Value creation through lean management: A case study of healthcare service operations

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Value creation through lean management: a case study of healthcare service operations

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Abstract: The purpose of this case study was to analyse a healthcare service facility, Thai Medical Centre (TMC), by applying lean thinking for system-wide process improvement and improved patient satisfaction. To address the research problem, a simulation-based case study was designed based on a private healthcare facility in Thailand. In this research, an attempt was made to understand and evaluate the factors associated with running an efficient healthcare system. Using the lean methodology process and the layout at the centre, the TMC system was analysed and then redesigned to optimise the lead time at its health promotion centre. The findings of this study demonstrate that through adopting lean process the system can become more efficient by providing a better, faster and safer healthcare system, which contributes to patient satisfaction. Also, these findings can be benchmarked elsewhere in order to improve healthcare system-wide efficiency.

Keywords: healthcare service; value chain; lean; process mapping; service operations management; patient satisfaction; Thailand.

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1 Introduction

Improving the efficiency of hospital management has become a necessity for developing countries, as well as for developed ones. Emergence of hospital care as a commodity and the privatisation of this sector have brought on many challenges. Healthcare is moving from focusing on addressing point-in-time issues toward coordinated and continuous health management systems (Chilukuri et al., 2014). Healthcare cost is increasing at a faster rate than other products or services, and healthcare providers are under continuous pressure to improve their services, cut operational costs, improve patient safety, reduce waiting times and minimise errors and resultant litigations and loss of effort and value (Aherne, 2006). A host of problems, combined with the emergence of globalisation, consumerism, demographic shifts, the increased burden of disease and expensive new technologies and treatments, are expected to force a fundamental change in healthcare within the coming decade. Even in the fastest growing economies, like China, the scenario is no different: 39% of the rural population and 36% of the urban population cannot afford professional medical treatment (OECD Health Data, 2006). In the USA, the expenditure on healthcare could hit more than $4 trillion by 2015 with one of every five dollars being spent on healthcare (Clothier, 2006). These higher costs, however, do not necessarily imply higher quality. Failure to implement best practice can result in a wide variation of healthcare across regions and hospitals in the USA and elsewhere. In other words, more expensive care is not necessarily better care.

Being able to provide timely and efficient service to customers leads to sustained competitive advantages for firms (Sachan et al., 2008). Competitive pressures created by new entrants in the market with innovative market offerings (Gunasekaran et al., 2008) are forcing firms to be highly customer-responsive and to improve quality in providing their services. Therefore, service firms need to continuously re-invent and co-create value to stay competitive and provide their clients with better services (Protopappa-Sieke and Seifert, 2011). The most common phenomena leading to customer dissatisfaction is due to the difference between their expectations and perceptions of delivered services (Parasuraman et al., 1988a). Service quality affects organisational performance, e.g., satisfaction, retention, market share, profits and costs (Sharifi et al., 2014). Due to the intangibility of service quality, it is critical that firms maintain a consistency in the service delivery process. One of the recognised definitions of service satisfaction is the difference between expectations and perceived performance of services (Schiffman and Kanuk, 2010). In fact, customer satisfaction is largely dependent on innovative services offered by firms (Anderson and Sullivan, 1993). Because of technological advancements and information availability, customers expect better, cheaper and faster services (Yadav

and Varadarajan, 2005). This is important to take into account, as customer expectations are predictions of an ongoing market offering (Parasuraman et al., 1988b). The health sector is no different and demands that its services be customer-responsive. As such, standardising services and increasing reliability in service processes through lean principles can increase efficiency of healthcare providers (Carlborg et al., 2013).

There is no denying the fact that like any other service sectors, healthcare needs continuous improvement to stay competitive. The performance of different operational processes in the healthcare industry can be simulated to explore improvement opportunities. Simulations include a design based on existing processes and generating computerised models from real or suggested systems, which are utilised for experimenting under different conditions to understand the systems for better improvement (Kelton et al., 2008).

2 Literature review

Lean thinking has dramatically transformed the world of manufacturing. Lean start-up practices are not just for young tech companies. In fact, large companies, such as GE, Qualcomm and Intuit have begun to implement the start-up technology because, while corporations have spent the past 20 years increasing their efficiency by driving down costs, they have discovered that simply improving existing business models is not enough (Blank, 2013). Following its success in the manufacturing sector, the lean concept has also been applied across service industries, which has helped in minimising customer time and effort and in delivering services how they want and when and where they want, as well as reaping huge benefits (Staats et al., 2011; LaGanga, 2011; Womack and Jones, 2005). Managers may have trouble implementing lean practices (Womack and Jones, 1996), but in general nobody can question the efficacy of lean practices (Longoni et al., 2013).

As we have indicated, healthcare is one of the sectors that need improvement and adopting the lean principle could help its delivery and quality of services. There are a number of reasons for poor healthcare performance. Hospitals are continually investing significantly in their information system projects that either fail or do not live up to their expectations. The primary reason for these failures is the lack of real process change that takes advantage of the information system itself. Clothier (2006) finds that approximately 50% of a clinician's time is spent on unnecessary activities. He is of the view that if this waste was eliminated, then clinicians would be able to spend more time on caring for patients. This would surely improve services and would reduce both clinicians' and patients' frustration.

Jones and Mitchell (2006) argue that recent experiences in the UK healthcare system have shown that the problem cannot be resolved by spending more money or by increasing capacity and staff. Better outcomes for patients, more satisfying working conditions for staff and lower costs to tax payers (or members of private healthcare schemes) can only come from fundamentally redesigning the underlying process for delivering healthcare. However, despite access to unprecedented data and technologies that can be used to drive better health outcomes by influencing customer behaviour, few are truly exploring digital-engagement models (Chilukuri et al., 2014).

