optimized and modified to be flexible so the system is best for caring for patients receiving NOACs.
41	Reinforcement	The support and resource allocation to facilitate the development of hospital management	To provide both tangible and intangible resources that are critical to hospital success	PJ34: The budget for the development of My B+, an application that facilitates access to hospital news and allows the online physician appointment, is set up. PJ41: Budget and human resources are allocated to facilitate the design and construction of robots that are used to monitor and dispense medications to COVID-19 patients.

BSR: Body shape rating, COVID-19: Coronavirus disease, ECMO: Extracorporeal membrane oxygenation, FDA: Food and drug administration, IPD: In-patient department, JCI: Joint commission international, KPI: Key Performance index, NOACs: Non-vitamin K antagonist oral anticoagulants, NSAIDs: Non-steroidal anti-inflammatory drugs, OPD: Out-patient department, R&D: Research and development, SOPs: standard operating procedures

In the previous Chapter, TRIZ inventive principle was used to improve the TQIM-H framework. The integration of the framework and principle led to TQIM-H inventive principle which had a procedure-like, and method-oriented characteristic. TQIM-H inventive principle provides an extensive framework for problem solving. It also comprehensively covers innovation design and development. As for the TQIM-H inventive principle (Table 6.3), it consisted of four elements: the first and second columns show the TQIM-H inventive principle, with all of their 37 dimensions, that were required for the development of quality innovation projects. The third and fourth columns provide definitions and goals of each inventive principle. The last column demonstrated instances where TQIM-H inventive principle has been applied in creating innovative projects. These instances were derived from an analysis of 50 innovation project case studies.

The developed TQIM-H inventive principle is a method or key procedure that explains definition, objective, and examples from real innovation cases. The TQIM-H inventive principle can be used as exemplary models and procedures in creating successful innovation projects. Healthcare innovators can identify and evaluate problems or innovation topics. The developed TQIM-H inventive principle can then be optimized to assist in solving the problems or developing innovation projects in hospitals. When TQIM-H inventive principle was compared with the previous inefficient new healthcare innovation-generating process, most of the new ideas were frequently limited by the experience and knowledge of the managers (Djellal & Gallouj, 2007; Glover et al., 2020) Nevertheless, in developing innovative projects in hospitals, TQIM-H inventive principle should be applied with discretion and should be adapted according to new contexts of the engaging project. With this, not only will the processes for the creation of innovative projects be effective, but be sustainable as well. When the TQIM-H inventive principle, which was developed in Chapter 4, was mapped with the fifty effective innovation projects, we found that the principle could be refined. The refining process reduced the number of the principle components from 40 (as in TRIZ inventive principle) to 37. All of the factors in the TQIM-H inventive principle were retained in the refined TQIM-H inventive principle with the frequency of use as shown in Figure 6.2. Principle 3, local quality, was the most frequently used for the TQIM-H solution. In addition, the component of the refined principle is shown in Table 5.6, which shows the 37 principles of the TQIM-H inventive principle, definitions, objectives, and examples for the application of each principle component in healthcare management. This would allow the users to comprehend and select the component to apply in their project efficiently.

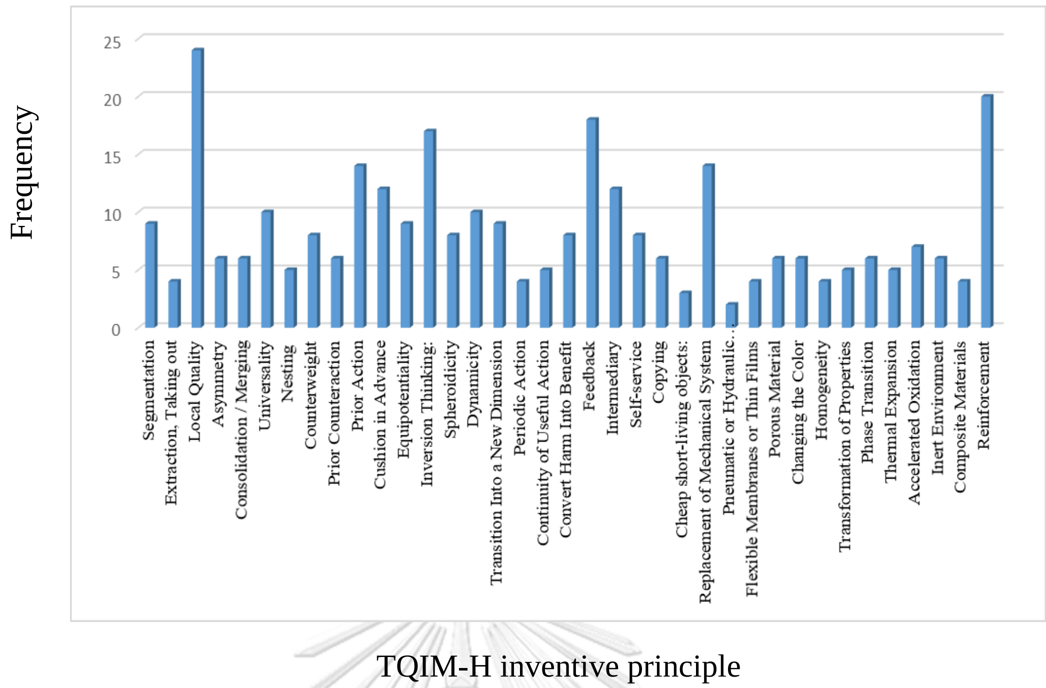


Figure 6.2 TQIM-H inventive principle, showed by frequency used

One of the obvious limitations of the refined TQIM-H inventive principle was that the importance of each factor (component) was not known. Thus, focusing on which factor in the principle would be challenging. The next Chapter aimed to study the structural model of TQIM-H to define the importance and relationship of each factor.

CHAPTER 7
A STRUCTURAL EQUATION MODELLING OF TQIM-H

In previous Chapters, key factors and inventive principles of TQIM-H were developed and refined. However, the relationship of each factor and the level of importance of each factor have never been identified. This Chapter aimed to develop the structural model of TQIM-H which explicitly demonstrated the relationship structure of each factor and the importance of each factor in order. We used SEM as a tool for the identification of such relationship and importance level.

Table 7.1 A structural equation modeling of TQIM-H

Objective	Process & Information	Result
To examine a relationship among each of TQIM-H and the effects of TQIM-H on sustainable innovation	The questionnaires were sent to the 395 respondents involved in quality and innovation management in the hospitals. After confirming the validity and reliability of the latent variables with confirmatory and exploratory factor analyses, we tested the model and hypotheses using structural equation modeling.	The structural model of TQIM-H

In this study, the author utilized SEM as the tool for analyzing the relationship between TQIM-H dimensions and sustainable innovation, and the important level of each TQIM-H dimension because SEM is a powerful tool that can provide direct and indirect analysis of a relationship in a model. In addition, SEM can analyze multiple relationships concurrently. Its CFA can be used to evaluate the fitness of the proposed model (Lee et al., 2010). Those factors render the SEM the most acceptable and widely used tool for analyzing the relationships of observed and latent variables. This study confirmed the hypotheses that TQIM-H has a significant relationship with sustainable innovation. Moreover, the study ranked each dimension of TQIM-H according to the loading result. The results of the SEM study were presented below.

Survey instrument

A draft questionnaire based on existing measurement scales for the research constructs was initially drafted. The participants rated the importance of each TQIM-H procedure component on the development of sustainable innovation. In addition, participants rated the importance of each sustainable innovation measurement component on the measurement of innovation project efficacy. The 1–10 Likert scale, which is a suitable tool for measuring ordinal data used to determine the construct validity (Afthanorhan, & Mamat 2016), was used to measure the TQIM-H constructs (1 = Not important; 10 = Very important). The respondents responded to the statements that closely represent their observations on how management in their organization was practiced (Appendix E: Table 1). Furthermore, the sustainable innovation project performance was also measured using the Likert scale (Appendix E: Table 2).

Pretesting

In this study, the draft questionnaire then was pretested with academics and practitioners to validate the content validity and terminology. To ensure that the instrument was accurate, valid, and reliable, a pretest was conducted using 40 questionnaires in the pilot analysis. Thus, Cronbach's alpha was used to measure the validity of the variables using the cut-off value suggested by Nunnally (1978), that is, 0.70. The results were then modified accordingly to provide their suitability and appropriateness for the target population before mailing.

7.1 Sample demographic data

The initial sample consisted of private and public hospitals in Southeast Asia that were operated under JCI or/and HA certified. The included hospitals represented TQM practices and specified the innovation-led vision and organizational strategy with tangible results in the organizational annual report. The questionnaire was mailed to the healthcare member who related to quality and/or innovation in the hospitals including quality and/or innovation project owner, quality and/or innovation manager in the hospitals, and healthcare innovator (healthcare practitioners and healthcare workers who participated in innovation training courses). Regarding the sample size, as proposed by the rules of thumb for determining sample size, the minimum sample size was then calculated to be 384 (Roscoe, 1975 cited in Sekaran and Bougie, 2016) and a prepaid return envelope. The cover letter outlined the objectives and importance of the study. In this study, empirical data were obtained through a survey of healthcare workers who had knowledge of hospital practices relating to quality and innovation management by mail. The response rate was 87.78% (395/450) which was considerably high. The reason for the high response rate might be from the attached cover letter that was delivered with the questionnaire by mail. The letter clearly explained the aim of the research, the importance, and the direct benefits that the participants would get from participating. Studies have found that identifying the benefits that participants obtain from participating in the studies increased the response rate (Dillman & Bowker, 2001; Harkness et al., 2004). A summary of the sampling demographic is shown in Table 7.2.

Table 7.2 Sample demographic data.

Respondents' demographics	Frequency	Percent
Gender		
Male	124	31.4
Female	271	68.6
Age		
<30 years	33	8.4
30-39 years	105	26.6
40-49 years	157	39.7
50-59 years	83	21.0
>60 years	17	4.3
Position		
President/Director/Manager	103	26.1
Physician/Dentist/Pharmacist	86	21.8
Medical technician/Radiologist/Physiotherapist/Nutritionist	49	12.4
Nurse/Nursing Assistant	70	17.7
Customer service	14	3.5
Office workers/Support staff	46	11.6
Other	27	6.8
Working Experience		
<10 years	96	24.3
10-20 years	196	49.6
>20 years	103	26.1
Types of innovation projects		
Product innovation	105	26.6
Process innovation	254	64.3
Business model innovation	36	9.1
Sources of innovation projects		
Research and development	30	7.6
Customer problem and need analysis	158	40.0
Work experience	98	24.8
Customer advises	109	27.6
Stage of the implementation of the innovation project.		
Research ideas and innovation projects initiation	47	11.9
Prototype development	76	19.2
Prototype to market test	135	34.2
Commercial market initiation	86	21.8
Further development and expansion	51	12.9

Data Analysis

SEM is generally selected to refine and validate the measurement scales (Al-Hawari et al., 2005). The data will be entered into the statistical software AMOS. Given the fact that the proposed model is based on logic, previous empirical research, and theoretical findings; the SEM approach is considered the most appropriate method to statistically confirm the proposed factors of the TQIM-H model. The conceptual model of TQIM-H contains the factors which are necessary to be grouped and does not contain the factors that are not involved with quality and innovation management systems affecting healthcare performance (Demirbag et al., 2006; El-Gohary, 2012; Fotopoulos & Psomas, 2009) The two-step data analysis will be employed such as step 1: the measurement models for each factor are tested using CFA to ascertain results in goodness-of-fit data and step 2: the association between TQIM-H integrated model and healthcare performance is measured using structural analysis.

Confirmatory Factor Analysis is performed for the TQIM-H to determine the validity of the constructs. According to Fornell and Larcker (1981), a more suitable indicator would be on composite reliability, as it takes into account the actual factor loadings rather than assuming that every item is equally weighted during composite load determination (Fuentes et al., 2006; Lin & Lee, 2004; Segars & Grover, 1998). According to Molina, et al., the minimum proposed value is 0.70, as this was obtained by calculating the Average Variance Extracted (AVE), which has a minimum suggested value of 0.5 (Fornell & Larcker, 1981; Molina et al., 2007).

According to Segars and Grover (1998), and Lin and Lee (2004), the measurement model can be measured for its goodness-of-fit based on eight common measures: ratio of $\chi2$ statistics to the degree of freedom (df), Comparative Fit Index (CFI), Goodness-ofFit Index (GFI), Tucker Lewis Index (TLI), Adjusted Goodness-of-Fit Index (AGFI), Normed Fit Index (NFI), Standardized Root Mean Square Residual (SRMR), and Root Mean Square Error of Approximation (RMSEA).

7.2 Normality of Distributions

The structure equation modeling (SEM) technique assumes multivariate normality of all latent variables (Tabachnick et al., 2001). Skewness and kurtosis are two components of univariate normality that are commonly used for determining the shape of the distribution. To decide whether distribution varies significantly from normality, statisticians divide the skew value by the standard error of skew to create a Z score. Skew is significant, if the value exceeds an absolute value of 2.58 for a sample less than 300 and 3.29 for samples greater than 300 (Tabachnick et al., 2001). The details of skew and kurtosis values of this research are presented in Table 7.3.

Table 7.3 Mean, SD, Skew and Kurtosis on TQIM-H

Dimension	Factors & Definitions	TQIM-H question	Mean	SD	Skew	Kurtosis
Context of the Environment (Internal & External)	**1.1 Customer (patient etc.) needs:** The hospital places importance on customers' satisfaction with the service. Keeping abreast of the market's situation and patient's needs is essential to increase the potential for competition.	CE1 Prioritizing according to important customer needs and demands.	9.02	1.17	-1.14	0.99
		CE2 Examining cases of complaints from customers for further improvement.	8.96	1.15	-0.82	-0.14
		CE3 Studying tangible and intangible differences among the customer segment in terms of, for example, age, race.	8.57	1.36	-0.54	-0.69
		CE4 Observing trends that reflect needs from both customers and the markets.	8.67	1.31	-0.68	-0.29
	1.2 Technological change: Technological changes affect an organization's	CE5 Collaborating with universities to conduct research that creates or imports technologies to the hospital.	8.89	1.16	-0.81	0.23

Dimension	Factors & Definitions	TQIM-H question	Mean	SD	Skew	Kurtosis
	development by superseding some processes. Technology can enhance working performance and streamline the process by removing irrelevant parts, resulting in increasing capability for competition in the healthcare market and augmenting customers' trust.	CE6 Adopting cross-industry innovation by studying trends of changes and adaptation of other businesses; and applying the knowledge to the healthcare business.	9.16	1.04	-0.98	0.10
		CE7 Using technology and innovation as a tool to build trust between personnel and customers.	9.02	1.19	-1.24	1.33
		CE8 Studying technological changes, medical innovative technologies, and emergent innovations and applying them in the hospital.	8.77	1.24	-0.72	-0.34
	1.3 Litigation law refers to the rules and practices: Law is important because it is the basis of all operations and covers medical ethics and patient rights.	CE9 Complying with laws, hospital standards, and medical ethics.	8.58	1.24	-0.44	-0.72
		CE10 Annexing regulations into part of the hospital's strategies.	8.37	1.32	-0.25	-0.96
		CE11 Following complaints or acts that do not comply with the law or medical ethics for further improvement.	8.58	1.42	-0.59	-0.67
Leadership	**2.1 Leader vision:** Leaders' visions and attitudes are significant for the creation of innovation and quality, as leaders are in charge of steering the direction of the management and organizational structures.	LD1 Acknowledging the importance of innovation and having a vision for developing innovation and quality in the hospital.	8.96	1.23	-0.97	0.17
		LD2 Proposing policies on quality and innovation as the main goals of the organization, with specified related KPIs.	8.69	1.27	-0.71	-0.13
		LD3 Joining the development of projects as examples.	8.47	1.37	-0.40	-0.79
		LD4 Including time used for creating innovation into working hours.	8.51	1.41	-0.49	-0.86
		LD5 Creating an atmosphere that encourages learning and experiments.	9.00	1.15	-1.02	0.39
	2.2 Resources allocation: Resources e.g. time, personnel, budgets, etc. is important. Allocating the resource is an essential task that enables leaders to manage the hospital.	LD6 Setting up a committee that monitors the results continuously.	9.05	3.94	17.50	333.71
		LD7 Allowing everyone to express equal and unlimited opinions.	8.85	1.32	0.50	8.06
		LD8 Punishing for mistakes that occur after any design or experiment is prohibited.	8.72	1.36	-1.43	4.28
		LD9 Allowing workers to consult leaders for advice when facing problems and to report progress periodically.	8.45	1.44	-0.64	-0.14
		LD10 Supporting and allocating resources need for the development of innovation including time, personnel, tools, training sessions, and money, all handled appropriately.	8.89	1.15	-0.68	-0.50
Planning	**3.1 Strategic plan development:** Implementation of organizational policies and planning direction in the management of the organization, together with quality and innovation management, can drive working processes toward success.	PN1 Stating policy and vision involving organizational quality and innovation	8.91	1.07	-0.62	-0.38
		PN2 Stating indicators and outcomes for organizational quality and innovation	8.67	1.31	-0.73	-0.08
		PN3 Stating strategies for organizational quality and innovation	8.64	1.34	-0.76	-0.03
	3.2 Alignment of innovation: Making innovation part of the organization's strategies and part of each member's work catalyzes innovation and generates innovation recognition from the organization's members, resulting in sustainability.	PN4 Creating an action plan that agrees with organization policy	8.69	1.28	-0.68	-0.36
		PN5 Integrating quality and innovation in hospital as a part of job and organization	8.77	1.22	-0.72	-0.32

Dimension	Factors & Definitions	TQIM-H question	Mean	SD	Skew	Kurtosis
Support	**4.1 Budgets:** Money is a crucial factor for the success of all activities in the hospital.	SP1 Setting up a funding budget for quality and innovation projects for suitable periods	8.75	1.21	-0.59	-0.54
	4.2 Facilities e.g. laboratories, space, etc.: Facilities constitute a factor that drives the organization towards development. There are two dimensions to facilities: intangible dimension and tangible dimension. The first one includes time, opportunity, trust, and knowledge. The second includes tools, apparatus, technology, human resources, and sandbox.	SP2 Providing “sandbox” or “simulative model” to experiment with projects or inventions developed in the hospital before their real use so risks can be predicted and minimized	8.57	1.28	-0.44	-0.78
		SP3 Creating a space or hub where innovators can exchange ideas and brainstorm to develop projects in the hospital	8.33	1.55	-0.50	-0.78
	4.3 Employee education and training programs: Healthcare programs are intended for equipping staff with the knowledge of working systems internal to the hospital so they can all work in the same direction. Further, cultivating critical thinking is very important to develop innovative projects in the hospital.	SP4 Creating a handbook for new personnel	8.72	1.21	-0.63	-0.39
		SP5 Planning a training session that encourages quality and innovation	8.24	1.40	-0.37	-0.69
		SP6 Providing courses that aim to create innovative thinking and a critical thinking mindset to cultivate innovators	8.55	1.47	-0.91	0.87
		SP7 Providing mandatory training courses for new personnel so that they work in the same direction	8.49	1.40	-0.75	-0.02
		SP8 Auditing healthcare staff working knowledge periodically	8.64	1.24	-1.08	3.12
		SP9 Providing space or time for opinion exchanges. Problems should be also discussed so knowledge for further development can be exchanged	8.89	1.17	-0.92	0.49
Operation	**5.1 Process management:** Management and operating processes are considered significant for effective performance. Process management can reduce organizational resources and risks, and can increase working performance in the hospital.	OP1 Creating a management system and a plan for each department with its specificity	8.79	1.21	-0.88	0.17
		OP2 Creating a management system and a plan that provide the whole picture of the organization	8.50	1.35	-0.59	-0.55
		OP3 Considering a working process to eliminate irrelevant processes	8.43	1.37	-0.51	-0.55
		OP4 Auditing and evaluating performance periodically to maintain standards and working potential	8.75	1.22	-0.72	-0.15
	5.2 Monitoring and evaluation: Monitoring and evaluating working processes eliminate pain points and increase the working potential that helps the organization achieve its goals.	OP5 Specifying the scope and goal of each innovative project clearly	8.60	1.30	-0.89	2.04
		OP6 Utilizing tools for evaluation and simultaneously improving the plan according to the objectives	8.71	1.20	-1.08	3.44
		OP7 Creating a monitoring system for innovative projects in the hospital	8.35	1.42	-0.69	0.79
	5.3 Decision-making to solve problems: The decision-making system is a significant part of the hospital, as patient treatment requires informed and quick decisions that create the minimum risks to patients.	OP8 Providing a system that furnishes decision-making	8.99	1.07	-0.82	0.04
		OP9 Having systems and technology that can make accurate decisions such as AI Robots	8.83	1.15	-0.66	-0.43
		OP10 Prioritizing work according to its importance to help with decision-making processes	9.01	1.12	-0.75	-0.53
		OP11 Having a reliable database that is adequate for decision-making	8.97	1.12	-1.01	0.82
	5.4 Risk management: Risk management is the process of analyzing processes and practices that are in the hospital,	OP12 Identifying the process that is the cause of risk	8.38	1.38	-0.59	-0.20
		OP13 Predicting and evaluating risks in the hospital	8.64	1.28	-0.53	-0.60
		OP14 Initiating risk prevention and	8.51	1.35	-0.44	-0.90

Dimension	Factors & Definitions	TQIM-H question	Mean	SD	Skew	Kurtosis
	identifying risk factors, and implementing procedures to address those risks.	mitigation in the hospital				
	5.5 Internal and external networking: Internal and external networking and collaboration from diverse sections increase the effectiveness in the development of the organization and working processes in the hospital.	OP15 Seeking alliances or networks with other organizations to develop between-organization or between-department innovation projects.	8.55	1.24	-0.38	-0.84
		OP16 Collaborating with a network of partners to create new business models.	8.32	1.32	-0.17	-1.12
	5.6 Knowledge management: Knowledge management is to collect and present knowledge necessary for effective organizational development. Knowledge management includes professional knowledge and critical thinking.	OP17 Providing activities involving knowledge-seeking or seminars led by experienced individuals from both inside and outside of the organization to obtain new bodies of knowledge.	8.76	1.19	-1.17	3.73
		OP18 Collecting knowledge necessary for developing management processes in the hospital for further research and access by interested personnel.	8.51	1.32	-0.80	1.62
	5.7 Building distinctive competencies and competitive advantage: Examining competitors' potential in the market can help create effective development in the hospital. Moreover, studying other competitors' weaknesses and strengths helps identify new opportunities for development in the organization.	OP19 Studying and comparing competitors in the market to increase potential in selling and treatment.	8.65	1.23	-0.53	-0.35
		OP20 Studying uncharted territory in the market and creating values out of those gaps.	8.35	1.42	-0.23	-1.16
	5.8 Establishing an innovation award: Awards granted to successful projects support and encourage personnel to improve their quality and innovation projects within the organization. Also, awards are one of the factors that stimulate healthcare workers to forge organizational development.	OP21 Promoting awarded projects and implementing them in the organization as models.	8.41	1.35	-0.39	-0.79
		OP22 Motivating personnel that win the competition or success in creating innovation by awards e.g. money, promotion, fame	8.72	1.27	-1.10	2.77
		OP23 Using awarded projects as learning examples.	8.74	1.30	-1.20	2.83
Tools and Analysis method	**6.1 Well-defined processes and formalized tools:** Using the right tools and system patterns ensures the effectiveness of working processes, minimizes risks, and creates trust between personnel and patients.	TA1 Establishing the center for quality and innovation tools	8.66	1.22	-0.57	-0.60
		TA2 Managing information that is brought into the system with clarity and accuracy	8.67	1.22	-0.45	-0.72
	6.2 Information management: Management of internal information is significant and complicated, so appropriate and accurate management, which is essential to the hospital, is required.	TA3 Managing information that is audited so that the accuracy of information is confirmed	8.90	1.15	-0.94	0.34
		TA4 Providing information that is available for retrieval at any time; is reliable; and, is ready to be used	8.91	1.12	-0.82	-0.01
		TA5 Collecting information and using statistical prediction is performed so weaknesses can be spotted. Overcoming the identified weakness can improve the organization	8.50	1.45	-0.70	-0.27
	6.3 Data availability and accuracy: Accuracy in the hospital's information is highly significant since it is	TA6 Initiating systems for validating the accuracy of the tools	8.98	1.14	-1.02	0.57
		TA7 Updating the information constantly according to the patient status	8.64	1.44	-0.75	-0.26

Dimension	Factors & Definitions	TQIM-H question	Mean	SD	Skew	Kurtosis
	directly relevant to medical information and patients' lives. The information must be up-to-date throughout the treatment duration so that effectiveness is brought to treatment processes.	that is changing throughout the treatment process				
		TA8 Managing information within the organization that is connected across departments	9.05	1.11	-1.00	0.14
	6.4 Data integrity and security: Keeping medical information confidential is bound by the law and medical ethics. Therefore, data safety and confidentiality must be managed effectively.	TA9 Creating effective and secure information retrieval processes e.g. the process that requires identification of users	8.74	1.28	-0.51	-1.05
Improvement	**7.1 Achieving quality standards:** Implementing quality standards, having clear working criteria, and gaining trust from customers can increase the working potential to the level of international standards.	IP1 Setting annual goals as reaching quality standards	8.83	1.24	-0.69	-0.65
		IP2 Evaluating working performance regularly to seek tools and methods that can develop the system continuously	8.57	1.28	-0.38	-1.00
		IP3 Designing and seeking new ways to develop continuously in place of old, existing processes.	8.99	1.11	-1.14	1.05
	7.2 Continuous solving: Continuous solving involves the improvement of the process after the weakness identification. Newly designed processes increase working potential, resulting in the ability to adapt to the ever-changing environment.	IP4 Creating a system that encourages knowledge sharing and that points to the significance of quality standards.	8.42	1.40	-0.32	-1.01
		IP5 Building customers' trust toward the organization through organizational standards.	8.39	1.36	-0.21	-1.10
		IP6 Providing a system or experts who can advise and support system development.	8.30	1.34	-0.10	-1.13
	7.3 Quality audits: To keep healthcare management effective and to minimize errors, auditors observe the process to maintain working efficiency and to stimulate personnel to remain in line with working standards.	IP7 Initiating internal auditing system that complies with international standard	8.41	1.38	-0.25	-1.08
		IP8 Setting goals and achievement levels from the audit	8.46	1.36	-0.22	-1.21

Table 7.4 Mean, SD, Skew and Kurtosis on sustainable innovation

Dimension	Factors & Definitions	Sustainable innovation measurement question	Mean	SD	Skew	Kurtosis
Economically sustainable innovation	**Crisis management:** Crisis management is identifying a threat to an organization and its stakeholders to respond effectively to the threat and license to operate protection. It can occur as a result of an unpredictable event or an unforeseeable consequence of some event that had been considered as a potential risk.	ECO1 Establishing a risk assessment system in the organization	9.00	1.06	-0.92	0.44
		ECO2 Establishing risk prevention and mitigation system in the hospital	9.28	0.92	-1.69	4.35
	Profit and value: This theme measures the wealth creation of a hospital and is related to traditional financial results that are crucial for the short and long term sustainability of all kinds of hospitals.	ECO3 Decreasing supply chain cost	8.62	1.57	-2.29	8.06
		ECO4 Decreasing personnel cost	8.23	1.48	-1.24	4.22
		ECO5 Maximizing hospital income	8.53	1.46	-1.83	6.15
		ECO6 Decreasing cost relating to facilities and utilities in the hospital	7.89	1.43	-0.17	0.39
		ECO7 Decreasing cost relating to medications and medical equipment	9.10	0.99	-0.81	-0.16

Dimension	Factors & Definitions	Sustainable innovation measurement question	Mean	SD	Skew	Kurtosis
	Investments: Investing is the act of allocating the resource to increase, replace or renew assets, usually money, with the expectation of generating an income or profit which these investments are related to future growth.	ECO8 Increasing business growth	8.78	1.20	-0.65	-0.30
		ECO9 Maximizing co-investment to build new business	8.12	1.49	-0.32	-0.58
Environmental sustainable innovation	**Waste management:** Waste Management includes the processes and actions required to manage waste from its inception to its final disposal.	ENV1 Establishing systems for climate management	8.15	1.47	-0.23	-0.94
		ENV2 Establishing systems for solid waste management	7.98	1.53	-0.04	-1.20
		ENV3 Establishing systems for water and wastewater management	8.10	1.49	-0.16	-1.10
		ENV4 Establishing systems for dangerous waste management	8.45	1.33	-0.41	-0.71
		ENV5 Establishing systems for waste recycling	8.90	1.05	-0.75	0.56
	Energy management: Energy management is the process of tracking and optimizing energy consumption to conserve usage in a hospital.	ENV6 Establishing systems to manage renewable energy	9.13	0.94	-0.98	1.13
		ENV7 Establishing systems to manage non-renewable energy	7.89	1.48	-0.20	0.16
Socially sustainable innovation	**External customer value:** The external social was patients or customers that pay for and use the products or services healthcare offers. The factor that all hospitals attend to, especially in the aspect of quality of care, which was the ability to take care of patients and cure them of illnesses safely and is at the center of concern.	SOC1 Improving treatment efficacy and safety	9.48	0.78	-1.67	3.21
		SOC2 Improving customer relationship	9.23	0.93	-1.14	1.01
		SOC3 Establishing systems for the safety and security of patient data	9.33	0.89	-1.38	2.08
		SOC4 Building facilities for patient care	9.15	0.94	-1.03	0.75
		SOC5 Incorporating technology and innovation to maximize utilities from the working process	8.77	1.25	-1.14	3.07
		SOC6 Establishing systems for the management of administration time and effective patient care	9.21	0.89	-1.21	1.77
		SOC7 Allowing community engagement and medical access	8.37	1.39	-0.13	-1.27
	Internal customer value: The internal social was healthcare staff in the healthcare system or as partners who deliver the product or service to the end-user, the external customer. Healthcare staff should have been provided the safety and health from their work because it affected treatment outcomes and healthcare performance.	SOC8 Establishing systems responsible for personnel health and safety	9.33	0.96	-1.67	2.77
		SOC9 Creating motivation and retaining personnel	8.76	1.39	-1.19	1.97
		SOC10 Allowing the engagement of personnel in organizational development	8.77	1.34	-1.10	1.94
		SOC11 Advancing personnel potential and knowledge	8.85	1.36	-1.40	2.74
		SOC12 Implementing medical ethics	9.35	1.02	-2.70	13.38

7.3 Measurement Model Assessment

Measurement model assessment is the first of the two-stage approach recommended for an SEM analysis. It assesses the conformity of data and the measures. This step allows researchers to modify measurement models, as well as purify measures, so that estimation of the structural regression model is reliable and valid. The key analysis of measurement model assessment is confirmatory factor analysis (CFA). The CFA verifies that each measured variable represents, or is loaded into, an expected latent variable. The measurement model assessment also examines the reliability and validity of the measures using variable properties, e.g. correlations, variances, etc. The details of SEM analysis are explained in the main analyses section.

In this study, the overall measurement model is initially broken down for a series of CFA for granular investigations and modifications. The first set of the assessment is the set of separated CFA of total quality and innovation management in hospital (TQIM-H): the context of the environment, leader, planning, support, operation, tools and analysis method, and improvement, and the second set is the CFA of the sustainable innovation: economic sustainable innovation, environmental sustainable innovation, and social sustainable innovation. Then, the overall model is assembled and analyzed for holistic properties. The global model is tested for its reliability and validity.

The CFA determined factor loadings of each variable into a latent variable. A general suggestion number for a good standardized loading is 0.7 or higher. Factor loading higher than 0.6 is applicable, where sometimes 0.5 is acceptable (Miller, 1995). Variables with factor loading less than those numbers are suggested to be dropped to increase the construct validity, especially, the convergent validity. In this study, any variables with a factor loading less than or close to 0.6 were investigated. The researcher relied mainly on the face validity and descriptive statistics to judge whether variables with low loading scores should be kept or not.

It is also recommended to re-specify measurement models by fitting them with the data to gain more accurate estimation (Byrne, 2010). Besides dropping variables, researchers could be parceling or combining variables, or correlating errors to gain fitness of the model. Byrne (2010) suggested that modification indices (M.I.) could be employed to solve the factor loading and error terms. AMOS provides modification indices to suggest such modifications. Moreover, high correlation residuals suggests high correlation among variables. These correlations may hinder discriminant validity. Any variables with correlation residuals of more than 2.0 were investigated. In this study, correlation residuals were investigated in the global measurement model where all variables were evaluated for their correlations. The goodness-of-fit is assessed for judging the soundness modification.

Once, the model was specified, the researcher tested its plausibility based on sample data that comprised all observed variables in the model. The primary task in this model-testing procedure was to determine the goodness-of-fit between the hypothesized model and the sample data. Evaluating the goodness-of-fit criteria is summarized in Table 7.5.

The overall fit model applies the likelihood ratio chi-square statistic ($\chi 2$) (Byrne, 2010; Hair et al., 2010; Kline, 2010). A high value of chi - square relative to the degree of freedom signifies that the observed and chi-square reference matrices differ considerably. On the other hand, a low $\chi 2$ value which results in a significance level greater than 0.05, indicates that the observed and chi-square reference matrices are not statistically different (for small sample size, less than 200) (Kline, 2010).

Normed chi-square (χ^2 / df) was applied to reduce the sensitivity of $\chi 2$ and indicated the observed and estimate matrices differ considerably. An accepted value of this ratio is less than or equal to 5.0 (Tabachnick et al., 2001; Tabachnick et al., 2007).

The comparative fit index (CFI) represents a comparison between the estimated model and a null or independent model. The values range from 0 to 1.0 and larger values indicate higher levels of goodness-of-fit. Comparative fit-index is more appropriate in a model development strategy or when the sample group is small.

Incremental Fit Index (IFI), also known as Bollen's IFI, is also relatively insensitive to sample size. Values that exceed .90 are regarded as acceptable, although this index can exceed 1. (Schumacher & Lomax, 2010)

Tucker Lewis fit index (TLI) or Non-normed Fit Index (NNFI) combines a measure of parsimony with a comparative index between the proposed and null models, with values ranging from 0 to 1.0 (Hair et al., 2010). An accepted value indicating the level of fit is greater than 0.9 (Baumgartner & Homburg, 1996). However, the value of all mentioned indices of less than 0.9 is acceptable for the complex model, while greater than 0.95 indicates superior fit (Abdullah et al., 2014).

Goodness - of - fit index (GFI) represents the overall degree of fit, but is not adjusted for the degrees of freedom (Byrne, 2013; Hair et al., 2014). Goodness-of-fit index is based on the parsimony of the estimated model. Ranging in value from 0, it calculates a weighted proportion of variance in the sample covariance, accounted for by the estimated population covariance matrix (Tabachnick & Fidell, 2007).

Root mean square error of approximation (RMSEA) is an index based on non-centrality and will compensate for the chi-square statistic in large samples (Hair et al., 2010). Schumacker & Lomax (2016) suggested that a value of 0.05 to 0.08 indicates a close fit. Values less than 0.05 indicate a close fit of the model in relation to the degrees of freedom. RMSEA value 0.08 or less, indicates a reasonable error of approximation and the value greater than 0.1 would not be employed as a model (Browne et al., 1993).

Table 7.5 Summarized Goodness-of-fit Criteria

Goodness of Fit	**Level of acceptable fit**
Chi square/ Degree of Freedom (χ^2/df)	< 5.00
Comparative fit index (CFI)	> 0.90
Incremental Fit Index (IFI)	> 0.90
Tucker–Lewis index (TLI)	> 0.90
Goodness of Fit Index (GFI)	> 0.90
Root Mean Square Error of Approximation (RMSEA)	< 0.08

7.3.1 Measurement Model Assessment of TQIM-H

TQIM-H is a construct composed of seven dimensions : context of the environment, leader, planning, support, operation, tools and analysis method, and improvement. The CFA of TQIM-H employed a method of second order confirmatory factor analysis, where each dimension is applied a general CFA or a first order confirmatory factor analysis, then the total score representing each dimension or sub-construct was treated as a variable for higher order CFA. Figure 7.1 depicts a graphical representation of CFA. The results of the analysis are shown in the following diagram and in Table 7.5.

The standardized estimates of factor loadings are the regression weights of variable loading into the indicated constructs constraining variances of the constructs equal to 1. These loadings are a major concern in CFA. Measurement errors indicate the difference in the observed data from the calculated true values. R^2 indicates information explained by the variable for the indicated measure. The standardized estimates for measurement errors are proportions of unexplained variance, which equals 1-R^2.

The goodness-of-fit parameters indicates that the model does not well-fit the data χ^2 = 9474.432, df = 2548, p = .000, χ^2/df = 3.718, CFI = .775, IFI = .775, TLI = .768, RMSEA = .083. The goodness-of-fit indices should be higher than 0.9, while all of them are less than 0.9. The CFA results and the modification of model are discussed as follows.

