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The Study Of Quality Improvement By Applying The Lean Approach: Survey And Case Studies Of Hospitals In Thailand

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Abstract

Background and Aim: *This research aims to investigate the adoption level of the Lean production system in hospitals in Thailand and to study the strategic approach to successfully implementing Lean in hospitals in Thailand.*

Materials and Methods: *This study is a mixed-method research study using questionnaires to survey the level of Lean adoption in hospitals in Thailand and in-depth interviews to research the strategic approach for successfully implementing Lean in hospitals in Thailand. The questionnaire was validated by hospital quality improvement experts. The survey received 160 complete responses, and two hospitals participated in the in-depth interviews.*

Results: *The quantitative results revealed that most hospitals in Thailand have adopted Lean in only some parts of the hospital. Notably, the Regional hospital group showed the highest average level of Lean adoption. The study's findings suggest that leadership, staff involvement, and perception are critical factors for successful Lean implementation in hospitals in Thailand.*

Conclusion: *Most hospitals in Thailand implement Lean at the medium level. For successful Lean implementation in hospitals in Thailand, the approach for them is integrating three factors: leadership, staff, and perception. Moreover, 'Perception' is one of the key factors in lean implementation, so Perception-Control Theory (PCT) in Lean implementation in hospitals should be studied further.*

Keywords: *Lean, Hospital Quality Improvement, Quality improvement, Lean production*

INTRODUCTION

There are various theories and concepts related to quality improvement, such as Total Quality Management (TQM), Six Sigma, Lean Six Sigma (LSS), the Theory of Constraints (TOC), Agile Management, and Lean Thinking (Asif et al., 2009). Many organizations have chosen quality improvement strategies to gain a competitive advantage (Brown, 1994; Asif et al., 2009). These quality management concepts can be integrated to enhance organizational performance (Soare, 2012). Among these, Lean Thinking, which focuses on eliminating waste in processes and adding value to products or services focused on customers, is the core of other quality management systems such as TQM and has a more significant role in improving competitive advantage. Additionally, Lean management emphasizes continuous learning and development by focusing on organizational culture and employees rather than overall quality management (TQM) (Pettersen, 2009) (Rattanawiboonsom & Khan, 2024). Unlike TQM, Lean has also been shown to influence innovation skills (Aoun et al., 2018). Therefore, Lean is vital in helping organizations achieve quality awards (Corbett, 2011).

Lean Thinking is a continuous improvement (CI) concept focusing on reducing waste and non-value-added activities in production or service processes. It aims to create value from the customer's perspective. Originating from Toyota's automotive manufacturing system in Japan, Lean helped improve efficiency by reducing lead time, reducing costs, and increasing production quality. This system became widely known as the "Toyota Production System" (TPS) (Liker, 2004). Womack et al. (1990) argued that Lean could be applied universally to all organizations (Cooney, 2002; Srichuachom, 2015) (Khan, Qureshi, et al., 2025). However, some studies suggest that not all industries can successfully implement Lean, as different sectors may require specific strategies or approaches for Lean adoption (Carlborg et al., 2013) (Qureshi et al., 2025).

Even though many studies have shown successful Lean adoption in hospitals (Kim et al., 2006), Lean in hospital management is still in its early stages, lacking an integrated approach tailored to the hospital context (Akmal et al., 2020). There is often a lack of integration across the supply chain or the entire organization (Costa & Fiho, 2016; Akmal et al., 2020), and challenges similar to those in the manufacturing sector are encountered, such as misunderstandings about Lean as merely a tool (Liker & Morgan, 2006; Kim et al., 2006). Additionally, the effectiveness of Lean implementation in hospitals is often unclear (Kim et al., 2006), and the sustainability of Lean practices tends to decline over time (Ulhassan et al., 2014a; Ulhassan et al., 2014b). Research has also sought to identify success factors and obstacles to Lean implementation (Al-Balushi et al., 2014) (Jabeen et al., 2025).

Therefore, for Lean to succeed in hospitals, specific studies are needed to identify factors, methods, or strategies that can ensure effective and sustainable Lean implementation tailored to the unique characteristics of hospitals, which differ from the manufacturing industry (Henao et al., 2019). Culture is a crucial factor in Lean's success. Liker & Hoseus (2010) stated that Toyota's culture, where continuous improvement (CI) through the Plan-Do-Check-Act (PDCA) cycle is embedded, was critical to its success and difficult to replicate in cultures like the U.S. or other Western countries. Each organization must adapt Lean principles to its unique culture and needs (Pettersen, 2009) (Rattanawiboonsom et al., 2025). Hence, the successful adoption of Lean in hospital quality management in Thailand may require specific strategies aligned with the local cultural context.

Organizational culture is a significant factor in Lean's success, as seen in Toyota's case (Antony & Kumar, 2012; Al-Balushi et al., 2014; White et al., 2013). Achieving a successful Lean transformation, which involves organizational culture change (AlManei et al., 2018), requires effective change management to ensure the changes are successfully implemented from the outset (Kotter, 2002; Natthaya Sintarakanphol, 2009; Price & Chahal, 2006) (Khan, Falahat, et al., 2025). This research adopts change management theory as the foundation for developing a framework for the successful implementation of Lean in Thai hospitals, considering the unique characteristics, operations, and culture of Thai hospitals.

