STUDYING THE EXISTING SERVICE PROCESS OF THREE HOSPITAL OUTPATIENT DEPARTMENTS

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ABSTRACT

The Care Guarantee Act has successfully promoted Thai people to visit hospitals. Growing demand for services has forced hospitals to intensify their service dramatically. Outpatients departments (OPD) have to identify how to cope with drastically increased demands. This paper presents a pilot study that precedes a future intensive study. The first stage of the analysis focuses on a medium sized hospital, with the purpose of identifying the elements of a model for the operations of outpatient servicing. The second stage compares the operational processes and service patterns for treating outpatients across hospitals of varying size. Discovery of similarities and differences of OPDs will support the development of a model of OPDs that includes scalability.

Keywords: Operations management, Human-centred planning, Lean operations, Functional allocation, Task analysis.

1. INTRODUCTION

The welfare agenda in Thailand mandates that hospitals treat patients without charge from 2001. This universal coverage has encouraged Thai people to visit hospitals. Increasing demand for services has forced hospitals to grow rapidly without a commensurate increase in funding. For many services, hospitals are enticed to trim the period that patients stay through a public policy that only reimburses costs for outpatient treatment. Thus, outpatients departments (OPDs) have to identify how to cope with drastically increased demands, while upholding or improving the flow time for treating patients. A universal characteristic of OPDs is waiting rooms full of patients. Tolerating of long waiting times challenges the tolerance of enfeebled patients. Indeed, awareness by some sick people of long waiting times deters them, and they seek alternative medical relief (NaRanong and NaRanong, 2006).

To meet the strong demand, either, the number of small or medium sized hospitals must increase, or, the size of current hospitals must expand massively. For either scenario, the focus is on OPDs, as they form 80% of the demand (Alpha...
Research, 2006). Studying how to manage such departments effectively and efficiently may lead to ways to improve performance. If demand is met by enlarging hospitals, then the experiences and practices of large hospitals may form an exemplar for their development. One hundred and forty-nine hospitals in Thailand (8%) are large (with more than 200 beds). Of these, 53% are in the central region of Thailand, near or in Bangkok.

The greatest demand within an OPD comes from the sub department of internal medicine, which is responsible for the management of nonsurgical treatment of serious diseases such as hypertension and diabetes. Patients within internal medicine have regular appointments over the course of their treatment. By studying the operational systems for internal medicine for hospitals of various sizes, we have identified non-value adding activities that may be removed to improve operational systems.

Since the United Kingdom set up the National Health Service in 1947, long waiting times in outpatient clinics have become infamous, as Paul and Kujjis (1991) highlight by referring to a report by Thakar and Malin (1989). To abate excessive waiting times, Finland in 2005 fixed a legal maximum of six months between a treatment decision and its execution (Paavola, 2008). Hospitals are therefore under pressure to restrain waiting times for treatments within lawful limits.

2. LITERATURE REVIEW
Decreasing waiting and treatment times can lessen costs while increasing accessibility. Hall et al. (2006) identified three goals of a healthcare system: minimisation of the cost of services; maximising convenience and access to services; maximisation of the likelihood of a positive outcome from the service. Reducing delays in healthcare contribute to these goals by reducing cost through removal of inefficiencies, improving timely access to services and reducing waiting time for needed service.

Elkhuizen et al. (2006) expressed that business process redesign is used to implement organizational transformation towards a more customer-focused and cost-effective care. From the perspective of a delivery model, hospitals transform inputs to outputs through clinical, management and ancillary processes (Vlissers, 1998). Vlissers contends that this process-oriented model does not account for externalities (e.g., national health policies) and decision-making at different levels (i.e., operational, tactical and strategic). Hall et al. (2006) claimed that solutions to problems due to delay concern processes relating to service, arrival and queueing. These are in rank order: the service needs of patients first, then changes affecting arrivals, and, finally — if all else fails — changes in performance are addressed through the management of queues.