There are a number of techniques and tools available to achieve the objectives associated with lean thinking. The most popular and effective of these include value stream mapping, Kaizen, 5S, visual workplace, standardisation, mistake proofing and poka-yoke. Adopting a business process which leads to better outcome with less input can, first, be better understood by understanding the 'lean' system. Lean has been operationalised in many ways (Parker, 2003; Tajri and Cherkaoni, 2011, cited by Longoni et al., 2013). The lean management system and 'lean thinking' is most commonly associated with Japanese manufacturing, particularly the Toyota Production System (TPS). Walthoff-Borm and Chalmet (2014) report that big safety audit firms are doing well after implementing a lean management system. In their study of a law firm, Swenseth and Olson (2014) advocate the genralisability of the lean system. Moreover, they report that the advantages of a lean system can be equally harnessed by using a simulation model and that the tools developed for very different purposes work appropriately in varying contexts. Within the healthcare system, lean management is being adopted as a way of improving quality and safety while controlling costs (LaGanga, 2011; Toussaint and Gerard, 2010).

The basic goals of a lean initiative can be summed up as follows: it improves the quality of products and services, in other words, product or service attributes conform to the expectations and requirements of the consumers and it eliminates waste, that is, any activity that does not add value in the production process and reduces lead time in the completion of an array of tasks in the process. The term 'lean' is used because a lean organisation or business:

- optimises human effort
- uses less space
- reduces the need for capital investment
- decreases amount of raw materials/supplies bought and consumed, and
- uses less time to produce and deliver products and services (Womack and Jones, 1996).

When we talk about improving the healthcare system it includes an array of tasks which needs to be managed: from patient entry to the exit in the healthcare system. Foley (2006) endorses a lean approach in providing healthcare and argues that a lean healthcare transformation cuts across organisational boundaries of departments involved because:

- The aim is to create smooth-flowing consumption streams (patients with needs) matched up with smooth-flowing provision streams (healthcare services).
- The criterion of success is that patients get what they need, where they need it, when they need it, without waiting.
- Consumption and provision streams run across organisational departments.
- Most improvement efforts have been aimed at particularly deficient single points within discrete departments along the stream rather than viewing the whole stream.
- No one tool will help and we may have to invent our own; just start doing something, get it wrong, learn and start again.

According to Seddon (2005), another way of viewing lean thinking is based on strategy, processes and structures. The strategy of lean transformation is to create smooth-flowing consumption streams matched up with a smooth-flowing provision stream and processes must be re-organised to achieve this goal. Structure plays an important role in supporting new processes by supporting the new strategy. It is obvious that lean thinking looks at the whole stream or process, therefore, strategy should not be formulated around the processes and structures that exist. Rather, these should be formulated and scrutinised thoroughly to see whether the processes add any value to the value stream. Though, lean management research has extensively focused on the automobile industry but lean as an approach is highly relevant for other industries as well (Bhamau and Sangwan, 2014).

The term 'lean healthcare' has become popular (Womack and Jones, 1996; Brandao de Souza, 2009), but the term is often misunderstood. In fact, hospitals may implement lean production (LP) without understanding the cultural and structural preconditions for implementing LP and TQM (Dahlgaard and Dahlgaard-Park, 2006; Dubey and Gunasekaran, 2015). Thus, there is a need for cultural change where soft and intangible factors of management, like leadership, people management, and partnership, are required to change to support and improve the hospital core processes (Dahlgaard et al., 2011). Dahlgaard et al. (2011) suggest an index innovativeness, learning and lean (ILL) for measuring the excellence and the potential to increase its levels. Using an excellence model which contains both intangible systemic factors (leadership, people management and partnership) and more logical tangible factors (processes and product/services results), they suggest that this model can be used for assessing the existing organisational culture in relation to ILL and for identifying necessary improvement areas. However, it has been found that the improper implementation of lean is at the root cause for the findings that lean has at times had a negative impact on employees (Adler and Landsbergis, 1998; Angelis et al., 2011 cited by Longoni et al., 2013). The organisation has to be candid when applying the lean system. Hence, lean managers must encourage employee empowerment rather than silencing it despite corporate rhetoric to the contrary (Jones et al., 2013).

Longoni et al. (2013), based on their ten case studies, suggest that the adoption of lean practices and an overall lean philosophy has a positive impact on operational and health and safety performance. In another study, Saats et al. (2011) document the influence of the lean initiative on internal processes and examine how the techniques affect learning by improving both problem identification and problem resolution. The key principles of lean are based on identifying 'waste' from the customer perspective and determining how to eliminate it. Waste is defined as activities that a customer would not want to pay for and which do not add value to the product or service from the customer's viewpoint. Once waste has been identified in the current or existing state, a plan is formulated to eliminate this waste and attain a desired future state as effectively and efficiently as possible. According to Womack and Jones (1996), wastes in any system can be typically categorised as:

- waiting – employee or equipment idle time
- transportation – any movement that does not add value
- processing itself – doing more work than necessary
- motion – wasted walking or movement

- poor 'quality' – errors or rework
- inventory – storing excess inventory
- overproduction – producing more, sooner, faster than required by the next step in the process (Womack and Jones, 1996).

Lean management fixes the root causes, and transforms waste into value from the perspective of patients, co-workers, paymasters and the community. It helps every worker, clinician and non-clinician alike, continuously search for ways to make work easier, safer, faster and with fewer errors. These norms become part of the everyday practices. The expected benefits of a lean healthcare system are increased through put or flow, cost reduction, quality (defect reduction), inventory reduction, space reduction, and lead time reduction. In this context, the present study is an attempt to understand the process of providing an effective goal-oriented healthcare system which can produce a better system by providing a win-win situation for providers, as well as users. It tries to capture the inherent ways of leveraging the benefits of a lean management system.