Implementing lean thinking in hospitals in Thailand was first promoted by the Hospital Accreditation Institution in 2009 at the 10th Hospital Accreditation (HA) National Forum. After that time, many hospitals presented their lean implementation projects and performances at the HA National Forum every year. However, only three hospitals were still listed as winners of the Thailand Lean Award, and there is no study on the success of lean implementation in hospitals in Thailand. Most studies on lean implementation in Thailand have focused on a single unit or process. This study has the first objective to identify the level of hospitals in Thailand that adopt lean in their organisation by measuring the maturity level of lean implementation. Moreover, the reimbursement system in healthcare in Thailand and Thai culture may require a specific approach to implement lean into the system successfully. Thus, the second objective of this study is to study the strategic approach to successfully implementing Lean in hospitals in Thailand

OBJECTIVES

The objectives of this study are

- to investigate the adoption level of the Lean production system in hospitals in Thailand
- to study the strategic approach to successfully implementing Lean in hospitals in Thailand.

LITERATURE REVIEW

Concept, Principles and Lean Production

Lean Thinking is a concept that started with automobile manufacturing in Japan in 1960 by Ohno Taiichi and later became well-known under the name Lean Production from the book The Machine that Changed the World by Womack (1990 as cited in Basu, 2009). Lean is the concept of reducing or eliminating waste or activities that do not create value from the customer's perspective from the production or service processes. Moreover, it requires the acceptance and participation of everyone in the organization to implement the lean concept successfully. Womack J. & Jones D. studied the lean concept from the Toyota Production System and concluded that the principles of lean (Lean Principles) consist of identifying the value of products and services (Customer Value), showing the value stream or value map (Value et al.), making the value flow

continuously (Flow), letting customers extract value from the process (Pull), and creating value and eliminating waste continuously (Perfection).

The lean production system has many tools to eliminate or reduce waste and activities that do not create value according to lean principles. These tools are called lean tools. Cudnney (2014) collected all lean tools and divided them into three types according to the level of knowledge required to manage them.

Direct measurement of lean implementation is complex. Most are measured as the performance or capabilities of the organization instead, which can be measured in many dimensions, such as time, cost, quality, and efficiency. Arthur (2007) summarised the indicators often used to measure value flow. Which is one of the crucial principles of the lean concept, including Lead time, Value-added ratio, Distance of products or people working, Productivity, Quality

Performance can be measured from many perspectives for measuring lean results in the service sector, such as hospitals. In the study by D'Andreamatteo et al. (2015), it was stated that the measurement of lean's results on performance is both tangible and intangible, including productivity results, production costs, quality of treatment, patient and relative safety, patient and relative satisfaction, and financial results. The study of Chiarini & Barcarani (2016; Fillingham, 2007) measured results in more dimensions, such as patient satisfaction, the time patients spent receiving services, waiting time, financial status, errors, inventory reserves, motivation and responsibility, communicating the need to send patients to the rehabilitation ward, number of days in bed, mortality rate, and multidisciplinary teamwork. However, the measurement of lean should not be measured by only one component, such as measuring time alone. Other measurement systems should be used as well. In order to measure lean comprehensively (Kollberg et al., 2007), from the study of Shazali et al. (2013), which studied the structural relationship between lean practices of hospitals and the performance of hospitals in Malaysia, the performance measurement of hospitals was divided into three aspects: financial performance, customer satisfaction, and employee performance. In order to successfully and sustainably apply lean to improve the process, it requires an understanding of the fundamental principles of lean, more than just selecting lean tools or lean production system techniques to apply (Anand & Kodali, 2009; Liker & Hoseus, 2010; Bicheno, & Holweg, 2016; Groove et al., 2010). However, organizations must learn until there is a learning cycle within the organization (Mazur et al., 2012). It must consider the impact of social and technological aspects that may change (Joosten et al., 2009), including the acceptance or mutual agreement of individuals in the organization, solid organizational leadership, and careful planning. Including the need to create knowledge and understanding for the organization's personnel (Anand & Kodali, 2009; Pavnaskar et al., 2003). Since the widespread use of lean concepts, many frameworks or models of lean principles and concepts have been developed to successfully apply lean concepts in organizations, following the prototype Toyota.

Change Management

Organizational change management refers to planning, managing, leading, and controlling an organization's change process to improve its performance and achieve its strategic goals. Failure to manage change can lead to 1) accumulated organizational problems, 2) business survival, and 3) social and environmental impacts. Meanwhile, effective organizational change management enables the organization to change in response to customer needs, perceptions, and preferences, enables the organization to cope with fluctuations in both internal and external environments, enables the organization to improve or maintain its financial and non-financial performance, and enables leaders to motivate employees to develop their potential (Ha H., 2014).

Both external and internal factors can cause change. In the event of a change, whether it is a change from external factors such as new technologies or a change from internal factors such as changes in organizational culture, if the company or organization fails to cope or fails to manage change quickly and effectively enough, it may cause stress that becomes resistance to change (Price, & Chahal, 2006) and may cause the organization to fail from the beginning (Kotter J. P., 2002; Natthaya Sintrakanphon, 2009)

Price and Chahal (2006) stated that an effective and efficient change process is an essential factor in the success of change, and support for organizational culture will also help achieve success. Learning to apply and continuously develop is necessary for lean implementation until it becomes the organizational culture, as mentioned above. From the comparison of the change management model of AlManei et al. (2018), it was concluded that the model of change that is suitable for lean implementation in the organization, which is a

Transformation change, is the 8-step model of change management of Kotter (2002), consisting of recognizing the urgency of change, building a core team, creating the right vision, communication, delegation, creating short-term success, not neglecting, and making changes all the time by stimulating a new organizational culture.