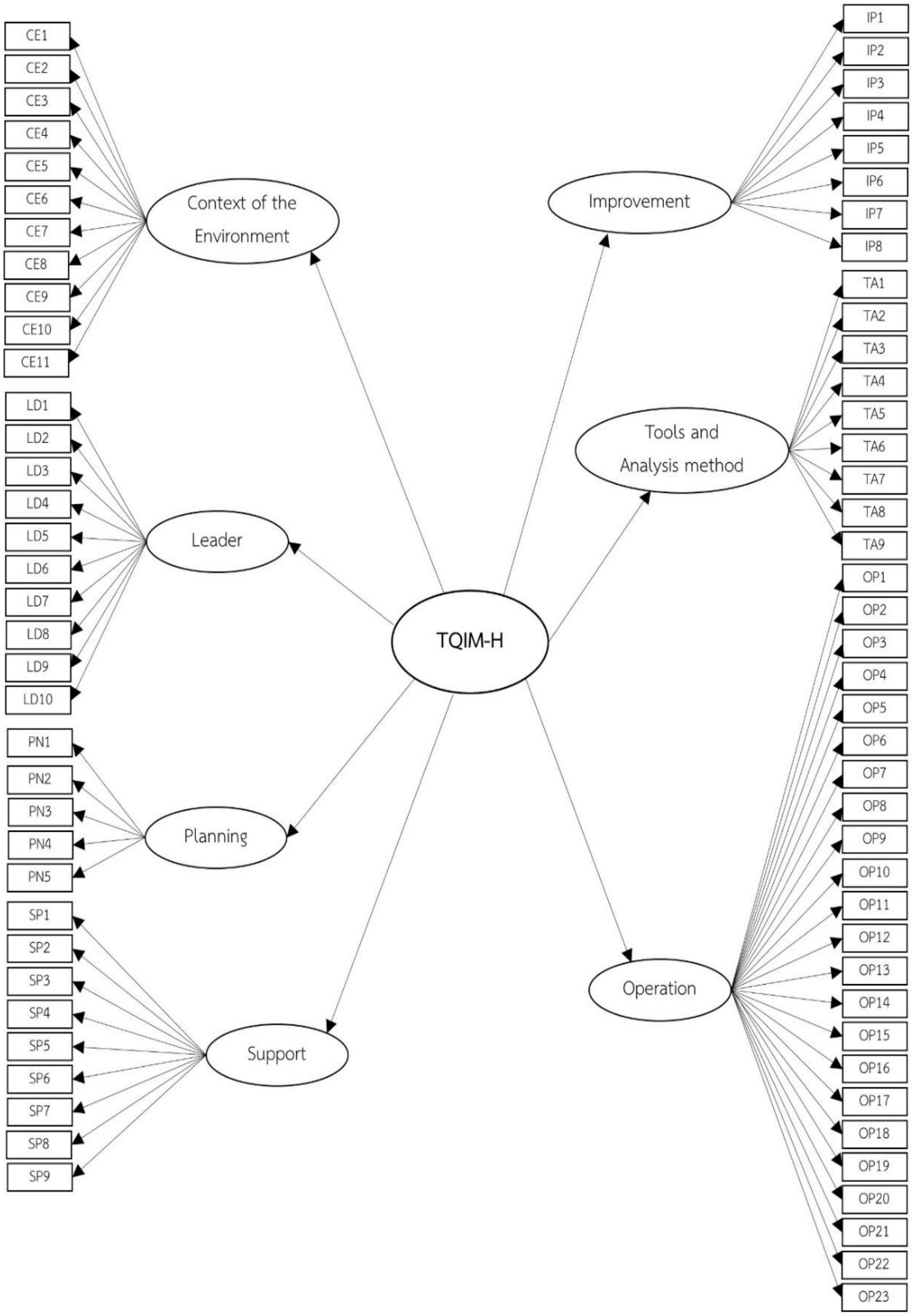


Figure 7.1 Measurement model of TQIM-H

Table 7.6 Results of Factor Loadings and Residuals for TQIM-H

Construct	Items	Standardized Loadings	Standard error	*t*-value	R^2
Context of the Environment	CE1 [a]	0.685			0.469
	CE2	0.642	0.077	14.074	0.55
	CE3	0.664	0.091	14.399	0.584
	CE4	0.765	0.088	14.300	0.585
	CE5	0.680	0.078	13.779	0.533
	CE6	0.678	0.070	14.731	0.605
	CE7	0.660	0.080	14.377	0.578
	CE8	0.781	0.083	14.633	0.611
	CE9	0.787	0.084	14.541	0.619
	CE10	0.673	0.088	12.580	0.453
	CE11	0.779	0.096	14.419	0.607
Leader	LD1 [a]	0.828			0.686
	LD2	0.817	0.052	19.776	0.668
	LD3	0.692	0.059	16.494	0.521
	LD4	0.806	0.058	19.347	0.649
	LD5	0.784	0.048	18.578	0.615
	LD6	0.659	0.049	14.589	0.434
	LD7	0.680	0.050	18.414	0.608
	LD8	0.699	0.061	13.742	0.395
	LD9	0.687	0.061	16.976	0.543
	LD10	0.674	0.048	18.233	0.599
Planning	PN1 [a]	0.820			0.672
	PN2	0.862	0.061	21.165	0.742
	PN3	0.877	0.061	21.787	0.769
	PN4	0.874	0.059	21.667	0.764
	PN5	0.670	0.058	19.622	0.673
Support	SP1 [a]	0.827			0.684
	SP2	0.688	0.055	17.029	0.544
	SP3	0.773	0.066	18.205	0.597
	SP4	0.694	0.052	17.572	0.569
	SP5	0.768	0.060	18.018	0.590
	SP6	0.849	0.060	20.997	0.720
	SP7	0.682	0.062	16.218	0.507
Operation	OP1 [a]	0.685			0.616
	OP2	0.839	0.062	19.191	0.703
	OP3	0.802	0.064	18.079	0.643
	OP4	0.693	0.056	18.397	0.660
	OP5	0.697	0.059	19.152	0.701
	OP6	0.697	0.056	17.938	0.635
	OP7	0.838	0.065	19.163	0.701
	OP8	0.675	0.051	15.88	0.525
	OP9	0.661	0.054	18.059	0.642
	OP10	0.666	0.053	17.037	0.587
	OP11	0.653	0.053	16.378	0.552
	OP12	0.684	0.066	15.601	0.510
	OP13	0.833	0.059	19.012	0.694
	OP14	0.864	0.061	19.992	0.746
	OP15	0.689	0.059	16.54	0.560
	OP16	0.679	0.062	17.392	0.606
	OP17	0.660	0.056	16.863	0.577
	OP18	0.855	0.060	19.715	0.731
	OP19	0.654	0.058	16.695	0.569
	OP20	0.656	0.067	16.758	0.572

Construct	Items	Standardized Loadings	Standard error	*t*-value	R^2
	OP21	0.833	0.062	19.007	0.693
	OP22	0.652	0.060	16.644	0.566
	OP23	0.664	0.061	16.986	0.584
Tools and Analysis method	TA1 [a]	0.649			0.561
	TA2	0.683	0.064	16.284	0.613
	TA3	0.609	0.060	16.921	0.655
	TA4	0.695	0.059	17.533	0.696
	TA5	0.698	0.076	16.886	0.653
	TA6	0.833	0.060	17.486	0.694
	TA7	0.831	0.076	17.443	0.691
	TA8	0.843	0.058	17.749	0.711
	TA9	0.855	0.067	18.021	0.731
Improvement	IP1 [a]	0.673			0.598
	IP2	0.653	0.063	15.572	0.568
	IP3	0.693	0.055	14.517	0.480
	IP4	0.809	0.068	17.033	0.654
	IP5	0.681	0.066	17.181	0.673
	IP6	0.814	0.065	17.35	0.662
	IP7	0.873	0.065	18.792	0.762
	IP8	0.864	0.065	18.545	0.747
χ^2 = 9474.432, df = 2548, p = .000, χ^2/df = 3.718, CFI = .775, IFI = .775, TLI = .768, GFI = .537, RMSEA = .083					

Note: [a] The corresponding parameter has been set equal to 1 (unstandardized) to fix the measurement scale

The series of CFA and modification results in a model with good fit with all goodness-of-fit indices, as shown in Table 7.7.

Table 7.7 Goodness-of-Fit Indices for TQIM-H Confirmatory Factor Analysis

Goodness-of-fit measure	Criterion	Initial Model	Final Model	Result
Chi-square (χ^2)		9474.432	1464.773	
Degree of Freedom (df)		2548	423	
χ^2/df	< 5.00	3.718	3.463	Good fit
CFI	> 0.90	.775	.916	Good fit
IFI	> 0.90	.775	.916	Good fit
TLI	> 0.90	.768	.907	Good fit
GFI	> 0.90	.537	.803	Marginal fit
RMSEA	< 0.08	.083	.079	Good fit

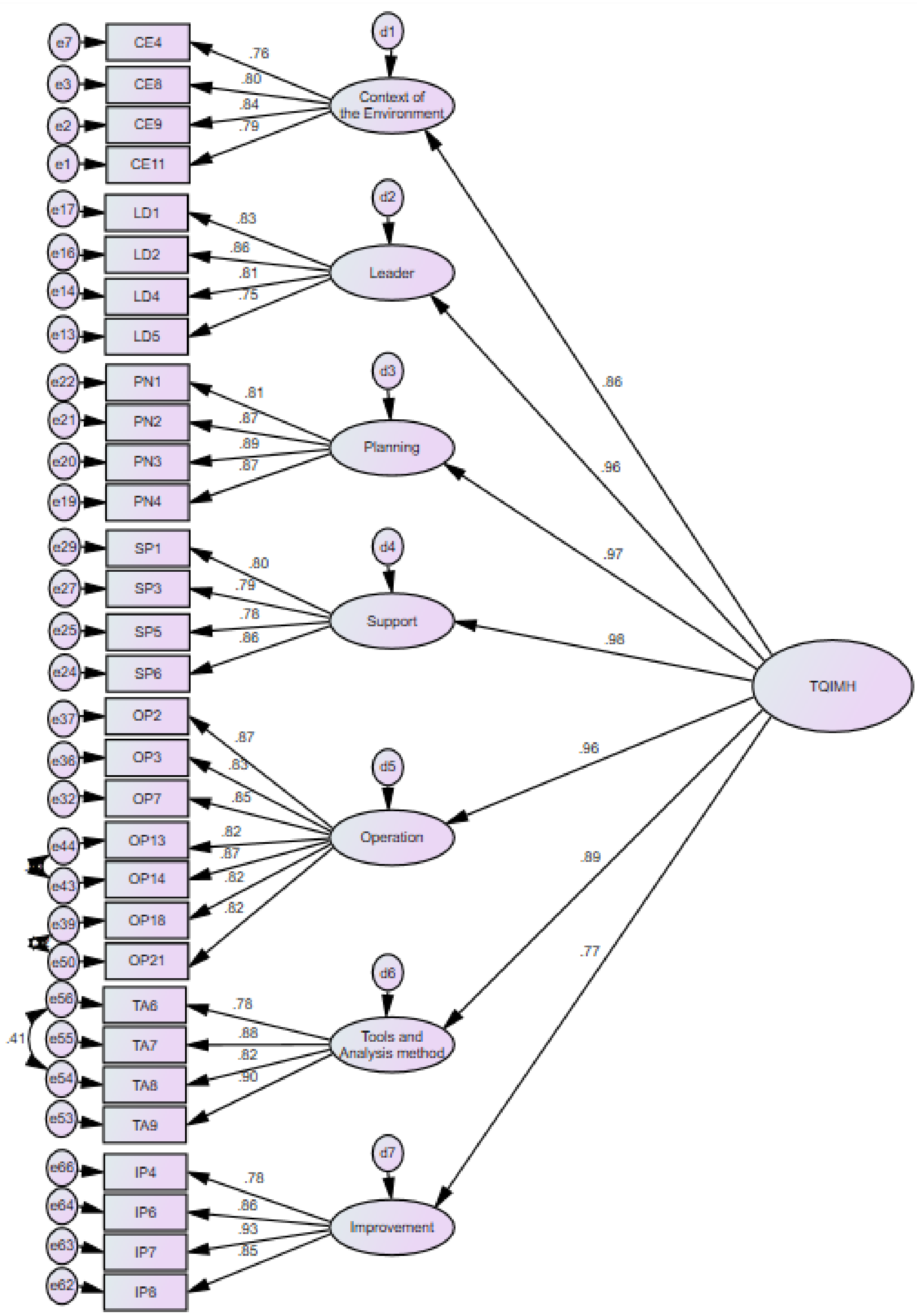


Figure 7.2 Final measurement model of TQIM-H

Table 7.8 Results of Factor Loadings and Residuals for a Final TQIM-H

Construct	Items	Standardized Loadings	Standard error	*t*-value	R^2
Context of the Environment	CE4 [a]	0.763			0.581
	CE8	0.801	0.061	16.359	0.642
	CE9	0.835	0.061	17.146	0.698
	CE11	0.790	0.070	16.099	0.624
Leader	LD1 [a]	0.832			0.692
	LD2	0.855	0.051	21.055	0.731
	LD4	0.810	0.058	19.336	0.656
	LD5	0.747	0.049	17.159	0.558
Planning	PN1 [a]	0.809			0.655
	PN2	0.872	0.062	21.033	0.760
	PN3	0.893	0.063	21.82	0.797
	PN4	0.868	0.061	20.91	0.754
Support	SP1 [a]	0.799			0.639
	SP3	0.790	0.071	17.869	0.624
	SP5	0.779	0.065	17.537	0.607
	SP6	0.863	0.064	20.366	0.745
Operation	OP2 [a]	0.869			0.756
	OP3	0.833	0.044	22.037	0.694
	OP7	0.847	0.045	22.75	0.718
	OP13	0.822	0.042	21.47	0.675
	OP14	0.866	0.042	23.74	0.750
	OP18	0.821	0.043	21.431	0.674
	OP21	0.821	0.044	21.444	0.674
Tools and Analysis method	TA6 [a]	0.785			0.616
	TA7	0.882	0.072	19.644	0.778
	TA8	0.816	0.043	23.347	0.666
	TA9	0.898	0.064	20.089	0.807
Improvement	IP4 [a]	0.780			0.608
	IP6	0.859	0.055	19.166	0.738
	IP7	0.926	0.056	21.054	0.858
	IP8	0.852	0.056	18.964	0.726

χ^2 = 1464.773, df = 423, p = .000, χ^2/df = 3.463, CFI = .916, IFI = .916, TLI = .907, GFI = .803, RMSEA = .079

Note: [a] The corresponding parameter has been set equal to 1 (unstandardized) to fix the measurement scale

7.3.2 Measurement Model Assessment of the Sustainable Innovation

Sustainable Innovation is a construct composed of three dimensions : economic sustainable innovation, environmental sustainable innovation, and social sustainable innovation**.** Figure 7.3 depicts a graphical representation of CFA. The results of the analysis are shown in the following diagram and in Table 7.9.

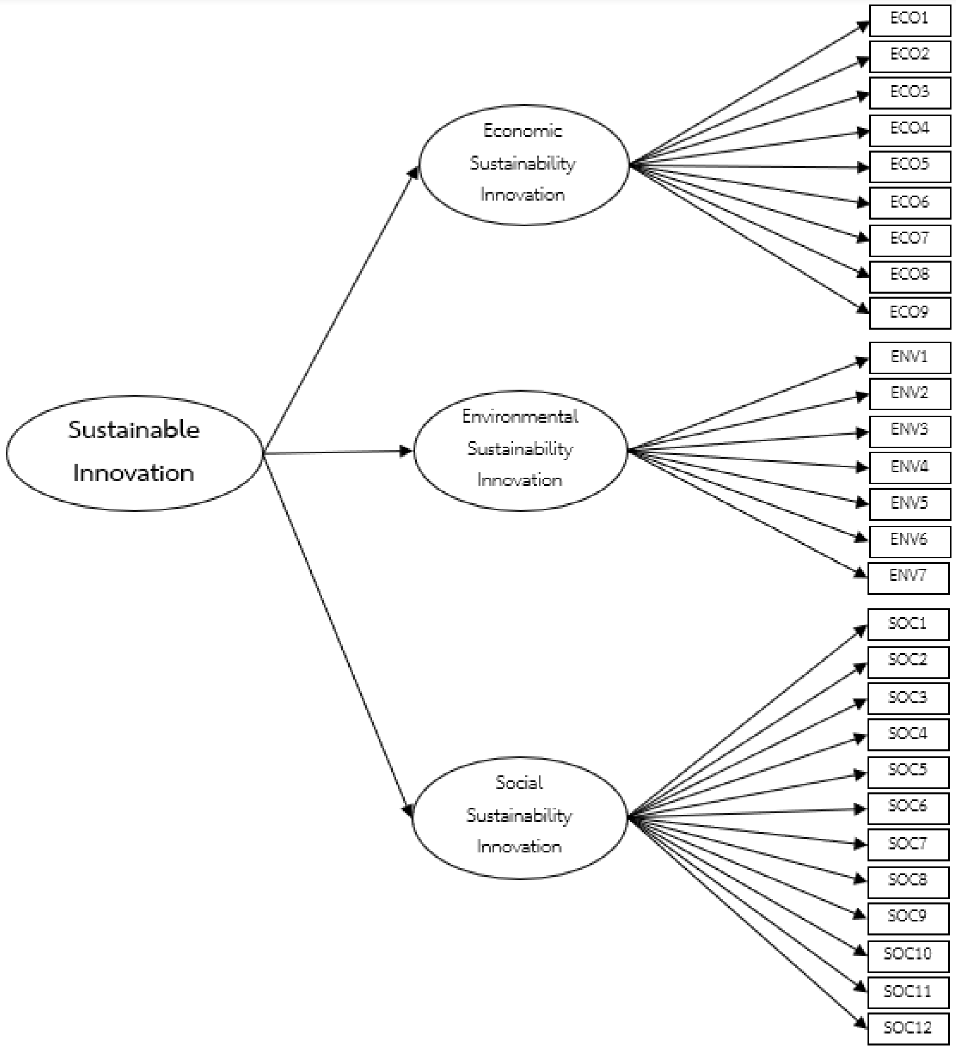


Figure 7.3 Measurement model of Sustainable Innovation

Table 7.9 Results of Factor Loadings and Residuals for Sustainable Innovation

Construct	Items	Standardized Loadings	Standard error	*t*-value	R^2
Economic Sustainability Innovation	ECO1 [a]	0.679			0.560
	ECO2	0.654	0.061	12.608	0.428
	ECO3	0.678	0.106	5.229	0.077
	ECO4	0.819	0.099	8.712	0.211
	ECO5	0.773	0.098	7.047	0.139
	ECO6	0.746	0.094	11.431	0.355
	ECO7	0.661	0.065	12.743	0.437
	ECO8	0.628	0.079	12.068	0.394
	ECO9	0.687	0.097	13.278	0.472
Environmental Sustainability Innovation	ENV1 [a]	0.803			0.645
	ENV2	0.742	0.060	16.007	0.550
	ENV3	0.834	0.056	18.669	0.695
	ENV4	0.801	0.051	17.701	0.642

Construct	Items	Standardized Loadings	Standard error	*t*-value	R^2
	ENV5	0.657	0.042	15.351	0.515
	ENV6	0.662	0.038	13.896	0.438
	ENV7	0.611	0.061	12.614	0.373
Social Sustainability Innovation	SOC1 [a]	0.775			0.601
	SOC2	0.658	0.100	19.082	0.736
	SOC3	0.692	0.103	17.233	0.627
	SOC4	0.740	0.079	15.848	0.548
	SOC5	0.687	0.073	14.489	0.472
	SOC6	0.758	0.068	16.306	0.574
	SOC7	0.697	0.071	17.635	0.651
	SOC8	0.788	0.095	17.115	0.621
	SOC9	0.661	0.066	19.168	0.741
	SOC10	0.715	0.109	14.206	0.456
	SOC11	0.659	0.074	16.331	0.575
	SOC12	0.807	0.105	17.646	0.651
χ^2 = 2282.578, df = 347, p = .000, χ^2/df = 6.578, CFI = .758, IFI = .759, TLI = .736, GFI = .648, RMSEA = .119					

Note: [a] The corresponding parameter has been set equal to 1 (unstandardized) to fix the measurement scale

The modified model is shown in Figure 7.10 and its goodness-of-fit indices are reported as follows.

Table 7.10 Goodness-of-Fit Indices for Sustainable Innovation Confirmatory Factor Analysis

Goodness-of-fit measure	Criterion	Initial Model	Final Model	Result
Chi-square (χ^2)		2282.578	267.871	
Degree of Freedom (df)		347	59	
χ^2/df	< 5.00	6.578	4.540	Good fit
CFI	> 0.90	.758	.935	Good fit
IFI	> 0.90	.759	.935	Good fit
TLI	> 0.90	.736	.914	Good fit
GFI	> 0.90	.648	.912	Good fit
RMSEA	< 0.08	.119	.075	Good fit

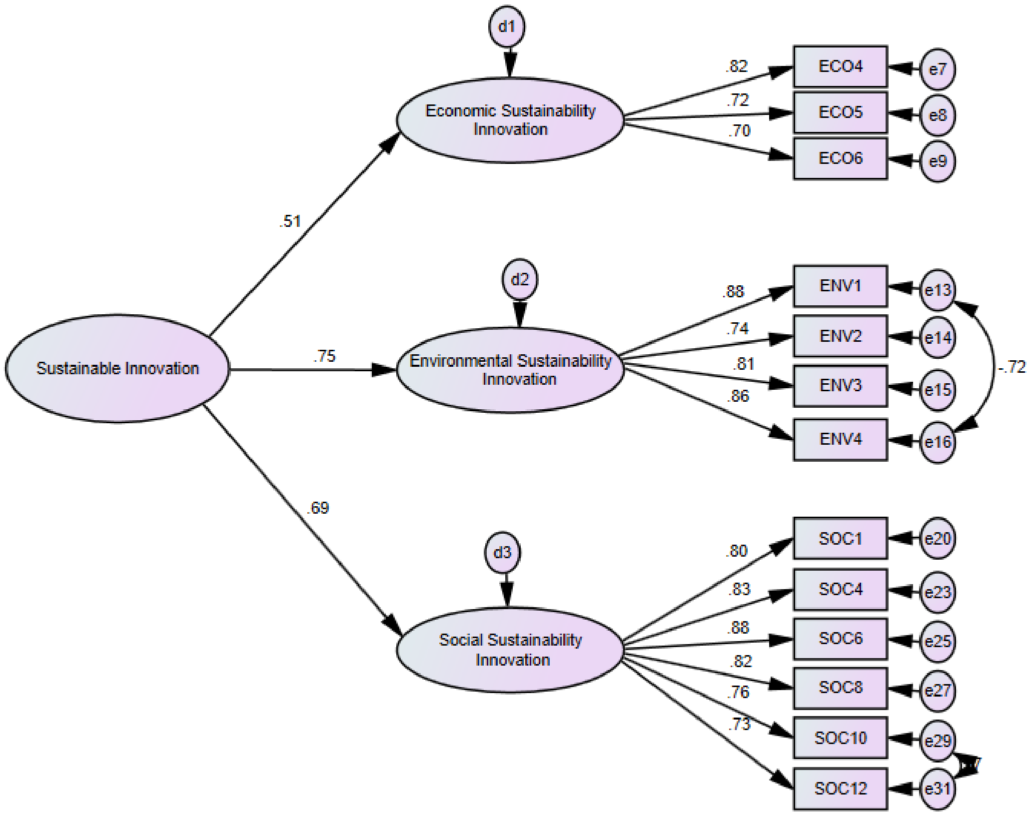


Figure 7.4 Final measurement model of Sustainable Innovation

Table 7.11 Results of Factor Loadings and Residuals for Sustainable Innovation

Construct	Items	Standardized Loadings	Standard error	*t*-value	R^2
Economic Sustainability Innovation	ECO4 [a]	0.820			0.672
	ECO5	0.716	0.070	12.265	0.513
	ECO6	0.703	0.068	12.138	0.494
Environmental Sustainability Innovation	ENV1 [a]	0.884			0.781
	ENV2	0.744	0.052	16.787	0.553
	ENV3	0.813	0.049	18.875	0.660
	ENV4	0.859	0.052	16.931	0.737
Social Sustainability Innovation	SOC1 [a]	0.798			0.636
	SOC4	0.758	0.100	16.403	0.575
	SOC6	0.732	0.077	15.666	0.536
	SOC8	0.835	0.068	18.622	0.697
	SOC10	0.885	0.063	20.109	0.783
	SOC12	0.819	0.069	18.162	0.671

χ^2 = 267.871, df = 59, p = .000, χ^2/df = 4.540, CFI = .935, IFI = .935, TLI = .914, GFI = .912, RMSEA = .075

Note: [a] The corresponding parameter has been set equal to 1 (unstandardized) to fix the measurement scale

7.3.3 Overall Measurement Model Assessment

Figure 7.5 shows a measurement model. Correlations among latent variables were assessed by inspecting their correlation residuals.

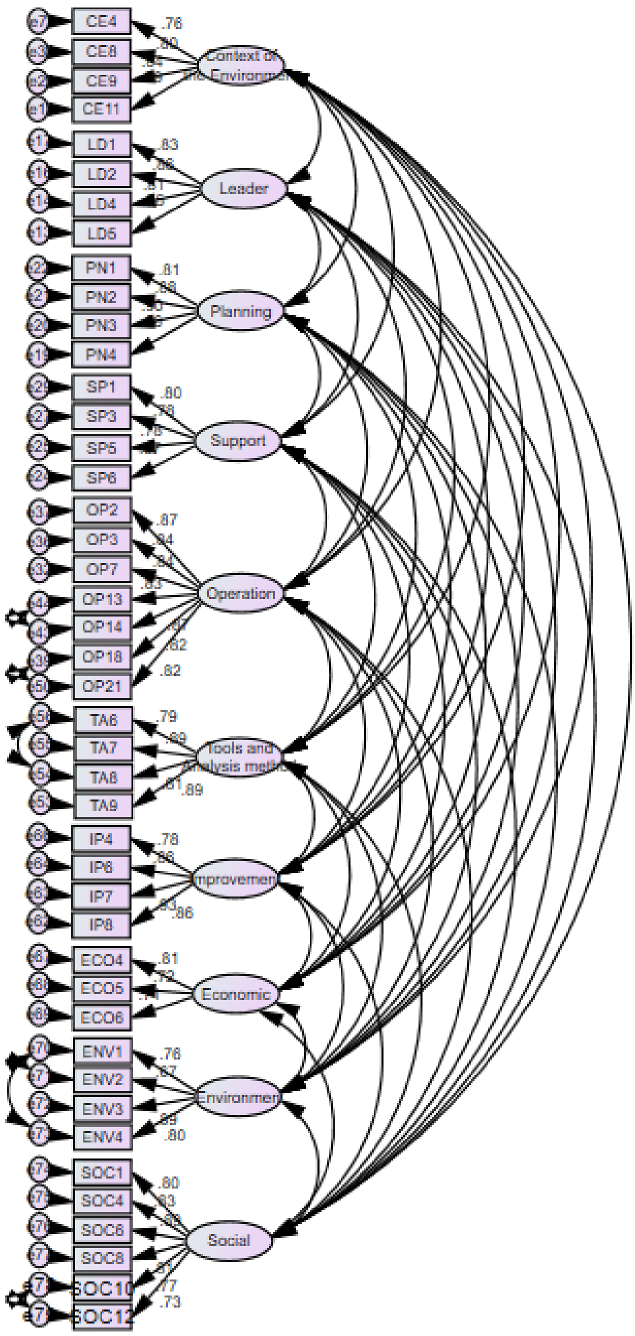


Figure 7.5 Overall measurement model

The model fit indices of the measurement model reveal that after the modified measurement model have a good fit with the empirical data. The $\chi^2/df = 2.832$ is less than 5. The values of CFI = 0.906, IFI = .907 and RMSEA = .068, indicate a good fit; while TLI = .895 and GFI = .882 which is sensitive to large sample size suggest a marginal fit as shown in Table 7.12. From the CFA, there was an acceptable fit between the measurement model and the data.

Table 7.12 Goodness-of-Fit Indices of Overall Measurement Model

Goodness-of-fit measure	Criterion	Initial Model	Final Model	Result
Chi-square (χ^2)		2582.520	2398.715	
Degree of Freedom (df)		851	847	
χ^2/df	< 5.00	3.035	2.832	Good fit
CFI	> 0.90	.895	.906	Good fit
IFI	> 0.90	.896	.907	Good fit
TLI	> 0.90	.884	.895	Marginal fit
GFI	> 0.90	.769	.882	Marginal fit
RMSEA	< 0.08	.072	.068	Good fit

Table 7.13 Results of Factor Loadings and Residuals for a Final Overall Measurement and Convergent Validity

Latent variable	Items	Mean	Standardized Loadings	*t*-value	R^2	Cronbach's alpha	CR	AVE
Context of the Environment	CE4[a]	8.67	0.759			0.871	0.785	0.636
	CE8	8.77	0.799	0.061	16.264			
	CE9	8.58	0.837	0.061	17.133			
	CE11	8.58	0.794	0.070	16.143			
Leader	LD1[a]	8.96	0.829			0.883	0.885	0.660
	LD2	8.69	0.854	0.051	21.085			
	LD4	8.51	0.813	0.058	19.510			
	LD5	9.00	0.747	0.049	17.222			
Planning	PN1[a]	8.91	0.830			0.918	0.939	0.795
	PN2	8.67	0.898	0.057	22.953			
	PN3	8.64	0.907	0.059	23.360			
	PN4	8.69	0.928	0.066	20.207			
Support	SP1[a]	8.75	0.801			0.885	0.883	0.654
	SP3	8.33	0.784	0.070	17.841			
	SP5	8.24	0.780	0.064	17.707			
	SP6	8.55	0.866	0.063	20.645			
Operation	OP2[a]	8.50	0.871			0.946	0.944	0.708
	OP3	8.43	0.836	0.044	22.298			
	OP7	8.35	0.843	0.045	22.684			
	OP13	8.64	0.833	0.041	22.142			
	OP14	8.51	0.867	0.042	23.928			
	OP18	8.51	0.818	0.043	21.421			
	OP21	8.41	0.819	0.044	21.440			
Tools and Analysis method	TA6[a]	8.98	0.787			0.916	0.910	0.717
	TA7	8.64	0.887	0.071	19.972			
	TA8	9.05	0.814	0.043	23.436			
	TA9	8.74	0.894	0.063	20.191			

Latent variable	Items	Mean	Standardized Loadings	*t*-value	R^2	Cronbach's alpha	CR	AVE
Improvement	IP4[a]	8.42	0.780			0.914	0.917	0.734
	IP6	8.30	0.857	0.055	19.087			
	IP7	8.41	0.927	0.055	21.089			
	IP8	8.46	0.856	0.056	19.042			
Economic	ECO4[a]	8.23	0.810			0.787	0.791	0.559
Sustainability	ECO5	8.53	0.722	0.069	12.669			
Innovation	ECO6	7.89	0.707	0.068	12.348			
Environmental	ENV1[a]	8.15	0.759			0.881	0.862	0.611
Sustainability	ENV2	7.98	0.669	0.052	17.597			
Innovation	ENV3	8.10	0.886	0.068	17.321			
	ENV4	8.45	0.798	0.062	15.260			
Social	SOC1[a]	9.48	0.795			0.910	0.918	0.650
Sustainability	SOC4	9.15	0.834	0.068	18.623			
Innovation								
	SOC6	9.21	0.888	0.062	20.254			
	SOC8	9.33	0.810	0.070	17.915			
	SOC10	8.77	0.775	0.099	16.877			
	SOC12	9.35	0.728	0.077	15.573			
χ^2 = 2398.715, df = 847, p = .000, χ^2/df = 2.832, CFI = .906, IFI = .907, TLI = .895, GFI = .882, RMSEA = .068								

Note: [a] The corresponding parameter has been set equal to 1 (unstandardized) to fix the measurement scale

7.3.4 Reliability and Construct Validity

The internal consistency of all the indicators in a relationship of any construct makes it possible to measure their Reliability. Therefore, to check the reliability of indicators, the Cronbach's alpha (Cronbach & Furby, 1970) and the composite reliability (CR) (Werts et al., 1974) are used. The results indicate that Cronbach's alpha ranged from 0.787 to 0.946, exceeding the threshold and thus demonstrating sufficient internal consistency. A composite reliability value that is more than a threshold of 0.7 indicates a reliable measure. The composite reliability values for each construct lists in Table 7.14. The composite reliability values range from 0.785 to 0.944 signifying the reliability of all constructs.

Convergent Validity

According to Hair et al. (2010), convergent validity is the degree to which a set of things converge to measure a given construct. Throughout the SEM literature, factor loading, composite reliability and average variance extracted (AVE) can be examined. Therefore, the loading should be strongly loaded and statistically significant for measuring constructs with at least 0.7 for factor loading and composite reliability and at least 0.5 for AVE. From table 7.12, AVE values range from 0.559 to 0.795 indicating that there is no convergent validity issue here.

Discriminant validity

Discriminant validity was examined by employing two classical approaches (Hair et al., 2016). First, cross-loadings were assessed. All of the indicators' outer loading on the associated constructs are greater than any of the loadings on other constructs (Hair et al., 2016), supporting discriminant validity. Second, we compared the square root of the AVE to the intercorrelations between constructs. Except for one, the square root of the AVE of all constructs was greater than the inter-construct correlations (Table 7.14), providing evidence of discriminant validity (Chin, 1998; Fornell & Larcker, 1981). The researcher further tested whether the correlation between constructs is significantly less than one (Anderson & Gerbing, 1988; Bagozzi & Yi, 1988). Discriminant validity is evidenced if the value of one is not contained within 2 standard errors of the correlation. All the associated confidence intervals did not capture the value of one. Therefore, base on the three analysis tests, discriminant validity was supported for all pairs of constructs.

Table 7.14 Discriminant Validity

	Mean	SD	CE	LD	PN	SP	OP	TA	IP	ECO	ENV	SOC
CE	8.65	1.11	**.797**									
LD	8.79	1.09	.777	**.812**								
PN	8.73	1.12	.754	.866	**.892**							
SP	8.47	1.22	.733	.835	.859	**.809**						
OP	8.48	1.17	.745	.807	.866	.855	**.841**					
TA	8.85	1.12	.686	.742	.775	.746	.803	**.847**				
IP	8.40	1.22	.620	.654	.658	.714	.705	.680	**.857**			
ECO	8.22	1.22	.292	.367	.348	.374	.366	.350	.360	**.748**		
ENV	8.17	1.25	.621	.621	.628	.640	.645	.586	.704	.339	**.782**	
SOC	9.21	0.83	.524	.580	.626	.634	.622	.653	.546	.300	.521	.806

Notes: Diagonal elements (bold) are the square root of AVEs; Off-diagonal elements are inter-construct correlation

7.4 Main Analyses

7.4.1 Structural Model Assessment

The primary task in this model-testing procedure was to determine the goodness-of-fit between the hypothesized model and the sample data. While, sample size should be large enough with the number of estimated parameters as discussed in the methodology; however, maximum likelihood estimation (MLE) found that, increasing sample size indicates that the goodness-of-fit produces a poor fit. The reason is the method becomes more sensitive. Thus the chi-square test revealed poor fit here (χ^2 = 2396.623, df = 875, $p < 0.05$). However, the rest fit indices indicate a good fit (χ^2 /df = 2.739, CFI = 0.908, IFI = 0.908, TLI = 0.900, RMSEA = 0.066), while traditional fit indices indicate a marginal fit (GFI = 0.784). Table 7.15 summarizes the goodness-of-fit measures.

Table 7.15 Goodness-of-Fit Indices of Structural Model

Goodness-of-fit measure	Criterion	Initial Model	Final Model	Result
Chi-square (χ^2)		2738.492	2396.623	
Degree of Freedom (df)		884	875	
χ^2/df	< 5.00	3.098	2.739	Good fit
CFI	> 0.90	.888	.908	Good fit
IFI	> 0.90	.888	.908	Good fit
TLI	> 0.90	.880	.900	Good fit
GFI	> 0.90	.756	.784	Marginal fit
RMSEA	< 0.08	.073	.066	Good fit

In the previous section, structural equation modeling (SEM) based on CFA was employed to test a measurement model fit and estimate constructs' content. In this part, structural equation modelling procedures were applied to assess the structural regression (SR) model or structural model, in general, in developing a fitting model; then a suitable model was used for testing research hypotheses. According to a theoretical model that was developed from literature, structural equation modelling allows a set of relationships between one or more independent variables, and one or more dependent variables to be examined (Hair et al., 1995; Tabachnick et al., 2001). Structural equation modelling examines a series of dependence relationships and is useful when one dependent variable becomes an independent variable in subsequent dependence relationships (Hair et al., 1995). Furthermore, program of structural equation modelling is a model fit assessment (Byrne, 2010; Kline, 2010; Tabachnick et al., 2001).

Structural equation modelling techniques use only the variance/covariance or correlation matrix as its input data (Hair et al., 1995). First, analysis for outliers was completed before covariance or correlation matrices were calculated and testing of each hypothesis separately. Correlation is appropriate when the objective of the researcher is only to understand the pattern of relationships between constructs, but not to explain the total variance of a construct. This research employed covariance testing of theory to satisfy the assumptions of the methodology, which was an appropriate form of the data to validate causal relationships. After the structural and measurement models were specified and the input data type was selected the estimation of the model was proceeded by a package of SPSS AMOS. The following diagram depicts the graphical input for AMOS analysis. Figure 7.6 Structural model estimation of the Impact of Total Quality and Innovation Management in Hospital (TQIM-H) on Sustainable Innovation.

The identification of the structural equation and variance/covariance matrix for the estimation was automatically generated by AMOS software from the diagram in Figure 7.6 together with raw data. Once, the model was specified, the researcher tested its plausibility based on sample data that comprised all observed variables in the model.

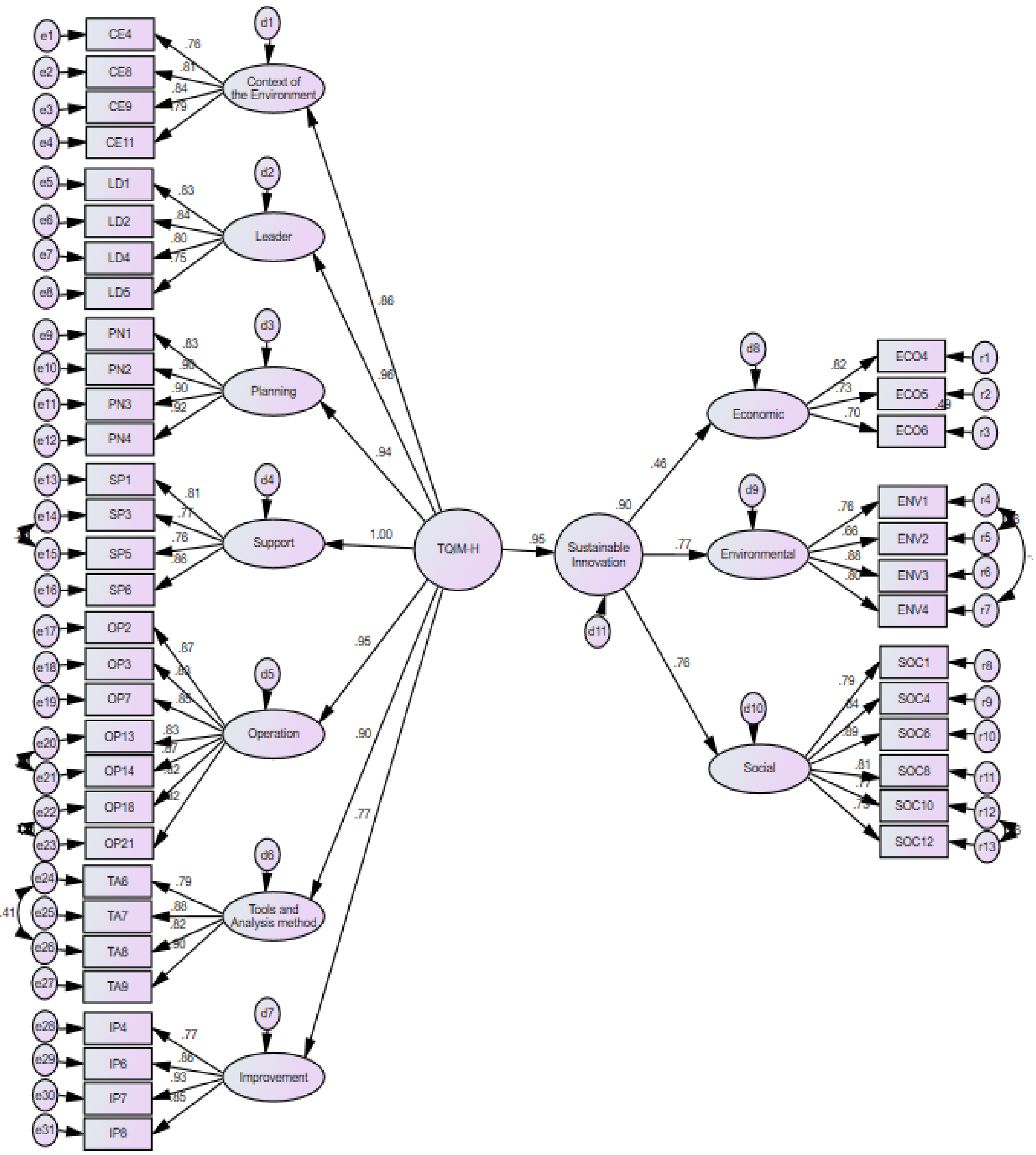


Figure 7.6 The structural model of TQIM-H

In this stage, the structural regression model can be used to test the hypotheses of the study without any modification since a series of measurement model modification yielded a good-fit structural regression model. The estimation of path coefficients and their significant values are shown in Table 7.16.

Table 7.16 Hypothesis testing result

Hypothesis	Path coefficient	Standard error	*t*-value	*P*-value	result
TQIM-H --> Sustainable Innovation	0.948*	0.083	7.37	0.001	Supported
χ^2 = 2398.715, df = 847, p = .000, χ^2/df = 2.832, CFI = .906, IFI = .907, TLI = .895, GFI = .882, RMSEA = .068, R^2 = .898					

* p<.001

Table 7.17 Factor Loadings and Residuals for a Structural model

Latent variable	Unstandardized Loadings	Standardized Loadings	Standard error	*t*-value	R^2
Context of the Environment [a]		0.862			0.743
Leader	1.145	0.957	0.078	14.746	0.915
Planning	0.979	0.939	0.067	14.562	0.883
Support	1.132	0.999	0.076	14.815	0.998
Operation	1.305	0.954	0.085	15.307	0.910
Tools and Analysis method	0.939	0.896	0.070	13.418	0.802
Improvement	0.971	0.767	0.081	12.006	0.589
Economic Sustainability Innovation [a]		0.461			0.213
Environmental Sustainability Innovation	1.479	0.772	0.202	7.325	0.596
Social Sustainability Innovation	0.844	0.755	0.116	7.268	0.571

Note: [a] The corresponding parameter has been set equal to 1 (unstandardized) to fix the measurement scale

The results of the statistical analysis support the hypothesis. The relationship between TQIM-H and sustainable Innovation is positive and significant, thus supporting the hypothesis ($\beta = .948$, $t = 7.37$, $p < 0.001$).