3 Research methodology

To analyse the healthcare service process in this research, a simulation method has been used. Simulation is an analytical tool that has quite extensively been used in service operation research. Protopappa-Sieke and Seifert (2011) demonstrated the importance of payment tardiness in regards to the profitability of an organisation and financial risk benefits using a simulation method. In another study, Ma and Mantyniemi (2008) analysed the information cost results and information time when the company receives documents with different meanings. The results were then analysed to improve information management through simulation analysis. Azadeh et al. (2012) optimised train schedules and timing in a complex train system through ambiguous and non-exact data using a consolidated fuzzy model and simulation approach to evaluate the system's authenticity and reliability. In a case study, using a simulation model, Sabaghi et al. (2015) found that the value stream mapping technique indicates the alleviation of information exchange and paper works between various departments engaged in the process.

The current study builds on Carlborg et al. (2013) who suggest that it is critical to understand and analyse the resources in services. This is typically applicable to healthcare because of the time and effort patients invest as part of productivity. This becomes especially important for service types where the patient or customer is active, e.g., the sequential, standardised and reciprocal service design. Hence, this study investigates how the application of lean principles affects customer perception of the service process. The purpose of this study is three-fold: first, to analyse and identify a single critical process for improvement within a healthcare operation; second, to evaluate and compare lean processes with existing processes; and finally, to propose a grounded methodology applicable to healthcare operations.

The current study was carried out within the health promotion centre (HPC) in a public listed hospital in Thailand, the Thai Medical Centre (TMC), which is a pseudonym being used here to protect the identity of the firm. This research looked into the improvement of operational processes by applying lean thinking and modelling. The

scope of the study was to identify value and eliminate or reduce non-value-adding (NVA) activities from the selected processes. This case study follows the most common case study approach described by Yin (2003) and analyses the service process improvement in light of lean principles. The proposed improvement in the system is based on simulated rather than actual changes, using lean tools and applications. The primary data was collected through observation and interviews. Secondary data was derived from the existing hospital information system (HIS) database named MEDTRAK.

3.1 Profile of the company

TMC was the first private medical institution in the nation and is now one of the largest private healthcare service providers in South-East Asia. TMC has an extensive network of modern healthcare facilities with 15 branches across four regions of North, South, East and West Thailand and has very fast growing international networks across different parts of Asia, e.g., Bangladesh, Myanmar, Cambodia and Vietnam. Operating under the name of a medical services public limited company, TMC ranks as the top medical care organisation in the kingdom and is accepted internationally as one of the most progressive healthcare institutions. The TMC Group is the kingdom's largest hospital operator, having 13 network locations throughout the Thailand. Each facility offers specialised medical treatments. Inspired by the company philosophy, "TMC is where advances in medicine meet with compassion", TMC is envisioned as a premier tertiary healthcare provider dedicated to international quality and customer focused care. It is known for its high standards and international quality and for its trustworthiness and the optimal satisfaction of its customers.

TMC operates its business keeping in mind its responsibility to customers, hospital personnel, all concerned persons and society by paying great attention to preserving the environment, occupational health and safety, as well as continually improving the system. TMC has a registered capital of 1,700 million Baht with 1,549 million Baht in paid-up capital, divided into 1,549 million common shares with par value of Baht 1 each (1$ US = 29 Baht). TMC consolidated assets are worth of Baht 76,399 million and consolidated shareholders' equity is Baht 42,644 million as of March 2014. As of 2013, TMC's net profit was 6261 million baht. With more than 10,000 employees, TMC recognises its role, duty and responsibility in practicing good corporate governance and believes that corporate governance determines the structure of the relationships among the shareholders, the Board of Directors, management and all stakeholders.

4 Case findings

Within lean methodology, the current system was studied in terms of process and layout. This was done by studying the nature of the service, product and service variation and its demand in order to develop a flow chart of the process. The best way to see the big picture can be done by creating a service blue print. In this case study, after drawing the service blueprint, critical processes were identified for a time and motion study. Based on that study, value and non-value activities were identified by focusing on service operation, transportation, delay in practices and value chain and approach towards the inspection process. A value stream map of the current state was thus constructed at the

first stage. The next stage was very crucial and an analysis of the data using lean techniques was used to eliminate or minimise waste activities like bottlenecks and points of dissatisfaction in the service providing stream. Thereafter, a value stream map was drawn for future processes. In the final stage, data was simulated and compared to see the improvement. The main criterion for evaluating the effectiveness of lean improvement was reduction in the cycle time.

In order to identify the value, it was necessary to distinguish between the value adding and non-value adding activities involved in the process. A detailed time study and its categorisation of waste were adopted to identify the value of the process. The most critical part of the present study was to undertake the time and motion study of a particular process. Motion study is the systematic study of human motions used to perform an operation or process (Chase, 1999). Recording was done for two consecutive weeks to estimate the average time consumed per patient to finish the process. A process chart is an organised way of documenting all the activities performed by a person, machine or workstation with a customer or on materials (Krajewski, 2007). In this case study, the study specimen was the patient. All recorded data was used in the format of a process chart.

4.1 Timing method: probabilistic time study

There are many methods available for calculating timing operations. To avoid biased timing, the researcher can choose a probabilistic time study (Russell and Taylor, 2005). In this study, the researchers analysed the flow and traffic of patients at different times of the day and also on different days of the week. Patient traffic was studied over the course of a week and also on a specific date. These data were collected from a database and analysed to choose which timing categories were most appropriate for this study. Table 1 provides a detailed explanation of the timing in a more elaborate way. This suggested that the process should be examined for three different conditions related to the time that the patient took to pass through the processes. These three conditions were categorised as the ‘best’, ‘standard’ and ‘worst’ case scenario for the completion time of the ultimate female healthcare package. The ultimate female healthcare package is offered to busy professional women who are employed and look for an easy, all-inclusive, ‘one-stop’ health maintenance and disease prevention programme. The wide range of this check-up package is tailored to the individual needs of women of every age. From Table 1, it can be seen that in the best case scenario, the patient went through a series of check-ups in this package within 3.93 hours, whereas in the standard case the patient spent 5.76 hours and in the worst case 7.76 hours. Calculating the mean time using the probabilistic formula, gave a result of 5.81 hours. According to current hospital standards, a completion time of 4 hours is considered to be satisfactory. But the check-up procedure cannot normally reach this standard in the present set up, except in the best cases. In this study, the researchers, using the lean system, attempted to minimise the total time taken and very specifically attempted to bring it to below 4 hours on average.