Characteristics of the hospital industry and hospitals in Thailand

Characteristics of the Hospital Business: Hospital services have specific characteristics that are different from other service businesses. Namely, they are more complex (Young, 2005; Al-Baliushi et al., 2014). The service process does not directly depend on the service activities. However, the hospital service process depends on the patient's information for treatment (Information-based activities) (McLaughlin, 1996). The treatment process for each patient is specific and varies depending on the disease, symptoms that the patient has (Young et al., 2004) and expectations from the treatment (McLaughlin, 1996). Therefore, data management or the quality of data collection in the hospital is an important factor in the hospital's management. However, because the treatment process is complex and involves many departments, and the hospital is divided into many sub-departments, there is a silos (Kim et al., 2006) and separate data collection. As a result, the data is scattered and is an obstacle to applying the lean concept to improve the process, including being inconsistent with the principles of the lean concept that focuses on improving the entire system or the entire organization. Hospital services are specific to customers (patients) and comparable to the small-volume production system or the customized production system of the manufacturing industry. This makes it difficult to manage lean quality, which requires a high level of process standardization.

In addition to the specificity and complexity of hospital services, the hospital hierarchy comprises administrative and clinical specialties hierarchies (Rich & Piercy, 2013). Doctors, comparable to shop-floor employees in the manufacturing industry, play an essential role in the treatment process. However, doctors have different characteristics from general shop-floor employees; they are knowledgeable and expect freedom in their work. Therefore, assigning doctors to work under conditions that they do not agree with or are limited to may result in a lack of cooperation from doctors and resistance (Liker & Morgan, 2006), which is an obstacle to applying lean concepts to improve the quality of services.

Characteristics of hospital services in Thailand : The management characteristics of private and government hospitals are different. Customers and payers in private hospitals are the same, making it easier for private hospitals to find the value they want. In government hospitals, most customers are not paying for their treatment, and the cost of treatment is often based on the coverage of government medical benefits. However, the management of government hospitals has the advantage of easily reallocating resources (Radnor et al., 2012). In Thailand's public health system, the majority of patients, almost 100 percent, are covered by government health benefits. Data from the Office of the Registrar, National Health Security Office (Poonsuk Nilkijsaranon, 2019) shows that Thailand has a public health system with three state health insurance funds: the Universal Coverage Scheme (UCS), the Social Security Scheme (SSS), and the Civil Servant Medical Benefit Scheme (CSMBS). Each fund provides different treatment rights and reimbursements for drugs and treatments (Thammatach-aree, 2011), which may affect the quality of service. The quality of medicine and the level of expertise in providing services (Nonkhuntod & Yu, 2018) affect the decision-making process of doctors and patients (Hallam & Contreras, 2018) in choosing medical treatment methods. It may be one of the factors that cause patients with the same disease characteristics, disease progression, and symptoms to receive different treatments. This makes the decision-making process of choosing medical treatment methods in Thailand more complicated and different from other countries, especially countries that have studied and published a lot about the application of lean concepts in hospitals. For example, in the United States, which has successfully applied lean concepts in private hospitals (Brandao de Souza, 2009), most service recipients use private health insurance and the government health insurance system. Meanwhile, the United Kingdom, which has a total welfare public health system under the National Health Service (NHS), is more interested in applying lean concepts in the government sector.

Many reimbursements in healthcare in Thailand, including three funds (which have different criteria for reimbursement), health insurance, and self-pay, may result in a more complex process than in other countries and may affect the success of lean implementation. Previous studies on the contextual factors of factories and hospitals regarding Lean implementation have provided valuable insights. Study by Vanichchinchai (2021)

examined how various characteristics of hospitals in Thailand, such as years of Lean implementation, hospital size, hospital type, and ISO 9001 certification, affected Lean expectations and Lean performance outcomes. The findings revealed that hospital size and the number of years implementing Lean significantly influenced Lean performance outcomes. In contrast, hospital type had no significant effect. The finding that hospital size influences Lean implementation aligns with studies by Shah and Ward (2003) and Tortorella et al. (2017), which concluded that larger factories are more likely to adopt Lean practices or implement Lean in their supply chains than smaller ones. Meanwhile, Mazzocato (2014) suggested that the complexity of internal hospital processes influences the improvement and sustainability of Lean implementation. However, no studies on the success of lean implementation in the Thai Healthcare sector were found.

CONCEPTUAL FRAMEWORK

To successfully apply Lean Production into different sectors, including healthcare, need to integrate their culture. Change Management will help incorporate Lean Production and its culture for successful Lean implementation.

METHODOLOGY

This study of lean quality development is exploratory research with a sequential mixed-method design. It starts with quantitative research, a survey using a questionnaire with a 5-point Likert scale to study the level of lean concept implementation in hospitals in Thailand at present. Then, a case study, which is a qualitative study, is conducted to find an approach to successfully implementing the lean concept in hospitals in Thailand.