Table 7.17 and Figure 7.6 show the structural path significance in TQIM-H and sustainable innovation. As indicated by the path coefficients, H_1 was also verified because TQIM-H excellence positively and significantly affects sustainable innovation ($\beta = 0.948$, $t = 7.37$, $p < 0.001$), which was consistent with the finding of Tonjang & Thawesaengskulthai, (2020). Furthermore, Table 7.16 reports the measured effects of all relationships of TQIM-H and sustainable innovation that is Support (structural loading = 0 . 9 99; $R^2 = 0.998$) had the highest contribution on TQIM-H. This was followed by Leader (structural loading = 0.957; $R^2 = 0.915$), Operation (structural loading = 0.954; $R^2 = 0.910$), Planning (structural loading = 0.939; $R^2 = 0.883$), Tools and Analysis method (structural loading = 0.896; $R^2 = 0.802$), Context of the Environment (structural loading = 0.862; $R^2 = 0.743$) and Improvement (structural loading = 0.767; $R^2 = 0.589$) . In the other side, Environmental Sustainability Innovation (structural loading = 0.772; $R^2 = 0.596$) had the highest contribution on sustainable innovation and followed by Social Sustainability Innovation (structural loading = 0.755; $R^2 = 0.571$) and Economic Sustainability Innovation (structural loading = 0.461; $R^2 = 0.213$), respectively. In this Chapter, TQIM-H structural model was developed by applying SEM as a tool to analyze the TQIM-H framework. While SEM is a tool widely used in several industries including education, manufacturing and banking, it has never been used for studying quality and innovation management in the healthcare context. When SEM was used in such context, as described in this Chapter, we found that SEM could explain the relationship of each TQIM-H factor in detail. Unrelated factors could be eliminated so the model was fitter, as shown by the goodness-of-fit. The model shows the importance of each TQIM-H component factor which could be ranked from the most important to less important dimension as Support, Leadership, Operation, Planning, Tools and Analysis method, Context of the Environment, and Improvement. The level of importance helped guide the users to select the suitable TQIM-H component for the management of different innovations effectively. To promote the use of TQIM-H structural model, it would be developed as a user-friendly application in the next Chapter.

CHAPTER 8
TOTAL QUALITY AND INNOVATION MANAGEMENT IN HOSPITAL (TQIM-H) PROGRAM

The quantitative and qualitative analysis in the previous phase provided important information necessary to develop total quality and innovation management in hospitals (TQIM-H). In addition, the importance of TQIM-H information such as the key factor, sub-factor, procedure (How to manage), and importance of each TQIM-H factor was investigated. Thus, understanding the key characteristic in developing quality innovation in the hospital helps achieve acceptance and create value in the hospital effectively. However, the TQIM-H structural model required expertise in interpreting the outcome from use since the current model did not have a user-friendly interface so it was deemed complicated for laypeople. This phase aimed to develop a web-based TQIM-H program from the knowledge obtained in previous Chapters to help healthcare organizations understand and make decisions concerning quality and innovation management in healthcare.

Table 8.1 The TQIM-H program

Objective	Process & Information	Result
To develop the TQIM-H program that guides developing healthcare innovation	The TQIM-H program was developed based on TQIM-H characteristic established in the previous stage. The program was developed in two parts: - The TQIM-H measurement concept. - The TQIM-H program was developed using the computer language	The developed TQIM-H program

This chapter is divided into three parts:

Part 1: Development of the TQIM-H program concept: In this part, the component, source of data, and how the data were used in the TQIM-H program were conceptualized.

Part 2: Development of the TQIM-H program via computer PHP language: This step required the development of the application using a computer language

Part 3: TQIM-H application validity testing methodology: The validity and reliability of the TQIM-H application was tested and validated

Part 1: Development of the TQIM-H program concept

Table 8.2 The Development of the TQIM-H program concept

Objective	Process & Information	Result
To develop the TQIM-H measurement concept that guides developing TQIM-H program	1. Providing the TQIM-H characteristic and weight of TQIM-H factor 2. Establishing the TQIM-H measurement scale (1-3 level) - A literature Review - Brainstorming with experts - Refine the TQIM-H measurement scale with effective innovation cases 3. Innovation project TQIM-H score 4. Best practice TQIM-H score 5. TQIM-H measurement analysis	The developed TQIM-H measurement concept

The principles of a working program for evaluating innovation projects were described. The importance of each TQIM-H factor was weighted based on the results from Chapter 7. The loading level showed the importance ranking of each TQIM-H factor in managing healthcare innovation projects. The result provides key information to the healthcare innovator or innovation project owner to understand the factor and the importance level of each TQIM-H in developing his/her innovation project.

Moreover, in the TQIM-H questionnaire part, the questionnaire was developed to measure the performance of each innovation project. The users provided a performance score, consisting of three ranking scales, in managing their innovation projects. Then, the working program calculated the performance level of the user's innovation project by multiplying the ranking level with the loading level. The innovation project performance level was compared with the best practice score via the radar chart diagram, which was used as a tool to show the differences in the user's project performance and best practice score in each TQIM-H aspect. The gap difference result of the radar chart diagram helped the users understand their strengths and weaknesses in TQIM-H managing performance. It guided the project owner to increase the potential in the future to improve the healthcare innovation project.

If a project has a high gap difference of project performance and best practice score, the innovation project is still poorly managed. On the other hand, the project that has a performance score equal to the best practice score represents high performance in managing innovation. Thus, that aspect of the project should be maintained and further developed.

A TQIM-H developed program, a program with a user-friendly user interface, would help innovators in understanding key factors and the level of importance of each factor in TQIM-H which would help guide innovation development. Thus, the developed program was used as a way to develop innovative projects effectively. In addition, healthcare innovators could check the level of competence of their innovation projects to understand the strengths and weaknesses of their project and compare their project performance with the best practice project from the program analysis results. The assessments enabled the development of innovative projects in the right direction and without errors. The development of the TQIM-H program concept of Part 1 was divided into three sections including:

Section 1: TQIM-H characteristic and weight of TQIM-H factor

Section 2: Establishing the TQIM-H measurement scale

Section 3: The comparison of innovation project score and best practice score

Section 1: TQIM-H characteristic and weight of TQIM-H factor

The quantitative analysis result with confirmatory factor analysis (CFA) and structural equation modeling (SEM) in the previous phase was able to identify seven dimensions or 31 procedures of the TQIM-H assessment criteria. These were taken as key elements in establishing the quality and innovation management in healthcare assessment criteria.

The result from SEM methodology showed a loading score (maximum score = 1) representing the importance level of each TQIM-H factor to provide the guideline in managing the TQIM-H system. The participant or user can study the importance level to plan and establish healthcare innovation projects. The TQIM-H factor with higher scores represented the key success factor that healthcare must focus on and value to manage organizational innovation (Table 5.1).

Table 8.3 TQIM-H key information with importance loading score

Dimension	Factors & Definitions	TQIM-H procedure	Importance loading level
Context of the Environment (Internal & External)	**1.1 Customer (patient etc.) needs:** The hospital places importance on customers' satisfaction with the service. Keeping abreast of the market's situation and patient's needs is essential to increase the potential for competition.	CE4 Observing trends that reflect needs from both customers and the markets.	0.759
	1.2 Technological change: Technological changes affect an organization's development by superseding some processes. Technology can enhance working performance and streamline the process by removing irrelevant parts, resulting in increasing capability for competition in the healthcare market and augmenting customers' trust.	CE8 Studying technological changes, medical innovative technologies, and emergent innovations and applying them in the hospital.	0.799
	1.3 Litigation law refers to the rules and practices: Law is important because it is the basis of all operations and covers medical ethics and patient rights.	CE9 Complying with laws, hospital standards, and medical ethics.	0.837
		CE11 Following complaints or acts that do not comply with the law or medical ethics for further improvement.	0.794
Lea	**2.1 Leader vision:** Leaders' visions and	LD1 Acknowledging the importance of	0.829

Dimension	Factors & Definitions	TQIM-H procedure	Importance loading level
	attitudes are significant for the creation of innovation and quality, as leaders are in charge of steering the direction of the management and organizational structures.	innovation and having a vision for developing innovation and quality in the hospital.	
		LD2 Proposing policies on quality and innovation as the main goals of the organization, with specified related KPIs.	0.854
		LD4 Including time used for creating innovation into working hours.	0.813
		LD5 Creating an atmosphere that encourages learning and experiments.	0.747
Planning	**3.1 Strategic plan development:** Implementation of organizational policies and planning direction in the management of the organization, together with quality and innovation management, can drive working processes toward success.	PN1 Stating policy and vision involving organizational quality and innovation	0.830
		PN2 Stating indicators and outcomes for organizational quality and innovation	0.898
		PN3 Stating strategies for organizational quality and innovation	0.907
	3.2 Alignment of innovation: Making innovation part of the organization's strategies and part of each member's work catalyzes innovation and generates innovation recognition from the organization's members, resulting in sustainability.	PN4 Creating an action plan that agrees with organization policy	0.928
Support	**4.1 Budgets:** Money is a crucial factor for the success of all activities in the hospital.	SP1 Setting up a funding budget for quality and innovation projects for suitable periods	0.801
	4.2 Facilities e.g. laboratories, space, etc.: Facilities constitute a factor that drives the organization towards development. There are two dimensions to facilities: intangible dimension and tangible dimension. The first one includes time, opportunity, trust, and knowledge. The second includes tools, apparatus, technology, human resources, and sandbox.	SP3 Creating a space or hub where innovators can exchange ideas and brainstorm to develop projects in the hospital	0.784
	4.3 Employee education and training programs: Healthcare programs are intended for equipping staff with the knowledge of working systems internal to the hospital so they can all work in the same direction. Further, cultivating critical thinking is very important to develop innovative projects in the hospital.	SP5 Planning a training session that encourages quality and innovation	0.780
		SP6 Providing courses that aim to create innovative thinking and a critical thinking mindset to cultivate innovators	0.866
Operation	**5.1 Process management:** Management and operating processes are considered significant for effective performance. Process management can reduce organizational resources and risks, and can increase working performance in the hospital.	OP2 Creating a management system and a plan that provide the whole picture of the organization	0.871
		OP3 Considering a working process to eliminate irrelevant processes	0.836
	5.2 Monitoring and evaluation: Monitoring and evaluating working processes eliminate pain points and increase the working potential that helps the organization achieve its goals.	OP7 Creating a monitoring system for innovative projects in the hospital	0.843
	5.4 Risk management: Risk management is the process of analyzing processes and practices that are in the hospital, identifying risk factors, and implementing procedures to address those risks.	OP13 Initiating risk prevention and mitigation in the hospital	0.833
		OP14 Providing a system that furnishes decision-making	0.867
	5.6 Knowledge management: Knowledge management is to collect and present knowledge necessary for effective organizational development. Knowledge management includes professional knowledge and critical thinking.	OP18 Collecting knowledge necessary for developing management processes in the hospital for further research and access by interested personnel.	0.818
	5.8 Establishing an innovation award: Awards granted to successful projects support and encourage personnel to improve their quality and innovation projects within the	OP21 Using awarded projects as learning examples.	0.819

Dimension	Factors & Definitions	TQIM-H procedure	Importance loading level
	organization. Also, awards are one of the factors that stimulate healthcare workers to forge organizational development.		
Tools and Analysis method	**6.1 Well-defined processes and formalized tools:** Using the right tools and system patterns ensures the effectiveness of working processes, minimizes risks, and creates trust between personnel and patients.	TA6 Initiating systems for validating the accuracy of the tools	0.787
		TA7 Updating the information constantly according to the patient status that is changing throughout the treatment process	0.887
		TA8 Managing information within the organization that is connected across departments	0.814
	6.4 Data integrity and security: Keeping medical information confidential is bound by the law and medical ethics. Therefore, data safety and confidentiality must be managed effectively.	TA9 Creating effective and secure information retrieval processes e.g. the process that requires identification of users	0.894
Improvement	**7.2 Continuous solving:** Continuous solving involves the improvement of the process after the weakness identification. Newly designed processes increase working potential, resulting in the ability to adapt to the ever-changing environment.	IP4 Creating a system that encourages knowledge sharing and that points to the significance of quality standards.	0.780
		IP6 Providing a system or experts who can advise and support system development.	0.857
	7.3 Quality audits: To keep healthcare management effective and to minimize errors, auditors observe the process to maintain working efficiency and to stimulate personnel to remain in line with working standards.	IP7 Initiating internal auditing system that complies with international standard	0.927
		IP8 Setting goals and achievement levels from the audit	0.856

Section 2: Establishing the TQIM-H measurement scale

To measure the TQIM-H performance of each innovation project, the importance loading level obtained from the SEM technique were multiplied by the measurement scale of each TQIM-H factor. The measurement scale is an indicator for each TQIM-H performance factor which shows the actual performance level of WHAT. The TQIM-H measurement scale is very novel and unique and has different criteria for the measurement of each TQIM-H factor. In this research, the TQIM-H measurement scale had 3 levels because the 3-level or 5-level scales are not complicated and suited for nonspecialist users (Brown, 2011; Croasmun & Ostrom, 2011; Nemoto & Beglar, 2014). This is in an agreement with REF which pointed out that in case of evaluating the level/order of innovation, people who are not innovation experts may not completely understand the structure of the innovation in detail so using the 3-level scale would be most effective since the scale would show the clear cutoff point (Jebb et al., 2021; Therrien et al., 2011; Wan et al., 2005). Therefore, the gap can be clearly illustrated.

The measurement scale was scored by healthcare innovators or healthcare innovation project owners. Thus, the expert panels suggested that the measurement scale of each TQIM-H factor by its nature and the practical program should be developed. This part aimed to develop the measurement scale of each TQIM-H factor by using three methodologies as follows:

Table 8.4 The process of the TQIM-H measurement scale development

Step	Methodology	Objective	Process	Result
1.	A literature review	To define the scope and key factor of quality and innovation management measurement scale	Review literature of quality and innovation management measurement scale through an international database	The quality and innovation management in healthcare measurement methodology
2.	Brainstorming with healthcare experts	To contribute TQIM-H measurement scale	Brainstorm and develop a TQIM-H measurement scale	The measurement scale of each TQIM-H factor
3.	Refining by effective innovation cases	To refine and confirm the TQIM-H measurement scale	Review 50 effective innovation project reports and confirm the information with the owner of the innovation project.	The TQIM-H measurement scale

The developed measurement scale of each TQIM-H factor was used to test the innovation project performance through ranking scores (1-3) by healthcare innovators of selected hospitals who well comprehended their innovation project. Table 8.2 shows TQIM-H information and loading factor with measurement levels ranging from 1 to 3, where each TQIM-H criteria has its characteristics that differ according to its purpose. The criteria of TQIM-H were prioritized in three levels including level 1 represented a low-performance level or 0%, meaning it had never been done, while level 2 represents an intermediate performance level, or 50% range of actions, representing some actions but not yet complete the criterion. Finally, level 3 represents a high-performance level, or 100% of the management was performed.

Table 8.5 The developed TQIM-H measurement scale

Dimension	Factors & Definitions	TQIM-H question	Reference	Level	TQIM-H measurement scale
Context of the Environment (Internal & External)	**1.1 Customer (patient etc.) needs:** The hospital places importance on customers' satisfaction with the service. Keeping abreast of the market's situation and patient's needs is essential to increase the potential for competition.	CE4 Observing trends that reflect needs from both customers and the markets.	(Zhao et al., 2018) (Bikker & Bos, 2005) (Loi & Le Ng, 2018)	1	The practice to fulfill the criterion is not implemented. The use of customer needs as input for the development of innovation is absent.
				2	The practice to fulfill the criterion is inadequate where improvement is necessary. Less than 50% of the data from customer needs are used as input for the development of innovation.
				3	The practice to fulfill the criterion is defined and implemented. More than 50% of the data from customer needs are used as input for the development of innovation.
	1.2 Technological change: Technological changes affect an organization's development by superseding some processes. Technology can enhance working performance and streamline the process by removing irrelevant parts, resulting in increasing capability for competition in the healthcare market and augmenting customers' trust.	CE8 Studying technological changes, medical innovative technologies, and emergent innovations and applying them in the hospital.	(Coccia, 2012) (Ciani et al., 2016) (Lehoux et al., 2016) (Coccia, 2017)	1	The practice to fulfill the criterion is not implemented. The use of research, technological changes, and medical innovative technologies as input for the development of innovation are absent.
				2	The practice to fulfill the criterion is inadequate where improvement is necessary. Less than 50% of the data from research, technological changes, and medical innovative technologies are used as input for the development of innovation.
				3	The practice to fulfill the criterion is defined and implemented. More than 50% of the data from research, technological changes, and medical innovative technologies are used as input for the development of innovation.
	1.3 Litigation law refers to the rules and practices: Law is important because it is the basis of all operations and covers medical ethics and patient rights.	CE9 Complying with laws, hospital standards, and medical ethics.	(Ghanavati et al., 2007) (Fox et al., 2010) (Samanta & Samanta, 2015) (Guan, 2019)	1	The practice to fulfill the criterion is not implemented. The use of laws, hospital standards, and medical ethics as input for the development of innovation is absent.
				2	The practice to fulfill the criterion is inadequate where improvement is necessary. Less than 50% of the data from laws, hospital standards, and medical ethics are used as input for the development of innovation.
				3	The practice to fulfill the criterion is defined and implemented. More than 50% of the data from laws, hospital standards, and medical ethics are used as input for the development of innovation.

Dimension	Factors & Definitions	TQIM-H question	Reference	Level	TQIM-H measurement scale
		CE11 Following complaints or acts that do not comply with the law or medical ethics for further improvement.	(Hickson et al., 2002) (Murdi, 2020) (Chan, 2013) (Nittari et al., 2020)	1	The practice to fulfill the criterion is not implemented. The use of complaints that do not comply with the law or medical ethics from the organizational satisfy questionnaire as input for the development of innovation is absent.
				2	The practice to fulfill the criterion is inadequate where improvement is necessary. Less than 50% of the data from complaints that do not comply with the law or medical ethics from the organizational satisfy questionnaire are used as input for the development of innovation.
				3	The practice to fulfill the criterion is defined and implemented. More than 50% of the data that do not comply with the law or medical ethics from the organizational satisfy questionnaire are used as an input for the development of innovation.
Leadership	**2.1 Leader vision:** Leaders' visions and attitudes are significant for the creation of innovation and quality, as leaders are in charge of steering the direction of the management and organizational structures.	LD1 Acknowledging the importance of innovation and having a vision for developing innovation and quality in the hospital.	(Jaskyte, 2004) (Harrison et al., 2016) (Hunter et al., 2017) (Rosing et al., 2011) (Gumusluoğlu & Ilsev, 2009)	1	The leader does not acknowledge the importance of developing innovation and quality in the hospital.
				2	The leader acknowledges the importance of developing innovation and quality in the hospital. A responsible person for innovation development is not appointed.
				3	The leader acknowledges the importance of developing innovation and quality in the hospital. A responsible person for innovation development is appointed.
		LD2 Proposing policies on quality and innovation as the main goals of the organization, with specified related KPIs.	(Dewangan & Godse, 2014) (Housawi et al., 2020) (Nada et al., 2010) (Muralidharan, 2020)	1	Policies on quality and innovation, with specified related KPIs, are not proposed as the main goals of the organization.
				2	Policies on quality and innovation, with specified related KPIs, are proposed by the leader as the main goals of the organization.
				3	Policies on quality and innovation, with specified related KPIs, are proposed and well-announced by the leader as the main goals of the organization.
		LD4 Including time used for creating innovation into working hours.	(De Jong & Den Hartog, 2007) (Gumusluoğlu & Ilsev, 2009) (Chevalier & Vollet, 2019) (Kastner, 2021)	1	Time used for creating innovation is not counted as working hours.
				2	Time used for creating innovation is counted as working hours.
				3	Time used for creating innovation is counted reliably as working hours.
		LD5 Creating an atmosphere that encourages learning and experiments.	(Hapsari et al., 2019) (Gumusluoğlu & Ilsev, 2009) (Vincent-Höper & Stein, 2019) (Toytok, 2016) (Li et al., 2018)	1	Employees are not allowed to express their opinions on work processes and departmental issues
				2	Employees are allowed to express their opinions on work processes and departmental issues in less than 50% of the number of meetings in a year.
				3	Employees are allowed to express their opinions on work processes and departmental issues in more than 50% of the number of meetings in a year.
Planning	**3.1 Strategic plan development:** Implementation of organizational policies and planning direction in the management of the organization, together with quality and innovation management, can drive working processes toward success.	PN1 Stating policy and vision involving organizational quality and innovation	(Mahama & Sausa, 2019) (Gumusluoglu & Ilsev, 2009) (Nam & Pardo, 2011) (Li et al., 2018)	1	Policy and vision involving organizational quality and innovation in hospitals are absent.
				2	Policy and vision involving organizational quality and innovation in hospitals are available for some issues.
				3	Policy and vision involving organizational quality and innovation in hospitals are fully available.
		PN2 Stating indicators and outcomes for organizational quality and innovation	(Hochleitner et al., 2017) (Heras & Ruiz-Mallén, 2017) (Taques et al., 2021)	1	Indicators and outcomes for organizational quality and innovation are absent.
				2	Indicators and outcomes for organizational quality and innovation are available for some issues.
				3	Indicators and outcomes for organizational quality and innovation are fully available
		PN3 Stating strategies for organizational quality and innovation	(Choi & Valikangas, 2001) (Pisano, 2015) (Johnston & Bate, 2013) (Lendel & Varmus, 2011) (Dal Mas et al., 2020) (Birken et al., 2015)	1	Strategies for organizational quality and innovation are absent.
				2	Strategies for organizational quality and innovation are available for some issues.
				3	Strategies for organizational quality and innovation are fully available.
	3.2 Alignment of innovation: Making innovation part of the organization's strategies and part of each member's work catalyzes innovation and generates innovation recognition from the organization's members, resulting in sustainability.	PN4 Creating an action plan that agrees with organization policy	(Pendharkar et al., 2016) (Schultz et al., 2016) (Biondo et al., 2016) (Zuckerman, 2006)	1	Action plans on innovation development do not agree with organization and organizational strategy.
				2	Action plans on innovation development agree with organization policy but do not align with organizational strategy.
				3	Action plans on innovation development agree with organization and organizational strategy.
Support	**4.1 Budgets:** Money is a crucial factor for the success of all activities in the hospital.	SP1 Setting up a funding budget for quality and innovation projects for	(Bindman et al., 2018) (Czarnitzki & Lopes-Bento, 2014)	1	A funding budget for quality and innovation projects for suitable periods is absent
				2	A funding budget for quality and innovation projects is available but controlled in other parts.
				3	A funding budget for quality and innovation projects is fully

Dimension	Factors & Definitions	TQIM-H question	Reference	Level	TQIM-H measurement scale
		suitable periods			available for suitable periods
	4.2 Facilities e.g. laboratories, space, etc.: Facilities constitute a factor that drives the organization towards development. There are two dimensions to facilities: intangible dimension and tangible dimension. The first one includes time, opportunity, trust, and knowledge. The second includes tools, apparatus, technology, human resources, and sandbox.	SP3 Creating a space or hub where innovators can exchange ideas and brainstorm to develop projects in the hospital	(Binz et al., 2014) (Nicolopoulou et al., 2017) (Prieto Mejia et al., 2019) (Youtie & Shapira, 2008)	1	You have never participated in the seminar of BDMS innovation incubator meeting
				2	You participate in BDMS innovation incubator meeting less than 50% per number of seminars in a year
				3	You participate in BDMS innovation incubator meeting more than 50% per number of seminars in a year
	4.3 Employee education and training programs: Healthcare programs are intended for equipping staff with the knowledge of working systems internal to the hospital so they can all work in the same direction. Further, cultivating critical thinking is very important to develop innovative projects in the hospital.	SP5 Planning a training session that encourages quality and innovation	(Naranjo-Valencia et al., 2018) (Bauernschuster et al., 2009) (Dostie, 2018)	1	You do not plan to attend a training session that encourages quality and innovation
				2	You are interested in attending the BDMS innovation training program, but there is no concrete plan yet.
				3	You tangibly plan to attend a training session that encourages quality and innovation
		SP6 Providing courses that aim to create innovative thinking and a critical thinking mindset to cultivate innovators	(Notar & Padgett, 2010) (Lai, 2011) (Tschimmel, 2012) (Donovan et al., 2014)	1	You do not participate in the innovation training program as planned
				2	You participate in the innovation training program as planned but less than 50% of the number of training courses in a year
				3	You participate in the innovation training program as planned more than 50% of the number of training courses in a year
	5.1 Process management: Management and operating processes are considered significant for effective performance. Process management can reduce organizational resources and risks, and can increase working performance in the hospital.	OP2 Creating a management system and a plan that provide the whole picture of the organization	(Hellström et al., 2010) (Tseng et al., 2020) (Chandrasekaran et al., 2012)	1	A management system and a plan that provide the whole picture of the organization is absent
				2	A management system and a plan that provide the whole picture of the organization is available for some issues
				3	A management system and a plan that provide the whole picture of the organization is fully available
		OP3 Considering a working process to eliminate irrelevant processes	(Costa & Godinho Filho, 2016) (Kimsey, 2010) (Kanamori et al., 2015) (Spagnol et al., 2013)	1	Negative complaints about customer service, time, and procedures are common.
				2	Negative complaints about customer service, time, and procedures are absent.
				3	Negative complaints about customer service, time, and procedures are absent. Favorable comments are common.
	5.2 Monitoring and evaluation: Monitoring and evaluating working processes eliminate pain points and increase the working potential that helps the organization achieve its goals.	OP7 Creating monitoring systems for innovative projects in the hospital	(Islam et al., 2020) (Narayana et al., 2019) (Gogate & Bakal, 2016)	1	Monitoring systems for innovative projects in the hospital are absent.
				2	There is a monitoring system for innovative projects in the hospital but the action plan is not clear.
				3	There is a monitoring system for innovative projects in the hospital with a clear action plan.
	5.4 Risk management: Risk management is the process of analyzing processes and practices that are in the hospital, identifying risk factors, and implementing procedures to address those risks.	OP13 Initiating risk prevention and mitigation in the hospital	(Cagliano et al., 2011) (Coronado & Wong, 2014) (Parker, 2009)	1	Risk prevention and mitigation system in the hospital is absent
				2	Risk prevention and mitigation in the hospital is available for some issues
				3	Initiate risk prevention and mitigation in the hospital is fully available
		OP14 Providing a system that furnishes decision-making	(Flynn et al., 2006) (Légaré et al., 2014) (Lysaght et al., 2019)	1	A system that facilitates decision-making is absent
				2	A system that furnishes decision-making is available for some issues
				3	A system that furnishes decision-making is fully available
	5.6 Knowledge management: Knowledge management is to collect and present knowledge necessary for effective organizational development. Knowledge management includes professional knowledge and critical thinking.	OP18 Collecting knowledge necessary for developing management processes in the hospital for further research and access by interested personnel.	(Schultz et al., 2012) (Almansoori et al., 2021) (Karamitri et al., 2017)	1	Knowledge management system in the future work process is absent
				2	Knowledge management system in the future work process is available but the implementation is absent
				3	Knowledge management system in the future work process is available and implemented.
	5.8 Establishing an innovation award: Awards granted to successful projects support and encourage personnel to improve their quality and innovation projects within the organization. Also, awards are one of the factors that stimulate healthcare workers to forge organizational development.	OP21 Using awarded projects as learning examples.	(Omachonu & Einspruch, 2010) (Hellström et al., 2015)	1	Award-winning innovative projects as a model to learn and develop healthcare innovation are absent.
				2	Award-winning innovative projects as a model to learn are available for some issues and have never been put into practice.
				3	The award-winning innovative projects as a model to develop learning from inside and outside the organization is fully available and put into practical application.
Tools and	**6.1 Well-defined processes and formalized tools:** Using	TA6 Initiating	(Gupta et al., 2011) (Smys, 2019)	1	The system for evaluating the correctness of the work system according to the operational guidelines is absent.

Dimension	Factors & Definitions	TQIM-H question	Reference	Level	TQIM-H measurement scale
	the right tools and system patterns ensures the effectiveness of working processes, minimizes risks, and creates trust between personnel and patients.	systems for validating the accuracy of the tools		2	The process for evaluating the correctness of work is available and complied with for some issues.
				3	The system for evaluating the correctness of the work system according to the concrete operational guidelines is fully available.
		TA7 Updating the information constantly according to the patient status that is changing throughout the treatment process	(Pai & Huang, 2011) (Pellowe et al., 2004)	1	A real-time working state tracking system is absent
				2	Tools to track the working status is available for some issues
				3	System to track the working status in real-time concretely is fully available.
		TA8 Managing information within the organization that is connected across departments	(Menon et al., 2000) (Fichman et al., 2011)	1	A network system within the organization that can connect is absent.
				2	Internal network connections in some processes are available for some issues
				3	A network system within the organization that can be connected concretely is fully available.
	6.4 Data integrity and security: Keeping medical information confidential is bound by the law and medical ethics. Therefore, data safety and confidentiality must be managed effectively.	TA9 Creating effective and secure information retrieval processes e.g. the process that requires identification of users	(Esposito et al., 2018) (Xu et al., 2020) (Al Ameen et al., 2012)	1	An information security system within the hospital is absent.
				2	Information security systems within the hospital are available for some issues
				3	Information security systems within the hospital are available for all issues
Improvement	**7.2 Continuous solving:** Continuous solving involves the improvement of the process after the weakness identification. Newly designed processes increase working potential, resulting in the ability to adapt to the ever-changing environment.	IP4 Creating a system that encourages knowledge sharing and that points to the significance of quality standards.	(Alkhenizan & Shaw, 2011) (Memon et al., 2014) (Aggarwal et al., 2019)	1	A knowledge system for quality standards is absent.
				2	A knowledge system for quality standards is available for some issues, but there is no concrete implementation.
				3	A knowledge system for quality standards is fully available and it has been concretely put into practice.
		IP6 Providing a system or experts who can advise and support system development.	(Chae et al., 2003) (Ryu et al., 2010)	1	A continuous process development system is absent.
				2	A continuous process development system is available in some departments.
				3	A continuous process development system is fully available.
	7.3 Quality audits: To keep healthcare management effective and to minimize errors, auditors observe the process to maintain working efficiency and to stimulate personnel to remain in line with working standards.	IP7 Initiating internal auditing system that complies with international standard	(McVey et al., 2021) (Rajendran & Devadasan, 2005)	1	A system for assessing quality standards within the hospital is absent.
				2	A system for assessing quality standards within the hospital is available for some issues.
				3	A system for assessing quality standards within the hospital is fully available.
		IP8 Setting goals and achievement levels from the audit	(Reddy et al., 2011) (Cesarotti & Di Silvio, 2006) (Jackson, 2001)	1	Goals for an international standard that are aligned with work processes within the hospital are absent.
				2	Goals for an international standard that are aligned with work processes within the hospital are available for some issues but have not yet been complied with.
				3	Goals for an international standard that are aligned with work processes within the hospital are fully available.

Table 8.6 The developed innovation sustainable measurement scale

Dimension	Factors & Definitions	Sustainable innovation measurement question	Reference	Result
Economically sustainable innovation	**Profit and value:** This theme measures the wealth creation of a hospital and is related to traditional financial results that are crucial for the short and long term sustainability of all kinds of hospitals.	ECO4 Decreasing cost relating to facilities and utilities in the hospital	(Schlegel et al., 2003) (Stone et al., 2005) (Trifonova & Pramatarov, 2016)	
		ECO5 Maximizing hospital income	(Sloan, 2000) (Picone et al., 2002) (Vita & Sacher, 2001)	
		ECO6 Decreasing personnel cost	(Moran et al., 2020) (Colamesta et al., 2019)	
Environmental sustainable innovatio	**Waste management:** Waste Management includes the processes and actions required to manage waste from its inception to	ENV1 Establishing systems for climate management	(Luisetto, 2020) (Tsakona et al., 2007)	
		ENV2 Establishing systems for solid waste management	(Karamouz et al., 2007) (Ali et al., 2016)	

Dimension	Factors & Definitions	Sustainable innovation measurement question	Reference	Result
	its final disposal.	ENV3 Establishing systems for water and wastewater management	(Tsakona et al., 2007) (Carraro et al., 2017) (Khan et al., 2019)	
		ENV4 Establishing systems for dangerous waste management	(Gidarakos et al., 2009) (Sawalem et al., 2009) (Abd El-Salam, 2010)	
		ENV5 Establishing systems for waste recycling	(Chaerul et al., 2008) (Aljabre, 2002)	
Socially sustainable innovation	**External customer value:** The external social was patients or customers that pay for and use the products or services healthcare offers. The factor that all hospitals attend to, especially in the aspect of quality of care, which was the ability to take care of patients and cure them of illnesses safely and is at the center of concern.	SOC1 Improving treatment efficacy and safety	(Propper et al., 2004) (Aiken et al., 2002) (Himmelstein et al., 2010) (Jha & Epstein, 2010)	
		SOC4 Building facilities for patient care	(Uneke et al., 2014) (Sodani et al., 2010) (He et al., 2013)	
		SOC6 Establishing systems for the management of administration time and effective patient care	(Kc & Terwiesch, 2009) (Yu & Yang, 2008)	
	Internal customer value: The internal social was healthcare staff in the healthcare system or as partners who deliver the product or service to the end user, the external customer. Healthcare staff should have been provided the safety and health from their work because it affected treatment outcome and healthcare performance.	SOC8 Establishing systems responsible for personnel health and safety	(Lin et al., 2008) (Malliarou et al., 2008) (Zeller & Levin, 2013)	
		SOC10 Allowing the engagement of personnel in organizational development	(Fiabane et al., 2013) (Griffin et al., 2020)	
		SOC12 Implementing medical ethics	(Meyer-Zehnder et al., 2017) (Dargahi, 2011) (Schochow et al., 2019)	

Then, to refine the TQIM-H measurement scale by analyzing 50 effective innovation projects. The innovation projects were analyzed to confirm the TQIM-H measurement as shown in Table 8.4 and Table 8.5

Table 8.7 The refined TQIM-H measurement scale through analyzing 50 effective innovation projects

Dimension	Factors & Definitions	TQIM-H question	TQIM-H Readiness	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Context of the Environment (Internal & External)	**1.1 Customer (patient etc.) needs:** The hospital places importance on customers' satisfaction with the service. Keeping abreast of the market's situation and patient's needs is essential to increase the potential for competition.	CE4 Observing trends that reflect needs from both customers and the markets.	The practice to fulfill the criterion is not implemented. The use of customer needs as input for the development of innovation is absent.		/			/	/	/		/		/	/			/		/	/		/	/			/			/	/		/
			The practice to fulfill the criterion is inadequate where improvement is necessary. Less than 50% of the data from customer needs are used as input for the development of innovation.			/	/						/						/						/							/	
			The practice to fulfill the criterion is defined and implemented. More than 50% of the data from customer needs are used as input for the development of innovation.	/							/					/	/					/				/		/	/				
	1.2 Technological change: Technological changes affect an organization's development by superseding some processes. Technology can enhance working performance and streamline the process by removing irrelevant parts, resulting in increasing capability for competition in the healthcare market and augment customers' trust.	CE8 Studying technological changes, medical innovative technologies, and emergent innovations and applying them in the hospital.	The practice to fulfill the criterion is not implemented. The use of research, technological changes, and medical innovative technologies as input for the development of innovation are absent.			/			/								/			/							/	/					
			The practice to fulfill the criterion is inadequate where improvement is necessary. Less than 50% of the data from research, technological changes, and medical innovative technologies are used as input for the development of innovation.				/								/			/			/			/									/
			The practice to fulfill the criterion is defined and implemented. More than 50% of the data from research, technological changes, and medical innovative technologies are used as input for the development of innovation.	/	/			/		/	/	/	/	/		/			/			/	/		/	/			/	/	/	/	
	1.3 Litigation law refers to the rules and practices: Law is important because it is the basis of all operations and covers medical ethics and patient rights.	CE9 Complying with laws, hospital standards, and medical ethics.	The practice to fulfill the criterion is not implemented. The use of laws, hospital standards, and medical ethics as input for the development of innovation are absent.	/					/			/	/	/			/	/					/		/	/			/			/	
			The practice to fulfill the criterion is inadequate where improvement is necessary. Less than 50% of the data from laws, hospital standards, and medical ethics are used as input for the development of innovation.		/	/		/		/	/				/				/		/	/		/				/		/	/		/
			The practice to fulfill the criterion is defined and implemented. More than 50% of the data from laws, hospital standards, and medical ethics are used as input for the development of innovation.				/									/				/							/						
		CE11 Following complaints or	The practice to fulfill the criterion is not implemented. The use of complaints that do															/															

Dimension	Factors & Definitions	TQIM-H question	TQIM-H Readiness	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		acts that do not comply with the law or medical ethics for further improvement.	not comply with the law or medical ethics from the organizational satisfy questionnaire as input for the development of innovation is absent.																														
			The practice to fulfill the criterion is inadequate where improvement is necessary. Less than 50% of the data from complaints that do not comply with the law or medical ethics from the organizational satisfy questionnaire are used as input for the development of innovation.													/																	
			The practice to fulfill the criterion is defined and implemented. More than 50% of the data that do not comply with the law or medical ethics from the organizational satisfy questionnaire are used as an input for the development of innovation.	/	/	/	/	/	/	/	/	/	/	/	/		/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Leadership	**2.1 Leader vision:** Leaders' visions and attitudes are significant for the creation of innovation and quality, as leaders are in charge of steering the direction of the management and organizational structures.	LD1 Acknowledging the importance of innovation and having a vision about developing innovation and quality in the hospital.	The leader does not acknowledge the importance of developing innovation and quality in the hospital.																														
			The leader acknowledges the importance of developing innovation and quality in the hospital. A responsible person for innovation development is not appointed.															/															
			The leader acknowledges the importance of developing innovation and quality in the hospital. A responsible person for innovation development is appointed.	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
		LD2 Proposing policies on quality and innovation as the main goals of the organization, with specified related KPIs.	Policies on quality and innovation, with specified related KPIs, are not proposed as the main goals of the organization.																														
			Policies on quality and innovation, with specified related KPIs, are proposed by the leader as the main goals of the organization.															/															
			Policies on quality and innovation, with specified related KPIs, are proposed and well-announced by the leader as the main goals of the organization.	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
		LD4 Including time used for creating innovation into working hours.	Time used for creating innovation is not counted as working hours.																														
			Time used for creating innovation is counted as working hours.																									/					
			Time used for creating innovation is counted reliably as working hours.	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/
		LD5 Creating an atmosphere that encourages	Employees are not allowed to express their opinions on work processes and departmental issues																														

Dimension	Factors & Definitions	TQIM-H question	TQIM-H Readiness	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		learning and experiments.	Employees are allowed to express their opinions on work processes and departmental issues in less than 50% of the number of meetings in a year.																									/					
			Employees are allowed to express their opinions on work processes and departmental issues in more than 50% of the number of meetings in a year.	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/
/Planning	**3.1 Strategic plan development:** Implementation of organizational policies and planning direction in the management of the organization, together with quality and innovation management, can drive working processes toward success.	PN1 Stating policy and vision involving organizational quality and innovation	Policy and vision involving organizational quality and innovation in hospitals are absent.																														
			Policy and vision involving organizational quality and innovation in hospitals are available for some issues.															/									/					/	
			Policy and vision involving organizational quality and innovation in hospitals are fully available.	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/		/	/	/	/		/
		PN2 Stating indicators and outcomes for organizational quality and innovation	Indicators and outcomes for organizational quality and innovation are absent.																														
			Indicators and outcomes for organizational quality and innovation are available for some issues.														/													/			
			Indicators and outcomes for organizational quality and innovation are fully available	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/		/	/	/
		PN3 Stating strategies for organizational quality and innovation	Strategies for organizational quality and innovation are absent.																														
			Strategies for organizational quality and innovation are available for some issues.															/	/														
			Strategies for organizational quality and innovation are fully available.	/	/	/	/	/	/	/	/	/	/	/	/	/	/			/	/	/	/	/	/	/	/	/	/	/	/	/	/
	3.2 Alignment of innovation: Making innovation part of the organization's strategies and part of each member's work catalyzes innovation and generates innovation recognition from the organization's members, resulting in sustainability.	PN4 Creating an action plan that agrees with organization policy	Action plans on innovation development do not agree with organization and organizational strategy.																														
			Action plans on innovation development agree with organization policy but do not align with organizational strategy.						/									/							/			/				/	
			Action plans on innovation development agree with organization and organizational strategy.	/	/	/	/	/		/	/	/	/	/	/	/	/		/	/	/	/	/	/		/	/		/	/	/		/
Support	**4.1 Budgets:** Money is a crucial factor for the success of all activities in the hospital.	SP1 Setting up a funding budget for quality and innovation projects for suitable periods	A funding budget for quality and innovation projects for suitable periods is absent			/												/															
			A funding budget for quality and innovation projects is available but controlled in other parts.					/												/								/					
			A funding budget for quality and innovation projects is fully available for suitable periods	/	/		/		/	/	/	/	/	/	/	/	/		/		/	/	/	/	/	/	/		/	/	/	/	/
	4.2 Facilities e.g. laboratories, space, etc.:	SP3 Creating a space or hub	You have never participated in the seminar of BDMS innovation incubator meeting																									/					