Table 1 Probabilistic time study: present mean time calculation for ultimate female package

No.		*Description*	*Distance*	*Time*			*T = 1/6(a + 4m + b)*	*Variance*
			(M)	*Optimistic*	*Most likely*	*Pessimistic*	*Estimated time*	
1	A	Walk to the reception counter	5	0.18	0.25	0.33	0.25	0.0006
2		Contact receptionist		1.40	2.00	2.60	2.00	0.0400
3	B	Walk and take escalator to the 1st floor	20	0.70	1.00	1.30	1.00	0.0100
4		Walk to the registration counter	10	0.35	0.50	0.65	0.50	0.0025
5		Contact registration officer		1.40	2.00	2.60	2.00	0.0400
6		Fill in patient information form		5.60	8.00	10.40	8.00	0.6400
7		Take photo		1.40	2.00	2.60	2.00	0.0400
8		Photocopy ID or passport		2.10	3.00	3.90	3.00	0.0900
9		Wait for key in completed form		3.50	5.00	6.50	5.00	0.2500
10		Verify information with patient		2.10	3.00	3.90	3.00	0.0900
95		Doctor key in and write report in paper		3.50	5.00	6.50	5.00	0.2500
96	W	Walk to the check up counter A	32	1.12	1.60	2.08	1.60	0.0256
97		Wait for the medical report in waiting area		18.00	30.00	45.00	30.50	20.2500
98		Receive report and book		2.10	3.00	3.90	3.00	0.0900
			575.0	236.08	347.25	465.43	348.42	45.3
				3.93	5.79	7.76	5.81	0.8

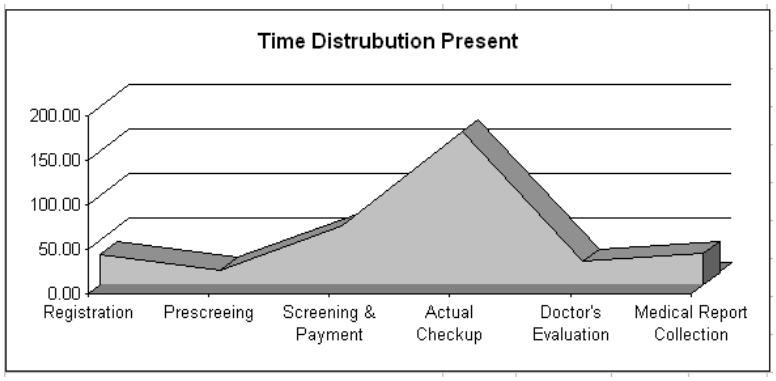
4.2 Dissecting the process

The process chart of the ultimate female health package was constructed on a spreadsheet to evaluate its efficacy and efficiency. The process was subdivided into registration, prescreening, screening and payment, diagnosis, doctor's evaluation and collection of medical reports. A timing summary was made. Processes were categorised into four sub-processes: transportation, delay, inspection and operation. These are defined as follows:

- Transportation: Movement of material within a process may be a necessary evil, but adds no value.
- Delay: An asset sitting idle and taking up space is waste.
- Inspection: If the task was done properly, then inspection is unnecessary.
- Operation: Operation is the only event where the patient sees value.

All data were converted into man-minutes (number of minutes undertaken in the completion of that activity) to produce comparable figures for the different sub-processes. It was important to evaluate and analyse the activity time involved and the distance of travel for realising the services. It was observed that a total of 38 operations takes about 207.83 minutes, 32 movements takes 28.75 minutes, delays occurred 18 times causing wastage of 88.83 minutes and inspection occurred ten times amounting to 23 minutes. After completing the process chart, it was important to distinguish between value-adding and non-value adding activities in this exercise. Researchers grouped value adding time and non-value adding time based on the perceptions of patients. Apart from time devoted to actual operations, all time was considered to be non-value adding for the patient. That means transportation, delay and inspection are all are non-value adding parts of the care process. After sorting the activities, total value-adding time was 207.83 and non-value adding time was 140.58 minutes. This was further broken down into registration, prescreening, screening and payment, actual check-up, doctor's evaluation and collection of medical report. The distance for each stage was also recorded. Time distribution by stages is shown in Figure 1. It was observed that screening and doctor's evaluation consumed most of the time and medical report collection took unnecessary time and needs to be streamlined.

Figure 1 Present time distribution by stages



4.3 Process analysis

Looking at the service blueprint, string diagram and analysis process chart, and value stream mapping of the current state, it was possible to summarise the current processing problems at TMC. Analysis was conducted using a cause and effect diagram (fish bone diagram). Analysis of the service blueprint failure points leads to the calculation of the process chart using time and motion studies and provides the current state map. To better understand and appreciate the system at TMC, interviews were conducted with the key stakeholders involved in the process. From an initial interview with the head nurse, staff members and patients, some very obvious causes of process problems came to light. The common complaint was the long procedure time invested in the health check-up. Below are the steps involved in this experimental case study which were adopted to analyse the current system. A redesign of the process was simulated for better outcomes. This can be grouped into eight distinct steps involved in this case study at TMC. The steps adopted were as follows:

1 drawing fish bone diagram for analysing cause and effect of the process

2 identifying failure points in service blueprint and to undertake fool-proofing (poka-yoke)

3 summarising the waste categories and applying lean methodology

4 redesigning the whole process flow

5 redesigning the physical layout for effecting the process

6 simulating a process chart with new probabilistic estimated time

7 calculating value and non-value times for activities important for patients

8 drawing a value stream for future state map.