Sample

The sample group used in the questionnaire research is 500 hospitals in Thailand randomly selected from various hospital groups using the cluster sampling method, excluding small hospitals and hospitals that do not provide overnight or inpatient services because they do not have staff directly responsible for hospital quality development. Subdistrict health promotion hospitals are also excluded because they are under the operation of larger hospitals and cannot operate independently. When calculating the margin of error at +/- 4% at a 95% confidence level and calculating the response rate at 50% from the total population, The sample group used in the research of research question 1 consisted of the following numbers: 12 regional hospitals, 31 general hospitals, 286 community hospitals, 44 hospitals under other ministries, and 127 private hospitals, totalling 500. The population was selected by purposive sampling to conduct a case study. The hospitals with high lean maturity scores and willingness to participate were selected as the case study hospitals

RESEARCH METHODOLOGY

This research has been examined for content validity by three experts. The quality of the content validity of the questions is checked. By considering the consistency of the questions with the definitions of the variables and the clarity of the language for each item, the questionnaire that has been reviewed for content validity by experts and improved language was tested with the sample group to test the reliability of the questionnaire. The sample group used for testing has the same characteristics as the sample group. However, it is not a sample group but has characteristics similar to the sample group used in the analysis. The questions used to measure consist of Part 1: Applying lean concepts in the hospital, including organizing training, creating mutual agreements, creating understanding for employees, involving supervisors, providing support in terms of time and resources, forming a team, finding value (Value), finding waste (Waste) and creating a value stream map (Value Stream Map), cooperation between departments, setting work standards, using a pull system, using Visual Control, multidisciplinary cooperation, and setting activity goals. Part 2 is an analysis of lean culture in the hospital and the results of organizational improvement with lean. The organizational

culture consists of organizational vision, leadership, value stream creation, process improvement, and support for hospital employees. Part 3: Results from process improvement with lean tools.
Qualitative data collection is an in-depth interview. Each interview takes about 60-90 minutes, with notes and audio recordings during the interview. The selection of informants will use the method of specifying informants (Intensity sampling) as representatives from the executive level, at least one person per hospital. The conversations during the interviews will be transcribed and the recorded conversations will be sent to the interviewees to check the interview data's accuracy to verify the data's accuracy (Construct validity) (Yin, 2009).
Data analysis from the questionnaires used descriptive statistics with the SPSS statistical program. The analysis of data in the case study used data from 3 parts to analyze the data: data obtained from documentary research, data from key informant interviews, and data from the hospital's questionnaire in Part 1. The data were analyzed using within-case analysis and Thematic - Cross Case Analysis (Creswell, 2013). The data collection and analysis of qualitative data will use the NVivo program to collect data and decode (coding).

RESULTS

We sent the questionnaires to the sample group the first time via mail and asked the respondents to answer the questionnaires via online channels a total of 2 times. It was found that the first time, there were ten responses. After four weeks, we sent the questionnaires online a second time and received 36 responses. In total, the responses from distributing the questionnaires online were 46 responses. We sent the questionnaires via mail again (454 responses), and 133 responses were received. In total, the responses were 179 questionnaires.
From all the responses, there were 19 incomplete responses and duplicate responses. The total number of responses that could be used was 160, representing a response rate of 32.00 per cent. The response rates from the sample group separated by hospital type are shown in Table 1.

Table 1 Response rate

Hospital type	SAMPLE	RESPONSE	RESPONSE RATE
Regional hospitals	12	7	58.33
General Hospital	30	18	60.00
Community hospitals	264	80	30.30
Non-Ministry of Public Health hospital	61	29	47.54
Private hospital	133	26	19.55
total	500	160	32.00

The general data of the respondents were analyzed using descriptive statistics in frequency and percentage, as shown in Table 2.

Table 2 The frequency and percentage of the general data of the respondents.

PROFILE	COUNT	PERCENTAGE
Age		
20 - 35	18	11.30
35 – 45	60	37.50
45 up	82	51.20
Sex		
Male	17	10.60
Female	140	87.50
Other	3	1.80
Position		
Eexcutive in QI division	39	24.40

PROFILE	COUNT	PERCENTAGE
Head of QI division	58	36.30
Head of operations unit (with QI experience)	32	20.00
Employee (with QI experience)	28	16.90
Other (with QI experience)	4	2.50
Experience in Quality improvement		
< 1 year	8	5.00
1-5 years	42	26.30
5-10 years	24	15.00
10 years up	86	53.80
Occupation		
Physician	16	10.00
Nurse	91	56.90
Pharmacist	31	19.40
Other	5	3.10
Non-Healthcare professional	17	10.60
Hospital type		
Regional hospitals	7	4.40
General hospital	18	11.30
Community hospitals	80	50.00
Non-ministry of Public Health hospital	29	18.10
Private hospital	26	16.30

Overview of Lean Implementation in Hospital Quality Development

When analyzing the overall score of lean implementation in hospitals, it was found that most hospitals in the country had lean implementation at a level of partial implementation, with a score range of 118-153 points, 36 hospitals (34.00 per cent), and the next highest level was implementation in all parts of the hospital, with a score range of 154-189 points, 33 hospitals (31.00 per cent).

The study's results found that the level of lean implementation in hospitals under the Ministry of Public Health, including regional hospitals, general hospitals, and community hospitals, was mostly partial, while the group of hospitals outside the Ministry of Public Health and hospital groups had the highest number of hospitals at a level of implementation in all parts of the hospital.

Analysis of lean adoption in hospitals

The study results found that most hospitals had lean activities in each activity at a level of partial implementation in the hospital (average score range of 2.61-3.40). There was only one lean activity with an average value at a level of implementation in all parts of the hospital (average score range of 3.41-4.20), which was the establishment of work standards. The mean score is 3.45) and there are lean activities that are in the initial implementation stage in the hospital (the mean score is between 1.81 and 2.60), including organizing lean training, creating mutual agreements for employees, creating understanding about lean, setting up a specific implementation team, creating a value stream map, designing processes from VSM, creating a pull system, and continuously developing or improving with lean.

Analysis of lean culture in hospitals

Analysis of lean culture in hospitals found that most had a relatively high level of lean culture (average between 3.41 and 4.20), with continuous learning culture as the activity for which most hospitals had the highest average score (average between 4.01). Cultures with moderate hospital operations (average between 2.61 and 3.40) included creating short-term success, setting goals or objectives for all activities, creating a pull system, improving processes by finding waste, and constantly testing employees.