Dimension	Factors & Definitions	TQIM-H question	TQIM-H Readiness	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
	Facilities constitute a factor that drives the organization towards development. There are two dimensions to facilities: intangible dimension and tangible dimension. The first one includes time, opportunity, trust, and knowledge. The second includes tools, apparatus, technology, human resources, and sandbox.	where innovators can exchange ideas and brainstorm to develop projects in the hospital	You participate in BDMS innovation incubator meeting less than 50% per number of seminars in a year															/			/												
			You participate in BDMS innovation incubator meeting more than 50% per number of seminars in a year	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/		/	/	/	/	/	/		/	/	/	/	/
	4.3 Employee education and training programs: Healthcare programs are intended for equipping staff with the knowledge of working systems internal to the hospital so they can all work in the same direction. Further, cultivating critical thinking is very important to develop innovative projects in the hospital.	SP5 Planning a training session that encourages quality and innovation	You do not plan to attend a training session that encourages quality and innovation																														
			You are interested in attending the BDMS innovation training program, but there is no concrete plan yet.																					/									
			You tangibly plan to attend a training session that encourages quality and innovation	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/
		SP6 Providing courses that aim to create innovative thinking and a critical thinking mindset to cultivate innovators	You do not participate in the innovation training program as planned																														
			You participate in the innovation training program as planned but less than 50% of the number of training courses in a year			/			/									/	/	/			/					/					/
			You participate in the innovation training program as planned more than 50% of the number of training courses in a year	/	/		/	/		/	/	/	/	/	/	/	/				/	/		/	/	/	/		/	/	/	/	
	5.1 Process management: Management and operating processes are considered significant for effective performance. Process management can reduce organizational resources and risks, and can increase working performance in the hospital.	OP2 Creating a management system and a plan that provide the whole picture of the organization	A management system and a plan that provide the whole picture of the organization is absent																														
			A management system and a plan that provide the whole picture of the organization is available for some issues				/														/												
			A management system and a plan that provide the whole picture of the organization is fully available	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/
		OP3 Considering a working process to eliminate irrelevant processes	Negative complaints about customer service, time, and procedures are common.				/												/														
			Negative complaints about customer service, time, and procedures are absent.	/		/				/				/	/	/	/	/					/	/		/	/			/			
			Negative complaints about customer service, time, and procedures are absent. Favorable comments are common.		/			/	/		/	/	/							/	/	/			/			/	/		/	/	/
	5.2 Monitoring and evaluation: Monitoring and evaluating working processes eliminate pain points and increase the working potential that helps the organization achieve its goals.	OP7 Creating monitoring system for innovative projects in the hospital	Monitoring systems for innovative projects in the hospital are absent.								/																						
			There is a monitoring system for innovative projects in the hospital but the action plan is not clear.	/					/	/						/				/									/				
			There is a monitoring system for innovative projects in the hospital with a clear action		/	/	/	/				/	/	/	/		/	/	/		/	/	/	/	/	/	/	/		/	/	/	/

Dimension	Factors & Definitions	TQIM-H question	TQIM-H Readiness	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
			plan.																														
	5.4 Risk management: Risk management is the process of analyzing processes and practices that are in the hospital, identifying risk factors, and implementing procedures to address those risks.	OP13 Initiating risk prevention and mitigation in the hospital	Risk prevention and mitigation system in the hospital is absent																														
			Risk prevention and mitigation in the hospital is available for some issues														/							/									
			Initiate risk prevention and mitigation in the hospital is fully available	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/		/	/	/	/	/	/	/	/	/
		OP14 Providing a system that furnishes decision-making	A system that facilitates decision-making is absent																														
			A system that furnishes decision-making is available for some issues							/												/											
			A system that furnishes decision-making is fully available	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/
	5.6 Knowledge management: Knowledge management is to collect and present knowledge necessary for effective organizational development. Knowledge management includes professional knowledge and critical thinking.	OP18 Collecting knowledge necessary for developing management processes in the hospital for further research and access by interested personnel.	Knowledge management system in the future work process is absent																														
			Knowledge management system in the future work process is available but the implementation is absent			/							/					/	/								/						
			Knowledge management system in the future work process is available and implemented.	/	/		/	/	/	/	/	/		/	/	/	/			/	/	/	/	/	/	/		/	/	/	/	/	/
	5.8 Establishing an innovation award: Awards granted to successful projects support and encourage personnel to improve their quality and innovation projects within the organization. Also, awards are one of the factors that stimulate healthcare workers to forge organizational development.	OP21 Using awarded projects as learning examples.	Award-winning innovative projects as a model to learn and develop healthcare innovation are absent.		/	/		/		/	/		/		/		/			/	/	/		/		/	/		/	/	/		
			Award-winning innovative projects as a model to learn are available for some issues and have never been put into practice.	/			/					/		/				/	/				/					/					/
			The award-winning innovative projects as a model to develop learning from inside and outside the organization is fully available and put into practical application.						/							/									/							/	
Tools and Analysis method	**6.1 Well-defined processes and formalized tools:** Using the right tools and system patterns ensures the effectiveness of working processes, minimizes risks, and creates trust between personnel and patients.	TA6 Initiating systems for validating the accuracy of the tools	The system for evaluating the correctness of the work system according to the operational guidelines is absent.								/																						
			The process for evaluating the correctness of work is available and complied for some issues.	/		/	/						/			/				/											/		
			The system for evaluating the correctness of the work system according to the concrete operational guidelines is fully available.		/			/	/	/		/		/	/		/	/	/		/	/	/	/	/	/	/	/	/	/		/	/
		TA7 Updating the information constantly according to the patient status that is changing throughout the	A real-time working state tracking system is absent								/											/											
			Tools to track the working status is available for some issues			/	/												/								/					/	
			System to track the working status in real-time concretely is fully available.	/	/			/	/	/		/	/	/	/	/	/	/		/	/		/	/	/	/		/	/	/	/		/

Dimension	Factors & Definitions	TQIM-H question	TQIM-H Readiness	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
		treatment process																															
		TA8 Managing information within the organization that is connected across departments	A network system within the organization that can connect is absent.																														
			Internal network connections in some processes are available for some issues	/			/				/		/			/	/		/		/	/		/					/	/			/
			A network system within the organization that can be connected concretely is fully available.		/	/			/	/		/		/	/			/		/			/		/	/	/	/			/	/	
	6.4 Data integrity and security: Keeping medical information confidential is bound by the law and medical ethics. Therefore, data safety and confidentiality must be managed effectively.	TA9 Creating effective and secure information retrieval processes e.g. the process that requires identification of users	An information security system within the hospital is absent.																														
			Information security systems within the hospital are available for some issues									/							/												/		
			Information security systems within the hospital are available for all issues	/	/	/	/	/	/	/	/		/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/		/	/
Improvement	**7.2 Continuous solving:** Continuous solving involves the improvement of the process after the weakness identification. Newly designed processes increase working potential, resulting in the ability to adapt to the ever-changing environment.	IP4 Creating a system that encourages knowledge sharing and that points to the significance of quality standards.	A knowledge system for quality standards is absent.																														
			A knowledge system for quality standards is available for some issues, but there is no concrete implementation.		/																/			/						/			
			A knowledge system for quality standards is fully available and it has been concretely put into practice.	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/		/	/	/	/	/		/	/	/
		IP6 Providing a system or experts who can advise and support system development.	A continuous process development system is absent.																														
			A continuous process development system is available in some departments.								/					/											/						
			A continuous process development system is fully available.	/	/	/	/	/	/	/		/	/	/	/		/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/
	7.3 Quality audits: To keep healthcare management effective and to minimize errors, auditors observe the process to maintain working efficiency and to stimulate personnel to remain in line with working standards.	IP7 Initiating internal auditing system that complies with international standard	A system for assessing quality standards within the hospital is absent.																														
			A system for assessing quality standards within the hospital is available for some issues.								/															/							
			A system for assessing quality standards within the hospital is fully available.	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/
		IP8 Setting goals and achievement levels from the audit	Goals for an international standard that are aligned with work processes within the hospital are absent.																														
			Goals for an international standard that are aligned with work processes within the hospital are available for some issues but have not yet been complied with.																/														
			Goals for an international standard that are aligned with work processes within the hospital are fully available.	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/

Table 8.8 The refined TQIM-H measurement scale through analyzing 50 effective innovation projects (continue)

Dimension	Factors & Definitions	TQIM-H question	TQIM-H Readiness	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	Sum
Context of the Environment (Internal & External)	**1.1 Customer (patient etc.) needs:** The hospital places importance on customers' satisfaction with the service. Keeping abreast of the market's situation and patient's needs is essential to increase the potential for competition.	CE4 Observing trends that reflect needs from both customers and the markets.	The practice to fulfill the criterion is not implemented. The use of customer needs as input for the development of innovation is absent.		/		/					/		/					/			/	/	**23**
			The practice to fulfill the criterion is inadequate where improvement is necessary. Less than 50% of the data from customer needs are used as input for the development of innovation.	/				/	/	/	/		/				/			/	/			**15**
			The practice to fulfill the criterion is defined and implemented. More than 50% of the data from customer needs are used as input for the development of innovation.			/									/	/		/						**12**
	1.2 Technological change: Technological changes affect an organization's development by superseding some processes. Technology can enhance working performance and streamline the process by removing irrelevant parts, resulting in increasing capability for competition in the healthcare market and augment customers' trust.	CE8 Studying technological changes, medical innovative technologies, and emergent innovations and applying them in the hospital.	The practice to fulfill the criterion is not implemented. The use of research, technological changes, and medical innovative technologies as input for the development of innovation are absent.		/					/								/					/	**10**
			The practice to fulfill the criterion is inadequate where improvement is necessary. Less than 50% of the data from research, technological changes, and medical innovative technologies are used as input for the development of innovation.				/					/							/					**9**
			The practice to fulfill the criterion is defined and implemented. More than 50% of the data from research, technological changes, and medical innovative technologies are used as input for the development of innovation.	/		/		/	/		/		/	/	/	/	/	/		/	/	/		**31**
	1.3 Litigation law refers to the rules and practices: Law is important because it is the basis of all operations and covers medical ethics and patient rights.	CE9 Complying with laws, hospital standards, and medical ethics.	The practice to fulfill the criterion is not implemented. The use of laws, hospital standards, and medical ethics as input for the development of innovation are absent.	/		/		/		/		/		/		/	/		/	/		/		**23**
			The practice to fulfill the criterion is inadequate where improvement is necessary. Less than 50% of the data from laws, hospital standards, and medical ethics are used as input for the development of innovation.		/				/		/				/			/					/	**20**
			The practice to fulfill the criterion is defined and implemented. More than 50% of the data from laws, hospital standards, and medical ethics are used as input for the development of innovation.				/						/								/			**7**

Dimension	Factors & Definitions	TQIM-H question	TQIM-H Readiness	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	Sum
		CE11 Following complaints or acts that do not comply with the law or medical ethics for further improvement.	The practice to fulfill the criterion is not implemented. The use of complaints that do not comply with the law or medical ethics from the organizational satisfy questionnaire as input for the development of innovation is absent.																					**1**
			The practice to fulfill the criterion is inadequate where improvement is necessary. Less than 50% of the data from complaints that do not comply with the law or medical ethics from the organizational satisfy questionnaire are used as input for the development of innovation.										/											**2**
			The practice to fulfill the criterion is defined and implemented. More than 50% of the data that do not comply with the law or medical ethics from the organizational satisfy questionnaire are used as an input for the development of innovation.	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	**47**
Leadership	**2.1 Leader vision:** Leaders' visions and attitudes are significant for the creation of innovation and quality, as leaders are in charge of steering the direction of the management and organizational structures.	LD1 Acknowledging the importance of innovation and having a vision about developing innovation and quality in the hospital.	The leader does not acknowledge the importance of developing innovation and quality in the hospital.																					0
			The leader acknowledges the importance of developing innovation and quality in the hospital. A responsible person for innovation development is not appointed.						/															2
			The leader acknowledges the importance of developing innovation and quality in the hospital. A responsible person for innovation development is appointed.	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	48
		LD2 Proposing policies on quality and innovation as the main goals of the organization, with specified related KPIs.	Policies on quality and innovation, with specified related KPIs, are not proposed as the main goals of the organization.																					0
			Policies on quality and innovation, with specified related KPIs, are proposed by the leader as the main goals of the organization.						/															2
			Policies on quality and innovation, with specified related KPIs, are proposed and well-announced by the leader as the main goals of the organization.	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	48
		LD4 Including time used for creating innovation into working hours.	Time used for creating innovation is not counted as working hours.						/															**2**
			Time used for creating innovation is counted as working hours.	/		/	/				/			/	/		/			/		/		**23**
			Time used for creating innovation is counted reliably as working hours.		/			/	/	/		/	/			/		/	/		/			**25**
		LD5 Creating an atmosphere that	Employees are not allowed to express their opinions on work processes and departmental																					**0**

Dimension	Factors & Definitions	TQIM-H question	TQIM-H Readiness	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	Sum
		encourages learning and experiments.	issues																					
			Employees are allowed to express their opinions on work processes and departmental issues in less than 50% of the number of meetings in a year.										/											**2**
			Employees are allowed to express their opinions on work processes and departmental issues in more than 50% of the number of meetings in a year.	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	**48**
Planning	**3.1 Strategic plan development:** Implementation of organizational policies and planning direction in the management of the organization, together with quality and innovation management, can drive working processes toward success.	PN1 Stating policy and vision involving organizational quality and innovation	Policy and vision involving organizational quality and innovation in hospitals are absent.																					**0**
			Policy and vision involving organizational quality and innovation in hospitals are available for some issues.						/				/											**5**
			Policy and vision involving organizational quality and innovation in hospitals are fully available.	/	/	/	/	/		/	/	/		/	/	/	/	/	/	/	/	/	/	**45**
		PN2 Stating indicators and outcomes for organizational quality and innovation	Indicators and outcomes for organizational quality and innovation are absent.																					**0**
			Indicators and outcomes for organizational quality and innovation are available for some issues.						/				/							/				**6**
			Indicators and outcomes for organizational quality and innovation are fully available	/	/	/	/	/		/	/	/		/	/	/	/	/	/		/	/	/	**44**
		PN3 Stating strategies for organizational quality and innovation	Strategies for organizational quality and innovation are absent.																					**0**
			Strategies for organizational quality and innovation are available for some issues.						/				/								/			**5**
			Strategies for organizational quality and innovation are fully available.	/	/	/	/	/		/	/	/		/	/	/	/	/	/	/		/	/	**45**
	3.2 Alignment of innovation: Making innovation part of the organization's strategies and part of each member's work catalyzes innovation and generates innovation recognition from the organization's members, resulting in sustainability.	PN4 Creating an action plan that agrees with organization policy	Action plans on innovation development do not agree with organization and organizational strategy.																					**0**
			Action plans on innovation development agree with organization policy but do not align with organizational strategy.						/				/								/			**8**
			Action plans on innovation development agree with organization and organizational strategy.	/	/	/	/	/		/	/	/		/	/	/	/	/	/	/		/	/	**42**
Support	**4.1 Budgets:** Money is a crucial factor for the success of all activities in the hospital.	SP1 Setting up a funding budget for quality and innovation projects for suitable periods	A funding budget for quality and innovation projects for suitable periods is absent						/	/							/							**5**
			A funding budget for quality and innovation projects is available but controlled in other parts.										/			/					/			**6**
			A funding budget for quality and innovation projects is fully available for suitable periods	/	/	/	/	/			/	/		/	/			/	/	/		/	/	**39**
	4.2 Facilities e.g. laboratories, space, etc.:	SP3 Creating a space or hub	You have never participated in the seminar of BDMS innovation incubator meeting																					**1**

Dimension	Factors & Definitions	TQIM-H question	TQIM-H Readiness	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	Sum
	Facilities constitute a factor that drives the organization towards development. There are two dimensions to facilities: intangible dimension and tangible dimension. The first one includes time, opportunity, trust, and knowledge. The second includes tools, apparatus, technology, human resources, and sandbox.	where innovators can exchange ideas and brainstorm to develop projects in the hospital	You participate in BDMS innovation incubator meeting less than 50% per number of seminars in a year	/					/				/						/					**6**
			You participate in BDMS innovation incubator meeting more than 50% per number of seminars in a year		/	/	/	/		/	/	/		/	/	/	/	/		/	/	/	/	**33**
	4.3 Employee education and training programs: Healthcare programs are intended for equipping staff with the knowledge of working systems internal to the hospital so they can all work in the same direction. Further, cultivating critical thinking is very important to develop innovative projects in the hospital.	SP5 Planning a training session that encourages quality and innovation	You do not plan to attend a training session that encourages quality and innovation																					**0**
			You are interested in attending the BDMS innovation training program, but there is no concrete plan yet.							/														**2**
			You tangibly plan to attend a training session that encourages quality and innovation	/	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	**48**
		SP6 Providing courses that aim to create innovative thinking and a critical thinking mindset to cultivate innovators	You do not participate in the innovation training program as planned																					**0**
			You participate in the innovation training program as planned but less than 50% of the number of training courses in a year		/	/							/						/	/				**13**
			You participate in the innovation training program as planned more than 50% of the number of training courses in a year	/			/	/	/	/	/	/		/	/	/	/	/			/	/	/	**37**
	5.1 Process management: Management and operating processes are considered significant for effective performance. Process management can reduce organizational resources and risks, and can increase working performance in the hospital.	OP2 Creating a management system and a plan that provide the whole picture of the organization	A management system and a plan that provide the whole picture of the organization is absent																					**0**
			A management system and a plan that provide the whole picture of the organization is available for some issues			/											/							**4**
			A management system and a plan that provide the whole picture of the organization is fully available	/	/		/	/	/	/	/	/	/	/	/	/		/	/	/	/	/	/	**46**
		OP3 Considering a working process to eliminate irrelevant processes	Negative complaints about customer service, time, and procedures are common.			/						/												**4**
			Negative complaints about customer service, time, and procedures are absent.				/			/	/			/	/			/			/	/		**21**
			Negative complaints about customer service, time, and procedures are absent. Favorable comments are common.	/	/			/	/			/	/			/	/		/	/			/	**25**
	5.2 Monitoring and evaluation: Monitoring and evaluating working processes eliminate pain points and increase the working potential that helps the organization achieve its goals.	OP7 Creating monitoring system for innovative projects in the hospital	Monitoring systems for innovative projects in the hospital are absent.			/																		**2**
			There is a monitoring system for innovative projects in the hospital but the action plan is not clear.				/					/	/						/					**10**
			There is a monitoring system for innovative projects in the hospital with a clear action	/	/			/	/	/	/			/	/	/	/	/		/	/	/	/	**38**

Dimension	Factors & Definitions	TQIM-H question	TQIM-H Readiness	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	Sum
			plan.																					
	5.4 Risk management: Risk management is the process of analyzing processes and practices that are in the hospital, identifying risk factors, and implementing procedures to address those risks.	OP13 Initiating risk prevention and mitigation in the hospital	Risk prevention and mitigation system in the hospital is absent																					**0**
			Risk prevention and mitigation in the hospital is available for some issues						/													/		**4**
			Initiate risk prevention and mitigation in the hospital is fully available	/	/	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/		/	**46**
		OP14 Providing a system that furnishes decision-making	A system that facilitates decision-making is absent																					**0**
			A system that furnishes decision-making is available for some issues								/									/			/	**5**
			A system that furnishes decision-making is fully available	/	/	/	/	/	/	/		/	/	/	/	/	/	/	/		/	/		**45**
	5.6 Knowledge management: Knowledge management is to collect and present knowledge necessary for effective organizational development. Knowledge management includes professional knowledge and critical thinking.	OP18 Collecting knowledge necessary for developing management processes in the hospital for further research and access by interested personnel.	Knowledge management system in the future work process is absent																					**0**
			Knowledge management system in the future work process is available but the implementation is absent								/		/			/	/	/				/		**11**
			Knowledge management system in the future work process is available and implemented.	/	/	/	/	/	/	/		/		/	/				/	/	/		/	**39**
	5.8 Establishing an innovation award: Awards granted to successful projects support and encourage personnel to improve their quality and innovation projects within the organization. Also, awards are one of the factors that stimulate healthcare workers to forge organizational development.	OP21 Using awarded projects as learning examples.	Award-winning innovative projects as a model to learn and develop healthcare innovation are absent.	/			/		/			/			/	/		/			/		/	**26**
			Award-winning innovative projects as a model to learn are available for some issues and have never been put into practice.		/	/		/		/			/	/			/		/			/		**18**
			The award-winning innovative projects as a model to develop learning from inside and outside the organization is fully available and put into practical application.								/									/				**6**
Tools and Analysis method	**6.1 Well-defined processes and formalized tools:** Using the right tools and system patterns ensures the effectiveness of working processes, minimizes risks, and creates trust between personnel and patients.	TA6 Initiating systems for validating the accuracy of the tools	The system for evaluating the correctness of the work system according to the operational guidelines is absent.		/											/			/					**4**
			The process for evaluating the correctness of work is available and complied for some issues.						/	/														**9**
			The system for evaluating the correctness of the work system according to the concrete operational guidelines is fully available.	/		/	/	/			/	/	/	/	/		/	/		/	/	/	/	**37**
		TA7 Updating the information constantly according to the patient status that is changing throughout the	A real-time working state tracking system is absent				/																	**3**
			Tools to track the working status is available for some issues	/							/							/				/		**9**
			System to track the working status in real-time concretely is fully available.		/	/		/	/	/		/	/	/	/	/	/		/	/	/		/	**38**

Dimension	Factors & Definitions	TQIM-H question	TQIM-H Readiness	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	Sum
		treatment process																						
		TA8 Managing information within the organization that is connected across departments	A network system within the organization that can connect is absent.																					0
			Internal network connections in some processes are available for some issues	/		/		/			/		/		/	/			/	/	/		/	24
			A network system within the organization that can be connected concretely is fully available.		/		/		/	/		/		/			/	/				/		26
	6.4 Data integrity and security: Keeping medical information confidential is bound by the law and medical ethics. Therefore, data safety and confidentiality must be managed effectively.	TA9 Creating effective and secure information retrieval processes e.g. the process that requires identification of users	An information security system within the hospital is absent.																					0
			Information security systems within the hospital are available for some issues	/																				4
			Information security systems within the hospital are available for all issues		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	46
Improvement	**7.2 Continuous solving:** Continuous solving involves the improvement of the process after the weakness identification. Newly designed processes increase working potential, resulting in the ability to adapt to the ever-changing environment.	IP4 Creating a system that encourages knowledge sharing and that points to the significance of quality standards.	A knowledge system for quality standards is absent.																					0
			A knowledge system for quality standards is available for some issues, but there is no concrete implementation.			/																	/	6
			A knowledge system for quality standards is fully available and it has been concretely put into practice.	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/		44
		IP6 Providing a system or experts who can advise and support system development.	A continuous process development system is absent.																					0
			A continuous process development system is available in some departments.							/	/								/					6
			A continuous process development system is fully available.	/	/	/	/	/	/			/	/	/	/	/	/	/		/	/	/	/	44
	7.3 Quality audits: To keep healthcare management effective and to minimize errors, auditors observe the process to maintain working efficiency and to stimulate personnel to remain in line with working standards.	IP7 Initiating internal auditing system that complies with international standard	A system for assessing quality standards within the hospital is absent.																					0
			A system for assessing quality standards within the hospital is available for some issues.																					2
			A system for assessing quality standards within the hospital is fully available.	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	48
		IP8 Setting goals and achievement levels from the audit	Goals for an international standard that are aligned with work processes within the hospital are absent.																					0
			Goals for an international standard that are aligned with work processes within the hospital are available for some issues but have not yet been complied with.				/																	2
			Goals for an international standard that are aligned with work processes within the hospital are fully available.	/	/	/		/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	48

Section 3: The TQIM-H comparison of Innovation project and Best practice score

The result scores of an innovation project show the level of its TQIM-H performance compared with the best practice score as shown in Table 8.9.

Table 8.9 The TQIM-H measurement score for the innovation project

TQIM-H question	Standardized Loadings	Best Practice	Best Result	Level 1	Level 2	Level 3	Standardized Loadings	Performance	Result
CE4 Observing trends that reflect needs from both customers and the markets.	0.759	3	2.28	The practice to fulfill the criterion is not implemented. The use of customer needs as input for the development of innovation is absent.	The practice to fulfill the criterion is inadequate where improvement is necessary. Less than 50% of the data from customer needs are used as input for the development of innovation.	The practice to fulfill the criterion is defined and implemented. More than 50% of the data from customer needs are used as input for the development of innovation.	0.759		
CE8 Studying technological changes, medical innovative technologies, and emergent innovations and applying them in the hospital.	0.799	3	2.40	The practice to fulfill the criterion is not implemented. The use of research, technological changes, and medical innovative technologies as input for the development of innovation are absent.	The practice to fulfill the criterion is inadequate where improvement is necessary. Less than 50% of the data from research, technological changes, and medical innovative technologies are used as input for the development of innovation.	The practice to fulfill the criterion is defined and implemented. More than 50% of the data from research, technological changes, and medical innovative technologies are used as input for the development of innovation.	0.799		
CE9 Complying with laws, hospital standards, and medical ethics.	0.837	3	2.51	The practice to fulfill the criterion is not implemented. The use of laws, hospital standards, and medical ethics as input for the development of innovation is absent.	The practice to fulfill the criterion is inadequate where improvement is necessary. Less than 50% of the data from laws, hospital standards, and medical ethics are used as input for the development of innovation.	The practice to fulfill the criterion is defined and implemented. More than 50% of the data from laws, hospital standards, and medical ethics are used as input for the development of innovation.	0.837		
CE11 Following complaints or acts that do not comply with the law or medical ethics for further improvement.	0.794	3	2.38	The practice to fulfill the criterion is not implemented. The use of complaints that do not comply with the law or medical ethics from the organizational satisfy questionnaire as input for the development of innovation is absent.	The practice to fulfill the criterion is inadequate where improvement is necessary. Less than 50% of the data from complaints that do not comply with the law or medical ethics from the organizational satisfy questionnaire are used as input for the development of innovation.	The practice to fulfill the criterion is defined and implemented. More than 50% of the data that do not comply with the law or medical ethics from the organizational satisfy questionnaire are used as input for the development of innovation.	0.794		
LD1 Acknowledging the importance of innovation and having a vision for developing	0.829	3	2.49	The leader does not acknowledge the importance of developing innovation and quality in the hospital.	The leader acknowledges the importance of developing innovation and quality in the hospital. A responsible person for innovation development is	The leader acknowledges the importance of developing innovation and quality in the hospital. A responsible person for innovation development is	0.829		

TQIM-H question	Standardized Loadings	Best Practice	Best Result	Level 1	Level 2	Level 3	Standardized Loadings	Performance	Result
innovation and quality in the hospital.					not appointed.	appointed.			
LD2 Proposing policies on quality and innovation as the main goals of the organization, with specified related KPIs.	0.854	3	2.56	Policies on quality and innovation, with specified related KPIs, are not proposed as the main goals of the organization.	Policies on quality and innovation, with specified related KPIs, are proposed by the leader as the main goals of the organization.	Policies on quality and innovation, with specified related KPIs, are proposed and well-announced by the leader as the main goals of the organization.	0.854		
LD4 Including time used for creating innovation into working hours.	0.813	3	2.44	Time used for creating innovation is not counted as working hours.	Time used for creating innovation is counted as working hours.	Time used for creating innovation is counted reliably as working hours.	0.813		
LD5 Creating an atmosphere that encourages learning and experiments.	0.747	3	2.24	Employees are not allowed to express their opinions on work processes and departmental issues	Employees are allowed to express their opinions on work processes and departmental issues in less than 50% of the number of meetings in a year.	Employees are allowed to express their opinions on work processes and departmental issues in more than 50% of the number of meetings in a year.	0.747		
PN1 Stating policy and vision involving organizational quality and innovation	0.830	3	2.49	Policy and vision involving organizational quality and innovation in hospitals are absent.	Policy and vision involving organizational quality and innovation in hospitals are available for some issues.	Policy and vision involving organizational quality and innovation in hospitals are fully available.	0.830		
PN2 Stating indicators and outcomes for organizational quality and innovation	0.898	3	2.69	Indicators and outcomes for organizational quality and innovation are absent.	Indicators and outcomes for organizational quality and innovation are available for some issues.	Indicators and outcomes for organizational quality and innovation is fully available	0.898		
PN3 Stating strategies for organizational quality and innovation	0.907	3	2.72	Strategies for organizational quality and innovation are absent.	Strategies for organizational quality and innovation are available for some issues.	Strategies for organizational quality and innovation are fully available.	0.907		
PN4 Creating an action plan that agrees with organization policy	0.928	3	2.78	Action plans on innovation development do not agree with organization and organizational strategy.	Action plans on innovation development agree with organization policy but do not align with organizational strategy.	Action plans on innovation development agree with organization and organizational strategy.	0.928		
SP1 Setting up a funding budget for quality and innovation projects for suitable periods	0.801	3	2.40	A funding budget for quality and innovation projects for suitable periods is absent	A funding budget for quality and innovation projects is available but controlled in other parts.	A funding budget for quality and innovation projects is fully available for suitable periods	0.801		
SP3 Creating a space or hub where innovators can	0.784	3	2.35	You have never participated in the seminar of BDMS innovation	You participate in BDMS innovation incubator meeting less than 50% per	You participate in BDMS innovation incubator meeting more than 50%	0.784		

TQIM-H question	Standardized Loadings	Best Practice	Best Result	Level 1	Level 2	Level 3	Standardized Loadings	Performance	Result
exchange ideas and brainstorm to develop projects in the hospital				incubator meeting	number of seminars in a year	per number of seminars in a year			
SP5 Planning a training session that encourages quality and innovation	0.780	3	2.34	You do not plan to attend a training session that encourages quality and innovation	You are interested in attending the BDMS innovation training program, but there is no concrete plan yet.	You tangibly plan to attend a training session that encourages quality and innovation	0.780		
SP6 Providing courses that aim to create innovative thinking and a critical thinking mindset to cultivate innovators	0.866	3	2.60	You do not participate in the innovation training program as planned	You participate in the innovation training program as planned but less than 50% of the number of training courses in a year	You participate in the innovation training program as planned more than 50% of the number of training courses in a year	0.866		
OP2 Creating a management system and a plan that provide the whole picture of the organization	0.871	3	2.61	A management system and a plan that provide the whole picture of the organization is absent	A management system and a plan that provide the whole picture of the organization is available for some issues	A management system and a plan that provide the whole picture of the organization is fully available	0.871		
OP3 Considering a working process to eliminate irrelevant processes	0.836	3	2.51	Negative complaints about customer service, time, and procedures are common.	Negative complaints about customer service, time, and procedures are absent.	Negative complaints about customer service, time, and procedures are absent. Favorable comments are common.	0.836		
OP7 Creating monitoring system for innovative projects in the hospital	0.843	3	2.53	Monitoring systems for innovative projects in the hospital are absent.	There is a monitoring system for innovative projects in the hospital but the action plan is not clear.	There is a monitoring system for innovative projects in the hospital with a clear action plan.	0.843		
OP13 Initiating risk prevention and mitigation in the hospital	0.833	3	2.50	Risk prevention and mitigation system in the hospital is absent	Risk prevention and mitigation in the hospital is available for some issues	Initiate risk prevention and mitigation in the hospital is fully available	0.833		
OP14 Providing a system that furnishes decision-making	0.867	3	2.60	A system that facilitates decision-making is absent	A system that furnishes decision-making is available for some issues	A system that furnishes decision-making is fully available	0.867		
OP18 Collecting knowledge necessary for developing management processes in the hospital for further research and access by interested personnel.	0.818	3	2.45	Knowledge management system in the future work process is absent	Knowledge management system in the future work process is available but the implementation is absent	Knowledge management system in the future work process is available and implemented.	0.818		

TQIM-H question	Standardized Loadings	Best Practice	Best Result	Level 1	Level 2	Level 3	Standardized Loadings	Performance	Result
OP21 Using awarded projects as learning examples.	0.819	3	2.46	Award-winning innovative projects as a model to learn and develop healthcare innovation are absent.	The award-winning innovative projects as a model to learn are available for some issues and have never been put into practice.	The award-winning innovative projects as a model to develop learning from inside and outside the organization is fully available and put into practical application.	0.819		
TA6 Initiating systems for validating the accuracy of the tools	0.787	3	2.36	The system for evaluating the correctness of the work system according to the operational guidelines is absent.	The process for evaluating the correctness of work is available and complied with for some issues.	The system for evaluating the correctness of the work system according to the concrete operational guidelines is fully available.	0.787		
TA7 Updating the information constantly according to the patient status that is changing throughout the treatment process	0.887	3	2.66	A real-time working state tracking system is absent	Tools to track the working status is available for some issues	System to track the working status in real-time concretely is fully available.	0.887		
TA8 Managing information within the organization that is connected across departments	0.814	3	2.44	A network system within the organization that can connect is absent.	Internal network connections in some processes are available for some issues	A network system within the organization that can be connected concretely is fully available.	0.814		
TA9 Creating effective and secure information retrieval processes e.g. the process that requires identification of users	0.894	3	2.68	An information security system within the hospital is absent.	Information security systems within the hospital are available for some issues	Information security systems within the hospital are available for all issues	0.894		
IP4 Creating a system that encourages knowledge sharing and that points to the significance of quality standards.	0.780	3	2.34	A knowledge system for quality standards is absent.	A knowledge system for quality standards is available for some issues, but there is no concrete implementation.	A knowledge system for quality standards is fully available and it has been concretely put into practice.	0.780		
IP6 Providing a system or experts who can advise and support system development.	0.857	3	2.57	A continuous process development system is absent.	A continuous process development system is available in some departments.	A continuous process development system is fully available.	0.857		
IP7 Initiating internal auditing system that complies with international	0.927	3	2.78	A system for assessing quality standards within the hospital is absent.	A system for assessing quality standards within the hospital is available for some issues.	A system for assessing quality standards within the hospital is fully available.	0.927		

TQIM-H question	Standardized Loadings	Best Practice	Best Result	Level			Standardized Loadings	Performance	Result
				1	2	3			
standard									
IP8 Setting goals and achievement levels from the audit	0.856	3	2.57	Goals for an international standard that are aligned with work processes within the hospital are absent.	Goals for an international standard that are aligned with work processes within the hospital are available for some issues but have not yet been complied with.	Goals for an international standard that are aligned with work processes within the hospital are fully available.	0.856		

After considering and analyzing the results of the last two parts, part of the best practice project score and the innovation project performance score, a radar chart was used to present the related and different results. The radar chart result was used to analyze the strengths and weaknesses of each TQIM-H dimension. TQIM-H factor was prioritized to development following the obtained score from the calculation of Z(x) (The gap of the best practice and innovation project on TQIM-H score) result. The TQIM-H factor that has a high Z(x) score indicated a high gap between the best practice and innovation project on TQIM-H, thus, this factor was prioritized to be improved first and in descending order. As a result of this stage, the organization was able to study the factors for improvement respectively. The healthcare innovation project which was tested via this TQIM-H program will be provided the guideline to get a more effective quality and innovation culture in the future.

Part 2: Development of the TQIM-H program

This part explains the capabilities and information of the TQIM-H program, describes the character in each TQIM-H dimension, TQIM-H questionnaire, best practice information and the radar chart result was used to analyze the strengths and weaknesses of each TQIM-H dimension. The healthcare innovation project which was tested via this TQIM-H program will be provided the guideline to get a more effective quality and innovation culture in the future. The developed TQIM-H program was presented in two parts including Section 1: System design and Section 2: User interface design and prototyping.

Table 8.10 The Development of the TQIM-H program

Objective	Process & Information	Result
To develop the TQIM-H program	The development of this TQIM-H program uses the computer language PHP for importing data, data processing control, and displaying the results as desired by the user. The developed TQIM-H program was presented in two parts - Section 1: System design - Section 2: User interface design and prototyping In program assessment, users can use it through a web	The developed TQIM-H Program

Objective	Process & Information	Result
	browser by typing the program name in the URL field: http://TQIM-H.com/ to go to the screen of the program	

Section 1: System design

The author developed the program using a website system with the name in the URL field: http://TQIM-H.com/ for ease of use. The program was constructed using JavaScript which enables the analysis and presentation via radar charts. The UML 2.0 model, consisting of a user diagram and activity diagram, was used as a prototype for the design and development. Figure 8.1 shows the user diagram that shows the system used to access user functions and explains the functions of the web-based application.