To improve the service process, some hospitals have adopted the Toyota production technique of lean manufacturing. Some examples are clinical services in the hospitals of New South Wales, Australia (Australian Healthcare Association, 2006) and the Florida Hospital — the largest provider of Medicare services in USA (Buzalka et al. 2006). The aim of lean manufacturing is minimization of waste and time. However, as Ballé and Régner (2007) point out, a focus of applying lean tools
Studying the Existing Service Process of three Hospital Outpatient Departments

to process improvement in healthcare can result in loss of perspective. Success does not come from application of tools, but on lean thinking: an attitude in which all people involved with a process, work together to eliminate activities that do not add value from the customer perspective. A lean system is constructed by persons acting in the system—ward managers, matrons and nurses—rather than “piecemeal application of Industrial practices to the wards” (Ballé and Régnier 2007).

Lean thinking is a practice that applies various industrial-engineering tools. According to Womack and Jones (1996), the five principles of lean start with a specification of value from the customer’s perspective. For the sequence of processes in the manufacture of a product or the provision of a service, time spent on each activity in the workflow is mapped, showing which steps value is added, from the patient’s perspective (Eitel et al., 2008). By monitoring the material flow associated with this value, wasteful steps can be eliminated and techniques for decreasing lead-time can be instigated, for example, moving material piece-by-piece. The ultimate goal is to provide exactly what the customer wants, when the customer wants it, and at an appropriate price, with minimum waste.

A method for reducing wastage in industrial environments is through the application of cellular manufacture. Dissimilar machines or processes used to produce one or more items that are similar are grouped into a cell. By so grouping, a component can be quickly produced when required, thereby eliminating the need to hold inventory (Samatova, Potok and Leuze, 2002; Hyer 1987). Wemmerlöv and Hyer (1989) found—in their survey of 32 companies in the USA that applied cellular manufacturing—that its application reduced set-up time, work-in-process, inventory, material-handling costs, and labour costs—both direct and indirect. By matching capacity with demand, cellular manufacturing can cater for variations and contingencies that arise. The number of operators working in a cell can be varied as demand fluctuates. Arranging the processes in a “U” shape reduces the distance that operators have to move, when they must attend more than a single process. The essence of the configuration is that the number of operators within the cell can increase or decrease in line with demand. For instance, within a hospital setting, workstations for nursing assistants could be arranged so the tasks of measuring weight and blood pressure may be carried out by one assistant or divided between two. A potential disadvantage of adjusting to meet demand is that staff may not have some respite from ceaseless demanding workload. Having all the processes for producing an item within a work cell simplifies tracking problems with quality (Ham, 1982). Cellular manufacturing allows for a better overview of production activities and faster response to schedule changes. Part families and associated processes are grouped into cells, so that inter-station movement of parts can be minimised (Heragu, 2006; Hyer, 1987; Hazier and Render, 1999).

Techniques for balancing assembly lines can be applied to work cells (Moodie, 1982). Line balancing is needed when idle time occurs due to an imbalance in the task times assigned to the various workstations (Salveson, 1955). Moodie (1982), in his discussion of line balancing basic concepts, states that Kilbridge and Wester (1962) found major contributions to high balancing delay are: inflexibility due to constraints on processing times; wide-ranging work tasks; fluctuating cycle times
as production capacity is varied to meet demand. Queueing theory provides another way for dealing with delays by tackling the flow process. Improvements may come via human performance concerning individual operator and teamwork (Meister, 1989).

Human performance involves task time and quality. Focus should not rest solely on reduction of steps adding no value, but should include consideration of inadequacies in system design that may engender human error. Systemic factors include reoccurring error traps and organisational processes that allow them to form (Reason, 2000). This is vital as errors in healthcare can be harmful to human life; Kohn, Corrigan and Donaldson (2000) indicate that somewhere between 44,000 and 98,000 deaths per year in the USA are due to documented, preventable medical errors. Alleviation of systemic flaws depends on non-punitive voluntary reporting of errors causing preventable injuries (Kohn, Corrigan and Donaldson, 2000; Bellandi, Albolino and Tomassini, 2007; Barach, 2007).

Errors not only affect quality, but they also affect patient flow. Poor diagnosis and treatment leads to persistence of ill health. Patients taking a longer term to recover place extra demand on healthcare. Such demand may significantly contribute to the patient load in internal medicine. Consequently, reducing demand would increase service performance.