Results from process improvement with lean tools

When analyzing the results from process improvement with lean tools, measured in financial dimensions, service recipient satisfaction, time results, service quality (less errors), employee productivity, and trend of results, it was found that the use of lean tools in hospitals had a significant effect on the results of most hospitals, including financial status, service recipient satisfaction, service quality (less errors), and drug and medical supply reserves (average range between 3.41-4.20), but had a moderate effect on the results of time and employee working hours (average range between 2.61-3.40).

The approach and factors affecting the application of lean hospitals in Thailand

From the results of the survey on the maturity level of lean implementation in hospitals in Part 1, the researcher used the total score to select one hospital from each group of hospitals to collect data as a case study using in-depth interviews to study the approaches and factors affecting the application of lean concepts in hospitals in Thailand from the perspective of hospital quality development leaders. From the total score of lean implementation maturity level in hospitals, there were 43 hospitals with lean implementation at level 4, with lean implementation in every part of the hospital, and at level 5, with lean implementation in every part of the hospital and continuously, totalling 43 hospitals. The researcher contacted 43 hospitals, including hospitals that received the Thailand Lean Award, to request data collection for the case study. Only community hospitals and hospitals outside the Ministry of Public Health responded.

General information about the hospitals studied and key informants

In this case study using semi-structured in-depth interviews, two hospitals were conducted, and three key informants were executives or leaders of hospital quality development.

Hospital A is a hospital under the Ministry of Education located in the northern region of Thailand. It has advanced tertiary-level capabilities and technology. This hospital has a mission in medical education and medical research, consisting of specialists in all majors, minors and minors as needed, with a size of 400 beds. The organizational structure has a quality control unit responsible for the hospital, which is quality assurance. Hospital A has a total score of a lean implementation maturity level of 5, which has been applied continuously in every part of the hospital. **Key informant-1** is a physician who has worked in quality development at Hospital A for 13 years. He is currently the deputy dean for administration and quality assurance. **Key informant-2** is a pharmacist who has 15 years of experience in quality development at Hospital A. She is currently the assistant dean for quality assurance.

Hospital B is a community hospital under the Ministry of Public Health. It has secondary level capabilities, level F1, meaning it is a large community hospital with 90-120 beds. It has general practitioners and specialists in every major field. It is located in the northern region of Thailand. The organizational structure has a quality centre responsible for quality development within the hospital and the network hospitals. This hospital has a total score of lean implementation maturity level of 4, and lean has been applied in every part of the hospitall. **Key informant-3** She is a pharmacist who has worked in quality development at Hospital B for 18 years and currently holds the position of Quality Center Manager.\

Results of Semi-structured In-depth Interview

Hospital A

The informant from Hospital A commented on the successful implementation of lean in the hospital, which requires support from the executives, hospital policy setting and supervision. The details of the issues are explained in the following example sentences:

Key informant – 1 provided information on support from senior leaders that affects the successful implementation of lean, which requires budget, resources support and monitoring KPIs to make lean in the hospital successful, as follows:

"*... Support from leaders, such as wanting to load more people here, there must be someone to help screen, long lines at the medicine counter, asking for people to help, after doing it, it must be seen that the outcome is better, their work is lighter. Otherwise, they will do the same thing, it is their last resort, support people or have a program, cut this and that, etc...*"

Key informant -1 commented on the motivation of hospital staff to participate in process improvement using lean tools as follows:

"*... but they must feel first that what they have done is not in vain; their words do not go in one ear and out the other because they are just small operators, right? Changing lean is like this. It is a cross-disciplinary work. We cannot adapt*

alone. We have to adjust the IT systems. Sometimes, it is not just us. Even if we know that a good flow should be like this, we do not know who to tell to change it...."

In addition, Key informant-1 also gave his opinion on team formation, training to provide knowledge about lean concepts, and organizing workshops to support the improvement of processes within the hospital with lean tools to be successful, as follows:

"*...Actually, there should be a team. It may not be a lean team, but a quality team that understands many quality tools and can apply them to different situations. ...*"

The key informant-1 gave suggestions about motivation to solve the problem of lack of cooperation in improving the work process with lean tools, as in the following message:

...If they work more comfortably, they must cooperate, right? If they still do not see the benefits, they do not know why they should do it... When the results are good, the steps are reduced, the time is reduced, work is more comfortable, use it as a reward, receive an award, etc., it may make them want to do it more.

Key informant - 2 provided information about support from senior leaders that affect the successful implementation of lean, which requires budget support, instructions, and setting indicators to make lean in the hospital successful, as follows:

"...Support money, people, and things because some things need to be improved. There may need to be an adjustment of the flow. It cannot be adjusted if the executives do not come to help decide the flow."

Key informant - 2 gave comments about the importance of middle leaders that affect creating an atmosphere that motivates process improvement, as in the following example sentence:

"...I mean leaders at all levels. I mean that leaders play a part in creating the atmosphere. Leaders at the unit level also have an impact. If these people have a concept about quality, They will make it run continuously...I think the atmosphere is freedom of thought. Allowing people to think for themselves, be creative, and create this and that. It will make people develop and have freedom of thought, where they do not feel afraid. It has to be open... The atmosphere is sent from the top management. It means that the atmosphere created by the top management will affect the middle level. It will affect the work site... If you propose it and it is accepted, you can do it, you can do it, and you do not have to be afraid of making mistakes or anything like that..."

"...In the Laboratory division example, the key to success is the supervisor. The supervisor knows many tools, has ideas about quality development, and has juniors do this and that. I think this comes from the supervisor."