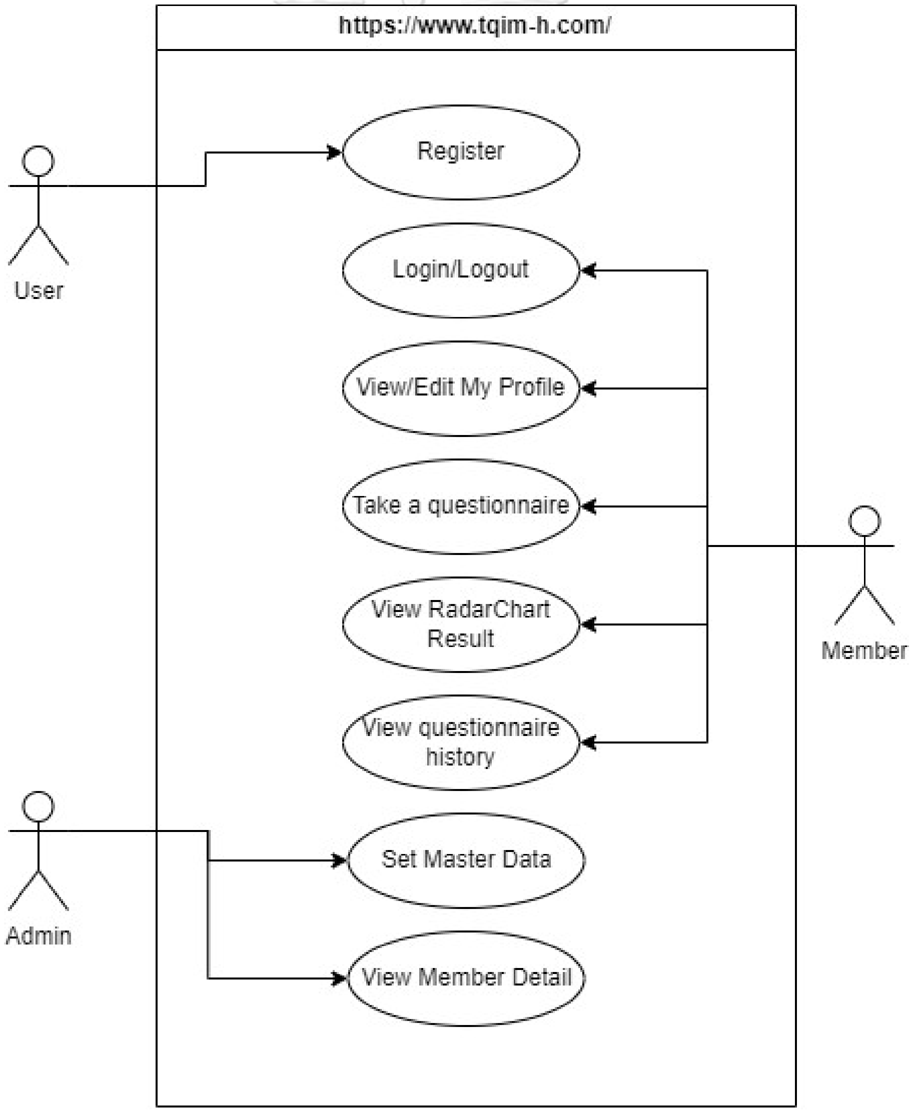


Figure 8.1 User diagram of TQIM-H program

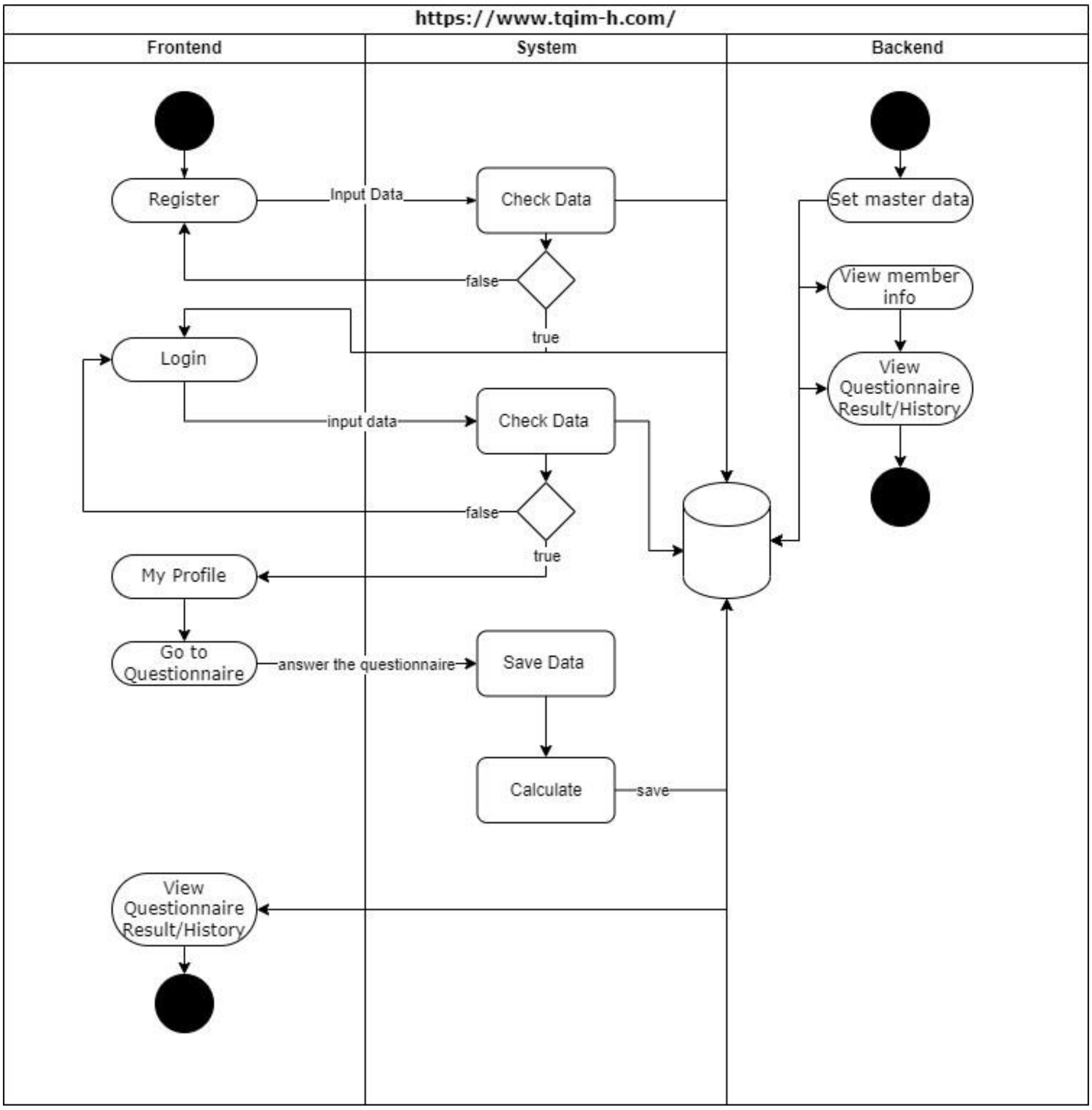


Figure 8.2 Activity diagram of TQIM-H program

Figure 8.2 shows the activity diagram of the TQIM-H program. In the front section, users start using the program by first registering to the system. Name, email address, phone number, affiliation, and names of the innovation projects are required for the registration. After logging in, the system proves the data and refers the users to the TQIM-H questionnaire. This section asks for the actual performance in innovation development projects from each user. After the evaluation using the TQIM-H questionnaire, users can prove their input and then submit the data. Then the program analyzes the input and shows the radar chart output on the screen. Each output is stored in History in the user profile, which allows longitudinal monitoring of the project.

In the backend part, the key factor and procedure of TQIM-H, importance level, Best practice score, and measurement scale 3 levels, which are key TQIM-H concepts from the previous Chapters, are input into the TQIM-H program. When users login into the backend, they can see the basic information and questionnaire results of each user.

Section 2: User Interface design and prototyping

The developed TQIM-H interface design and prototyping were presented in two parts including Sub-section 1: For the use and Sub-section 2: For the administer.

Sub-section 1: For the user

1. Subscription to access the TQIM-H program

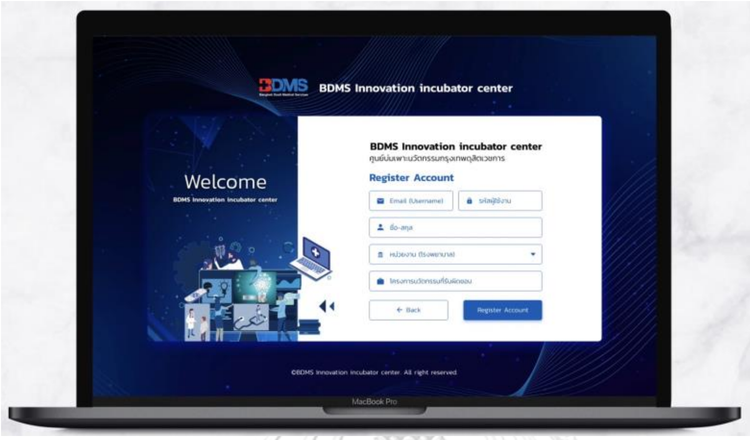


Figure 8.3 The TQIM-H program assessment

Participants register to approach the TQIM-H program. Username (E-mail), password, hospital, and participant's innovation project name were required to register to the program.

2. The TQIM-H program login page.

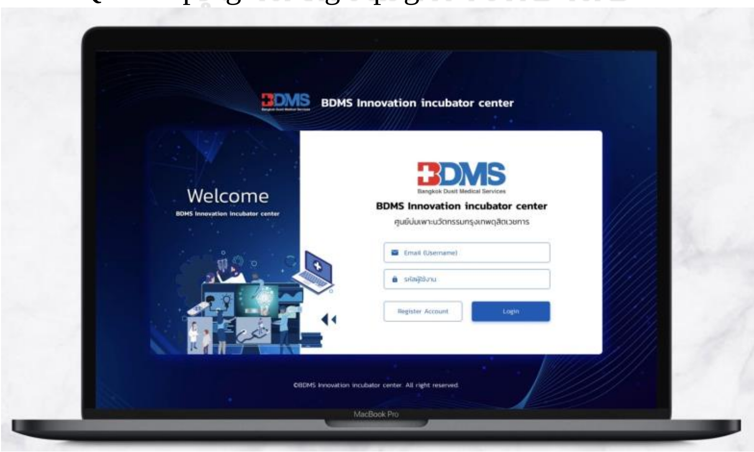


Figure 8.4 The TQIM-H program login page.

If the user has registered successfully, he/she can login to the innovation program by providing an Email (username) and password in the login screen as shown in Figure 8.2. Then, features will be available.

3. TQIM-H evaluation part

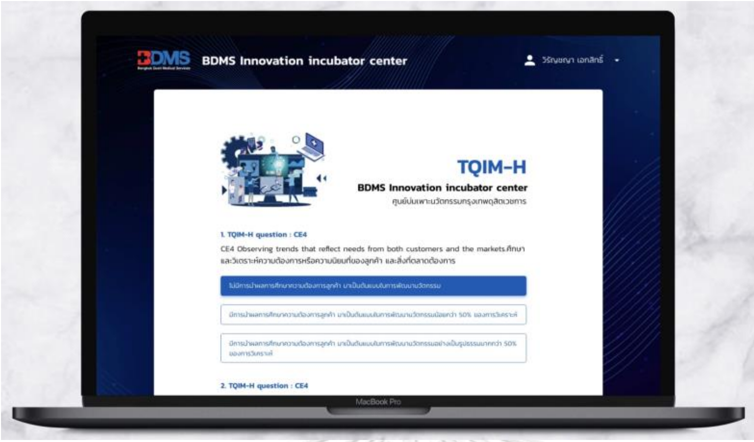


Figure 8.5 The TQIM-H questionnaire to evaluate a healthcare innovation project

To evaluate the healthcare innovation project performance through TQIM-H in seven dimensions, the evaluated questionnaire and the measurement scale was presented as shown in Figure 8.3. The developed measurement scale of each TQIM-H factor was used to test the innovation project performance through ranking scores (1-3) by healthcare innovators of selected hospitals who well comprehended their innovation project. It shows the TQIM-H factor and measurement levels ranging from 1 to 3, where each TQIM-H criteria has its characteristics that differ according to its purpose. Then, the user must choose the appropriate choice which matches the actual performance of his/her innovation project.

4. TQIM-H evaluation part (continue)

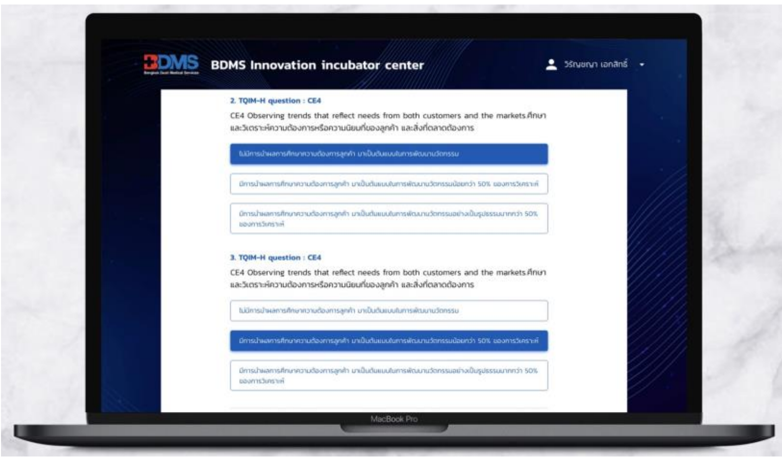


Figure 8.6 The TQIM-H questionnaire to evaluate a healthcare innovation project (continue)

If the user would like to check or change the previous answer, he/she can slide back to the previous questionnaire and correct his/her information as shown in Figure 8.4.

5. TQIM-H evaluation analysis

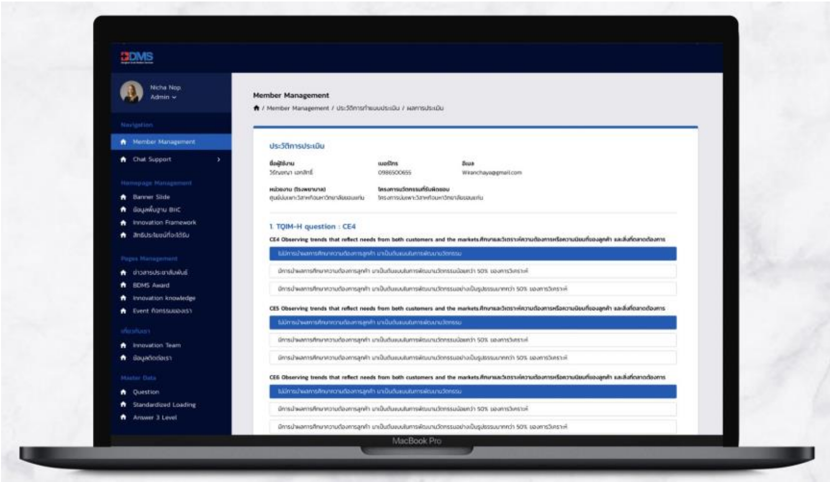


Figure 8.7 The historical evaluation of the TQIM-H question

The historical evaluation of the innovation project will be summarized and shown the overall result of TQIM-H on the final page as shown in Figure. The user must check and approve the final TQIM-H evaluation before send to the analysis process.

6. Reporting the TQIM-H actual performance through radar chart

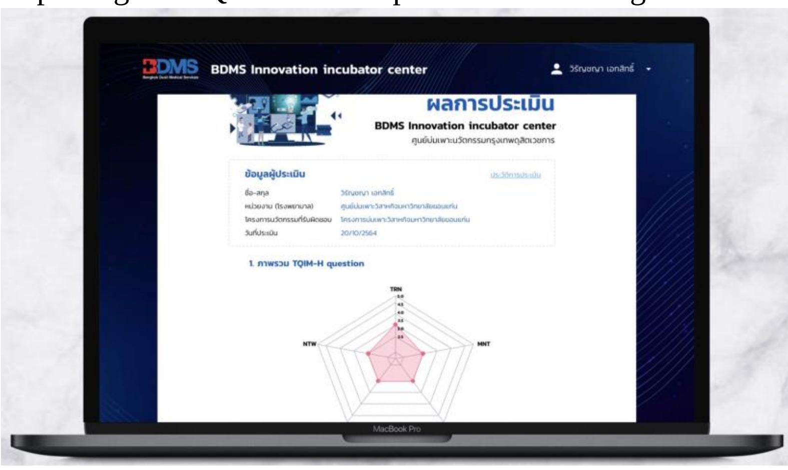


Figure 8.8 The TQIM-H analysis result

Figure 8.6 shows the TQIM-H analysis result presenting the actual performance levels in each dimension. The innovation project performance level was compared with the best practice score via the radar chart diagram, which was used as a tool to show the differences in the user's project performance and best practice score in each TQIM-H aspect. The gap difference result of the radar chart diagram helped the users understand their strengths and weaknesses in TQIM-H managing performance. It guided the project owner to increase the potential in the future to improve the healthcare innovation project.

Sub-section 2: For the administer

1. Member analysis

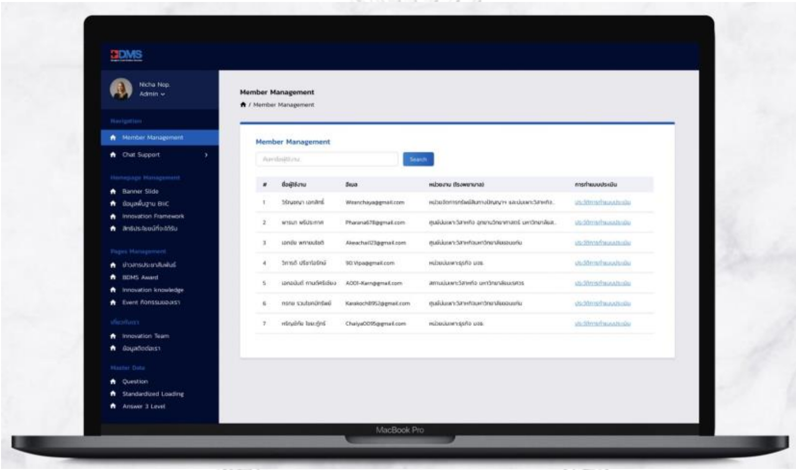


Figure 8.9 The historical evaluation of engaged projects

The historical performance evaluation of each innovation project was shown in the member analysis part. This page provided the historical user and evaluated results of each innovation project. The administration can use this historical information to evaluate and develop organizational management.

10. Innovation project analysis

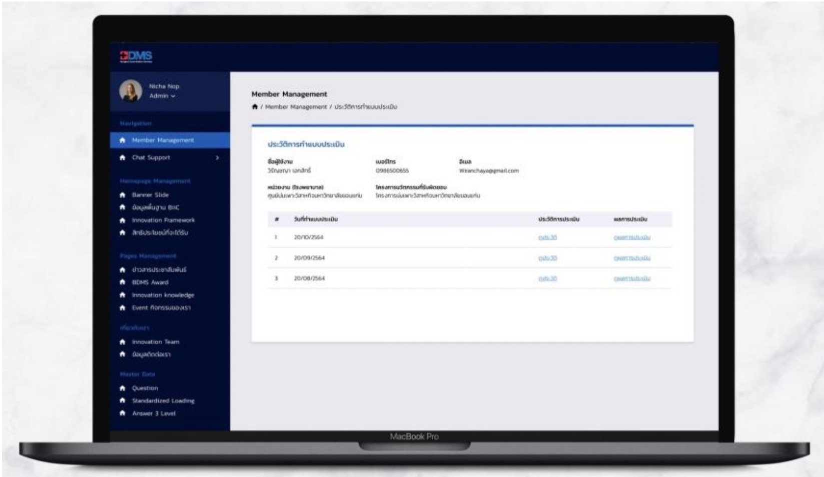


Figure 8.10 The member information

When the administer click to enter the user panel that was shown in the member analysis part. The historical information of the panel was presented such as the user’s biography and the project evaluation results which were examined in the previous times. This information will be used as a guideline to get a more effective quality and innovation culture in the future.

Part 3: TQIM-H application validity testing methodology

In this part, the proposed TQIM-H was tested and validated to determine that the subscriber level of acceptance rate to change a new best fit offering to ensure that predictive subscriber usages model is accepted and valid at an appropriate level. By the end of the validity testing period, the company will be able to decide to launch this application on a larger scale and move on to the rollout phase or not.

This application testing was conducted at beginning of November 2021. Effective healthcare innovation projects were selected and used for the validation testing. The projects, best practice innovation projects were selected if they had systemic management processes, completed key characteristics required for healthcare innovation, and had more than 80% of the innovation criteria REF.

Population and Sampling procedure

A validity test was conducted by recruiting the best practice innovation project owners. They were asked to use the program.

Result for application validity test

After the trial, 90.2% of the best practice innovation project owners agreed that the program was complete in terms of the concepts in innovation development. The program can be used to create innovative projects in hospitals.

The result from the validity test led to the conclusion that the TQIM-H program had a complete feature required for the development of healthcare innovation. The program also helped the user understand the key conceptual framework for the innovation development, and was easy to use. The radar chart that demonstrated the gap between the current practice and the best practice was illustrative and could guide the evaluation of the project's strengths and weaknesses. We concluded that the development of the TQIM-H program from the TQIM-H concept studied in the previous chapter was successful. In the next Chapter, the acceptance, effectiveness, and ease of use of the program were surveyed using a TAM (Technology Acceptance Model) questionnaire.

CHAPTER 9
INVESTIGATING ACCEPTANCE OF THE TQIM-H PROGRAM THROUGH THE TECHNOLOGY ACCEPTANCE MODEL (TAM)

In the previous Chapter, Chapter 8, the TQIM-H program was developed and validated. To conclude that the program was more convenient and more user-friendly than using TQIM-H as a structural model, TAM (Technology Acceptance Model) was selected as a tool to see if the TQIM-H users accepted the TQIM-H program. TAM questionnaire evaluates the effective implementation of the TQIM-H incubation program to develop quality innovation projects in healthcare; ease of use, user interface, the comparison of the quality and innovation project development in healthcare through the TQIM-H incubation program, and the traditional developed innovation project in healthcare without the program; and the practicality of the TQIM-H incubation program. In this Chapter, another 50 healthcare innovators were asked to use the TQIM-H program thoroughly. Then they were asked to evaluate the program using the TAM questionnaire.

Table 9.1 The Development of the TQIM-H program concept

Objective	Process & Information	Result
To test the ease of the TQIM-H program's use and show the acceptance level of TQIM-H program	The participant (the healthcare innovator or healthcare members related to healthcare innovation project) was invited to use and test the developed program by TAM questionnaire consisting of six important components.	The acceptance TQIM-H program

The acceptance study on the TQIM-H system from the population and sample

To study the TQIM-H system acceptance, the participant (the healthcare innovator or healthcare member related to healthcare innovation project development from the hospital having quality and innovation management background in Southeast Asia including 20 hospitals) from each project was invited to use and test the developed program. Then, the author surveyed the ability and efficiency of the TQIM-H program. The participant information and frequency of the study are shown in Table 9.1.

Table 9.2 General data of the sample group.

Respondents’ demographics	Frequency	Percent
Gender		
Male	19	38
Female	31	62
Total	50	100
Age		
<30 years	3	6
30-39 years	11	22
40-49 years	19	38
50-59 years	12	24
>60 years	5	10
Total	50	100
Level of education		
Bachelor’s degree	28	56
Master’s degree	16	32
Doctorate	6	12
Total	50	100
Position		
President/Director/Manager	17	34
Physician/Dentist/Pharmacist	12	24
Medical technician/Radiologist/Physiotherapist/Nutritionist	2	4
Nurse/Nursing Assistant	8	16
Customer service	2	4
Office workers/Support staff	7	14

Respondents' demographics	Frequency	Percent
Other	2	4
Total	50	100
Working Experience		
<10 years	8	16
10-20 years	32	64
>20 years	10	20
Total	50	100
The TQIM-H program experience		
Not used to	50	100
Used to	0	0
Total	50	100
Preference to use the TQIM-H program		
Acceptation	50	100
Rejection	0	0
Total	50	100

Table 9.1 shows the information of the sample group engaging to test the TQIM-H program. The result showed that the majority of participants were female (62%). Moreover, they have graduated with a bachelor's degree (56%), with 10-20 years of working experience, representing 64%. All of the participants had no experience in using the TQIM-H program before.

Research methodology

A usability testing was conducted with the TQIM-H program which would help innovators in understanding key factors and the level of importance of each factor in the TQIM-H framework that would help guide innovation development. The process to test the program acceptance is shown below.

The tasks were designed according to test the usability of TQIM-H program

↓

The participant was invited to register to be the TQIM-H program member.

↓

The participant was required to complete the TQIM-H measurement concept questionnaire about his/her innovation performance as quickly and successfully as possible.

↓

The program analysis results were presented to the participant to understand the strengths and weaknesses of his/her project via the radar chart diagram.

↓

After the testing task, the participant was asked to fill in a technology acceptance questionnaire to elicit their perceptions on variables in the TQIM-H program.

↓

The analysis of TQIM-H program acceptance and utilization to develop a healthcare innovation project using average statistics and standard deviation.

Figure 9.1 The step to examine the acceptance of the TQIM-H program

After using the TQIM-H program, the feasibility and acceptability of the TQIM-H program were evaluated based on the Technology Acceptance Theory (TAM). The questionnaire was designed as shown in Table 9.2 and sent to 50 healthcare innovators and healthcare staff who used it to examine the developed TQIM-H program.

Table 9.3 The technology acceptance model with the TQIM-H program

The program characteristic	**Mean**	**SD**
1. Effective implementation of TQIM-H program to develop quality innovation projects in healthcare		0.52
1.1) Decreases time wasted in developing quality and innovation projects in healthcare	4.75	0.65
1.2) Provides an effective process in developing quality and innovation projects in the healthcare	4.62	0.54
1.3) Be comprehensive and completely cover the development of quality and innovation projects in the healthcare	4.74	0.69
1.4) Is a modern technology and acceptable tool.	4.56	0.78
2. Ease of use		0.92
2.1) The objective of using the TQIM-H program is clear	4.55	0.80
2.2) The operation procedure of the TQIM-H program is clear and easy to understand	4.64	0.48
2.3) The system is easy to learn and understand. Self-study using the instructions TQIM-H program is easy	4.58	0.32
2.4) A healthcare innovator can easily use the TQIM-H program to develop quality and innovation projects in the healthcare	4.76	0.58
2.5) The practitioner can use the results of the TQIM-H program assessment for analyzing and improving the process of quality and innovation project development in the healthcare	4.56	0.88
2.6) TQIM-H program is easy to use.	4.54	0.65
3. User Interface		0.49
3.1) TQIM-H program is attractive	4.68	0.75
3.2) TQIM-H program is up-to-date	4.60	0.92
3.3) The font size and font color of the TQIM-H program is appropriate	4.52	0.81
4. The comparison of the quality and innovation project development in healthcare through the TQIM-H program and the traditional developed innovation project in healthcare without the program.		
4.1) The program reduces time spent collecting, analyzing and processing develop quality and innovation projects in healthcare		
□ Before the TQIM-H program is used	3.34	0.67
□ After the TQIM-H program is used	4.54	0.83
4.2) The program reduces skills, expertise and reduces decision using experience to measure and evaluate develop quality and innovation projects in healthcare		
□ Before the TQIM-H program is used	3.48	0.59
□ After the TQIM-H program is used	4.76	0.68
4.3) The program provides a systematic work process that is clear so using the program is convenient and easy.		
□ Before the TQIM-H program is used	3.12	0.95
□ After the TQIM-H program is used	4.82	0.87

The program characteristic	Mean	SD
4.4) The program reduces work processes and eliminates the duplication of operations.		
□ Before the TQIM-H program is used	3.26	0.75
□ After the TQIM-H program is used	4.86	0.64
4.5) The program provides the ability to store data in a systematic way that can be easily retrieved.		
□ Before the TQIM-H program is used	3.38	0.83
□ After the TQIM-H program is used	4.62	0.65
4.6) The program provides the ability to link data and precisely forecast important information.		
□ Before the TQIM-H program is used	3.40	0.66
□ After the TQIM-H program is used	4.78	0.53
4.7) The program can quickly search and provide important information to develop quality and innovation in healthcare projects.		
□ Before the TQIM-H program is used	3.46	0.72
□ After the TQIM-H program is used	4.80	0.89
5. The practical program of the TQIM-H program	4.60	0.38
5.1) TQIM-H program can be applied to quality and innovation project development in healthcare effectively.	4.70	0.96
5.2) Recommendations from the TQIM-H program reduce processing errors of quality and innovation project development in healthcare.	4.68	0.88
5.3) TQIM-H program leads to the improvement of processes involved in the development of quality and innovation projects in healthcare.	4.62	0.94

The evaluated result of the TQIM-H program was presented in five parts. In the first part, effective implementation of the TQIM-H program to develop quality innovation projects in healthcare, the result showed that the overall average score was more than 4.20 points comprised of decreasing time wasted (4.75 points) and providing an effective process in developing quality and innovation project in healthcare (4.62 points). Moreover, the program provided a modern technology level (4.56 points) and completely covered the development of quality and innovation projects in healthcare (4.74 points). The second is followed by usability result which has an overall average score is 4.65 comprised of TQIM-H program is easy to use (4.72 points), the objective of using the TQIM-H program is clear (4.55 points), the operation procedure of the TQIM-H program is clear and easy to understand (4.64 points) and the system is easy to learn and understand (4.51 points). Furthermore, a healthcare innovator can easily use the program to develop quality and innovation projects in healthcare (4.76 points) and the practitioner can use the results of the TQIM-H program assessment for analyzing and improving the process of quality and innovation project development in the healthcare (4.56 points). The third part is the user Interface result provided the overall average score is 4.58. This part included TQIM-H program is attractive (4.68 points), the TQIM-H program is up-to-date (4.60 points) and the font size and font color of the TQIM-H program were appropriate (4.52 points).

Moreover, the evaluated result from using the quality and innovation project development in healthcare through the TQIM-H program showed that the overall average score is 4.5-5.0 compared to the traditional developed innovation project in healthcare without the program in the previous time which provided an average score 3.0-3.5. After using the developed program, the result showed that the program reduces time spent collecting, analyzing and processing develop quality and innovation projects in healthcare (4.71 points) and reduces skills, expertise, decision using experience to measure and evaluate develop quality and innovation projects in healthcare (4.68 points). Moreover, the program provides a systematic work process that is clear so using the program is convenient and easy (4.65 points) and reduces work processes and eliminates the duplication of operations (4.54 points). Furthermore, the program provides the ability to store data in a systematic way that can be easily retrieved (4.5 points) and provides the ability to link data and precisely forecast important information (4.49 points). Finally, the program can quickly search and provide important information to develop quality and innovation in healthcare projects (4.47 points).

The practical program of the TQIM-H program result showed that the TQIM-H program can be applied to quality and innovation project development in healthcare effectively (4.70 points) and leads to the improvement of processes involved in the development of quality and innovation projects in healthcare (4.68 points). Moreover, recommendations from the TQIM-H program reduce processing errors of quality and innovation project development in healthcare (4.62 points). The evaluated result of the TQIM-H program has been shown that the overall average score was a high level and the standard deviation of all scores was found to tend to go in the same direction.

It can be seen that the users are interested and intended to use the TQIM-H program because the program is easy to use and understand TQIM-H characteristics which is a key concept to develop a quality innovation in healthcare. Moreover, the evaluated results were consistent with the research of Shibl et al. (2013) who studies the program acceptance and commercial feasibility perceived benefits. Thus, the developed TQIM-H program is an effective tool that leads and guides the healthcare innovator or healthcare staff involved in quality innovation project development to establish an effective innovation project in healthcare resulting in organizational sustainability.

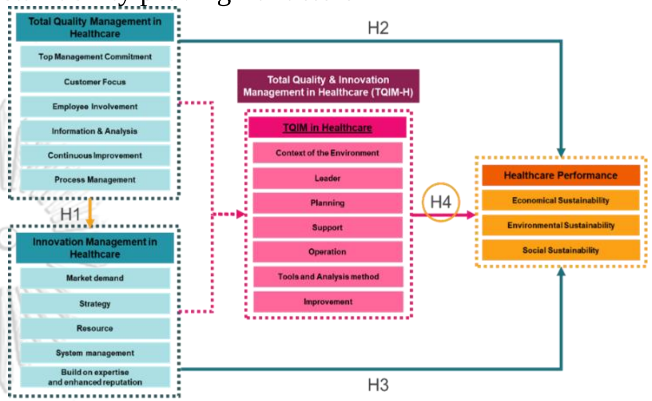
CHAPTER 10
DISCUSSION AND CONCLUSION

The main outcome of this research is to develop the total quality and innovation management in hospital (TQIM-H) system which increase an organizational performance to manage and develop healthcare quality innovation project. This TQIM-H can assist healthcare innovators or healthcare member to systematically manage and establish the quality innovation project providing healthcare sustainability, which is queuing speed, accuracy, employee capability, ambience condition and friendliness. In addition, this thesis provides the detail of the new system of TQIM-H that was designed to plug in the healthcare management to provide the sustainable organization. Moreover, the TQIM-H system provides the indicators for healthcare innovators in order to take action for the development approach. The development of the TQIM-H system requires five main outputs, which are TQM and innovation management in healthcare factor, the conceptual background of total quality and innovation management in hospital (TQIM-H) integrated model, a developed TQIM-H inventive principle, a TQIM-H structural model by using SEM and evaluated TQIM-H program.

This chapter attempts to summarize the key findings referring to research objectives, contribution to knowledge, limitations, and areas for future research.

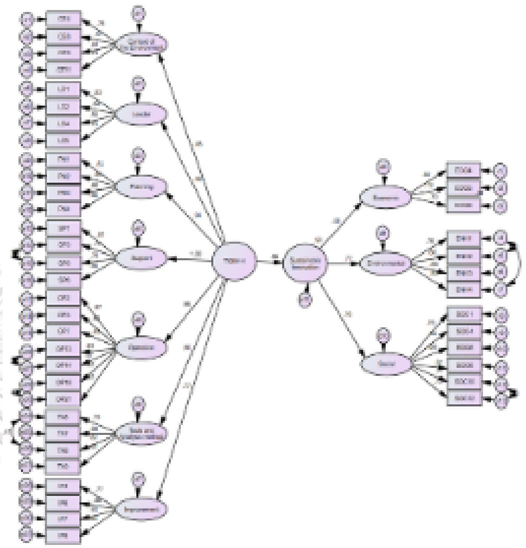
Table 10.1 Summary of research findings

Content	Research objective	Chapter	Research Method	Research Findings
The scope of TQM and innovation management in healthcare	- To define the scope and key factor of TQM in healthcare and innovation management in healthcare	2	- A systematic literature reviews was studied to examine and analyze characteristics, scope, and factors involved in managing quality and innovation in healthcare from previous studies through planning the review, executing the review, and reporting the review.	**Total quality management in healthcare factor** grouped into six dimensions and 25 factors which are: 1. Top management proving four factors 2. Customer focus proving four factors 3. Continuous improvement proving four factors 4. Employee involvement proving five factors 5. Process management proving five factors 6. Information and analysis proving three factors **Innovation management in healthcare factor** grouped into five dimensions and 20 factors which are: 1. Market demand proving four factors 2. Strategy proving five factors 3. Resource proving four factors 4. System management proving four factors 5. Build on expertise and enhanced reputation proving three factors **Healthcare performance in healthcare factor** grouped into three dimensions and 33 factors which are: 1. Economic sustainability proving 12 factors 2. Environmental sustainability proving 11 factors 3. Social sustainability proving 10 factors
The integration of total quality and innovation management in hospital (TQIM-H)	- To develop an integrated framework of total quality and innovation management in hospital (TQIM-H), which was a management	4	- TQM in healthcare and innovation management in healthcare were integrated through dimensions of ISO 56002 as the core axis by healthcare experts	The integrated TQIM-H conceptual framework which was developed from TQM in healthcare and innovation management in healthcare consists of seven dimensions, which were, 1. Context of the Environment (Internal & External) proving five factors 2. Leader proving four factors 3. Planning proving four factors 4. Support proving six factors 5. Operation proving 12 factors

Content	Research objective	Chapter	Research Method	Research Findings
	framework showing scope, characteristics and key success factors that favored the development of healthcare innovative effective project.		with 30 healthcare experts resulting in TQIM-H inventive principle. - TQIM-H inventive principle was confirmed through 50 impactful innovation case studies in hospitals.	6. Tools and analysis method proving three factors 7. Improvement proving four factors The integrated TQIM-H results in positive healthcare performance including three sustainability impacts: 1. Economic sustainability proving 12 factors 2. Environmental sustainability proving 11 factors 3. Social sustainability proving 10 factors  The integrated framework of TQIM-H
TQIM-H inventive principle	- To develop the TRIZ inventive principle to provide practitioners with an effective procedure to manage quality and innovation management systems in healthcare (TQIM-H) that can be used as a guide for the development of	5	- Design the process to develop the integration of the TQIM-H framework and TRIZ inventive principle using Delphi methodology with 30 healthcare experts. - Define the scope and extract the procedure of the TQIM-H and TRIZ	The TQIM-H inventive principle consists of 37 inventive principles and 72 procedures, each of which was a key success procedure in the hospital management that aims for quality innovation projects. 1.Segmentation: The categorization of processes in hospital administration by characteristics. 2.Extraction, Taking out: The omission or elimination of the process that does not create value. 3.Local Quality: The management of data or working process for quality. 4.Asymmetry: The design of the working process by considering characteristics and specifications of the job. 5.Consolidation / Merging: The act of combining processes or hospital

Content	Research objective	Chapter	Research Method	Research Findings
	effective innovation projects in hospitals.		methodology through a literature review, experts' brainstorming and IPA analysis. - TQIM-H framework and TRIZ inventive principle were integrated with results from in-depth interviews with 30 healthcare experts, resulting in TQIM-H inventive principle. - The TQIM-H inventive principle was validated using 50 effective innovation projects from one of the largest healthcare conglomerates in Southeast Asia.	management. 6.Universality: The multifunctionalization of processes. 7.Nesting: The merging of a process to a part of a major process. 8.Counterweight: Co-working with others to brainstorm ideas and develop the balanced working process. 9.Prior Counteraction: Vigilance or preparation to avoid mistakes. 10.Prior Action: The prioritization of the issue or working process. 11.Cushion in Advance: The preparation for backup measures or methods to prevent errors. 12.Equipoten-tiality: A permission that allows hospital peronnel to raise their opinion equally. 13.Inversion Thinking : The thinking process that is opposite or different from the standard or pattern currently used in the hospital. 14.Spheroidicity: Validation by repeating or auditing the repeated process. 15.Dynamicity: The adjustment for the continuous development of hospital management. 17.Transition Into a New Dimension: The designing of hospital administration or process to create innovation. 19.Periodic Action: The monitoring of the working process periodically. 20.Continuity of Useful Action: The development of the working process or management of the hospital constantly. 22.Convert Harm Into Benefit: The change of weaknesses or risks to strengths or opportunities. 23.Feedback: The evaluation of hospital managerial outcomes. 24.Intermediary: The provision of areas or opportunities for innovators or startups to meet. 25.Self-service: The act that allows patients to access healthcare by themselves or allows healthcare providers to develop the working process by themselves. 26.Copying: The application of rules or good practices in hospital administration.

Content	Research objective	Chapter	Research Method	Research Findings
				27.Cheap short-living objects: The availability of manual or guidance for effective working that aligns with the objective of processes. 28.Replacement of Mechanical System: The application of technology or innovation in working processes. 29.Pneumatic or Hydraulic Constructions (Intangibility) : The building of belief or trust in the hospital 30.Flexible Membranes or Thin Films: The availability of walls or systems that screen or prevent access to data or processes. 31.Porous Material: The searching for loopholes or gaps in hospital management and administration. 32.Changing the Color: The change of direction or pattern in hospital management and administration according to technology or social needs. 33.Homogeneity: The harmonization of the working process in the hospital to render the system the same working pattern. 35.Transformation of Properties: The changing in pattern and strategy in hospital management. 36.Phase Transition: The implementation of the developed working process in the hospital. 37.Thermal Expansion: The use of a model to improve working processes. 38.Accelerated Oxidation: The stimulation and expedition of the development of working processes. 39.Inert Environment: The creation of a good working environment. 40.Composite Materials: The formation of working patterns and structures that are flexible and free from punishment when the error occurs. 41.Reinforcement: The support and resource allocation to facilitate the development of hospital management.
TQIM-H structural model	- To propose a model showing the functional relationships among total quality and innovation	7	- The questionnaires were sent to the 395 respondents involved in quality and innovation management in the	The results supported that TQIM-H containing seven dimensions (context of the environment, leadership, planning, support, operation, tools and analysis method, improvement) had a highly positive effect on sustainable innovation (economic, environment, and social dimension). The structural path significance in TQIM-H and sustainable innovation

Content	Research objective	Chapter	Research Method	Research Findings
	management in hospital (TQIM-H) and - To examine the effects of this conceptualization of TQIM-H on sustainable innovation performance.		hospitals from 60 Southeast Asian private and public hospitals that certified global quality standards such as HA and JCI and had strategies in innovation. - The confirmatory and exploratory factor analyses were used to confirm the validity and reliability of this study. - The model was tested using structural equation modeling (SEM).	The measured effects of all relationships of TQIM-H and sustainable innovation 
TQIM-H program	To develop the web-based program to help healthcare organizations understand the characteristic and key factor of quality and innovation management in healthcare.	8	Software development process	A developed TQIM-H program, a program with a user-friendly user interface, was established from the knowledge and key characteristics about 7 dimensions of TQIM-H that are important in creating quality and innovation management in healthcare including component, characteristic, sub-factor, procedure (How to manage) of each factor. Moreover, best practice information and the radar chart result were presented in this developed program to analyze the strengths and weaknesses of each TQIM-H dimension. Then, a web browser version of the program was developed to allow more accessibility and ease of use. User Experience (UX) and user interface (UI) are the two main considered issues for the development of this browser version. The UX aims to maximize user satisfaction and consists of

Content	Research objective	Chapter	Research Method	Research Findings
				convenience, ease of use, and user friendliness. The UI, which allows users to interact with the TQIM-H program, aims to improve the design, attractiveness, uniqueness, and two-way communication.
Technology Acceptance Model	To test the ease of the TQIM-H program's use and show the acceptance level of the TQIM-H program	9	Surveying opinions from 30 healthcare staff for Tools acceptance	The experience of the staff after using the program is highly positive as can be seen by the overall average score which was more than 4.5 points. The result showed that the interface of the program, in terms of color, font, size, and composition of the browser, was attractive. In addition, our result showed that using the TQIM-H program had higher results than using TQIM-H delivered by conventional modes (e.g. paper-based) in all domains (reduces time spent processing and reduces skills, expertise to develop innovation project). Moreover, the developed program provides a systematic work process that is clear so using the program is easy and the ability to link important information. We conclude that the developed TQIM-H program is user friendly, complete and practical thus, helping increase the effectiveness of the TQIM-H usage.