As discussed above, after analysing the old process at TMC, the researcher redesigned the process shown in Figure 2. The stages were combined to reduce the number of steps from 6 to 4. The detailed string diagram of the redesigned ultimate female package is shown in Figure 2. Lean principles and philosophy were used to redesign the process and layout. The most significant concepts (see also, Gabow, 2005) used were to eliminate waste, minimise inventory, maximise flow, pull production from customer demand, meeting customer requirements, doing it right the first time and empowering employees, which is a key issue for providing better services in the healthcare industry. Other important issues were the design for rapid changeover to deal with the challenges of change management and partnering with other stakeholders including suppliers. To sustain any service, it is also important to invest in human capital and strive to have a culture of learning and dedication to continuous improvement. These steps need long term treatment and reinforce the workforce requirement for better realisation of goals and excellence in providing any service, including a better healthcare system. It was observed in this study, which can be validated in Figure 3, that there was a decrease in the proportion of time devoted to non-value adding activities. The new simulated process has 80% value adding and 20% non-value adding activities, which is a dramatic improvement from the current process. This was revealing to find and provides hope for benchmarking this experiment in some other situations.

Figure 2 Redesigned string diagram for ultimate female health package at TMC (see online version for colours)

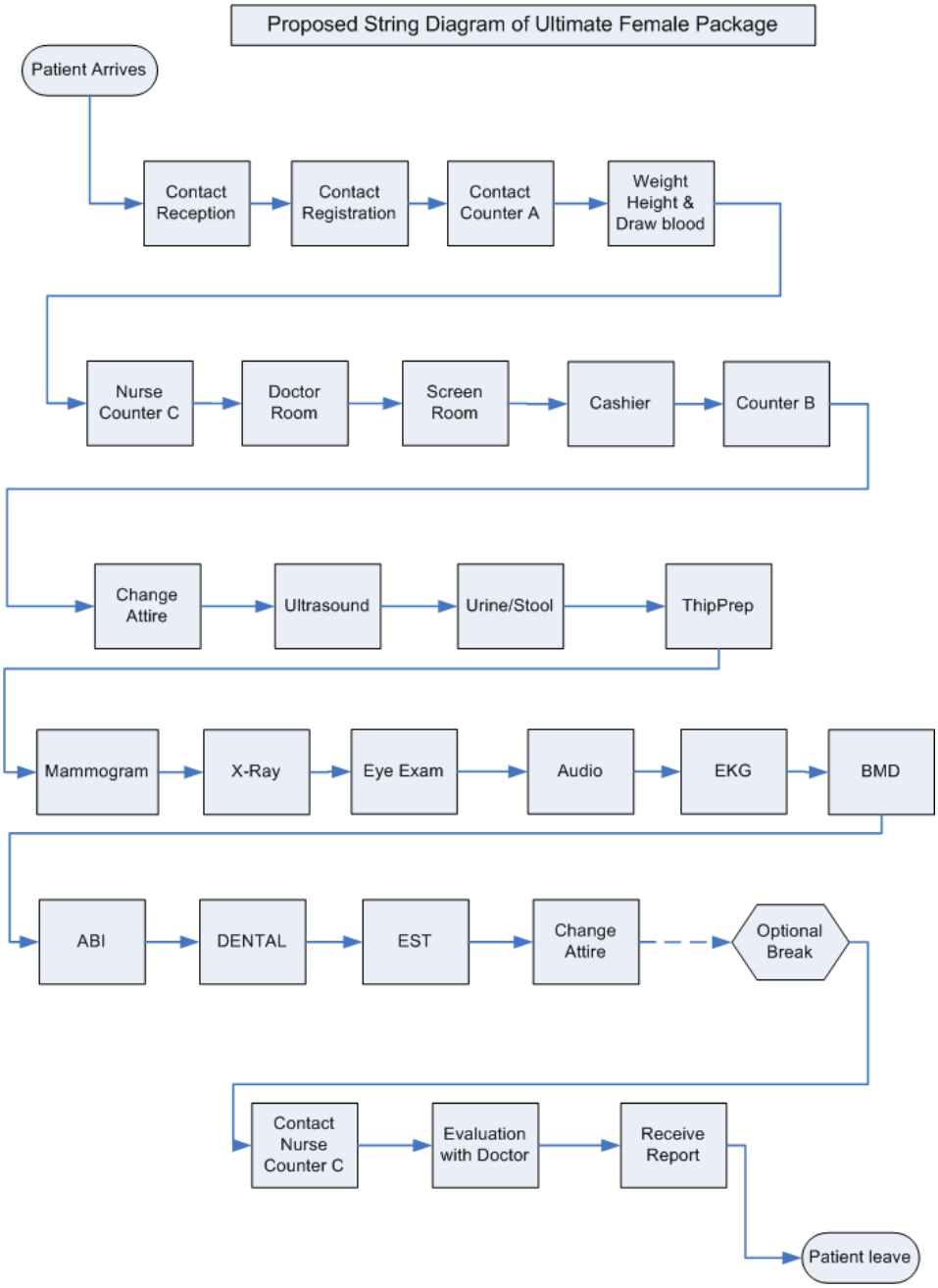
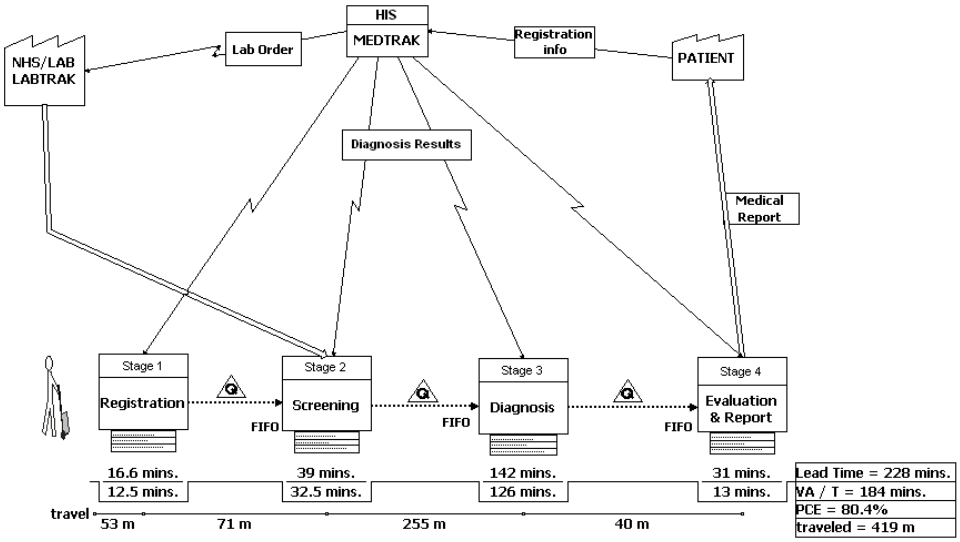