Key informant-2 gave his opinion about the motivation to improve the work process with Lean from recognizing the problems and seeing the benefits of the improvement as follows:

"...The lab did it themselves. I think it is because they saw the benefits of the tools. It makes them better, faster...It came from their complaints. The lab is slow. There were complaints about the lab being crowded in the morning. They had to make a system like this. There was no coercion...."

In addition, Key informant-2 gave information about training or listening to experiences of improving the process with lean tools. It affected the cooperation of the employees as follows:

"...I think training must be given at all levels. Every level because it creates cooperation. If only the supervisor does it, some supervisors cannot pass it on."

Hospital B:

Key informant-3 from Hospital B gave his opinion about the successful implementation of lean in the hospital. It is necessary to set a direction, indicators, and supervision. Including receiving the diagram from the senior leadership team, with the issues explained in detail, such as the following example sentence:

"*... I think the most important thing is the leader. Moreover, it is a leader who has a clear direction, always supervising and following up and ... listening. However, for things that are not yet done, they will prioritize. ...*"

Key informant 3 explained that middle leaders, such as department heads, must control, supervise, follow up on work, and analyze problems for correction and improvement.

"*... Another critical person is the head of the department, who must supervise and make them follow one, two, three, four, and five. Moreover, the head of the department must follow up on the information to see if they have done it or not. If they have done it, is it still slow? We have to sit down and analyze together whether we have done it or not.*"

Key informant 3 provided information about the hospital's teamwork culture, which is part of its success in improving its work or operations.

"*... For the hospital, it will be about teamwork and safety culture. The first thing is the teamwork culture. I think it is the core value of the hospital. That is, do everything as a team. Otherwise, it will not be successful.*"

In this regard, the main informant-3 provided information about visiting the supervisor's unit to listen to problems and support problem-solving. This will make the staff feel involved. Having a support team will make the improvement or operation go in the same direction, as in the example sentence below.

"*...Visiting the unit, he said that if there is a change in the report, he will be encouraged to report and develop together. It is like saying something, and someone responds. He will feel that he is involved. ...In particular, the Facilitator position uses the coaching method, which means going in to give ideas about what to do and whether there are other ways to achieve the same goal. No matter what the tool is, the FA is important.*"

The main informant-3 provided information about training or introducing new tools in the hospital that they will use words that make it seem easy and not technical terms that make the staff feel difficult to understand, which will cause resistance, as in the following sentence:

"*...Because the doctor and I do not want to have a lot of English transliterated words, we should learn that this is a way to reduce steps. At least the goal is the same: patient safety. Reduce waiting times, which is Thai. We can learn on-site that it is Reducing steps, not shortcuts. Reduce steps to reduce waiting and patient safety. Something like this...*"

In this regard, Key informant-3 provided information that creating understanding or a mutual agreement and recognizing the benefits of improving the process with lean tools will result in more employee cooperation.

"*...The steps in the work should be under the specified guidelines; we must follow them because if we do not do it at that time, it is equal to the risk of causing patients to be unsafe or having to wait longer. Because the guidelines and procedures guarantee that if we follow 1, 2, 3, 4, 5, which are reduced from 6, 7, 8, 9, 10, and it is something that we adjust the new steps, it is expected that patients will receive the service that we expect. The guaranteed time of the pharmacy room is no more than 30 minutes. The period from 11 a.m. to noon is no more than 45 minutes. If we follow this, the employees or all personnel at all levels understand this, right? It will make the work go in the same direction... They will have a kind of motivation when they are involved. If we analyze this, the hospital's money increases... and when others see they are useful, they will participate more.*"

From the information from key informants from the semi-structured in-depth interviews mentioned above, it is possible to summarise the approach for using lean tools to improve the quality of hospitals in Thailand (as shown in Figure 2).

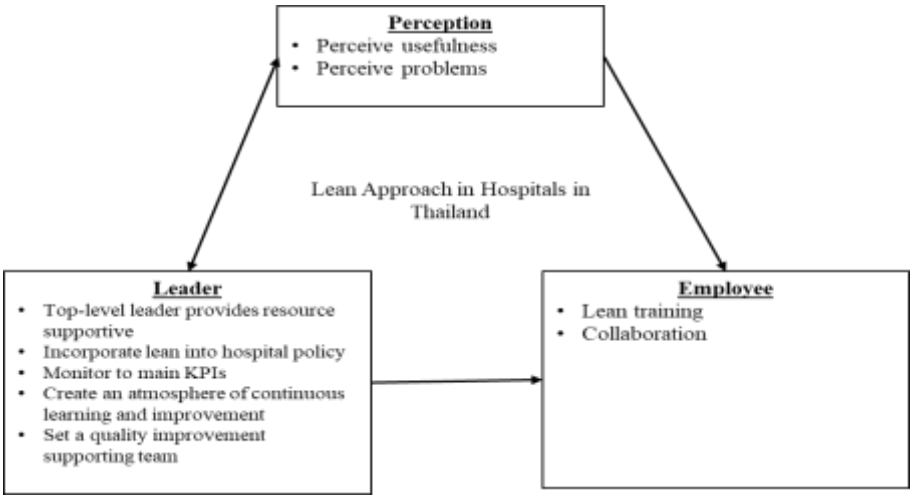

Figure 2 The framework of lean implementation approach in hospitals in Thailand.