The healthcare industry might learn from the successful programme in commercial aviation to alleviate catastrophes due to human errors. Like healthcare, serious errors are lethal in aviation. Moreover, the major culprit is human causation (70% in commercial aviation). In healthcare, critical decision-making concerns the management of labour-intensive operations (Pizzi, Goldfarb and Nash, 2001). Interest is developing in applying successful programmes for reducing error in aviation to healthcare. Barach (2007) proposes a clinical risk modification programme that uses principles of transparency, standardisation and scenario-based team training, which commercial aviation have successfully applied to improve safety. The emphasis is on training persons how to work in teams to reduce the frequency and severity of errors. It includes awareness training for avoiding, trapping and mitigating errors (Helmreich, Merritt and Wilhelm, 1999). A coordinated cross-organizational approach of Crew Resource Management (CRM) may produce an effective outcome within healthcare (Barach, 2007). However, Pizzi, Goldfarb and Nash (2001) temper enthusiasm for application of CRM in medicine, by pointing out that organizational complexity of healthcare make relevant data collection very difficult and costly. Nevertheless, organisational factors and processes affecting the quality of treatment must be considered in the structuring of the service process.

3. METHODOLOGY

3.1 Patient Grouping

Within the sub department of internal medicine of an outpatients department, patients fit to two major categories—with or without an appointment—and subcategories as shown in Table 1, as classified below.
Table 1
Patients who Visit the Diabetes Clinic Held in Internal Medicine

<table>
<thead>
<tr>
<th>Type of patient</th>
<th>Category</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appointment</td>
<td>On-time</td>
<td>Existing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internal-referred</td>
</tr>
<tr>
<td></td>
<td>Late</td>
<td></td>
</tr>
<tr>
<td>No appointment</td>
<td>No-show</td>
<td></td>
</tr>
<tr>
<td></td>
<td>External-referred</td>
<td></td>
</tr>
</tbody>
</table>

1. **Appointment patient**: Registered on the appointment list to attend at a specified time and date.
   1.1. **On-time patient**: Arrives at the specified time and date.
      1.1.1. **Existing patient**
      1.1.2. **Internal-referred patient**: Referred by a doctor elsewhere in the hospital to attend a specialist at a specified time and date. As it is the first visit they follow a different route to existing patients.
    1.2. **Late patient**: Arrives late on the appointed day. The doctor only examines them after all on-time patients.

2. **No appointment patient**:
   2.1. **No-show patient**: Misses an appointment and arrives without warning on another day. The doctor only examines them after all on-time patients.
   2.2. **External-referred patient**: Is a new patient, whose malady has been treated by a doctor from another hospital or clinic. The registration department has no record on the database. The doctor only examines them after all on-time patients.

The examination of late patients and those without appointments are on a first-come-first-served (FCFS) basis, after all patients with appointments have been treated.

### 3.2 Queueing Theory

Basic Single-Server Model for queueing may be applied to the service process in internal medicine. For some workstations, the service process and number of personnel are not within a single channel. For example, a diabetes clinic in a medium sized hospital would have around five doctors examining patients and four nurses interviewing patients. At both registration and pharmacy departments, typically, there would be three windows (queues) servicing patients. Throughout the outpatients department, large rooms are full of patients waiting for service for each step in the service process. This is indicative of a process that is not running smoothly. The capacity for an individual station is determined from the average service time. Therefore, the average arrival rate for a station is the average service rate of the preceding station. Personnel at each station are assumed to work as a team. The capacity for a team is calculated by using the average service time \( \bar{x} \) per operator for a workstation divided by number of "operators". The capacity (patients per minute)
is the reciprocal of the average service time for the workstation. The personnel at each station work together attending the patients. In effect, they act as parallel equal resources served by a single queue. Each patient has an allocated medical practitioner. Medical examination is not a service environment in which a team of persons work together. However, for a first approximation, the capacity for the examination section can be calculated as if it were, assuming patients are evenly distributed across doctors.

The data collected are from a pilot study of three characteristically sized hospitals. The purpose was to identify key parameters for modelling patient flow within real hospitals, rather than the artifice of an ideal simplified model. The data are sufficient only to make a first approximation, in which demand and services are not considered to be stochastic.