Table 2 Summary of value and non-value adding timing of proposed process

Process	*No. act*	*Time*	*%*
Value added time	37	183.52	0.80
Non-value added time	39	44.93	0.20

	Time	*Value added*	*Non-value added*	*Distance*
Registration	17.05	12.50	4.15	53
Prescreening	13.90	10.50	3.80	16
Screening and payment	24.74	22.00	2.74	55
Actual check up	141.74	125.50	16.24	255
Doctor's evaluation	18.40	12.00	6.40	8
Medical report collection	12.62	1.02	11.60	32
Total minutes	228.45	183.52	44.93	419
Total hours	3.81	3.06	0.75	

Figure 3 Value stream map showing details of (future state) for longest stream (ultimate female package)

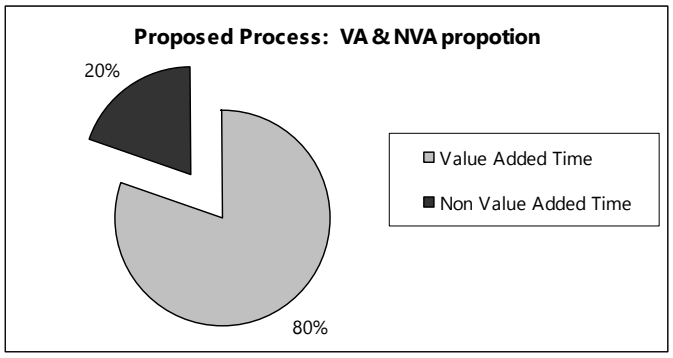


4.4 Proposing a better service at TMC

Based on the information above, the value stream map for the future state of services was drawn (refer to Figure 3). In this simulated experiment, minimising the number of delays, search, inspection and streamlining the sequence of the activities was attempted, as well as maximising the value-adding time. Most of the non-value adding activities were removed, with the exception of those which were necessary. The future-state map used the first-in-first-out or first-come-first-served method to receive patients and reduced a number of stages involved in: registration, screening, diagnosis and doctor evaluation and medical reports. Lead time recorded in the new arrangement was impressive, and

recorded a total time of 228 minutes: value-adding time constituted 184 minutes (80.7%) and distance travelled was reduced to 417 metres. Most importantly, the process cycle efficiency (PCE) was found to be 80.4%, much higher than the current-state map existing at TMC. The future-state map has a fully electronic-based flow of the process across all stages. More efficient use of MEDTRAK and LABTRAK was designed and adopted, facilitating movement from one stage to another stage making it more efficient and cutting the time involved in it. The future-state map design is based on the sorting and analysis of data from the proposed process chart (refer to Table 2). Before drawing the future value stream map, careful consideration was given to improving process efficiency and applying all the lean principles involved in it (see also, Liker, 2005). The future state map was drawn using i-Grafx software (see also, Corel Inc., 2006).

Figure 4 Proportion of value adding and non-value adding activities



Proposing a future course of action and suggesting a better lean system at TMC proved to be very informative. For this purpose, data comparison was undertaken in the final stage of this case study. The main objective was to reduce the cycle time of the current process and streamline it. However, the comparison was done in three ways for better realisation of goals and for deciphering the efficacy of the proposed system. These were: cycle time reduction, process efficiency and estimated financial improvement resulting from the simulated exercise. Cost benefit analysis was a key factor for cutting the cost of the system and evaluating the confidence level of managers in the old and new proposed process.

A number of methods can be used to compare time issues between present and future processes. These include the use of the process chart, the proportions of time that are devoted to value adding or non-value adding activities, comparing the transport processes, delays, time spent on inspection, distance covered, and finally calculating the process cycle time efficiency for each activity. Table 4 shows the comparisons by activity (operation, transport, delay and inspection). The total number of man-minutes saved was 159, which happened to be a significant outcome of this study. In the case of non-value adding activities, the proposed system utilised the time in a better way and even reduced the operation time. This was achieved and made possible because of automation of some processes like registration, which reduced paper work and reduced the number of steps involved in it – thus, removing redundancy. In the case of value adding time, similar improvements were produced and it was noted that value adding time became more efficient. Figure 4 provides the Pareto diagram which was used to compare in detail the

use of all the station time. Time consumed in the doctors' rooms, medical report screening rooms and registration of patients showed great improvement; these altogether resulted in a reduction in overall time consumed in these processes. The effect of the 80/20 rule, where only a few stations take a long time, was kept in mind and the new designed effort focused on those stations. Consequently, it resulted in significantly increasing the efficiency of the system. The formula used for PCE was value added time/total lead time. In short, based on the cycle time comparison, it can be seen (refer to Tables 3 and 4) that there was a satisfactory improvement in cycle time, reducing it by 2 hours, which was quite an achievement as it showed an improvement of 31.5% (5.81 hours to 3.81 hours average time).