Regarding the research objectives in Chapter 1, the Discussions were written in five parts. Academic contribution and practical business contribution of this research were also discussed.

10.1 The relationship between TQM and innovation management in healthcare

Because healthcare is directly related to human life, TQM plays a key role that is essential in keeping up with the criteria for hospitals, standards, and regulation, boosting performance; and, decreasing risks on the part of patients and competitiveness of the business to meet customer requirements (Fundin et al., 2018; Hoang et al., 2006; Lilja et al., 2019; Prajogo & Sohal, 2003; Terziovski, 2006),. Indeed, TQM is employed to such an extent that it has become an integral part of the healthcare culture. However, several researchers claimed that by the twenty-first century, TQM is an effective tool, but it cannot generate sustainable value unless coupled with more innovative and forward-looking strategies only. They have contended that innovation has become a critical capacity of all healthcare organizations and a significant factor in the effectiveness of healthcare systems (Alwashmi, 2020; Fundin et al., 2020; van Kemenade & Hardjono, 2019; Vandenbrande, 2021). For innovation management, it is a newly-emerged and widely-practiced business process and it is believed to generate performance that is efficiency needed to create customer satisfaction and to make hospitals well-equipped with capacities to deal with new diseases, which are likely to be found and proliferate in the future. Again, healthcare innovation in this thesis was defined as innovative procedures, emphasizing service and treatment processes that enhance effectiveness, speed, and satisfaction. Medical devices and tools were not included in our study.

Although innovation management has played a crucial part in the performance, and design of products, processes, and business models with such a high level of accomplishment, TQM is still indispensable because it keeps organizations in line with standards and regulations (Tonjang & Thawesaengskulthai, 2020). As can be seen, the two management philosophies are complementary, woven together into a strong strand, whose parts not only correspond but also resemble each other so the two management philosophies can be combined. Thus, for a healthcare organization to achieve success and be effective in facing the world’s transformation, it has to utilize both TQM and innovation. Thus, both TQM and innovation included key success factors that facilitate the creation of healthcare performance.

In term of healthcare performance, a literature review has shown that, in the past, success in an organization has been measured predominantly in the economic sphere (e.g. market success). However, recently the non-economic sphere has increasingly become a matter of corporate management (Christiansen & Buen, 2002; Preuss, 2007). So, organization performance included not only the product's economic success but also the direction of sustainability effects (Aguilera-Caracuel & Ortiz-de-Mandojana, 2013b; Paech, 2007). The need for sustainability was embedded in achieving a balance between economic activities and associated ecological and social impacts (Edgeman & Hensler, 2001; Hediger, 1999). This perspective suggested that an organization has to find a balance between profit-oriented goals and goals concerning the society and environment (Tasleem et al., 2015).

10.2 The integration of total quality and innovation management in hospital (TQIM-H)

For a healthcare organization to achieve success and be effective in facing the world's transformation, it has to utilize both TQM and innovation. The authors developed the integrated framework of total quality and innovation management in hospitals (TQIM-H) that increases efficiency in their treatment processes and performance in terms of organizational sustainability. The new integration was created by analyzing and merging TQM and innovation management factors from a systematic literature review with ISO 56002as a core axis by expert panels. Then, the new integrated framework was refined and confirmed through 50 innovation projects which were then studied from the largest hospital conglomerate which comprised 47 hospitals in Southeast Asia.

In addition, the presentation of the TQIM-H conceptual framework demonstrated the integration between TQM and innovation management in healthcare. All this resulted in seven dimensions of TQIM-H including Context of the Environment (Internal & External), Leader, Planning, Support, Operation, Tools and analysis method, and Improvement. The new integrated management affected healthcare performance in three performance dimensions: Economic, Environmental, and Social sustainability. The newly developed framework could respond to demands made by society, the changing world with technology, all measuring up to standards, quality basic to hospitals, medical ethics, and regulation. Thus, the TQIM-H framework would facilitate the innovator who would like to develop innovative healthcare projects in understanding characteristics and key success factors in creating projects more easily and more effectively.

10.3 TQIM-H inventive principle

In a previous stage, TQIM-H was proposed as a conceptual framework that assists in the generation of effective innovation in hospitals to meet customers' demands and global changes. However, TQIM-H explored only types of factors that are important to the management of healthcare innovation projects. The systematic solutions or procedures in engaging with TQIM-H in each of its factors are not available. Thus, TQIM-H inventive principle was adapted from TQIM-H and TRIZ inventive principle to be used for managing quality and innovation in the healthcare system. TRIZ can be considered as guidance for fixing or creating novel innovative management. Several industries have utilized and applied TRIZ inventive principle for developing innovation by revising the concept to align with the goal for creating each innovation. In service industries, TRIZ is used to develop innovative processes that increase customer satisfaction (Chai et al., 2005; Lin & Su, 2007; Su et al., 2008).

These examples demonstrate that TRIZ inventive principle is a tool that may be utilized to build innovation projects and is accepted by a variety of businesses. Although multiple examples show the effectiveness of applying the TRIZ inventive principle in the development of innovative projects, the examples are limited to some industries including electronics manufacturing, chemical manufacturing, banking service, airline service (Abramov et al., 2015; Jeeradist et al., 2016; Karnjanasomwong & Thawesaengskulthai, 2019; Shahin et al., 2016). TRIZ has never been applied in constructing quality innovation projects in healthcare before. This might be because the hospital section is unique and complex. In addition, healthcare innovators do not know how to use TRIZ correctly.

The TQIM-H inventive principle consisted of 37 inventive principles and 72 procedures. The developed inventive principle is a method or key procedure that explains definition, objective, and examples from real innovation cases. The TQIM-H inventive principle can be used as exemplary models and procedures in creating successful innovation projects. Healthcare innovators can identify and evaluate problems or innovation topics. The developed TQIM-H inventive principle can then be optimized to assist in solving the problems or developing innovation projects in hospitals. When TQIM-H inventive principle was compared with the previous inefficient new healthcare innovation-generating process, most of the new ideas were frequently limited by the experience and knowledge of the managers (Djellal & Gallouj, 2007; Glover et al., 2020; Page, 2014). Nevertheless, in developing innovative projects in hospitals, TQIM-H inventive principle should be applied with discretion and should be adapted according to new contexts of the engaging project. With this, not only will the processes for the creation of innovative projects be effective, but be sustainable as well.

10.4 TQIM-H structural model

This study utilized SEM as the tool for analyzing the relationship between TQIM-H dimensions and sustainable innovation, and the important level of each TQIM-H dimension because SEM is a powerful tool that can provide direct and indirect analysis of a relationship in a model. In addition, SEM can analyze multiple relationships concurrently. Its CFA can be used to evaluate the fitness of the proposed model (Lee et al., 2010).

The study shows that the SEM confirmed that TQIM-H has a significant relationship with sustainable innovation. Moreover, this study ranked each dimension of TQIM-H according to the loading result. The most important dimension was Support which comprised of employee education training, facilities and budget since it drives and facilitates changes at the organizational level. Adequate and goal-oriented support greatly enhances the success chance of innovation development (Adams et al., 2006; Tidd, 2006). The second most important dimension was Leadership. All studies agreed that leaders play important roles in organizational changes and directions (Prajogo & Sohal, 2006). The third most important dimension was Operation, the practices that follow the plan effectively. With the complete process management that agrees with strategy and planning, and the effective follow-up process, the effectiveness of the innovation development is maximized and the failure rate is minimized (Demirbag et al., 2006; Nagano et al., 2014; Zhang et al., 2000). The fourth most important dimension was Planning which is the process of designing and arranging operating procedures in advance (Dutta et al., 2018). The fifth most important dimension was Tools and Analysis method which helps collect data and tools necessary for quality enhancement, analyze problems so the problems can be converted to innovations, and mediate the potential and acceptance of the developed innovations (Kaplan et al., 2001). The sixth most important dimension was Context of the Environment. The analysis of surroundings and problems leads to the development of innovation (Hidalgo & Albors, 2008). The least important dimension was Improvement. Continuous improvement leads to the replacement of regular processes with tools or other processes, leading to the creation of product, process, and business model innovation (Eveleens, 2010; Tidd, 2006). Studies support that organizations with good planning, complete operation, and effective tools have a high chance for organizational improvement (Arumugam et al., 2008; Eveleens, 2010; Volberda & Van Den Bosch, 2011; Volberda et al., 2013).

In terms of sustainable innovation, environmental and social dimensions had high importance loading. This agrees with the value of healthcare that emphasizes the importance of health and the environment. The holistic care approach brings a good image and trust for the hospital (Faezipour & Ferreira, 2011; Fanta et al., 2015; Wijethilake, 2017). Improving innovation in these two aspects, therefore, is the main goal in healthcare that leads to maximum sustainability. Interestingly, the economic dimension had the lowest importance loading, meaning that profit was not the main goal of the hospitals which is very unique and different from other industries (Buffoli et al., 2013; Faezipour & Ferreira, 2013b; Jamaludin et al., 2013; Rodríguez et al., 2019). This is because the healthcare industry is regulated by medical ethics (Suhrcke et al., 2007) so hospital administration aims for cost management, rather than profit maximization, with effective and safe patient care (Ramirez et al., 2013). The relationship between TQIM-H and sustainable innovation and the importance level of the TQIM-H component found in this research help healthcare innovators understand the relationship and importance of each TQIM-H procedure which will facilitate sustainable innovation creation in the hospitals. Future research should focus on the implementation of the TQIM-H framework, according to the relationship and importance of each factor, in developing innovative projects in hospitals. The outcome from the implementation should be used to further refine the framework.

10.5 TQIM-H program

A developed TQIM-H program, a program with a user-friendly user interface, was established from the knowledge and key characteristics about of seven dimensions of TQIM-H. Each dimension was described for its key component, characteristic, sub-factor, procedure (How to manage) of each factor. Each factor of TQIM-H component and procedure is prioritized by weight loading with the result from Structural Equation Model (SEM). The prioritization makes users know the important factors that affect the innovation development in their hospitals, leading to more effective innovation management. The program also provides the best practice score as a standard or the indication for the achievement of innovation indicator. In addition, the TQIM-H program provides a TQIM-H questionnaire which allows the user to input the data from their hospitals into the program to evaluate the innovation project performance in their hospitals. The result from the evaluation, presented as scores in three-ranking levels, are compared to the best practice project score and presented as the radar chart diagram. The diagram shows the difference between the performance of the users and the best practice scores in each domain of TQIM-H. Projects with substantial gaps between the performance and the goal demonstrate the potential for the improvement of innovation projects in the domain of TQIM-H while projects with insignificant gaps demonstrate the best performance in the domain. The improvement or maintenance of managerial practice according to the result from the program help lead the projects in the correct direction. After the demonstrated version of the program was developed, a web browser version of the program is developed to allow more accessibility and ease of use. User Experience (UX) and user interface (UI) are the two main considered issues for the development of this browser version. The UX aims to maximize user satisfaction and consists of convenience, ease of use, and user friendliness. The UI, which allows users to interact with the TQIM-H program, aims to improve the design, attractiveness, uniqueness, and two-way communication.

The acceptance of the TQIM-H program was evaluated using the Technology Acceptance Model (TAM) by surveying opinions from 50 healthcare innovators (David et al., 1989). The experience of the innovator after using the program is highly positive as can be seen by the overall average score which was more than 4.20 points. For the UX, the domain with the highest scores is “Decreasing time wasted” and “Completely covers the development of quality and innovation projects in healthcare” with the scores ranging from 4.51-4.75. The “Usability” also achieved a high score with the average of 4.54-4.76. We also found that all users could follow the instructions for evaluating TQIM-H innovation project performance correctly in the first use. This demonstrates the completeness, clear operational procedure, and ease of use of the program. For the UI, the average scores were ranging from 4.52-4.68. The result showed that interface of the program, in terms of color, font, size, and composition of the browser, was attractive. In addition, our result showed that using the TQIM-H program had higher results than using TQIM-H delivered by conventional modes (e.g. paper-based) in all domains (reduces time spent processing and reduces skills, expertise to develop innovation project). Moreover, the developed program provides a clear systematic work process that is easy to use and can connect important information. We conclude that the developed TQIM-H program is user friendly, complete and practical thus, helping increase the effectiveness of the TQIM-H usage. The evaluated result from using the quality and innovation project development in healthcare through the TQIM-H program showed that the overall average score is 4.5-5.0 compared to the traditional developed innovation project in healthcare without the program in the previous time which provided an average score 3.0-3.5. It can be seen that the users are interested and intended to use the TQIM-H program because the program is easy to use and understand TQIM-H characteristic which is a key concept to develop a quality innovation in healthcare. Moreover, the evaluated results were consistent with the research of Shibl et al. (2013) who studies the program acceptance and commercial feasibility perceived benefits. Thus, the developed TQIM-H program is an effective tool that leads and guides the healthcare innovator or healthcare staff involved in quality innovation project development to establish an effective innovation project in healthcare resulting in organizational sustainability.

10.6 Contribution to the knowledge

This research provides significant contributions to TQIM-H knowledge in five areas, which are a comprehensive literature review of four main areas, TQIM-H conceptual framework development by using healthcare experts' brainstorming and healthcare innovation case studies' analysis. TQIM-H inventive principle development by using Delphi study with healthcare experts, IPA analysis and experts' brainstorming. Then, analyzing the structural model of TQIM-H via CFA and SEM methodology. Finally, developing the TQIM-H program and confirming the developed program by TAM. This research has both academic and business application.

Academic contribution

The relationship of TQM and innovation management in healthcare

Although there is research on the relationship of TQM and innovation management in other industries including manufacturing, education, energy, food, and hospitality industry, such relationship in the healthcare industry has never been investigated. To the best of our knowledge, this study is the first to explore the relationship between TQM and innovation management in the healthcare environment. The result from our study can be also applied hospitality and banking industry which have similarities in the nature of the industry.

The integration of TQM and innovation management in healthcare

Rebelo (2016) suggested that integrating framework or philosophy effectively increases potentials and strengths, and decreases weakness. Several research integrated framework or philosophy together e.g. TQM integrated with QFD, TQM integrated with Six sigma, QFD integrated with TRIZ, TRIZ integrated with Six sigma, Kano model integrated with QFD etc. However, TQM and innovation management in healthcare integration has never been conducted. To the best of our knowledge, this study is the first to explore the integration of TQM and innovation management in healthcare. Moreover, for the construction of the integrate model, standard as a core is one of the method that has been used widely.

This was undertaken in response to Rebelo, et al., who established that the integrated methodology should have used "management system standards" (Rebelo, Santos, & Silva, 2016) as the core axis, an argument similarly found in research by several authors (Beckmerhagen, Berg, Karapetrovic, & Willborn, 2003; Jørgensen, 2006; Karapetrovic & Jonker, 2003; Pojasek, 2006), who have highlighted the efficiency of standards or awards. Therefore, this research used research and knowledge in standard management and award tools as a tool to integrate quality with innovation in healthcare. This study used ISO 56002 as a core axis since this ISO, which has been recently developed in 2019 from other ISOs, concerns innovation management in organizations.

The applied TRIZ and TQIM-H

TRIZ is a widely accepted engineering tool which was developed by Al′tshuller for fixing problems in engineering and manufacturing. Later, TRIZ has been applied as a tool for seeking solutions in the service industry. However, TRIZ has never been used for designing and fixing innovative process in healthcare industry. This study integrated TRIZ with TQIM-H, demonstrating the novel contribution of TRIZ in the healthcare field.

SEM with TQIM-H

SEM has been widely used as a tool to study the relationship among factors because of its effectiveness, credibility, and reliability. Since SEM has never been used in innovation management in healthcare, this study can be used as a model for using SEM in this field of study. Also, the relationship among factors and the priority of each factor enables the future.

Practical Business Contribution

To cope with the fast-changing healthcare trends and customer needs and with the competitive environment of the healthcare business, quality and innovation management can help organizations handle threads and improve their service capability. The use of the tool also leads to sustainable innovation and organizational sustainability. This is because using TQIM-H, which is a key conceptual framework to manage quality innovation in hospitals, helps the hospitals understand their strength and weakness in each aspect demonstrated in TQIM-H, allowing the targeted fix or improvement in priority oriented patterns. In 2021, the TQIM-H concept was used as a reference for accelerating 73 healthcare innovation projects from which were 21 product innovation projects, 46 process innovation projects, 6 business model innovation projects. All of them were considered effective innovation projects since they were beneficial to healthcare performance and led to the sustainable performance of the organization in all 3 aspects.

Economic sustainability: 73 innovation projects that were developed through the TQIM-H framework led to an 8.6 million Bahts increase in income and a 13.5 million Bahts reduction in expense.

Environmental sustainability: 73 innovation projects led to the reduction of 1,590 kgCO2e carbon footprint, an important indicator for environmental effects.

Social sustainability: 73 innovation projects delivered values to more than 18,000 internal and external stakeholders, increased good activities, and enhanced people engagement.

This indicated the potential use of the TQIM-H concept in developing effective innovation projects. Together with the use of the user-friendly interface, the transmission of effective innovation projects would be wilder which would lead to more creation of the projects.

10.7 Research limitation and recommendation for future research

This research has contributed to both the academic understanding of the subject and the improvement of industrial practice. The strengths of this research are plenty. Using the well-developed philosophies as a core and integrated part allows the development of a valid and reliable tool, TQIM-H-TRIZ. In addition, experts in healthcare innovation are interviewed and involved in this research. Moreover, this study applied the tool to analyze the successful innovative management cases derived from multiple large Government and Private Hospitals in Southeast Asia (SEA). This allows the generalization of our results to other settings. However, this work has some worth mentioning limitations.

First of all, TQIM-H is a screening tool for the preparation and initiation of innovation management in the healthcare organization. The innovation management performance level according to the Global Innovation Index 2021 (GII) classified countries into 3 categories based on their innovation potential and ability. Countries in Southeast Asia are classified as a seeding level, which are beginners in innovation development. Therefore, the developed TQIM-H is suitable for countries with intermediate innovation management levels. The modification of TQIM-H to be used with countries with a middle and higher level of innovation management is required. In addition, increasing the access of TQIM-H can be promoted by creating TQIM-handbooks. Guinée & Lindeijer, 2002 stated that presenting knowledge in as a handbook helped the reader access and understand the knowledge better. By following the handbook development guideline by Guinée & Lindeijer (2002), TQIM-H handbook should consist of eight parts as the following:

OVERVIEW: Providing an overview of the content.

SUBJECT MATTER: Providing the subject matter which has been divided into suitable sections.

QUESTIONS: Providing questions that help reader to reflect on what he/she has just read.

ACTIVITIES: Providing activities for reader to do. These give a chance to apply the new knowledge or skills reader has been introduced to.

ILLUSTRATIONS: Illustrations have been included to support important points or to help reader understand certain key concepts.

TABLES: Tables have been used to present new information in a compact way for easy reference.

EXAMPLES: There are many examples taken from actual university teaching experiences. Some of these are good models for reader to follow, while others have been selected for you to criticize and improve.

CONCLUSION: Each chapter has a conclusion which summarizes the main ideas.

The TQIM-H handbook provides a guideline for effective innovation development and increases access to the TQIM-H concept.

REFERENCES

Abd El-Salam, M. M. (2010). Hospital waste management in El-Beheira governorate, Egypt. *Journal of environmental management*, *91*(3), 618-629.

Abdullah, A., Liew, S. M., Hanafi, N. S., Ng, C. J., Lai, P. S. M., Chia, Y. C., & Loo, C. K. (2016). What influences patients' acceptance of a blood pressure telemonitoring service in primary care? A qualitative study. *Patient preference and adherence*, *10*, 99.

Abdullah, M. A., Manaf, N. H. A., Yusuf, M.-B. O., Ahsan, K., & Azam, S. F. (2014). Determinants of customer satisfaction on retail banks in New Zealand: an empirical analysis using structural equation modeling. *Global Economy and Finance Journal*, *7*(1), 63-82.

Abramov, O., Kogan, S., Mitnik-Gankin, L., Sigalovsky, I., & Smirnov, A. (2015). TRIZ-based approach for accelerating innovation in chemical engineering. *Chemical Engineering Research and Design*, *103*, 25-31.

Abrunhosa, A., & Sá, P. M. E. (2008). Are TQM principles supporting innovation in the Portuguese footwear industry? *Technovation*, *28*(4), 208-221.

Adams, R., Bessant, J., & Phelps, R. (2006). Innovation management measurement: A review. *International journal of management reviews*, *8*(1), 21-47.

Adler, M., & Ziglio, E. (1996). *Gazing into the oracle: The Delphi method and its application to social policy and public health*. Jessica Kingsley Publishers.

Aggarwal, A., Aeran, H., & Rathee, M. (2019). Quality management in healthcare: The pivotal desideratum. *Journal of Oral Biology and Craniofacial Research*, *9*(2), 180-182.

Aggelidis, V. P., & Chatzoglou, P. D. (2009). Using a modified technology acceptance model in hospitals. *International journal of medical informatics*, *78*(2), 115-126.

Aguilera-Caracuel, J., & Ortiz-de-Mandojana, N. (2013a). *The financial performance of green prospector firms: a contingent approach*.

Aguilera-Caracuel, J., & Ortiz-de-Mandojana, N. (2013b). Green innovation and financial performance: An institutional approach. *Organization & Environment*, *26*(4), 365-385.

Agus, A., & Hassan, Z. (2000). TQM benchmarking for Malaysian manufacturing companies: an exploratory study. *Bangi: UKM, Malaysia*.

Ahire, S. L., Golhar, D. Y., & Waller, M. A. (1996). Development and validation of TQM implementation constructs. *Decision sciences*, *27*(1), 23-56.

Ahmed, P. K., & Zairi, M. (1999). Benchmarking for brand innovation. *European Journal of Innovation Management*.

Aiken, L. H., Clarke, S. P., Sloane, D. M., & Consortium, I. H. O. R. (2002). Hospital staffing, organization, and quality of care: cross-national findings. *International Journal for quality in Health care*, *14*(1), 5-14.

Ajzen, I., & Fishbein, M. (1977). Attitude-behavior relations: A theoretical analysis and review of empirical research. *Psychological bulletin*, *84*(5), 888.

Akenroye, T. O. (2012). Factors influencing innovation in healthcare: a conceptual synthesis. *The Innovation Journal*, *17*(2), 1.

Akenroye, T. O., & Kuenne, C. W. (2015). Key competencies for promoting service innovation: what are implications for the health sector? *The Innovation Journal*.

Al-Hawari, M., Hartley, N., & Ward, T. (2005). Measuring Banks' Automated Service Quality: A Confirmatory Factor Analysis Approach. *Marketing bulletin*, *16*.

Al-Shdaifat, E. A. (2015). Implementation of total quality management in hospitals. *Journal of Taibah University Medical Sciences*, *10*(4), 461-466.

Al‐Marri, K., Ahmed, A. M. M. B., & Zairi, M. (2007). Excellence in service: an empirical study of the UAE banking sector. *International Journal of Quality & Reliability Management*.

Al Ameen, M., Liu, J., & Kwak, K. (2012). Security and privacy issues in wireless sensor networks for healthcare applications. *Journal of medical systems*, *36*(1), 93-101.

Aldosari, B. (2012). User acceptance of a picture archiving and communication system (PACS) in a Saudi Arabian hospital radiology department. *BMC medical informatics and decision making*, *12*(1), 1-10.

Alhaddi, H. (2015). Triple bottom line and sustainability: A literature review. *Business and Management Studies*, *1*(2), 6-10.

Alharbi, S., & Drew, S. (2014). Using the technology acceptance model in understanding academics' behavioural intention to use learning management systems. *International Journal of Advanced Computer Science and Applications*, *5*(1), 143-155.

Ali, M., Wang, W., & Chaudhry, N. (2016). Application of life cycle assessment for hospital solid waste management: A case study. *Journal of the Air & Waste Management Association*, *66*(10), 1012-1018.

Aljabre, S. H. (2002). Hospital generated waste: a plan for its proper management. *Journal of family & community medicine*, *9*(2), 61.

Alkhenizan, A., & Shaw, C. (2011). Impact of accreditation on the quality of healthcare services: a systematic review of the literature. *Annals of Saudi medicine*, *31*(4), 407-416.

Almansoori, A., AlShamsi, M., Salloum, S. A., & Shaalan, K. (2021). Critical review of knowledge management in healthcare. *Recent Advances in Intelligent Systems and Smart Applications*, 99-119.

Alʹtshuller, G. S. (1999). *The innovation algorithm: TRIZ, systematic innovation and technical creativity*. Technical innovation center, Inc.

Altuntaş, S., & Yener, E. (2012). An approach based on TRIZ Methodology and SERVQUAL scale to improve the quality of Health-Care Service: a case study. *Ege Academic Review*, *12*(1), 95-104.

Álvarez-Rodríguez, C., Martín-Gamboa, M., & Iribarren, D. (2020). Sustainability-oriented efficiency of retail supply chains: A combination of Life Cycle Assessment and dynamic network Data Envelopment Analysis. *Science of the Total Environment*, *705*, 135977.

Alwashmi, M. F. (2020). The use of digital health in the detection and management of COVID-19. *International journal of environmental research and public health*, *17*(8), 2906.

Anderson, J. C., & Gerbing, D. W. (1988). Structural equation modeling in practice: A review and recommended two-step approach. *Psychological bulletin*, *103*(3), 411.

Anderson, N., De Dreu, C. K., & Nijstad, B. A. (2004). The routinization of innovation research: A constructively critical review of the state-of-the-science. *Journal of organizational Behavior*, *25*(2), 147-173.

Arumugam, V., Chang, H. W., Ooi, K. B., & Teh, P. L. (2009). Self-assessment of TQM practices: a case analysis. *The TQM Journal*.

Arumugam, V., Ooi, K. B., & Fong, T. C. (2008). TQM practices and quality management performance. *The TQM Journal*.

Atuahene-Gima, K. (1996). Market orientation and innovation. *Journal of business research*, *35*(2), 93-103.

Aujirapongpan, S., Vadhanasindhu, P., Chandrachai, A., & Cooparat, P. (2010). Indicators of knowledge management capability for KM effectiveness. *Vine*.

Azzopardi, E., & Nash, R. (2013). A critical evaluation of importance–performance analysis. *Tourism management*, *35*, 222-233.

Bacon, D. R. (2003). A comparison of approaches to importance-performance analysis. *International Journal of Market Research*, *45*(1), 1-15.

Bagozzi, R. P., & Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the academy of marketing science*, *16*(1), 74-94.

Baregheh, A., Rowley, J., & Sambrook, S. (2009). Towards a multidisciplinary definition of innovation. *Management decision*.

Barnes, J. L. (1987). *An international study of curricular organizers for the study of technology*. Virginia Polytechnic Institute and State University.

Basole, R. C., & Rouse, W. B. (2008). Complexity of service value networks: Conceptualization and empirical investigation. *IBM systems journal*, *47*(1), 53-70.

Bauernschuster, S., Falck, O., & Heblich, S. (2009). Training and innovation. *Journal of Human Capital*, *3*(4), 323-353.

Baumgartner, H., & Homburg, C. (1996). Applications of structural equation modeling in marketing and consumer research: A review. *International journal of Research in Marketing*, *13*(2), 139-161.

Baumgartner, R. J. (2014). Managing corporate sustainability and CSR: A conceptual framework combining values, strategies and instruments contributing to sustainable development. *Corporate Social Responsibility and Environmental*

Management, *21*(5), 258-271.

Beckmerhagen, I., Berg, H., Karapetrovic, S., & Willborn, W. (2003). Integration of management systems: focus on safety in the nuclear industry. *International Journal of Quality & Reliability Management*.

Bennett, R. C., & Cooper, R. G. (1981). The misuse of marketing: an American tragedy. *Business Horizons*, *24*(6), 51-61.

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological bulletin*, *107*(2), 238.

Bentler, P. M., & Chou, C.-P. (1987). Practical issues in structural modeling. *Sociological methods & research*, *16*(1), 78-117.

Benzaquen, J., Carlos, M., Norero, G., Armas, H., & Pacheco, H. (2019). Quality in private health companies in Peru: The relation of QMS & ISO 9000 principles on TQM factor. *International Journal of Healthcare Management*, 1-9.

Berger, A. (1997). Continuous improvement and kaizen: standardization and organizational designs. *Integrated manufacturing systems*.

Berwick, D. M. (2003). Disseminating innovations in health care. *Jama*, *289*(15), 1969-1975.

Bikker, J. A., & Bos, J. W. (2005). *Trends in competition and profitability in the banking industry: A basic framework*. SUERF Studies.

Bindman, A. B., Pronovost, P. J., & Asch, D. A. (2018). Funding innovation in a learning health care system. *Jama*, *319*(2), 119-120.

Binz, C., Truffer, B., & Coenen, L. (2014). Why space matters in technological innovation systems—Mapping global knowledge dynamics of membrane bioreactor technology. *Research Policy*, *43*(1), 138-155.

Biondo, P. D., Lee, L. D., Davison, S. N., Simon, J. E., Research, A. C. P. C., & Program, I. O. (2016). How healthcare systems evaluate their advance care planning initiatives: results from a systematic review. *Palliative medicine*, *30*(8), 720-729.

Birken, S. A., Lee, S.-Y. D., Weiner, B. J., Chin, M. H., Chiu, M., & Schaefer, C. T. (2015). From strategy to action: how top managers' support increases middle managers' commitment to innovation implementation in healthcare organizations. *Health care management review*, *40*(2), 159.

Birkinshaw, J., & Goddard, J. (2009). What is your management model? *MIT Sloan Management Review*, *50*(2), 81.

Birkinshaw, J., Hamel, G., & Mol, M. J. (2008). Management innovation. *Academy of management Review*, *33*(4), 825-845.

Boavida, R., Navas, H., Godina, R., Carvalho, H., & Hasegawa, H. (2020). A combined use of TRIZ methodology and eco-compass tool as a sustainable innovation model. *Applied Sciences*, *10*(10), 3535.

Boley, B. B., McGehee, N. G., & Hammett, A. T. (2017). Importance-performance analysis (IPA) of sustainable tourism initiatives: The resident perspective. *Tourism management*, *58*, 66-77.

Bollen, K. A. (1989). Structural equations with latent variables Wiley. *New York*.

Bollen, K. A., & Long, J. S. (1992). Tests for structural equation models: introduction. *Sociological Methods & Research*, *21*(2), 123-131.

Booth, A., Sutton, A., & Papaioannou, D. (2016). *Systematic approaches to a successful literature review*. Sage.

Bos-Brouwers, H. E. J. (2010). Corporate sustainability and innovation in SMEs: evidence of themes and activities in practice. *Business strategy and the environment*, *19*(7), 417-435.

Bossink, B. A. G. (2002). The strategic function of quality in the management of innovation. *Total Quality Management*, *13*(2), 195-205.

Braguglia, K. H. (1995). A national Delphi study of the fashion industry for curriculum development in collegiate programs of fashion merchandising.

Brah, S. A., Wong, J. L., & Rao, B. M. (2000). TQM and business performance in the service sector: a Singapore study. *International Journal of Operations & Production Management*.

Brown, J. D. (2011). Likert items and scales of measurement. *Statistics*, *15*(1), 10-14.

Brown, M. M., Brown, G. C., Sharma, S., & Landy, J. (2003). Health care economic analyses and value-based medicine. *Survey of ophthalmology*, *48*(2), 204-223.

Brown, S. (1988). An assessment of ethical dilemmas experienced by university or college counseling center directors: A Delphi study. Digital Abstracts

International,

Browne, M. W., Cudeck, R., Bollen, K. A., & Long, J. S. (1993). Testing structural equation models.

Bryman, A. (2003). *Quantity and quality in social research* (Vol. 18). Routledge.

BSI, B. (2008). 7000-1: 2008 Design Management Systems–Part 1: Guide to Managing Innovation. *British Standard Institution, London, UK*.

Buckley, C. (1995). Delphi: a methodology for preferences more than predictions. *Library management*.

Buffoli, M., Capolongo, S., Bottero, M., Cavagliato, E., Speranza, S., & Volpatti, L. (2013). Sustainable Healthcare: how to assess and improve healthcare structures' sustainability. *Ann Ig*, *25*(5), 411-418.

Byrne, B. M. (2001a). Structural equation modeling with AMOS, EQS, and LISREL: Comparative approaches to testing for the factorial validity of a measuring instrument. *International journal of testing*, *1*(1), 55-86.

Byrne, B. M. (2001b). Structural equation modeling: Perspectives on the present and the future. *International Journal of Testing*, *1*(3-4), 327-334.

Byrne, B. M. (2013). *Structural equation modeling with Mplus: Basic concepts, applications, and programming*. routledge.

Cabaniss, K. (2001). *Counseling and Computer Technology in the New Millennium--An Internet Delphi Study* Virginia Tech].

Cagliano, A. C., Grimaldi, S., & Rafele, C. (2011). A systemic methodology for risk management in healthcare sector. *Safety science*, *49*(5), 695-708.

Campbell, R., & Ahrens, C. E. (1998). Innovative community services for rape victims: An application of multiple case study methodology. *American Journal of Community Psychology*, *26*(4), 537-571.

Carman, W. H. (1999). An application of the Delphi method of forecasting to the future of technology infrastructure in West Virginia high schools.

Carraro, E., Bonetta, S., & Bonetta, S. (2017). Hospital wastewater: existing regulations and current trends in management. In *Hospital Wastewaters* (pp. 1-16). Springer.

Carter, L., & Bélanger, F. (2005). The utilization of e‐government services: citizen trust, innovation and acceptance factors. *Information systems journal*, *15*(1), 5-25.

Cavallucci, D., & Khomenko, N. (2007). From TRIZ to OTSM-TRIZ: addressing complexity challenges in inventive design. *International Journal of Product Development*, *4*(1-2), 4-21.

Cesarotti, V., & Di Silvio, B. (2006). Quality management standards for facility services in the Italian health care sector. *International Journal of Health Care Quality Assurance*.

Chae, Y. M., Kim, H. S., Tark, K. C., Park, H. J., & Ho, S. H. (2003). Analysis of healthcare quality indicator using data mining and decision support system. *Expert Systems with Applications*, *24*(2), 167-172.

Chaerul, M., Tanaka, M., & Shekdar, A. V. (2008). A system dynamics approach for hospital waste management. *Waste management*, *28*(2), 442-449.

Chai, K.-H., Zhang, J., & Tan, K.-C. (2005). A TRIZ-based method for new service design. *Journal of Service Research*, *8*(1), 48-66.

Chan, A. P., Yung, E. H., Lam, P. T., Tam, C., & Cheung, S. (2001). Application of Delphi method in selection of procurement systems for construction projects. *Construction management and economics*, *19*(7), 699-718.

Chan, T. E. (2013). Legal and regulatory responses to innovative treatment. *Medical law review*, *21*(1), 92-130.

Chandrasekaran, A., Senot, C., & Boyer, K. K. (2012). Process management impact on clinical and experiential quality: Managing tensions between safe and patient-centered healthcare. *Manufacturing & Service Operations Management*, *14*(4), 548-566.

Chang, P., Hsu, Y.-S., Tzeng, Y.-M., Hou, I., & Sang, Y.-Y. (2004). Development and pilot evaluation of user acceptance of advanced mass-gathering emergency medical services PDA support systems. MEDINFO 2004,

Chang, P., Hsu, Y.-S., Tzeng, Y.-M., Sang, Y.-Y., Hou, I.-C., & Kao, W.-F. (2004). The development of intelligent, triage-based, mass-gathering emergency medical service PDA support systems. *The journal of nursing research: JNR*, *12*(3), 227-236.

Chen, C.-K., Shie, A.-J., Wang, K.-M., & Yu, C.-H. (2010). Developing a TRIZ-based service system innovation model for aging in place. The 11th Asia Pacific Industrial Engineering and Management Systems Conference,

Chen, J. L., & Liu, C.-C. (2001). An eco-innovative design approach incorporating the TRIZ method without contradiction analysis. *The Journal of Sustainable Product Design*, *1*(4), 263-272.

Chen, M.-M., Murphy, H. C., & Knecht, S. (2016). An importance performance analysis of smartphone applications for hotel chains. *Journal of Hospitality and Tourism Management*, *29*, 69-79.

Chen, S.-C., Shing-Han, L., & Chien-Yi, L. (2011). Recent related research in technology acceptance model: A literature review. *Australian journal of business and management research*, *1*(9), 124.

Chevalier, P., & Vollet, D. (2019). LEADER 2007–2013: An innovation dependent on local and national institutional arrangements? Some European illustrations. *Regional Science Policy & Practice*, *11*(2), 219-234.

Chismar, W. G., & Wiley-Patton, S. (2003). Does the extended technology acceptance model apply to physicians. 36th Annual Hawaii International Conference on System Sciences, 2003. Proceedings of the,

Cho, H. J., & Pucik, V. (2005). Relationship between innovativeness, quality, growth, profitability, and market value. *Strategic management journal*, *26*(6), 555-575.

Choi, D., & Valikangas, L. (2001). Patterns of strategy innovation. *European Management Journal*, *19*(4), 424-429.

Choi, T. Y., & Eboch, K. (1998). The TQM paradox: relations among TQM practices, plant performance, and customer satisfaction. *Journal of Operations management*, *17*(1), 59-75.

Christian, L. R. (2004). Essential characteristics of accreditation site visit team members: A Delphi study.

Christiansen, A. C., & Buen, J. (2002). Managing environmental innovation in the energy sector: the case of photovoltaic and wave power development in Norway. *International journal of innovation management*, *6*(03), 233-256.

Chung, J. W., & Meltzer, D. O. (2009). Estimate of the carbon footprint of the US health care sector. *Jama*, *302*(18), 1970-1972.

Chuttur, M. Y. (2009). Overview of the technology acceptance model: Origins, developments and future directions. *Working Papers on Information Systems*, *9*(37), 9-37.

Ciani, O., Armeni, P., Boscolo, P. R., Cavazza, M., Jommi, C., & Tarricone, R. (2016). De innovatione: The concept of innovation for medical technologies and its implications for healthcare policy-making. *Health Policy and Technology*, *5*(1), 47-64.

Cilliers, L., & Flowerday, S. (2014). User acceptance of telemedicine by health care workers a case of the eastern cape province, South Africa. *The Electronic Journal of Information Systems in Developing Countries*, *65*(1), 1-10.

Clarke, M., & Oxman, A. (2001). Formulating the problem. *Cochrane reviewers' handbook*, *4*(0).

Coccia, M. (2012). Driving forces of technological change in medicine: Radical innovations induced by side effects and their impact on society and healthcare. *Technology in Society*, *34*(4), 271-283.

Coccia, M. (2017). Sources of technological innovation: Radical and incremental innovation problem-driven to support competitive advantage of firms. *Technology Analysis & Strategic Management*, *29*(9), 1048-1061.

Colamesta, V., Tamburrano, A., Barbara, A., Gentili, A., La Milia, D. I., Berloco, F., Cicchetti, A., Piacentini, D., Galluzzi, R., & Mastrodonato, S. R. (2019). Cost-consequence analysis of influenza vaccination among the staff of a large teaching hospital in Rome, Italy: A pilot study. *PloS one*, *14*(11), e0225326.

Colton, S., & Hatcher, T. (2004). The Web-Based Delphi Research Technique as a Method for Content Validation in HRD and Adult Education Research. *Online Submission*.