From Figure 2, we can summarise the guidelines for implementing quality development tools in hospitals in Thailand as follows:

1. Organizational leaders

Senior leaders should define quality development with lean tools as part of the hospital's policy or strategy, provide support in various aspects, and monitor the results for the implementation of quality development with lean tools to be successful. The topics that need to be supported are as follows:

1.1 Providing necessary resources for quality development activities with lean tools in the hospital, including human resources, budget, time, and technology; defining quality development as part of the hospital's policy, in the strategic plan, or as indicators, including creating a teamwork culture;
1.2 Providing supervision and monitoring of important indicators from senior leaders and supervision and monitoring of indicators of the unit from middle leaders or heads of various units;
1.3 Creating an atmosphere in the hospital to promote continuous learning and development, such as allowing employees to express their opinions and listening to their problems; Providing freedom of thought, and creating an atmosphere that is free from fear when mistakes are made;
1.4 Creating a team to support hospital quality development to be a consultant, assist, and support the necessary resources to develop the quality of various units in the hospital;

2. Employees

Employees should be encouraged and supported for quality development with lean tools in the hospital to succeed. Furthermore, there is teamwork as follows:
2.1 Providing training on lean concepts, lean tools, and lean tool development for all levels of employees in the hospital, including organizing workshops or activities in all employees to participate. Using easy-to-understand vocabulary for employees will make employees accept quality development tools more than using English transliteration, which is difficult for operational staff to understand.
2.2 Encouraging employees to collaborate in quality development using lean tools in the hospital, such as creating joint agreements, setting indicators for the unit, providing incentives, and organizing activities to promote teamwork between multidisciplinary professionals, etc.

3. Perception

Perception of problems that occur both in the unit and in the hospital and perception of the benefits of quality development tools, such as lean tools, for both leaders and employees in the hospital will allow both leaders and employees in the hospital to take the initiative in solving problems that occur by using lean tools and result in collaboration.

DISCUSSION

The results show that quantitative research using questionnaires has a very low response rate (32.00%). This may be due to the specific nature of the questions. Only respondents with knowledge or experience using lean in hospitals can answer the questionnaire. Respondents unfamiliar with the hospital's vision or policy may struggle to complete the questionnaire. Therefore, it is challenging to reach the target group, which includes individuals who wish to participate in the questionnaire, particularly medical personnel with a heavy workload. This is an important reason for the lower response rate of the questionnaire than general questions, which is consistent with the response rate of the online survey study of medical personnel by Aerny-Perreten et al. (2015), which had a relatively low initial response rate (22.6%) and increased to 32.9% when prompted to answer again. The study on the maturity level of lean implementation in hospitals in Thailand found that most hospitals still have a moderate level of lean tool adoption, indicating that only a few hospitals fully implement lean tools.
Meanwhile, previous research abroad has found that the number of hospitals implementing lean tools is increasing. However, the implementation level is still low (Costa & Fiho, 2016; Burgess & Radnor, 2013; Rich & Piercy, 2013). This study found that only 10% of the responding sample hospitals had a very high level of lean implementation maturity. When analyzed, the results are consistent with those of the study, which found that most hospitals in Thailand have not yet implemented a Value Stream Map (VSM) and have not yet designed a new process based on VSM. This indicates that most hospitals in Thailand still use the lean concept only superficially. The lean tools that hospitals in Thailand use the most are Standardisation. The second is finding waste, which is consistent with the study of Radnor et al. (2012), who studied four hospitals by interviewing managers and conducting Focus Group interviews and found that the hospitals studied selected to use only some lean tools that were consistent with the desired results (reducing costs and number of employees).
The study's results on applying lean concepts in the case study hospital found that the main content in the leadership category is consistent with previous research, especially receiving support from leaders. Many

previous studies have indicated that support from top executives is a key strategy for successful lean implementation in hospitals (Grove et al., 2010; Al-Balushi, 2014; Laureani et al., 2013; Chiarini & Baccarani, 2016). Hwang et al. (2014) and Laureani et al. (2013) noted that setting clear strategies and goals is one of the key success factors in implementing lean to improve processes. Monitoring key indicators and the participation of leaders help stimulate and motivate employees, resulting in changes in the organization's lean culture (Antony & Kumar, 2012).

In terms of creating a learning and development atmosphere, although no research has been found that has mentioned this issue before. However, there was research that identified the characteristics of lean leaders that were consistent with this study, namely the research of Aij (2015) that mentioned the characteristics of lean leaders, namely lean leaders who have "go Gemba" activities in addition to simply following up on performance, empowering and trusting employees, and lean leaders who are polite, open and straightforward, which are the characteristics of leaders who create an atmosphere of continuous learning and promote quality development with lean tools.

However, even though having a team to support quality development in the hospital is necessary for quality development with lean tools, the context of the hospital, as well as the characteristics of the team that supports quality development with lean, the participation of supervisors and doctors, and cross-department or multidisciplinary teamwork affect the success, attitudes, and perceptions of employees (doctors and nurses) towards lean tools (Holden et al., 2015).

In the category of employee essence, using easy-to-understand Thai instead of English transliteration to call the names of lean tools helps employees understand and accept them. This will impact the collaboration and perception of employees (Chiarini et al., 2016) and help reduce rejection or resistance to using lean concepts for quality development in hospitals (Savage et al., 2016).

Organizing workshops to allow employees to learn and experience success from lean quality development is a short-term success in change management. Allowing employees to see success for themselves will create more acceptance and cooperation than learning only lean concepts and tools (Fillingham, 2007).

From the results of this survey, although it was found that lean activities and lean culture differed between hospital groups, especially the differences in lean activities between regional hospitals and community hospitals, which were statistically significantly different, there are still other contexts that may affect lean activities in hospitals that were not studied in this research, such as hospital size, number of hospital personnel, and number of hospital personnel responsible for quality development. Number of years of hospital quality certification (HA, AHA, JCI), etc.