Table 3 Overall time comparison

Process	*Before*	*After*	*Difference*	*% save*
Registration	34.25	16.65	17.60	51.39
Prescreening	16.50	14.30	2.20	13.33
Screening and payment	65.73	24.74	40.99	62.36
Diagnosis	170.93	141.74	29.20	17.08
Doctor's consultation	25.90	18.40	7.50	28.96
Medical report	35.10	12.62	22.48	64.06
Total minutes	348.42	228.45	119.97	34.43
Total hours	5.81	3.81	2.00	34.43

Table 4 Data comparison of value stream map

	Present	*Future*
Lead time	348	228
Value added time	208	184
Percentage	59.60%	80.40%
Distance traveled	575	419

5 Conclusions, theoretical and managerial implications

This simulated case study of TMC clearly demonstrates that the lean approach is equally relevant for streamlining and making the healthcare system more responsive and effective. It can be a useful tool for providing quality services in the healthcare industry. Given the current state of healthcare being offered in Thailand or other parts of the world, it is apparent that the problem lies in the execution of the process by which healthcare is delivered. Thus, it is important to see how far the lean approach adds value in serving patients effectively. Throughout this research, it became quite evident that healthcare providers recognise the need to adopt a process improvement approach, and they should take advantage of the forces driving change in both the industry and the organisations within the healthcare industry.

The present simulation-based research experiment contributes in the following ways:

- It clearly suggests that there is great waste that exists in the delivery, as found in this study (i.e., waiting time, process redundancies, cost, etc.) of healthcare services and there are plenty of opportunities for improving and streamlining these services.

- Because of technological advancements, the competitive landscape in the healthcare industry has changed dramatically and there is need to streamline this change across the process to leverage the benefits of the system. As found in this research, in bringing appropriate change, organisations should exploit the advances of information management and information technology.

- Through the application of lean methodology in healthcare, and using value-steam mapping, the present research documents how to deliver value for patients by eliminating waste and providing value added services at a reasonable cost. It will help companies save operating costs and make them competitively sustainable in this sector.

- The present study shows how to optimise the usage of resources in healthcare service operations.

From this study, it is apparent that lean thinking can be applied to the advantage of the healthcare industry. Similarly, those concepts of improvement can be applied throughout the whole organisation using a continuous improvement method or Kaizen. Sometimes small continuous change is more achievable than a breakthrough change. The tools, methods and the philosophy of lean thinking can help healthcare providers improve the way they care for patients every day. Despite its limitations, the present study provides much information for improving the healthcare system by adopting a lean system of management. With many answers emerging from the current research, an improved, simplified and efficient process can be developed and implemented in any hospital by replicating this knowledge. Once implemented, it can be subjected to monitoring and continuous improvement.

6 Limitations and future research directions

Apart from deciphering the Hawthorne effect of the undertaken research, further research should attempt to extend this study in a number of ways to examine the potential application of lean thinking in healthcare operations. The researchers have not been able to study other aspects of lean process design in an organisation, e.g., arrival modelling, workforce modelling, and lean training and staff learning. Applying these additional powerful tools could significantly increase efficiency levels and improve the operations of healthcare services. To benchmark the learning derived from the case, there is a need to replicate a research to validate the application of the methodologies adopted in this study in another healthcare facility in order to evaluate the efficacy of improvement achieved.

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References

Adler, P. and Landsbergis, P. (1998) 'Lean production and worker health: a discussion', *New Solutions*, Vol. 8, No. 4, pp.499–523.

Aherne, J. (2006) *Lean Healthcare Services Blog: 'Leaning' your Healthcare Organisation – A Recipe for Continuing Success!* [online] http://www.leanhealthcareservices.com/2006/12/leaning-your-healthcare-organisation.html (accessed 20 November 2013).

Anderson, E.W. and Sullivan, M.W. (1993) 'The antecedents and consequences of customer satisfaction for firms', *Marketing Science*, Vol. 12, No. 2, pp.125–143.

Angelis, J., Conti, R., Cooper, C. and Gill, C. (2011) 'Building a high commitment lean culture', *Journal of Manufacturing Technology Management*, Vol. 22, No. 5, pp.569–586.

Azadeh, A., Faghihroohi, S. and Izadbakhsh, H.R. (2012) 'Optimization of train scheduling in complex railways with imprecise and ambiguous input data by an improved integrated model', *International Journal of Services and Operations Management*, Vol. 13, No. 3, pp.310–328.

Bhamau, J. and Sangwan, K.S. (2014) 'Lean manufacturing: literature review and research issues', *International Journal of Operations and Production Management*, Vol. 34, No. 7, pp.876–940.

Blank, S. (2013) 'Why the lean start-up changes everything', *Harvard Business Review*, Vol. 91, No. 5, pp.63–72.

Brandao de Souza, L. (2009) 'Trends and approaches in lean healthcare', *Leadership in Health Services*, Vol. 22, No. 2, pp.121–139.

Carlborg, P., Kindström, D. and Kowalkowski, C. (2013) 'A lean approach to service productivity improvements: synergy or oxymoron?', *Managing Service Quality*, Vol. 23, No. 4, pp.291–304.

Chase, N. (1999) 'Loose the waste – get lean', *Quality*, Vol. 38, No. 3, pp.2–6.

Chilukuri, S., Rosenberg, R. and Van Kuiken, S. (2014) 'A digital prescription for pharma companies', *McKinsey & Company*, pp.1–6.

Clothier, J. (2006) *Lean Healthcare Services Blog: Can Lean Thinking Save our Healthcare System?* [online] http://www.leanhealthcareservices.com/2006/12/can-lean-thinking-save-our-healthcare.html (accessed 20 November 2013).

Corel Inc. (2006) *Creating Lean vs. m Diagrams* [online] http://www.igrafx.com/resources/UserGuides/1033_English/Creating%20Lean%20VSM%20Diagrams.pdf (accessed 11 April 2013).

Dahlgaard, J. and Dahlgaard-Park, S.M. (2006) 'Lean production, six sigma quality, TQM and company culture', *The TQM Magazine*, Vol. 18, No. 3, pp.263–281.

Dahlgaard, J.J., Pettersen, J. and Dahlgaard-Park, S.M. (2011) 'Quality and lean health care: a system for assessing and improving the health of healthcare organizations', *Total Quality Management & Business Excellence*, Vol. 22, No. 6, pp.673–689.