Cong, H., & Tong, L. H. (2008). Grouping of TRIZ Inventive Principles to facilitate automatic patent classification. *Expert systems with applications*, *34*(1), 788-795.

Coronado, A. J., & Wong, T. L. (2014). Healthcare cybersecurity risk management: Keys to an effective plan. *Biomedical instrumentation & technology*, *48*(s1), 26-30.

Costa, L. B. M., & Godinho Filho, M. (2016). Lean healthcare: review, classification and analysis of literature. *Production Planning & Control*, *27*(10), 823-836.

Cramer, R. H. (1990). *Issues related to the education of gifted children in the United States: A Delphi study* Virginia Tech].

Cranen, K., Veld, R. H. i. t., Ijzerman, M., & Vollenbroek-Hutten, M. (2011). Change of patients' perceptions of telemedicine after brief use. *Telemedicine and e-Health*, *17*(7), 530-535.

Crespo-Gonzalez, C., Benrimoj, S. I., Scerri, M., & Garcia-Cardenas, V. (2020). Sustainability of innovations in healthcare: A systematic review and conceptual framework for professional pharmacy services. *Research in Social and Administrative Pharmacy*, *16*(10), 1331-1343.

Croasmun, J. T., & Ostrom, L. (2011). Using likert-type scales in the social sciences. *Journal of Adult Education*, *40*(1), 19-22.

Cronbach, L. J., & Furby, L. (1970). How we should measure" change": Or should we? *Psychological bulletin*, *74*(1), 68.

Czarnitzki, D., & Lopes-Bento, C. (2014). Innovation subsidies: Does the funding source matter for innovation intensity and performance? Empirical evidence from Germany. *Industry and Innovation*, *21*(5), 380-409.

Czinkota, M. R., & Ronkainen, I. A. (1997). International business and trade in the next decade: Report from a Delphi study. *Journal of International Business Studies*, *28*(4), 827-844.

Daft, R. L., & Becker, S. W. (1978). *Innovation in organizations: Innovation adoption in school organizations*. Elsevier.

Dal Mas, F., Piccolo, D., Edvinsson, L., Skrap, M., & D'Auria, S. (2020). Strategy Innovation, Intellectual Capital Management, and the Future of Healthcare: The Case of Kiron by Nucleode. In *Knowledge, People, and Digital Transformation* (pp. 119-131). Springer, Cham.

Dale, B. G., & Wan, G. (2002). Setting up a quality costing system. *Business Process Management Journal*.

Dalkey, N., & Helmer, O. (1963). An experimental application of the Delphi method to the use of experts. *Management science*, *9*(3), 458-467.

Damanpour, F., Walker, R. M., & Avellaneda, C. N. (2009). Combinative effects of innovation types and organizational performance: A longitudinal study of service organizations. *Journal of management studies*, *46*(4), 650-675.

Dana, L.-P., Gurău, C., Hoy, F., Ramadani, V., & Alexander, T. (2019). Success factors and challenges of grassroots innovations: learning from failure. *Technological Forecasting and Social Change*, 119600.

Dargahi, H. (2011). The implementation of the sharia law in medical practice: a balance between medical ethics and patients rights. *Journal of medical ethics and history of medicine*, *4*.

David, F., Bagozzi, R., & Warshaw, P. (1989). Perceived enjoyment is a condition where consumers perceived an enjoyable online service experience as well as performance consequences that can be anticipated. *Management Science*, *35*(8), 982-1003.

Davies, H. T., & Crombie, I. K. (1998). *What is meta-analysis?* Hayward Medical Communications.

Davila, A., Foster, G., & Oyon, D. (2009). Accounting and control, entrepreneurship and innovation: Venturing into new research opportunities. *European Accounting Review*, *18*(2), 281-311.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340.

De Jong, J. P., & Den Hartog, D. N. (2007). How leaders influence employees' innovative behaviour. *European Journal of innovation management*.

De Vries, H., Bekkers, V., & Tummers, L. (2016). Innovation in the public sector: A systematic review and future research agenda. *Public administration*, *94*(1), 146-166.

Delbecq, A. L., Van de Ven, A. H., & Gustafson, D. H. (1975). *Group techniques for program planning: A guide to nominal group and Delphi processes*. Scott, Foresman.

Delbeq, A., Van de Ven, A., & Gustafson, D. (1975). Group techniques: A guide to nominal and delphi processes. *Glenview, IL: Scott, Foresman*.

Deming, W. E. (1986). Out of crisis Boston. In: MIT/CAES, Cambridge.

Demirbag, M., Koh, S. L., Tatoglu, E., & Zaim, S. (2006). TQM and market orientation's impact on SMEs' performance. *Industrial Management & Data Systems*.

Dervitsiotis, K. N. (2011). The challenge of adaptation through innovation based on the quality of the innovation process. *Total Quality Management & Business Excellence*, *22*(5), 553-566.

Dewangan, V., & Godse, M. (2014). Towards a holistic enterprise innovation performance measurement system. *Technovation*, *34*(9), 536-545.

Dilber, M., Bayyurt, N., Zaim, S., & Tarim, M. (2005). Critical factors of total quality management and its effect on performance in health care industry: a Turkish experience. *Problems and Perspectives in Management*(4), 220-234.

Dillman, D. A., & Bowker, D. K. (2001). The web questionnaire challenge to survey methodologists. *Online social sciences*, 53-71.

DJ, B., DS, S., & WA, C. (2003). Evaluating a spoken dialogue system for recording clinical observations during an endoscopic examination. *Medical informatics and the Internet in medicine*, *28*(2), 85-97.

Djellal, F., & Gallouj, F. (2007). Innovation in hospitals: a survey of the literature. *The European Journal of Health Economics*, *8*(3), 181-193.

do Carmo Caccia‐Bava, M., Guimaraes, V. C., & Guimaraes, T. (2009). Testing some major determinants for hospital innovation success. *International Journal of Health Care Quality Assurance*.

Dodgson, M., Gann, D. M., & Phillips, N. (2014). Perspectives on innovation management. *The Oxford handbook of innovation management*, 3-25.

Donovan, L., Green, T. D., & Mason, C. (2014). Examining the 21st century classroom: Developing an innovation configuration map. *Journal of Educational Computing Research*, *50*(2), 161-178.

Dostie, B. (2018). The impact of training on innovation. *ILR review*, *71*(1), 64-87.

Dow, D., Samson, D., & Ford, S. (1999). Exploding the myth: do all quality management practices contribute to superior quality performance? *Production and operations management*, *8*(1), 1-27.

Doz, Y., Hamel, G., & Prahalad, C. (1989). Collaborate with your competitors and win. *Harvard business review*, *67*(1), 133-139.

Drucker, P. F. (1985). Entrepreneurial strategies. *California Management Review*, *27*(2).

Dutta, S., & Lanvin, B. (2012). The global innovation index 2012. *Stronger innovation linkages for global*.

Dutta, S., Lanvin, B., & Wunsch-Vincent, S. (2018). Global innovation index 2018: Energizing the world with innovation. In: WIPO.

Edgeman, R. L., & Hensler, D. A. (2001). The AO chronicle: earth@ omega or sustainability@ alpha? *The TQM Magazine*.

Edmunds, H. (1999). The focus group research handbook. *The Bottom Line*.

El-Gohary, H. (2012). Factors affecting E-Marketing adoption and implementation in tourism firms: An empirical investigation of Egyptian small tourism organisations. *Tourism management*, *33*(5), 1256-1269.

Engert, S., Rauter, R., & Baumgartner, R. J. (2016). Exploring the integration of corporate sustainability into strategic management: a literature review. *Journal of cleaner production*, *112*, 2833-2850.

Erdil, A. ASSESSMENT OF TOTAL QUALITY MANAGEMENT ACCORDING TO STRATEGIC PLANNING: A CASE STUDY FOR A BUSINESS IN THE TEXTILE-APPAREL INDUSTRY. *Research Journal of Business and Management*, *7*(3), 157-168.

Esposito, C., De Santis, A., Tortora, G., Chang, H., & Choo, K.-K. R. (2018). Blockchain: A panacea for healthcare cloud-based data security and privacy? *IEEE Cloud Computing*, *5*(1), 31-37.

Eveleens, C. (2010). Innovation management; a literature review of innovation process models and their implications. *Science*, *800*(2010), 900-916.

Fadhil, N. F. M., Jusop, M., & Abdullah, A. A. (2012). Hospital information system (his) implementation in a public hospital: a case study from malaysia. *Far East Journal of Psychology and Business*, *8*(1), 1-11.

Faezipour, M., & Ferreira, S. (2011). Applying systems thinking to assess sustainability in healthcare system of systems. *International Journal of System of Systems Engineering*, *2*(4), 290-308.

Faezipour, M., & Ferreira, S. (2013a). Developing a systems thinking perspective of hospital water sustainability. 2013 IEEE International Systems Conference (SysCon),

Faezipour, M., & Ferreira, S. (2013b). A system dynamics perspective of patient satisfaction in healthcare. *Procedia Computer Science*, *16*, 148-156.

Fanta, G. B., Pretorius, L., & Erasmus, L. (2015). An evaluation of eHealth systems implementation frameworks for sustainability in resource constrained environments: a literature review. IAMOT 2015 Conference Proceedings, Cape Town,

Faruque, M. O., Naieni, K. H., Ardalan, A., Ahmadnezhad, E., & Mohammadinia, L. (2015). Feasibility assessment of using geoinformatics technology in disaster disease surveillance in a developing country, Iran. *PLoS currents*, *7*.

Faulkner, A., & Kent, J. (2001). Innovation and regulation in human implant technologies: developing comparative approaches. *Social science & medicine*, *53*(7), 895-913.

Feagin, J. R., Orum, A. M., & Sjoberg, G. (1991). *A case for the case study*. UNC Press Books.

Feng, J., Prajogo, D. I., Tan, K. C., & Sohal, A. S. (2006). The impact of TQM practices on performance. *European Journal of Innovation Management*.

Fernández, Á. M. (2001). Innovation processes in an accident and emergency department. *European journal of innovation management*.

Fiabane, E., Giorgi, I., Sguazzin, C., & Argentero, P. (2013). Work engagement and occupational stress in nurses and other healthcare workers: the role of organisational and personal factors. *Journal of clinical nursing*, *22*(17-18), 2614-2624.

Fichman, R. G., Kohli, R., & Krishnan, R. (2011). Editorial overview—the role of information systems in healthcare: current research and future trends. *Information systems research*, *22*(3), 419-428.

Fitzgerald, L., Ferlie, E., & Hawkins, C. (2003). Innovation in healthcare: how does credible evidence influence professionals? *Health & social care in the community*, *11*(3), 219-228.

Fleiszer, A. R., Semenic, S. E., Ritchie, J. A., Richer, M. C., & Denis, J. L. (2015). The sustainability of healthcare innovations: a concept analysis. *Journal of Advanced Nursing*, *71*(7), 1484-1498.

Flynn, K. E., Smith, M. A., & Vanness, D. (2006). A typology of preferences for participation in healthcare decision making. *Social science & medicine*, *63*(5), 1158-1169.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of marketing research*, *18*(1), 39-50.

Fotopoulos, C. B., & Psomas, E. L. (2009). The impact of “soft” and “hard” TQM elements on quality management results. *International Journal of Quality & Reliability Management*.

Fowles, J. (1978). The Delphi method. *Department of Civil and Architectural Engineering, Illinois Institute of Technology, http://www. iit. edu/~ it/delphi. html (retrieved June 2001).*

Fowles, J., & Fowles, R. B. (1978). Handbook of futures research.

Fox, E., Bottrell, M. M., Berkowitz, K. A., Chanko, B. L., Foglia, M. B., & Pearlman, R. A. (2010). IntegratedEthics: An innovative program to improve ethics quality in health care. *Innovation Journal*, *15*(2), 1-36.

Fuentes, M. M. F., Montes, F. J. L., & Fernández, L. M. M. (2006). Total quality management, strategic orientation and organizational performance: the case of Spanish companies. *Total Quality Management & Business Excellence*, *17*(3), 303-323.

Fundin, A., Bergquist, B., Eriksson, H., & Gremyr, I. (2018). Challenges and propositions for research in quality management. *International Journal of Production Economics*, *199*, 125-137. https://doi.org/10.1016/j.ijpe.2018.02.020

Fundin, A., Lilja, J., Lagrosen, Y., & Bergquist, B. (2020). Quality 2030: quality management for the future. *Total Quality Management & Business Excellence*, 1-17.

Garvare, R., & Isaksson, R. (2001). Sustainable development: extending the scope of business excellence models. *Measuring Business Excellence*.

Gazem, N., & Rahman, A. A. (2014a). Improving TRIZ 40 inventive principles grouping in redesign service approaches. *Asian Social Science*, *10*(17), 127-138.

Gazem, N., & Rahman, A. A. (2014b). Interpretation of TRIZ principles in a service related context. *Asian Social Science*, *10*(13), 108.

Gefen, D., & Straub, D. W. (1997). Gender differences in the perception and use of e-mail: An extension to the technology acceptance model. *MIS quarterly*, 389-400.

Ghanavati, S., Amyot, D., & Peyton, L. (2007). Towards a framework for tracking legal compliance in healthcare. International Conference on Advanced Information Systems Engineering,

Gidarakos, E., Petrantonaki, M., Anastasiadou, K., & Schramm, K.-W. (2009). Characterization and hazard evaluation of bottom ash produced from incinerated hospital waste. *Journal of hazardous materials*, *172*(2-3), 935-942.

Glover, W. J., Nissinboim, N., & Naveh, E. (2020). Examining innovation in hospital units: a complex adaptive systems approach. *BMC health services research*, *20*(1), 1-12.

Glynn, M. A. (1996). Innovative genius: A framework for relating individual and organizational intelligences to innovation. *Academy of management review*, *21*(4), 1081-1111.

Goes, J. B., & Park, S. H. (1997). Interorganizational links and innovation: The case of hospital services. *Academy of management journal*, *40*(3), 673-696.

Gogate, U., & Bakal, J. W. (2016). Smart healthcare monitoring system based on wireless sensor networks. 2016 International Conference on Computing, Analytics and Security Trends (CAST),

Gong, M., Xu, Y., & Yu, Y. (2004). An enhanced technology acceptance model for web-based learning. *Journal of Information Systems Education*, *15*(4).

Gözükara, İ., Çolakoğlu, N., & Şimşek, Ö. F. (2019). Development culture and TQM in Turkish healthcare: importance of employee empowerment and top management leadership. *Total Quality Management & Business Excellence*, *30*(11-12), 1302-1318.

Greco, P. J., & Eisenberg, J. M. (1993). Changing physicians' practices. In: Mass Medical Soc.

Greenhalgh, T. (2014). *How to read a paper: the basics of evidence-based medicine*. John Wiley & Sons.

Griffin, K. M., Karas, M. G., Ivascu, N. S., & Lief, L. (2020). Hospital preparedness for

COVID-19: a practical guide from a critical care perspective. *American journal of respiratory and critical care medicine*, *201*(11), 1337-1344.

Guan, J. (2019). Artificial intelligence in healthcare and medicine: promises, ethical challenges and governance. *Chinese Medical Sciences Journal*, *34*(2), 76-83.

Gumusluoglu, L., & Ilsev, A. (2009). Transformational leadership, creativity, and organizational innovation. *Journal of business research*, *62*(4), 461-473.

Gumusluoğlu, L., & Ilsev, A. (2009). Transformational leadership and organizational innovation: The roles of internal and external support for innovation. *Journal of Product Innovation Management*, *26*(3), 264-277.

Gupta, S., Kumar, D., & Sharma, A. (2011). Performance analysis of various data mining classification techniques on healthcare data. *International journal of computer science & Information Technology (IJCSIT)*, *3*(4), 155-169.

Gustafson, D. H., & Hundt, A. S. (1995). principles for. *Health Care Manage Rev*, *20*(2), 16-33.

Ha, S., & Stoel, L. (2009). Consumer e-shopping acceptance: Antecedents in a technology acceptance model. *Journal of business research*, *62*(5), 565-571.

Hair, J. F., Gabriel, M., & Patel, V. (2014). AMOS covariance-based structural equation modeling (CB-SEM): Guidelines on its application as a marketing research tool. *Brazilian Journal of Marketing*, *13*(2).

Halal, W. E., Kull, M. D., & Leffmann, A. (1997). Emerging Technologies: What's ahead for 2001-2030. *The Futurist*, *31*(6), 20.

Halvorsen, T., Hauknes, J., Miles, I., & Røste, R. (2005). On innovation in the public sector. *HALVORSEN, T.; HAUKNES, J.; MILES, I. On the differences between public and private sector innovation. Oslo: NIFU STEP*, 2-21.

Hamel, G. (2006). The why, what, and how of management innovation. *Harvard business review*, *84*(2), 72.

Hanauer, D. A., Wu, D. T., Yang, L., Mei, Q., Murkowski-Steffy, K. B., Vydiswaran, V. V., & Zheng, K. (2017). Development and empirical user-centered evaluation of semantically-based query recommendation for an electronic health record search engine. *Journal of biomedical informatics*, *67*, 1-10.

Hancock, G. R., & Mueller, R. O. (2013). *Structural equation modeling: A second course*.

lap.

Hansen, E. G., & Grosse-Dunker, F. (2012). Sustainability-oriented innovation. *Encyclopedia of Corporate Social Responsibility: Heidelberg, Germany*.

Hapsari, C., Stoffers, J., & Gunawan, A. (2019). The influence of generational diversity management and leader–member exchange on innovative work behaviors mediated by employee engagement. *Journal of Asia-Pacific Business*, *20*(2), 125-139.

Harari, O. (1993). Ten reasons why TQM doesn't work. *Management review*, *82*(1), 33.

Harkness, J., Pennell, B. E., & Schoua‐Glusberg, A. (2004). Survey questionnaire translation and assessment. *Methods for testing and evaluating survey questionnaires*, 453-473.

Harrison, C., Paul, S., & Burnard, K. (2016). Entrepreneurial Leadership: A Systematic Literature Review. *International Review of Entrepreneurship*, *14*(2).

Hayduk, L. A. (1987). *Structural equation modeling with LISREL: Essentials and advances*. Jhu Press.

He, K., Kalbfleisch, J. D., Li, Y., & Li, Y. (2013). Evaluating hospital readmission rates in dialysis facilities; adjusting for hospital effects. *Lifetime data analysis*, *19*(4), 490-512.

Hediger, W. (1999). Reconciling “weak” and “strong” sustainability. *International journal of social economics*.

Hellsten, U., & Klefsjö, B. (2000). TQM as a management system consisting of values, techniques and tools. *The TQM Magazine*.

Hellström, A., Lifvergren, S., Gustavsson, S., & Gremyr, I. (2015). Adopting a management innovation in a professional organization: the case of improvement knowledge in healthcare. *Business Process Management Journal*.

Hellström, A., Lifvergren, S., & Quist, J. (2010). Process management in healthcare: investigating why it's easier said than done. *Journal of Manufacturing Technology Management*.

Hellström, I., Nolan, M., & Lundh, U. (2005). ‘We do things together’ A case study of ‘couplehood’in dementia. *Dementia*, *4*(1), 7-22.

Helmer, O. (1977). Problems in futures research: Delphi and causal cross-impact analysis. *Futures*, *9*(1), 17-31.

Hendricks, K. B., & Singhal, V. R. (1997). Does implementing an effective TQM program actually improve operating performance? Empirical evidence from firms that have won quality awards. *Management science*, *43*(9), 1258-1274.

Heras, M., & Ruiz-Mallén, I. (2017). Responsible research and innovation indicators for science education assessment: how to measure the impact? *International Journal of Science Education*, *39*(18), 2482-2507.

Herzlinger, R. E. (2006). Why innovation in health care is so hard. *Harvard business review*, *84*(5), 58.

Hickson, G. B., Federspiel, C. F., Pichert, J. W., Miller, C. S., Gauld-Jaeger, J., & Bost, P. (2002). Patient complaints and malpractice risk. *Jama*, *287*(22), 2951-2957.

Hidalgo, A., & Albors, J. (2008). Innovation management techniques and tools: a review from theory and practice. *R&D Management*, *38*(2), 113-127.

Higgins, J. M. (1995). Innovation: The core competence. *Planning review*.

Himmelstein, D. U., Wright, A., & Woolhandler, S. (2010). Hospital computing and the costs and quality of care: a national study. *The American journal of medicine*, *123*(1), 40-46.

Hitt, M. A., Ireland, R. D., Camp, S. M., & Sexton, D. L. (2001). Strategic entrepreneurship: Entrepreneurial strategies for wealth creation. *Strategic management journal*, *22*(6‐7), 479-491.

Hoang, D. T., Igel, B., & Laosirihongthong, T. (2006). The impact of total quality management on innovation. *International Journal of Quality & Reliability Management*.

Hochleitner, F. P., Arbussà, A., & Coenders, G. (2017). Inbound open innovation in SMEs: indicators, non-financial outcomes and entry-timing. *Technology Analysis & Strategic Management*, *29*(2), 204-218.

Holden, R. J., & Karsh, B.-T. (2010). The technology acceptance model: its past and its future in health care. *Journal of biomedical informatics*, *43*(1), 159-172.

Holmes, W. M. (2005). *Emerging practice in occupational therapy: An exploratory study* *of its nature and competencies for practice*. Gonzaga University.

Hoogland, J. J., & Boomsma, A. (1998). Robustness studies in covariance structure modeling: An overview and a meta-analysis. *Sociological Methods & Research*, *26*(3), 329-367.

Housawi, A., Al Amoudi, A., Alsaywid, B., Lytras, M., bin Moreba, Y. H., Abuznadah, W., & Alhaidar, S. A. (2020). Evaluation of Key Performance Indicators (KPIs) for Sustainable Postgraduate Medical Training: An Opportunity for Implementing an Innovative Approach to Advance the Quality of Training Programs at the Saudi Commission for Health Specialties (SCFHS). *Sustainability*, *12*(19), 8030.

Howze, P. C., & Dalrymple, C. (2004). Consensus without all the meetings: using the Delphi method to determine course content for library instruction. *Reference Services Review*.

Hox, J. J., & Bechger, T. M. (1998). An introduction to structural equation modeling.

Hoyle, R. H. (1995). The structural equation modeling approach: Basic concepts and fundamental issues.

Hsu, C.-C., & Sandford, B. A. (2007). The Delphi technique: making sense of consensus. *Practical Assessment, Research, and Evaluation*, *12*(1), 10.

Hu, P. J., Chau, P. Y., Sheng, O. R. L., & Tam, K. Y. (1999). Examining the technology acceptance model using physician acceptance of telemedicine technology. *Journal of management information systems*, *16*(2), 91-112.

Hung, H.-M. (2007). Influence of the environment on innovation performance of TQM. *Total Quality Management & Business Excellence*, *18*(7), 715-730.

Hunter, S. T., Cushenbery, L. D., & Jayne, B. (2017). Why dual leaders will drive innovation: Resolving the exploration and exploitation dilemma with a conservation of resources solution. *Journal of Organizational Behavior*, *38*(8), 1183-1195.

Huser, V., Narus, S. P., & Rocha, R. A. (2010). Evaluation of a flowchart-based EHR query system: A case study of RetroGuide. *Journal of biomedical informatics*, *43*(1), 41-50.

Hwang, J., & Christensen, C. M. (2008). Disruptive innovation in health care delivery: a framework for business-model innovation. *Health affairs*, *27*(5), 1329-1335.

i Casasnovas, G. L., Rivera, B., & Currais, L. (2007). *Health and economic growth: findings and policy implications*. Mit Press.

Ilevbare, I. M., Probert, D., & Phaal, R. (2013). A review of TRIZ, and its benefits and challenges in practice. *Technovation*, *33*(2-3), 30-37.

Irfan, S., Kee, D. M. H., Waheed Qureshi, R., & Hussain, R. (2014). IDENTIFICATION OF CRITICAL SUCCESS FACTORS OF TQM IMPLEMENTATION IN HEALTH CARE SECTOR OF PAKISTAN USING PARETO ANALYSIS APPROACH. *Science international*, *26*(5).

Islam, M. M., Rahaman, A., & Islam, M. R. (2020). Development of smart healthcare monitoring system in IoT environment. *SN computer science*, *1*, 1-11.

Jackson, S. (2001). Successfully implementing total quality management tools within healthcare: what are the key actions? *International Journal of Health Care Quality Assurance*.

Jahangir, N., & Begum, N. (2008). The role of perceived usefulness, perceived ease of use, security and privacy, and customer attitude to engender customer adaptation in the context of electronic banking. *African journal of business management*, *2*(2), 032-040.

Jamaludin, N. H., Habidin, N. F., Shazali, N. A., Ali, N., & Khaidir, N. A. (2013). Exploring sustainable healthcare service and sustainable healthcare performance: based on Malaysian healthcare industry. *Journal of Sustainable Development Studies*, *3*(1).

Janchome, J., & Thawesaengskulthai, N. (2016). Innovation management framework: case studies of firms in Thailand. *International Journal of Technological Learning, Innovation and Development*, *8*(4), 345-374.

Jaruzelski, B., Staack, V., & Goehle, B. (2014). Proven paths to innovation success.

Jaskyte, K. (2004). Transformational leadership, organizational culture, and innovativeness in nonprofit organizations. *Nonprofit Management and Leadership*, *15*(2), 153-168.

Jebb, A. T., Ng, V., & Tay, L. (2021). A review of key Likert scale development advances: 1995–2019. *Frontiers in psychology*, *12*, 1590.

Jeeradist, T., Thawesaengskulthai, N., & Sangsuwan, T. (2016). Using TRIZ to enhance passengers' perceptions of an airline's image through service quality and safety. *Journal of Air Transport Management*, *53*, 131-139.

Jha, A., & Epstein, A. (2010). Hospital governance and the quality of care. *Health Affairs*, *29*(1), 182-187.

Jillson, I. A. (1975). III. B. 3. The national drug-abuse policy delphi: Progress report and findings to date. *The Delphi method: Techniques and applications*, 124.

Jiménez‐Jiménez, D., & Martínez‐Costa, M. (2009). The performance effect of HRM and TQM: a study in Spanish organizations. *International Journal of Operations & Production Management*.

Jin, Z., & Chen, Y. (2015). Telemedicine in the cloud era: Prospects and challenges. *IEEE Pervasive Computing*, *14*(1), 54-61.

Johnston, R. E., & Bate, J. D. (2013). *The power of strategy innovation: a new way of linking creativity and strategic planning to discover great business opportunities*. Amacom.

Joia, L. A. (2002). Analysing a Web‐based e‐commerce learning community: a case study in Brazil. *Internet Research*.

Jöreskog, K. G., & Sörbom, D. (1993). *LISREL 8: Structural equation modeling with the SIMPLIS command language*. Scientific Software International.

Jørgensen, B. (2006). *Integrating lean design and lean construction: processes and methods*. BYG. DTU.

Joseph, I., Rajendran, C., & Kamalanabhan, T. (1999). An instrument for measuring total quality management implementation in manufacturing-based business units in India. *International Journal of Production Research*, *37*(10), 2201-2215.

Juran, J. M. (1992). *Juran on quality by design: the new steps for planning quality into goods and services*. Simon and Schuster.

Juran, J. M., & Gryna, F. M. (1988). *Juran's quality control handbook* (Vol. 4). McGraw-Hill New York.

K Arya, D. (2016). Innovation in public healthcare systems: Do we really understand its potential. *Management Issues in Healthcare System*, *2*, 52-63.

Kanamori, S., Sow, S., Castro, M. C., Matsuno, R., Tsuru, A., & Jimba, M. (2015). Implementation of 5S management method for lean healthcare at a health center in Senegal: a qualitative study of staff perception. *Global health action*, *8*(1), 27256.

Kanji, G. K. (1996). Implementation and pitfalls of total quality management. *Total Quality Management*, *7*(3), 331-343.

Kanji, G. K., & Wallace, W. (2000). Business excellence through customer satisfaction. *Total quality management*, *11*(7), 979-998.

Kanter, R. M. (1983). *The change masters: Innovation for productivity in the American corporation*. ERIC.

Kaplan, D. (2000). Structural Equation Modeling Foundations and Extensions Sage Publications. *Thousand Oaks, Calif*.

Kaplan, R. S., Robert, N. P. D. K. S., Kaplan, R. S., & Norton, D. P. (2001). *The strategy-focused organization: How balanced scorecard companies thrive in the new business environment*. Harvard Business Press.

Karamitri, I., Talias, M. A., & Bellali, T. (2017). Knowledge management practices in healthcare settings: a systematic review. *The International journal of health planning and management*, *32*(1), 4-18.

Karamouz, M., Zahraie, B., Kerachian, R., Jaafarzadeh, N., & Mahjouri, N. (2007). Developing a master plan for hospital solid waste management: A case study. *Waste Management*, *27*(5), 626-638.

Karapetrovic, S., & Jonker, J. (2003). Integration of standardized management systems: searching for a recipe and ingredients. *Total Quality Management & Business Excellence*, *14*(4), 451-459.

Karaveg, C., Thawesaengskulthai, N., & Chandrachai, A. (2016). R & D commercialization capability criteria: implications for project selection. *Journal of Management Development*.

Karia, N., & Asaari, M. H. A. H. (2006). The effects of total quality management practices on employees' work‐related attitudes. *The TQM magazine*.

Karnjanasomwong, J., & Thawesaengskulthai, N. (2019). Dynamic sigma-TRIZ solution model for manufacturing improvement and innovation, case study in Thailand. *International Journal of Six Sigma and Competitive Advantage*, *11*(2-3), 114-156.

Kastner, C. (2021). The Role of a Leader: Transformational Efforts in Innovation and Change. *Creating Innovation Spaces: Impulses for Start-ups and Established Companies in Global Competition*, 71-84.

Kc, D. S., & Terwiesch, C. (2009). Impact of workload on service time and patient safety: An econometric analysis of hospital operations. *Management science*, *55*(9), 1486-1498.

Khamalah, J. N., & Lingaraj, B. P. (2007). TQM in the service sector: a survey of small businesses. *Total quality management*, *18*(9), 973-982.

Khan, N. A., Ahmed, S., Vambol, S., Vambol, V., & Farooqi, I. H. (2019). Field hospital wastewater treatment scenario. *Ecological Questions*, *30*(3), 57-69.

Kim, D.-Y., Kumar, V., & Kumar, U. (2012). Relationship between quality management practices and innovation. *Journal of operations management*, *30*(4), 295-315.

Kim, S., & Park, Y. (2012). A TRIZ-based approach to generation of service-supporting product concepts. *World academy of science, Engineering and technology*, *62*(111), 574-574.

Kim, W. C., & Mauborgne, R. (1999). Strategy, value innovation, and the knowledge economy. *MIT Sloan Management Review*, *40*(3), 41.

Kimberly, J. R. (1981). Managerial innovation,[in:] Nystrom PC and Starbuck WH (Ed), Hand Book of Organization Design. In: Oxford University Press, Oxford.

Kimsey, D. B. (2010). Lean methodology in health care. *AORN journal*, *92*(1), 53-60.

King, W. R., & He, J. (2006). A meta-analysis of the technology acceptance model. *Information & management*, *43*(6), 740-755.

Kirner, E., Kinkel, S., & Jaeger, A. (2009). Innovation paths and the innovation performance of low-technology firms—An empirical analysis of German industry. *Research Policy*, *38*(3), 447-458.

Klefsjö, B., Bergquist, B., & Garvare, R. (2008). Quality management and business excellence, customers and stakeholders: do we agree on what we are talking about, and does it matter? *The TQM Journal*, *20*(2), 120-129.

Kline, R. (1998). Principles and practice of structural equation modeling. 1998. *New*

York: Guilford.

Kline, R. B. (2010). Promise and pitfalls of structural equation modeling in gifted research.

Koufaris, M. (2002). Applying the technology acceptance model and flow theory to online consumer behavior. *Information systems research*, *13*(2), 205-223.

KP, S., & Srinivasan, R. Total Quality Management and Innovation Performance: An Empirical Study on the Interrelationships and Effects. *SOUTH ASIAN JOURNAL OF MANAGEMENT*, 8.

Kriegel, G., Bell, S., Delbanco, T., & Walker, J. (2020). Covid-19 as innovation accelerator: cogenerating telemedicine visit notes with patients. *Nejm Catalyst Innovations in Care Delivery*.

Kumar, V., Choisne, F., de Grosbois, D., & Kumar, U. (2009). Impact of TQM on company's performance. *International Journal of Quality & Reliability Management*, *26*(1), 23-37. https://doi.org/10.1108/02656710910924152

Kuratko, D. F., & Hodgetts, R. M. (1998). Entrepreneurship: a contemporary approach . USA: The Dryden. In: Harcourt Brace College Publishers.

Kuratko, D. F., Ireland, R. D., Covin, J. G., & Hornsby, J. S. (2005). A model of middle–level managers' entrepreneurial behavior. *Entrepreneurship theory and practice*, *29*(6), 699-716.

Kwon, H. S., & Chidambaram, L. (2000). A test of the technology acceptance model: The case of cellular telephone adoption. Proceedings of the 33rd Annual Hawaii International Conference on System Sciences,

Lai, E. R. (2011). Critical thinking: A literature review. *Pearson's Research Reports*, *6*(1), 40-41.

Länsisalmi, H., Kivimäki, M., Aalto, P., & Ruoranen, R. (2006). Innovation in healthcare: a systematic review of recent research. *Nursing science quarterly*, *19*(1), 66-72.

Lawler III, E. E. (1994). Total quality management and employee involvement: are they compatible? *Academy of Management Perspectives*, *8*(1), 68-76.

Lawton, L., & Parasuraman, A. (1980). The impact of the marketing concept on new product planning. *Journal of Marketing*, *44*(1), 19-25.

Lee, C.-H., Chen, C.-H., Li, F., & Shie, A.-J. (2020). Customized and knowledge-centric service design model integrating case-based reasoning and TRIZ. *Expert Systems with Applications*, *143*, 113062.

Lee, D. (2012). Implementation of quality programs in health care organizations. *Service Business*, *6*(3), 387-404.

Lee, D. (2015). The effect of operational innovation and QM practices on organizational performance in the healthcare sector. *International Journal of Quality Innovation*, *1*(1), 1-14.

Lee, K.-H., & Saen, R. F. (2012). Measuring corporate sustainability management: A data envelopment analysis approach. *International Journal of Production Economics*, *140*(1), 219-226.

Lee, S. M., Lee, D., & Schniederjans, M. J. (2011). Supply chain innovation and organizational performance in the healthcare industry. *International Journal of Operations & Production Management*.

Lee, V. H., Ooi, K. B., Tan, B. I., & Chong, A. Y. L. (2010). A structural analysis of the relationship between TQM practices and product innovation. *Asian Journal of Technology Innovation*, *18*(1), 73-96.

Lee, W., Xiong, L., & Hu, C. (2012). The effect of Facebook users' arousal and valence on intention to go to the festival: Applying an extension of the technology acceptance model. *International Journal of Hospitality Management*, *31*(3), 819-827.

Légaré, F., Stacey, D., Turcotte, S., Cossi, M. J., Kryworuchko, J., Graham, I. D., Lyddiatt, A., Politi, M. C., Thomson, R., & Elwyn, G. (2014). Interventions for improving the adoption of shared decision making by healthcare professionals. *Cochrane database of systematic reviews*(9).

Lehoux, P., Roncarolo, F., Rocha Oliveira, R., & Pacifico Silva, H. (2016). Medical innovation and the sustainability of health systems: A historical perspective on technological change in health. *Health Services Management Research*, *29*(4), 115-123.

Lendel, V., & Varmus, M. (2011). Creation and implementation of the innovation strategy in the enterprise. *Economics and management*, *16*(1), 819-826.

Levary, R. R., & Han, D. (1995). Choosing a technological forecasting method.

INDUSTRIAL MANAGEMENT-CHICAGO THEN ATLANTA-, *37*, 14-14.

Li, W., Bhutto, T. A., Nasiri, A. R., Shaikh, H. A., & Samo, F. A. (2018). Organizational innovation: the role of leadership and organizational culture. *International Journal of Public Leadership*.

Lilja, J., Hansen, D., Richardsson, D., & Svedin, I. (2019). How Quality Management Needs Emergence for Engaging Agenda 2030: As "improving" increasingly means getting a complex system to take transformative steps towards sustainability and flourishing. 22nd QMOD conference, 13-15 October 2019, Krakow, Poland,

Lin, C.-S., & Su, C.-T. (2007). An innovative way to create new services: Applying the TRIZ methodology. *Journal of the Chinese Institute of Industrial Engineers*, *24*(2), 142-152.

Lin, H. F., & Lee, G. G. (2004). Perceptions of senior managers toward knowledge-sharing behaviour. *Management decision*.

Lin, J.-D., Loh, C.-H., Lai, C.-I., Lo, Y.-T., Lu, H.-L., Yen, C.-F., Hsu, S.-W., Lin, L.-P., & Chu, C. (2008). Perceived adverse occupational health effects in hospital personnel: An exploration of the effects of the workplace environment. *J Med Sci*, *28*(6), 227-232.

Linstone, H. A. (1978). The Delphi technique. Handbook of futures research. *J. Fowlers. Westport, CT, Greenwood Press*, 273-300.

Linstone, H. A., & Turoff, M. (1975). *The delphi method*. Addison-Wesley Reading, MA.

Loi, T. S. A., & Le Ng, J. (2018). Anticipating electricity prices for future needs–Implications for liberalised retail markets. *Applied energy*, *212*, 244-264.

Lopez-Casasnovas, G. (2005). Economic considerations regarding pharmaceutical expenditure in Spain and its financing. *The Public Financing of Pharmaceuticals: An Economic Approach*, 189-209.

López-Mielgo, N., Montes-Peón, J. M., & Vázquez-Ordás, C. J. (2009). Are quality and innovation management conflicting activities? *Technovation*, *29*(8), 537-545.

Lorente, A. R. M., Dewhurst, F., & Dale, B. G. (1999). TQM and business innovation. *European Journal of Innovation Management*.

Lotzkar, M., & Bottorff, J. L. (2001). An observational study of the development of a nurse-patient relationship. *Clinical Nursing Research*, *10*(3), 275-294.

Lu, J., Yu, C. S., Liu, C., & Yao, J. E. (2003). Technology acceptance model for wireless Internet. *Internet research*.

Luck, L., Jackson, D., & Usher, K. (2007). STAMP: components of observable behaviour that indicate potential for patient violence in emergency departments. *Journal of Advanced Nursing*, *59*(1), 11-19.

Luisetto, M. (2020). Public Hospital Gas Management System: Health, Risk, Economic Implication–A Practical Experience 2015-2020. *IJCMCR. 2020; 2 (4): 004 DOI: 10.46998/IJCMCR*, *44*, 2015-2020.

Lysaght, T., Lim, H. Y., Xafis, V., & Ngiam, K. Y. (2019). AI-assisted decision-making in healthcare. *Asian Bioethics Review*, *11*(3), 299-314.

Mahama, M. D., & Sausa, L. P. (2019). Vision, mission, policy, administrative support, and customer demand as predictors of organizational innovation of selected hospitals in the Philippines. *Journal of Business, Governance, & Information Technology*, *1*(1), 132-145.

Mahapatra, S., & Khan, M. (2006). Current practices of TQM implementation and future trend. *Industrial Engineering Journal*, *35*(5), 28-33.

Majumdar, J. P., & Manohar, B. M. (2016). Why Indian manufacturing SMEs are still reluctant in adopting total quality management. *International Journal of Productivity and Quality Management*, *17*(1), 16-35.

Maliszewska, M., Mattoo, A., & Van Der Mensbrugghe, D. (2020). The potential impact of COVID-19 on GDP and trade: A preliminary assessment. In: The World Bank.

Malliarou, M. M., Moustaka, E. C., & Konstantinidis, T. C. (2008). BURNOUT OF NURSING PERSONNEL IN A REGIONAL UNIVERSITY HOSPITAL. *Health Science Journal*, *2*(3).

Manion, M. T., & Cherion, J. (2009). Impact of strategic type on success measures for product development projects. *Journal of Product Innovation Management*, *26*(1), 71-85.