CONCLUSION

Maturity level of lean implementation in hospitals in Thailand

The study results of lean implementation in hospitals found that most hospitals in Thailand have lean implementation at the level of partial implementation in the hospital. Most hospitals under the Ministry of Public Health, including regional hospitals, general hospitals, and community hospitals, are at the level of lean implementation in only some parts of the hospital (Level 3). Meanwhile, hospitals outside the Ministry of Public Health and private hospitals have the highest number of hospitals at the level of lean implementation in all parts of the hospital (Level 4).

When analyzing lean implementation in hospitals, it was found that most hospitals have lean activities in each activity at the level of partial implementation in the hospital (average score 2.61-3.40). There are lean activities that are implemented in all parts of the hospital, namely, Standardization (average score equal to 3.45), and lean activities that are in the initial phase of implementation in the hospital (average score between 1.81-2.60), namely, organizing lean training, creating mutual agreements for employees, creating understanding about lean, establishing specific implementation teams, creating value stream maps, designing processes from VSM, creating pull systems, and continuously developing or improving lean.

In terms of culture regarding lean activities in hospitals, it was found that most hospitals had a relatively high level of lean activity culture (the average score was between 3.41 and 4.20), with continuous learning culture as the activity in most hospitals having the highest average score (the average score was 4.01). Cultures with a moderate average of hospital operations (the average score was between 2.61 and 3.40) included creating

short-term success, setting goals or objectives for all activities, creating a pulling system, improving processes by finding waste, and constantly testing employees. The analysis of lean tools in hospitals found that lean tools in hospitals had a fairly significant effect on the outcomes of most hospitals, including financial status, customer satisfaction, service quality (less errors), and drug and medical supply reserves (the average score was between 3.41-4.20), but had a moderate effect on the outcomes of employee time and working hours (the average score was between 2.61-3.40).

Approaches and factors affecting the application of lean concepts in hospital case studies

From the qualitative research results of in-depth interviews, it was found that the approach to applying lean concepts in Thai hospitals, from the perspective of hospital quality development leaders, can be divided into three main categories: leaders, employees, and perceptions. Details and examples of key informants' statements can be divided as follows:

Category One: Leaders

Leaders should define quality development using lean tools as part of the hospital's policy or strategy, provide support in various areas, and monitor the results for implementing quality development using lean tools to be successful. The topics that need to be supported are as follows:

1. Providing necessary resources for quality development activities using lean tools in the hospital, including human resources, budget, time, and technology. Determining quality development as part of the hospital's policy or strategic plan or as an indicator, including creating a teamwork culture.
2. Determining quality development as one of the hospital's policies, strategies, or indicators, including creating an organizational culture to support teamwork and allowing employees to participate more in lean quality development activities, such as those in the medical profession.
3. Monitoring key indicators and participation of leaders. Participation in lean quality development by executives. This will lead to decisions to improve specific processes, including supervising middle leaders, such as department heads.
4. Creating an atmosphere of continuous learning and quality development. Leaders who provide employees with opportunities to express their opinions and are open to listening to their concerns will encourage employees and allow them to participate in quality development, as their opinions are heard and not ignored. Creating a work atmosphere from leaders will influence the courage to take action, reducing fear of guilt or punishment and fostering freedom of thought in the development process.
5. Having a team to support continuous quality development. Having a team that understands various quality tools will enable employees to utilize them effectively, improving their work processes.

Category 2: Employees

Employees should be encouraged and supported to ensure that quality development with lean tools in the hospital is successful and that there is teamwork, as follows:

1. Training employees on lean concepts, including activities to provide employees with learning through other methods, such as workshops, so that employees understand the correct principles and tools of lean and can apply them in their departments. Providing knowledge to employees at all levels will foster collaboration in the workplace, as some supervisors may struggle to pass on knowledge to their subordinates effectively.
2. Collaborating in employee quality development. In this regard, providing lean knowledge to employees may involve selecting methods suitable for the hospital context, such as embedding knowledge in routine work and utilizing English terms as tools, rather than transliterating them to facilitate understanding.

Category 3: Perception of leaders and employees

Creating awareness of the problems that occur will lead to attempts to solve the problems, and awareness of the benefits of lean quality development tools will lead to the use of tools to solve problems in the department or in their work processes, which are divided into the following categories of awareness:

1. Employees' perception of the benefits of lean tools. The perception of the benefits of lean tools or other quality development tools will encourage employees and doctors to participate in quality development activities or initiate using lean tools to enhance quality in their work processes.
2. Leaders' perception of the benefits of lean tools. Leaders who recognize the benefits of lean tools will be motivated to use lean tools as one of the strategies or policies for improving the quality of the hospital, including providing necessary resources to the work team.

3. Recognizing problems within the organization. Recognizing customers' problems or needs creates a desire to develop quality or improve processes within the organization.

Recommendation

The study on the approaches affecting the application of lean in hospitals in Thailand in this study is limited to the perspective of administrators. Further study from the perspectives of employees and customers (patients) will help provide a more comprehensive understanding of the application of lean in hospitals. In addition, from the perception of the benefits of lean that affect the acceptance and decision to use lean tools to develop hospital quality, there should be further study on the Unified Theory of Acceptance and Use of Technology (UTAUT) model to find out which factors, directly and indirectly, influence the intention to use lean tools in hospitals. This will be useful for adapting various quality development tools for use in healthcare settings, such as hospitals.

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