Dubey, R. and Gunasekaran, A. (2015) 'Exploring soft TQM dimensions and their impact on firm performance: some exploratory empirical results', *International Journal of Production Research*, Vol. 53, No. 2, pp.371–382.

Foley, R. (2006) *NHS Lean Implementation Handbook Draft* [online] http://www.networks.nhs.uk/uploads (accessed 6 June 2013).

Gabow, P. (2005) *A Toolkit for Redesign in Health Care* [online] http://www.ahrq.gov/qual/toolkit (accessed 20 November 2013).

Gunasekaran, A., Lai, K-H. and Cheng, E.T.C. (2008) 'Responsive supply chain: a competitive strategy in a networked economy', *Omega, Special Issue on Logistics: New Perspectives and Challenges*, Vol. 36, No. 4, pp.549–564.

Jones, D. and Mitchell, A. (2006) *Lean Thinking for the NHS*, NHS Confederation, London.

Jones, R., Latham, J. and Betta, M. (2013) 'Creating the illusion of employee empowerment: lean production in the international automobile industry', *The International Journal of Human Resource Management*, Vol. 24, No. 8, pp.1629–1645.

Kelton, W.D., Sadowski, R.P. and Sturrock, D.T. (2008) *Simulation with Arena*, 4th ed., McGraw-Hill, New York, NY.

Krajewski, L. (2007) *Operations Management: Processes and Value Chains*, Pearson Prentice Hall, Toronto.

LaGanga, L.R. (2011) 'Lean service operations: reflections and new directions for capacity expansion in outpatient clinics', *Journal of Operations Management*, Vol. 29, No. 5, pp.422–433.

Liker, J.K. (2005) *The Toyota Way*, McGraw-Hill, New York, NY.

Longoni, A., Pagell, M., Johnston, D. and Veltri, A. (2013) 'When does lean hurt? – An exploration of lean practices and worker health and safety outcomes', *International Journal of Production Research*, Vol. 51, No. 11, pp.3300–3320.

Ma, H. and Mantyniemi, T. (2008) 'Evaluating information management in an insurance company by simulation: a case study', *International Journal of Services and Operations Management*, Vol. 4, No. 1, pp.56–71.

OECD Health Data (2006) *Statistics and Indicators for 30 Countries* [online] http://www.oecd.org/health/healthdata (accessed 4 April 2013).

Parasuraman, A., Zeithmal, V. and Berry, L. (1988a) 'Communication and control processes in the delivery of service quality', *Journal of Marketing*, Vol. 52, No. 1, pp.33–55.

Parasuraman, A., Zeithmal, V. and Berry, L. (1988b) 'SERVQUAL: a multiple-item scale for measuring customer perceptions of service quality', *Journal of Retailing*, Vol. 64, No. 1, pp.12–40.

Parker, S.K. (2003) 'Longitudinal effects of lean production on employee outcomes and the mediating role of work characteristics', *Journal of Applied Psychology*, Vol. 88 No. 4, pp.620–634.

Protopappa-Sieke, M. and Seifert, R.W. (2011) 'Interrelating operational and financial performance measurements in a multiproduct inventory system', *International Journal of Services and Operations Management*, Vol. 10, No. 3, pp.328–347.

Russell, R. and Taylor, B. (2005) *Operations Management: Quality and Competitiveness in a Global Environment*, Wiley, New York.

Sabaghi, M., Rostamzadeh, R. and Mascle, C. (2015) 'Kanban and value stream mapping analysis in lean manufacturing philosophy via simulation: a plastic fabrication', *International Journal of Services and Operations Management*, Vol. 20, No. 1, pp.118–140.

Sachan, A., Datta, S. and Arora, A.P. (2008) 'Integrating customer preferences and organization strategy for resource allocation', *International Journal of Services and Operations Management*, Vol. 4, No. 3, pp.345–367.

Schiffman, L.G. and Kanuk, L.L. (2010) *Consumer Behavior*, 10th ed., Practice-Hall, Upper Saddle River, New Jersey.

Seddon, J. (2005) *Freedom from Command & Control: Rethinking Management for Lean Service*, Productivity Press, Portland.

Sharifi, S., Sajadi, S.M. and Tavakoli, M.M. (2014) 'Simulation process of Isfahan post office using Arena', *International Journal of Services and Operations Management*, Vol. 17, No. 1, pp.50–66.

Staats, B.R., Brunner, D.J. and Upton, D.M. (2011) 'Lean principles, learning, and knowledge work: evidence from a software services provider', *Journal of Operations Management*, Vol. 29, No. 5, pp.376–390.

Swenseth, S.R. and Olson, D.L. (2014) 'Simulation model of professional service personnel inventory', *International Journal of Services and Operations Management*, Vol. 19, No. 4, pp.451–467.

Tajri, I. and Cherkaoui, A. (2011) 'Role of cognitive ergonomics in the design and successful implementation of a total lean environment', *International Journal of Research and Reviews in Mechatronic Design and Simulation*, Vol. 1, No. 4, pp.79–85.

Toussaint, J. and Gerard, R.A. (2010) *On the Mend: Revolutionizing Healthcare to Save Lives and Transform the Industry*, Lean Enterprise Institute, Cambridge, MA.

Walthoff-Borm, X. and Chalmet, L. (2014) 'Behind closed doors: the potential of lean management in safety audit services', *International Journal of Services and Operations Management*, Vol. 19, No. 4, pp.413–430.

Womack, J.P. and Jones, D.T. (1996) *Lean Thinking*, Simon Schuster, New York, NY.

Womack, J.P. and Jones, D.T. (2005) 'Lean consumption', *Harvard Business Review*, Vol. 83, No. 3, pp.58–68.

Yadav, M.S. and Varadarajan, R.P. (2005) 'Understanding product migration to the electronic marketplace: a conceptual framework', *Journal of Retailing*, Vol. 81, No. 2, pp.125–140.

Yin, R. (2003) *Case Study Research – Design and Methods*, Sage, London.