Manjunath, U., Metri, B. A., & Ramachandran, S. (2007). Quality management in a healthcare organisation: a case of South Indian hospital. *The TQM Magazine*.

Mariadoss, B. J., Tansuhaj, P. S., & Mouri, N. (2011). Marketing capabilities and innovation-based strategies for environmental sustainability: An exploratory investigation of B2B firms. *Industrial Marketing Management*, *40*(8), 1305-1318.

Martin, A., & Przybocki, M. (2000). The NIST 1999 speaker recognition evaluation—An overview. *Digital signal processing*, *10*(1-3), 1-18.

Martinez-Costa, M., & Martínez-Lorente, A. R. (2008). Does quality management foster or hinder innovation? An empirical study of Spanish companies. *Total Quality Management*, *19*(3), 209-221.

Martínez-García, A., Moreno-Conde, A., Jódar-Sánchez, F., Leal, S., & Parra, C. (2013). Sharing clinical decisions for multimorbidity case management using social network and open-source tools. *Journal of biomedical informatics*, *46*(6), 977-984.

Maru, Y., & Woodford, K. B. (2007). Revisiting sustainability boundaries from a systems perspective.

Matzler, K., Bailom, F., Hinterhuber, H. H., Renzl, B., & Pichler, J. (2004). The asymmetric relationship between attribute-level performance and overall customer satisfaction: a reconsideration of the importance–performance analysis. *Industrial marketing management*, *33*(4), 271-277.

McDonald, R. P., & Marsh, H. W. (1990). Choosing a multivariate model: Noncentrality and goodness of fit. *Psychological bulletin*, *107*(2), 247.

McKenna, H. P. (1994). The Delphi technique: a worthwhile research approach for nursing? *Journal of advanced nursing*, *19*(6), 1221-1225.

McVey, L., Alvarado, N., Keen, J., Greenhalgh, J., Mamas, M., Gale, C., Doherty, P., Feltbower, R., Elshehaly, M., & Dowding, D. (2021). Institutional use of National Clinical Audits by healthcare providers. *Journal of evaluation in clinical practice*, *27*(1), 143-150.

Melas, C. D., Zampetakis, L. A., Dimopoulou, A., & Moustakis, V. (2011). Modeling the acceptance of clinical information systems among hospital medical staff: an extended TAM model. *Journal of biomedical informatics*, *44*(4), 553-564.

Memon, M., Wagner, S. R., Pedersen, C. F., Beevi, F. H. A., & Hansen, F. O. (2014). Ambient assisted living healthcare frameworks, platforms, standards, and quality attributes. *Sensors*, *14*(3), 4312-4341.

Menon, N. M., Lee, B., & Eldenburg, L. (2000). Productivity of information systems in the healthcare industry. *Information Systems Research*, *11*(1), 83-92.

Metcalfe, J. S. (1998). *Evolutionary economics and creative destruction* (Vol. 1). Psychology Press.

Meyer-Zehnder, B., Schleger, H. A., Tanner, S., Schnurrer, V., Vogt, D. R., Reiter-Theil, S., & Pargger, H. (2017). How to introduce medical ethics at the bedside-Factors influencing the implementation of an ethical decision-making model. *BMC medical ethics*, *18*(1), 1-14.

Michela, J. L., Noori, H., & Jha, S. (1996). The dynamics of continuous improvement. *International Journal of Quality Science*, *1*(1), 19-47.

Moehrle, M. G. (2005). How combinations of TRIZ tools are used in companies–results of a cluster analysis. *R&D Management*, *35*(3), 285-296.

Mol, M. J., & Birkinshaw, J. (2009). The sources of management innovation: When firms introduce new management practices. *Journal of business research*, *62*(12), 1269-1280.

Molina, L. M., Lloréns-Montes, J., & Ruiz-Moreno, A. (2007). Relationship between quality management practices and knowledge transfer. *Journal of operations management*, *25*(3), 682-701.

Money, A. G., Atwal, A., Young, K. L., Day, Y., Wilson, L., & Money, K. G. (2015). Using the Technology Acceptance Model to explore community dwelling older adults' perceptions of a 3D interior design application to facilitate pre-discharge home adaptations. *BMC medical informatics and decision making*, *15*(1), 1-15.

Moran, D., Wu, A. W., Connors, C., Chappidi, M. R., Sreedhara, S. K., Selter, J. H., & Padula, W. V. (2020). Cost-benefit analysis of a support program for nursing staff. *Journal of patient safety*, *16*(4), e250-e254.

Moreira, M. R., Gherman, M., & Sousa, P. S. (2017). Does innovation influence the performance of healthcare organizations? *Innovation*, *19*(3), 335-352.

Moreno‐Luzon, M. D., Gil‐Marques, M., & Valls‐Pasola, J. (2013). TQM, innovation and the role of cultural change. *Industrial Management & Data Systems*.

Morgan, D. L., & Krueger, R. A. (1998). *The focus group guidebook*. Sage.

Moura E Sá, P., & Abrunhosa, A. (2007). The role of TQM practices in technological innovation: The Portuguese footwear industry case. *Total Quality Management & Business Excellence*, *18*(1-2), 57-66.

Mueller, R. O. (1997). Structural equation modeling: Back to basics. *Structural Equation Modeling: A Multidisciplinary Journal*, *4*(4), 353-369.

Mulaik, S. A., James, L. R., Van Alstine, J., Bennett, N., Lind, S., & Stilwell, C. D. (1989). Evaluation of goodness-of-fit indices for structural equation models. *Psychological bulletin*, *105*(3), 430.

Mulrow, C. D. (1994). Systematic reviews: rationale for systematic reviews. *Bmj*, *309*(6954), 597-599.

Muralidharan, V. (2020). A Structured Innovation Strategy. *IEEE Engineering Management Review*, *48*(4), 12-16.

Murdi, P. B. (2020). The Application of the IPSA Loquitur Principle in the Regulation of Medical Malpractice Resolution'. *International Journal of Innovation, Creativity and Change*, *12*, 756-764.

Mutingi, M., & Mbohwa, C. (2014). Understanding sustainability in healthcare systems: A systems thinking perspective. 2014 IEEE International Conference on Industrial Engineering and Engineering Management,

Nabitz, U., & Klazinga, N. (1999). EFQM approach and the Dutch Quality Award. *International Journal of Health Care Quality Assurance*.

Nada, N., Kholeif, M., Elbadawy, A., & Yanik, T. (2010). An integrated innovation management framework. PROCEEDINGS of INTERNATIONAL WORKSHOP ON INNOVATION & ENTREPRENEURSHIP CONGRESS 2010 NOVEMBER 11-12, 2010,

Nagano, M. S., Stefanovitz, J. P., & Vick, T. E. (2014). Innovation management processes, their internal organizational elements and contextual factors: An investigation in Brazil. *Journal of Engineering and Technology Management*, *33*, 63-92.

Nam, T., & Pardo, T. A. (2011). Smart city as urban innovation: Focusing on management, policy, and context. Proceedings of the 5th international conference on theory and practice of electronic governance,

Naranjo-Valencia, J. C., Naranjo-Herrera, C. G., Serna-Gómez, H. M., & Calderón-Hernández, G. (2018). The relationship between training and innovation in companies. *International journal of innovation management*, *22*(02), 1850012.

Narayana, V. L., Gopi, A. P., & Chaitanya, K. (2019). Avoiding Interoperability and Delay in Healthcare Monitoring System Using Block Chain Technology. *Rev. d'Intelligence Artif.*, *33*(1), 45-48.

Nemoto, T., & Beglar, D. (2014). Likert-scale questionnaires. JALT 2013 conference proceedings,

Nicola, M., Alsafi, Z., Sohrabi, C., Kerwan, A., Al-Jabir, A., Iosifidis, C., Agha, M., & Agha, R. (2020). The socio-economic implications of the coronavirus pandemic (COVID-19): A review. *Int J Surg*, *78*, 185-193. https://doi.org/10.1016/j.ijsu.2020.04.018

Nicolopoulou, K., Karataş‐Özkan, M., Vas, C., & Nouman, M. (2017). An incubation perspective on social innovation: the London Hub–a social incubator. *R&D Management*, *47*(3), 368-384.

Nittari, G., Khuman, R., Baldoni, S., Pallotta, G., Battineni, G., Sirignano, A., Amenta, F., & Ricci, G. (2020). Telemedicine practice: review of the current ethical and legal challenges. *Telemedicine and e-Health*, *26*(12), 1427-1437.

Njoroge, M., Anderson, W., & Mbura, O. (2019). Innovation strategy and economic sustainability in the hospitality industry. *The Bottom Line*.

Noblin, A. M., Wan, T. T., & Fottler, M. (2013). Intention to use a personal health record: a theoretical analysis using the technology acceptance model. *International Journal of Healthcare Technology and Management*, *14*(1-2), 73-89.

Notar, C. E., & Padgett, S. (2010). Is think outside the box 21st century code for imagination, innovation, creativity, critical thinking, intuition? *College Student Journal*, *44*(2), 294-299.

Nowak, A. (1997). Strategic relationship between quality management and product innovation. *The Mid-Atlantic Journal of Business*, *33*(2), 119.

Omachonu, V. K., & Einspruch, N. G. (2010). Innovation in healthcare delivery systems: a conceptual framework. *The Innovation Journal: The Public Sector Innovation Journal*, *15*(1), 1-20.

Organization, W. H. (2008). *World alliance for patient safety: forward programme 2008-2009*.

Osayawe Ehigie, B., & McAndrew, E. B. (2005). Innovation, diffusion and adoption of total quality management (TQM). *Management Decision*, *43*(6), 925-940. https://doi.org/10.1108/00251740510603646

Paech, N. (2007). Directional certainty in sustainability-oriented innovation management. In *Innovations Towards Sustainability* (pp. 121-139). Springer.

Paech, N. (2013). Economic growth and sustainable development. In *Factor X* (pp. 31-44). Springer.

Page, T. (2014). Notions of innovation in healthcare services and products. *International Journal of Innovation and Sustainable Development*, *8*(3), 217-231.

Pai, F.-Y., & Huang, K.-I. (2011). Applying the technology acceptance model to the introduction of healthcare information systems. *Technological Forecasting and Social Change*, *78*(4), 650-660.

Pakdeelao, W. (2011). *The study of characteristics of innovative organization: Case studies from awarded organizations* Thesis M. Sc. Human Resource and Organization Development. Bangkok: National ...].

Parker, D. (2009). Managing risk in healthcare: understanding your safety culture using the Manchester Patient Safety Framework (MaPSaF). *Journal of nursing management*, *17*(2), 218-222.

Patel, G. (2009). Total quality management in healthcare. *The Midas Journal*, *23*, 1-4.

Patrício, L., Teixeira, J. G., & Vink, J. (2019). A service design approach to healthcare innovation: from decision-making to sense-making and institutional change. *AMS Review*, *9*(1), 115-120.

Pavlou, P. A. (2003). Consumer acceptance of electronic commerce: Integrating trust and risk with the technology acceptance model. *International journal of electronic commerce*, *7*(3), 101-134.

Pekovic, S., & Galia, F. (2009). From quality to innovation: Evidence from two French Employer Surveys. *Technovation*, *29*(12), 829-842.

Pellowe, C., Pratt, R., Loveday, H., Harper, P., Robinson, N., & Jones, S. (2004). The epic project. Updating the evidence-base for national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England: a report with recommendations. *British Journal of Infection Control*, *5*(6), 10-16.

Pendharkar, S. R., Woiceshyn, J., da Silveira, G. J., Bischak, D., Flemons, W., McAlister, F.,

& Ghali, W. A. (2016). What happens when healthcare innovations collide? *BMJ quality & safety*, *25*(1), 9-13.

Perdomo-Ortiz, J., Gonzalez-Benito, J., & Galende, J. (2009). The intervening effect of business innovation capability on the relationship between Total Quality Management and technological innovation. *International Journal of Production Research*, *47*(18), 5087-5107.

Perdomo-Ortiz, J., González-Benito, J., & Galende, J. (2006). Total quality management as a forerunner of business innovation capability. *Technovation*, *26*(10), 1170-1185.

Perlich, A., von von Thienen, J., Wenzel, M., & Meinel, C. (2018). Learning from success and failure in healthcare innovation: The story of tele-board MED. In *Design Thinking Research* (pp. 327-345). Springer.

Pfau, L. D. (1989). Total quality management gives companies a way to enhance position in global marketplace. *Industrial Engineering*, *21*(4), 17-&.

Picone, G., Chou, S.-Y., & Sloan, F. (2002). Are for-profit hospital conversions harmful to patients and to Medicare? *RAND Journal of Economics*, 507-523.

Pikkarainen, T., Pikkarainen, K., Karjaluoto, H., & Pahnila, S. (2004). Consumer acceptance of online banking: an extension of the technology acceptance model. *Internet research*.

Pisano, G. P. (2015). You need an innovation strategy. *Harvard business review*, *93*(6), 44-54.

Pojasek, R. B. (2006). Is your integrated management system really integrated? *Environmental Quality Management*, *16*(2), 89-97.

Prahalad, C. K., & Hamel, G. (1994). Strategy as a field of study: Why search for a new paradigm? *Strategic management journal*, *15*(S2), 5-16.

Prajogo, D. I., & Brown, A. (2004). The relationship between TQM practices and quality performance and the role of formal TQM programs: An Australian empirical study. *Quality management journal*, *11*(4), 31-42.

Prajogo, D. I., & Hong, S. W. (2008). The effect of TQM on performance in R&D environments: A perspective from South Korean firms. *Technovation*, *28*(12), 855-863.

Prajogo, D. I., & Sohal, A. S. (2001). TQM and innovation: a literature review and research framework. *Technovation*, *21*(9), 539-558.

Prajogo, D. I., & Sohal, A. S. (2003). The relationship between TQM practices, quality performance, and innovation performance. *International journal of quality & reliability management*.

Prajogo, D. I., & Sohal, A. S. (2006). The integration of TQM and technology/R&D management in determining quality and innovation performance. *Omega*, *34*(3), 296-312.

Preuss, L. (2007). Buying into our future: sustainability initiatives in local government procurement. *Business Strategy and the Environment*, *16*(5), 354-365.

Prieto Mejia, S., Montes Hincapie, J. M., & Taborda Giraldo, J. A. (2019). A Hub-based university innovation model. *Journal of technology management & innovation*, *14*(1), 11-17.

Propper, C., Burgess, S., & Green, K. (2004). Does competition between hospitals improve the quality of care?: Hospital death rates and the NHS internal market. *Journal of Public Economics*, *88*(7-8), 1247-1272.

Raja, M. P. N., Deshmukh, S., & Wadhwa, S. (2007). Quality award dimensions: a strategic instrument for measuring health service quality. *International Journal of Health Care Quality Assurance*.

Rajendran, M., & Devadasan, S. (2005). Quality audits: their status, prowess and future focus. *Managerial Auditing Journal*.

Ramirez, B., West, D. J., & Costell, M. M. (2013). Development of a culture of sustainability in health care organizations. *Journal of Health Organization and Management*.

Rebelo, M. F., Santos, G., & Silva, R. (2016). Integration of management systems: Towards a sustained success and development of organizations. *Journal of Cleaner Production*, *127*, 96-111.

Reddy, K. S., Patel, V., Jha, P., Paul, V. K., Kumar, A. S., Dandona, L., & Healthcare, L. I. G. f. U. (2011). Towards achievement of universal health care in India by 2020: a call to action. *The Lancet*, *377*(9767), 760-768.

Retseptor, G. (2005). 40 inventive principles in marketing sales and advertising. In:

Citeseer.

Roca, J. C., Chiu, C.-M., & Martínez, F. J. (2006). Understanding e-learning continuance intention: An extension of the Technology Acceptance Model. *International Journal of human-computer studies*, *64*(8), 683-696.

Rodríguez, R., Svensson, G., & Otero-Neira, C. (2019). Future direction of sustainable development in private hospitals: general similarities and specific differences. *Journal of Business & Industrial Marketing*.

Rogers, R. W. (1985). Attitude change and information integration in fear appeals. *Psychological reports*, *56*(1), 179-182.

Rondinelli, D. A., & Berry, M. A. (2000). Environmental citizenship in multinational corporations: social responsibility and sustainable development. *European Management Journal*, *18*(1), 70-84.

Rosing, K., Frese, M., & Bausch, A. (2011). Explaining the heterogeneity of the leadership-innovation relationship: Ambidextrous leadership. *The leadership quarterly*, *22*(5), 956-974.

Rowe, G., & Wright, G. (1999). The Delphi technique as a forecasting tool: issues and analysis. *International journal of forecasting*, *15*(4), 353-375.

Ryu, H. J., Kim, W. S., Lee, J. H., Min, S. W., Kim, S. J., Lee, Y. S., Lee, Y. H., Nam, S. W., Eo, G. S., & Seo, S. G. (2010). Asan medical information system for healthcare quality improvement. *Healthcare informatics research*, *16*(3), 191-197.

Salaheldin, S. I. (2009). Critical success factors for TQM implementation and their impact on performance of SMEs. *International journal of productivity and performance management*.

Samaha, H. (1996). Overcoming the TQM barrier to innovation: TQM focuses only on improving current practices, but identifying work processes that need revamping or replacing is vital to finding new, more efficient ways of doing business. *HR magazine*, *41*, 144-149.

Samanta, J., & Samanta, A. (2015). Quackery or quality: the ethicolegal basis for a legislative framework for medical innovation. *Journal of medical ethics*, *41*(6), 474-477.

Samat, N., Ramayah, T., & Saad, N. M. (2006). TQM practices, service quality, and market orientation. *Management Research News*.

Sandelowski, M., Docherty, S., & Emden, C. (1997). Focus on qualitative methods. Qualitative metasynthesis: issues and techniques. *Research in nursing & health*, *20*(4), 365-371.

Santos-Vijande, M. L., & Álvarez-González, L. I. (2007). Innovativeness and organizational innovation in total quality oriented firms: The moderating role of market turbulence. *Technovation*, *27*(9), 514-532.

Saravanan, R., & Rao, K. (2007). The impact of total quality service age on quality and operational performance: an empirical study. *The TQM Magazine*.

Sawalem, M., Selic, E., & Herbell, J.-D. (2009). Hospital waste management in Libya: A case study. *Waste management*, *29*(4), 1370-1375.

Scheele, D. (1975). II. C. Reality Construction as a Product of Delphi Interaction. *The Delphi method: Techniques and applications*, 37.

Scheib, J. W. (2003). Role stress in the professional life of the school music teacher: A collective case study. *Journal of Research in music education*, *51*(2), 124-136.

Schlegel, D., Kolb, S. J., Luciano, J. M., Tovar, J. M., Cucchiara, B. L., Liebeskind, D. S., & Kasner, S. E. (2003). Utility of the NIH Stroke Scale as a predictor of hospital disposition. *Stroke*, *34*(1), 134-137.

Schochow, M., Schnell, D., & Steger, F. (2019). Implementation of clinical ethics consultation in German hospitals. *Science and engineering ethics*, *25*(4), 985-991.

Schramm, C. (2008). The advisory committee on measuring innovation in the 21 century. Innovation measurement: Tracking the state of innovation in the American economy. A report to the secretary of commerce. January 2008 [Electronic resource]. *Access mode: http://www. esa. doc. gov/sites/default/files/reports/documents/innovation_measurement_01-08. pdf*.

Schultz, C., Zippel-Schultz, B., & Salomo, S. (2012). Hospital innovation portfolios: Key determinants of size and innovativeness. *Health care management review*, *37*(2), 132-143.

Schultz, J. S., André, B., & Sjøvold, E. (2016). Managing innovation in eldercare: A glimpse into what and how public organizations are planning to deliver healthcare services for their future elderly. *International Journal of Healthcare Management*, *9*(3), 169-180.

Schulz, S. A., & Flanigan, R. L. (2016). Developing competitive advantage using the triple bottom line: A conceptual framework. *Journal of Business & Industrial Marketing*.

Segars, A. H., & Grover, V. (1998). Strategic information systems planning success: an investigation of the construct and its measurement. *MIS quarterly*, 139-163.

Sekaran, U., & Bougie, R. (2016). Research methods for business.

Sever, I. (2015). Importance-performance analysis: A valid management tool? *Tourism management*, *48*, 43-53.

Shahin, A., Iraj, E. B., & Shahrestani, H. V. (2016). Developing House of Quality by integrating top roof and side roof matrices and service TRIZ with a case study in banking services. *The TQM Journal*.

Sharma, S. (2002). Research in corporate sustainability: What really matters. *Research in corporate sustainability: The evolving theory and practice of organizations in the natural environment*, 1-29.

Shieh, H., & Wu, K. (2002). The relationship between TQM and project performance in building planning phase: an empirical study of real estate industries in Taiwan. *Total Quality Management*, *13*(1), 133-151.

Shipley, B. (2000). A new inferential test for path models based on directed acyclic graphs. *Structural Equation Modeling*, *7*(2), 206-218.

Shortell, S. M., Bennett, C. L., & Byck, G. R. (1998). Assessing the impact of continuous quality improvement on clinical practice: what it will take to accelerate progress. *The Milbank Quarterly*, *76*(4), 593-624.

Shuaib, M., Seevers, D., Zhang, X., Badurdeen, F., Rouch, K. E., & Jawahir, I. (2014). Product sustainability index (ProdSI) a metrics-based framework to evaluate the total life cycle sustainability of manufactured products. *Journal of Industrial Ecology*, *18*(4), 491-507.

Sila, I., & Ebrahimpour, M. (2005). Critical linkages among TQM factors and business results. *International Journal of Operations & Production Management*.

Singh, P. J., & Smith, A. J. (2004). Relationship between TQM and innovation: an empirical study. *Journal of Manufacturing Technology Management*.

Skulmoski, G., & Hartman, F. (2002). The Delphi method: Researching what does not exist (yet). Proceedings of the International Research Network on organization by projects, IRNOP V Conference, Renesse, the Netherlands,

Sloan, F. A. (2000). Not-for-profit ownership and hospital behavior. *Handbook of health economics*, *1*, 1141-1174.

Smith, J. (1995). The use of quality function deployment to help adopt a total quality strategy. *Total Quality Management*, *6*(1), 35-44.

Smys, S. (2019). Survey on accuracy of predictive big data analytics in healthcare. *Journal of Information Technology*, *1*(02), 77-86.

Sodani, P. R., Kumar, R. K., Srivastava, J., & Sharma, L. (2010). Measuring patient satisfaction: A case study to improve quality of care at public health facilities. *Indian journal of community medicine: official publication of Indian Association of Preventive & Social Medicine*, *35*(1), 52.

Sohal, A. S., & Terziovski, M. (2000). TQM in Australian manufacturing: factors critical to success. *International Journal of Quality & Reliability Management*.

Spagnol, G. S., Min, L. L., & Newbold, D. (2013). Lean principles in Healthcare: an overview of challenges and improvements. *IFAC Proceedings Volumes*, *46*(24), 229-234.

Stake, R. E. (1995). *The art of case study research*. sage.

Steiger, J. H. (1990). Structural model evaluation and modification: An interval estimation approach. *Multivariate behavioral research*, *25*(2), 173-180.

Stevanovic, M., Allacker, K., & Vermeulen, S. (2017). Hospital building sustainability: the experience in using qualitative tools and steps towards the life cycle approach. *Procedia environmental sciences*, *38*, 445-451.

Stienstra, M., Baaij, M., Van den Bosch, F., & Volberda, H. (2004). Strategic Renewal of Europe's Largest Telecom Operators (1992–2001):: From Herd Behaviour Towards Strategic Choice? *European Management Journal*, *22*(3), 273-280.

Stone, P. W., Braccia, D., & Larson, E. (2005). Systematic review of economic analyses of health care-associated infections. *American journal of infection control*, *33*(9), 501-509.

Straub, D., Keil, M., & Brenner, W. (1997). Testing the technology acceptance model across cultures: A three country study. *Information & management*, *33*(1), 1-11.

Su, C.-T., & Lin, C.-S. (2008). A case study on the application of Fuzzy QFD in TRIZ for service quality improvement. *Quality & Quantity*, *42*(5), 563-578.

Su, C.-T., Lin, C.-S., & Chiang, T.-L. (2008). Systematic improvement in service quality through TRIZ methodology: An exploratory study. *Total Quality Management*, *19*(3), 223-243.

Suhrcke, M., Rechel, B., & Michaud, C. (2005). Development assistance for health in central and eastern European Region. *Bulletin of the World Health Organization*, *83*, 920-927.

Suhrcke, M., Rocco, L., & McKee, M. (2007). *Health: a vital investment for economic development in eastern Europe and central Asia*. World Health Organization. Regional Office for Europe.

Sumaila, U. R., Teh, L., Watson, R., Tyedmers, P., & Pauly, D. (2006). Fuel subsidies to global fisheries: Magnitude and impacts on resource sustainability. *Fisheries Centre Research Reports*, *14*(6), 38.

Sureshchandar, G., Rajendran, C., & Anantharaman, R. (2002). The relationship between management's perception of total quality service and customer perceptions of service quality. *Total Quality Management*, *13*(1), 69-88.

Szekely, F., & Strebel, H. (2013). Incremental, radical and game-changing: strategic innovation for sustainability. *Corporate governance*.

Tabachnick, B. G., Fidell, L. S., & Osterlind, S. (2001). Using multivariate. *New York: Statistics*.

Tabachnick, B. G., Fidell, L. S., & Ullman, J. B. (2007). *Using multivariate statistics* (Vol. 5). Pearson Boston, MA.

Talib, F., Rahman, Z., Qureshi, M., & Siddiqui, J. (2011). Total quality management and service quality: an exploratory study of quality management practices and barriers in service industry. *International Journal of Services and Operations Management*, *10*(1), 94-118.

Taques, F. H., López, M. G., Basso, L. F., & Areal, N. (2021). Indicators used to measure service innovation and manufacturing innovation. *Journal of Innovation & Knowledge*, *6*(1), 11-26.

Tasleem, M., Khan, N., & Masood, S. A. (2015). Integrated role of TQM and technology management in organizational sustainability. 2015 International Conference on Industrial Engineering and Operations Management (IEOM),

Taylor, B., Younie, D., Matheson, S., Coutts, M., Mayer, C., Watson, C., & Walker, R. (2006). Output and sustainability of organic ley/arable crop rotations at two sites in northern Scotland. *The Journal of Agricultural Science*, *144*(5), 435-447.

Tello, S. F., & Yoon, E. (2008). Examining drivers of sustainable innovation. *International Journal of Business Strategy*, *8*(3), 164-169.

Terziovski, M. (2006). Quality management practices and their relationship with customer satisfaction and productivity improvement. *Management Research News*.

Terziovski, M., & Samson, D. (1999). The link between total quality management practice and organisational performance. *International Journal of Quality & Reliability Management*.

Thakur, R., Hsu, S. H., & Fontenot, G. (2012). Innovation in healthcare: Issues and future trends. *Journal of business research*, *65*(4), 562-569.

Thawesaengskulthai, N. (2019). *Quality Engineering and Management: Guide to continual improvement and innovation.* (Vol. 1).

Thawesaengskulthai, N., & Tannock, J. D. (2008). Pay-off selection criteria for quality and improvement initiatives. *International Journal of Quality & Reliability Management*.

Thawesaengskulthai, N., Wongrukmit, P., & Dahlgaard, J. J. (2015). Hospital service quality measurement models: patients from Asia, Europe, Australia and America. *Total Quality Management & Business Excellence*, *26*(9-10), 1029-1041. https://doi.org/10.1080/14783363.2015.1068596

Therrien, P., Doloreux, D., & Chamberlin, T. (2011). Innovation novelty and (commercial) performance in the service sector: A Canadian firm-level analysis. *Technovation*, *31*(12), 655-665.

Thiagaragan, T., Zairi, M., & Dale, B. (2001). A proposed model of TQM implementation based on an empirical study of Malaysian industry. *International Journal of Quality & Reliability Management*.

Thomas, B., Ciliska, D., Dobbins, M., & Micucci, S. (2004). A process for systematically reviewing the literature: providing the research evidence for public health nursing interventions. *Worldviews on Evidence-Based Nursing*, *1*(3), 176-184.

Thong, J. Y., Venkatesh, V., Xu, X., Hong, S.-J., & Tam, K. Y. (2011). Consumer acceptance of personal information and communication technology services. *IEEE Transactions on Engineering Management*, *58*(4), 613-625.

Tidd, J. (2006). A review of innovation models. *Imperial College London*, *16*.

Tolson, D., Fleming, V., & Schartau, E. (2002). Coping with menstruation: understanding the needs of women with Parkinson's disease. *Journal of Advanced Nursing*, *40*(5), 513-521.

Tonjang, S., & Thawesaengskulthai, N. (2020). A systematic literature review of TQM and innovation in healthcare. ISPIM Conference Proceedings,

Tontini, G., & Picolo, J. D. (2014). Identifying the impact of incremental innovations on customer satisfaction using a fusion method between importance-performance analysis and Kano model. *International Journal of Quality & Reliability Management*.

Tontini, G., Picolo, J. D., & Silveira, A. (2014). Which incremental innovations should we offer? Comparing importance–performance analysis with improvement-gaps analysis. *Total Quality Management & Business Excellence*, *25*(7-8), 705-719.

Topper, W. W. (2006). *Leadership change in privately controlled businesses: A Delphi study of succession planning best practices* Capella University].

Toytok, E. H. (2016). School Leaders' Innovation Managements and Organizational Stress: A Relational Model Study. *Universal Journal of Educational Research*, *4*(n12A), 173-179.

Tranfield, D., Denyer, D., & Smart, P. (2003). Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British journal of management*, *14*(3), 207-222.

Trifonova, S., & Pramatarov, A. (2016). SWOT analysis of the facility management of hospitals: the case of Bulgaria. *Academy of Contemporary Research Journal*, *5*(1), 1-9.

Trochim, W. M. (1989). Outcome pattern matching and program theory. *Evaluation and program planning*, *12*(4), 355-366.

Tsakona, M., Anagnostopoulou, E., & Gidarakos, E. (2007). Hospital waste management and toxicity evaluation: a case study. *Waste Management*, *27*(7), 912-920.

Tsang, J. H. Y., & Antony, J. (2001). Total quality management in UK service organisations: some key findings from a survey. *Managing Service Quality: An International Journal*.

Tschimmel, K. (2012). Design Thinking as an effective Toolkit for Innovation. ISPIM Conference Proceedings,

Tseng, M.-L., Ha, H. M., Lim, M. K., Wu, K.-J., & Iranmanesh, M. (2020). Sustainable supply chain management in stakeholders: supporting from sustainable supply and process management in the healthcare industry in Vietnam. *International Journal of Logistics Research and Applications*, 1-20.

Tsou, H.-f. (2005). *An effective food and beverage management internship model in Taiwan*. La Sierra University.

Uneke, C. J., Ndukwe, C. D., Oyibo, P. G., Nwakpu, K. O., Nnabu, R. C., & Prasopa-Plaizier, N. (2014). Promotion of hand hygiene strengthening initiative in a Nigerian teaching hospital: implication for improved patient safety in low-income health facilities. *Brazilian Journal of Infectious Diseases*, *18*, 21-27.

van Kemenade, E., & Hardjono, T. W. (2019). Twenty-first century total quality management: the emergence paradigm. *The TQM Journal*.

Van Schaik, P., Bettany-Saltikov, J. A., & Warren, J. (2002). Clinical acceptance of a low-cost portable system for postural assessment. *Behaviour & Information Technology*, *21*(1), 47-57.

Vandenbrande, W. W. (2021). Quality for a sustainable future. *Total Quality Management & Business Excellence*, *32*(5-6), 467-475.

Varkey, P., Horne, A., & Bennet, K. E. (2008). Innovation in health care: a primer. *American Journal of Medical Quality*, *23*(5), 382-388.

Venkatesh, V., & Morris, M. G. (2000). Why don't men ever stop to ask for directions? Gender, social influence, and their role in technology acceptance and usage behavior. *MIS quarterly*, 115-139.

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, 425-478.

Venkatesh, V., & Ramesh, V. (2006). Web and wireless site usability: Understanding differences and modeling use. *MIS quarterly*, 181-206.

Venkatesh, V., Thong, J. Y., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS quarterly*, 157-178.

Vijayasarathy, L. R. (2004). Predicting consumer intentions to use on-line shopping: the case for an augmented technology acceptance model. *Information & management*, *41*(6), 747-762.

Vincent-Höper, S., & Stein, M. (2019). The Leader Support for Innovation Questionnaire (LSIQ): Development and validation of a measure for assessing leader support for innovation. *Leadership & Organization Development Journal*.

Vita, M. G., & Sacher, S. (2001). The competitive effects of not-for-profit hospital mergers: a case study. *The Journal of Industrial Economics*, *49*(1), 63-84.

Volberda, H. W., & Van Den Bosch, F. (2011). Management innovation: a journey into the core of research in management.

Volberda, H. W., Van Den Bosch, F. A., & Heij, C. V. (2013). Management innovation: Management as fertile ground for innovation. *European Management Review*, *10*(1), 1-15.

Walter, Z., & Lopez, M. S. (2008). Physician acceptance of information technologies: Role of perceived threat to professional autonomy. *Decision Support Systems*, *46*(1), 206-215.

Wan, D., Ong, C. H., & Lee, F. (2005). Determinants of firm innovation in Singapore. *Technovation*, *25*(3), 261-268.

Wang, C. C., Lo, S. K., & Fang, W. (2008). Extending the technology acceptance model to mobile telecommunication innovation: The existence of network externalities.

Journal of Consumer Behaviour: An International Research Review, *7*(2), 101-110.

Wang, F.-K., & Chen, K.-S. (2010). Applying Lean Six Sigma and TRIZ methodology in banking services. *Total Quality Management*, *21*(3), 301-315.

Wang, Y.-H., Lee, C.-H., & Trappey, A. J. (2017). Service design blueprint approach incorporating TRIZ and service QFD for a meal ordering system: A case study. *Computers & Industrial Engineering*, *107*, 388-400.

Werts, C. E., Linn, R. L., & Jöreskog, K. G. (1974). Intraclass reliability estimates: Testing structural assumptions. *Educational and Psychological measurement*, *34*(1), 25-33.

West, M. A. (1990). The social psychology of innovation in groups.

Whittinghill, W. (2001). Identification of the initial curriculum components for the preparation of graduate-level substance abuse counselors.

Wijethilake, C. (2017). Proactive sustainability strategy and corporate sustainability performance: The mediating effect of sustainability control systems. *Journal of environmental management*, *196*, 569-582.

Wilkins, M. A. (2009). Factors influencing acceptance of electronic health records in hospitals. *Perspectives in Health Information Management/AHIMA, American Health Information Management Association*, *6*(Fall).

William, K. (1989). Healthcare: Is Total Quality Relevant? *The TQM Magazine*, *1*(2).

Wind, J., & Mahajan, V. (1997). Issues and opportunities in new product development: An introduction to the special issue. In: SAGE Publications Sage CA: Los Angeles, CA.

Winskel, M. (2007). Marine energy innovation in the UK energy system: financial capital, social capital and interactive learning. *International journal of global energy issues*, *27*(4), 472-491.

Wissema, J. G. (1982). Trends in technology forecasting. *R&D Management*, *12*(1), 27-36.

Wonglimpiyarat, J. (2010). Innovation index and the innovative capacity of nations. *Futures*, *42*(3), 247-253.

Wongrukmit, P., & Thawesaengskulthai, N. (2014). Hospital service quality preferences among culture diversity. *Total Quality Management & Business Excellence*, *25*(7-8), 908-922.

Wood, E., & Kaplan, D. (2005). Innovation and performance improvement in the South African wine industry. *International Journal of Technology and Globalisation*, *1*(3-4), 381-399.

Woudenberg, F. (1991). An evaluation of Delphi. *Technological forecasting and social change*, *40*(2), 131-150.

Wu, I.-L., & Hsieh, P.-J. (2011). Understanding hospital innovation enabled customer-perceived quality of structure, process, and outcome care. *Total Quality Management*, *22*(2), 227-241.

Wu, I.-L., & Hsieh, P.-J. (2015). Hospital innovation and its impact on customer-perceived quality of care: a process-based evaluation approach. *Total Quality Management & Business Excellence*, *26*(1-2), 46-61.

Wu, X., Law, C.-k., & Yip, P. S. F. (2019). A Projection of Future Hospitalisation Needs in a Rapidly Ageing Society: A Hong Kong Experience. *International journal of environmental research and public health*, *16*(3), 473.

Xu, J., Wei, L., Wu, W., Wang, A., Zhang, Y., & Zhou, F. (2020). Privacy-preserving data integrity verification by using lightweight streaming authenticated data structures for healthcare cyber–physical system. *Future Generation Computer Systems*, *108*, 1287-1296.

Yang, C. C. (2003). The establishment of a TQM system for the health care industry. *The TQM Magazine*, *15*(2), 93-98. https://doi.org/10.1108/09544780310461107

Yang, C. C. (2006). The impact of human resource management practices on the implementation of total quality management. *The TQM magazine*.

Yang, L., & Xing, K. (2013). Innovative conceptual design approach for product service system based on TRIZ. 2013 10th International Conference on Service Systems and Service Management,

Yang, Y. H. (2001). Software quality management and ISO 9000 implementation. *Industrial Management & Data Systems*.

Yellowlees, P., Odor, A., Patrice, K., Parish, M. B., Nafiz, N., Iosif, A.-M., & Hilty, D. (2011). Disruptive innovation: the future of healthcare? *Telemedicine and e-Health*, *17*(3), 231-234.

Yin, R. (1984). case study research. Beverly Hills. In: ca: Sage.

Yin, R. (2003). Designing case studies. *Qualitative Research Methods*, 359-386.

Yin, R. K. (1989). Research design issues in using the case study method to study management information systems. *The information systems research challenge: Qualitative research methods*, *1*, 1-6.

Yin, R. K. (1994). Discovering the future of the case study. Method in evaluation research. *Evaluation practice*, *15*(3), 283-290.

Youtie, J., & Shapira, P. (2008). Building an innovation hub: A case study of the transformation of university roles in regional technological and economic development. *Research policy*, *37*(8), 1188-1204.

Yu, L., Li, H., Wang, Z., & Duan, Y. (2019). Technology imports and self-innovation in the context of innovation quality. *International Journal of Production Economics*, *214*, 44-52.

Yu, Q., & Yang, K. (2008). Hospital registration waiting time reduction through process redesign. *International Journal of Six Sigma and Competitive Advantage*, *4*(3), 240-253.

Yuan, K. H., & Bentler, P. M. (1998). Structural equation modeling with robust covariances. *Sociological methodology*, *28*(1), 363-396.

Yusof, S. r. M., & Aspinwall, E. (2000). TQM implementation issues: review and case study. *International Journal of Operations & Production Management*, *20*(6), 634-655.

Zanetell, B. A. (2003). Stakeholder collaboration and discourse: Delphi-generated global and local visions for water resources management.

Zeller, J. M., & Levin, P. F. (2013). Mindfulness interventions to reduce stress among nursing personnel: An occupational health perspective. *Workplace health & safety*, *61*(2), 85-89.

Zhang, J., Tan, K.-C., & Chai, K.-H. (2003). Systematic innovation in service design through TRIZ. *The TRIZ Journal*, *9*(1), 1013-1022.

Zhang, Z., Waszink, A., & Wijngaard, J. (2000). An instrument for measuring TQM implementation for Chinese manufacturing companies. *International Journal of Quality & Reliability Management*.

Zhao, S., Zhu, Q., & Cui, L. (2018). A decision-making model for remanufacturers: Considering both consumers' environmental preference and the government subsidy policy. *Resources, Conservation and Recycling*, *128*, 176-186.

Zuckerman, A. M. (2006). Advancing the state of the art in healthcare strategic planning. *Frontiers of health services management*, *23*(2), 3.

VITA

NAME	สืบสกุล โทนแจ้ง
DATE OF BIRTH	7 กันยายน 2537
PLACE OF BIRTH	พิษณุโลก
INSTITUTIONS ATTENDED	จุฬาลงกรณ์มหาวิทยาลัย
HOME ADDRESS	21/5 หมู่ 12 ต.หัวรอ อ.เมือง จ.พิษณุโลก 65000
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