3.3 Assembly Line Balancing

Techniques for assembly line balancing can be applied to find the cycle time for patient flow.

\[ C = \text{Cycle time.} \]

\[ k = \text{Work station number } 1 \leq k \leq K. \]

\[ i = \text{Work element identification number } 1 \leq i \leq N. \]

\[ T_i = \text{Time value for work element } i. \]

\[ S_k = \text{Amount of time assigned to station } k. \]

\[ d_k = \text{Delay (idle time) at station } i. \]

\[ D = \text{Balance delay for entire assembly line.} \]

\[ H = \text{Hours per planning horizon (day, work, etc.).} \]

\[ P = \text{production volume desired in } H \text{ hours.} \]

The cycle time for a workstation identifies the maximum service time to treat a patient. \( P \) determines the number of patients who require visiting the specific clinic in \( H \) hours. From the cycle time, \( C = H/P \), the minimum number of stations is given by:

\[
K_{\text{min}} = \min \left( \frac{\sum_{i=1}^{N} T_i}{C} \right) \quad \text{or } K_{\text{min}} = \frac{\sum_{i=1}^{N} T_i}{C} + r \quad (0 \leq r < 1)
\]

\[ = \text{integer.} \]

Thus if the division of the patient service process, \( \frac{\sum_{i=1}^{N} T_i}{C} \), for a given cycle time, has a remainder, \( r \). In the case that lines cannot be perfectly balanced. Where lines can be perfectly balanced, there is no remainder and \( C \) is given by:
4. PILOT STUDY

We observed the operational processes and service patterns for treating outpatients at three hospitals: a medium-sized hospital (MSH), a medium-large sized hospital (MLSH), and a large sized hospital (LSH). Size is identified by the number of beds provided for inpatients, which is indicative of overall resources, funding and public visibility. Patient flow was monitored for twenty days at each hospital. During the four-hourly clinical sessions held daily at each hospital, over the observation period, 1430, 930 and 1200 patients were observed at the medium, the medium-large and large hospitals, respectively.

4.1 Medium Sized Hospital

In the first stage of our analysis, we focused on the medium sized hospital, with the purpose of identifying the essential elements in modelling the operations of outpatient servicing. The study covered, inter alia, patient flow, work activity and information flow at workstations, service time, material flow, such as specimens and documentation within the sub department of internal medicine. It required an examination of each workstation’s physical layout and equipment, staffing levels, job descriptions, task analyses and service demands. Service demand is a critical constraint, as the hospital is compelled to treat anyone who seeks medical treatment. This includes information behaviour, the context in which the service providers work, and the reasons for their actions. It encompasses why, and how, they collaborate during the series of treatment phases in managing the health of patients.

The average flow time that patients experience is extremely long: 8615 seconds for no appointment patients and 8511 seconds for appointment patients. Most of their time in Internal medicine, patients wait to be served. The waiting time is found by subtracting the processing time for all situations where patients are directly served by hospital personnel from the flow time: For no-appointment patients, the average waiting time is 8040 seconds (i.e., 8615 – 575), which is 93.3% of the time at the hospital. Mapping outpatient flow reveals the location of bottlenecks and the consequential overcrowding of waiting rooms. In the medium sized hospital, overcrowded waiting rooms overtax building resources as they take up a third of the outpatients department. The major contributions to waiting time are the interview with the nurse, the examination by the doctor and the dispensing of medicine.

Patient flow starts differently for appointment and no-appointment patients. No-appointment patients first visit the welfare desk and the registration counter, as shown in Fig. 1. Appointment patients miss these steps and go directly to internal medicine, as their record file is held already within internal medicine. When they enter internal medicine, patients drop their appointment cards in a box. They then go to the workstation that records their weight and blood pressure. Staff can identify
the attendance of patients from the appointment cards in the box. A patient is called for an interview by a nurse and is then examined by a doctor. After the examination, the patient takes the prescription order from the doctor to the pharmacy department. The prescription order is entered into the computer, and identifying stickers are printed. Stickers describing the medication are placed on plastic envelopes that will hold the medicine; the medicine is then picked from storage and inserted into the envelopes, and subsequently inspected by a pharmacist. Finally, it is dispensed to the patient.

The cumulative time delay between the three steps—registration, interview by a nurse, and examination by a doctor—is the key factor of outpatient waiting time. Figure 2 shows that the service time of the registration department starts at 7.30 am. Nurses begin interviewing at 8.00 am. An hour later, doctors commence

Fig. 1: The Service Process within Internal Medicine at the Medium Sized Hospital

Fig. 2: Services within Internal Medicine Start Work at Different Times
consultations. The 1.5 hours difference between registration and examination is due to the lead-time for pathology. Patients who do not need pathology tests have to be taken into account for the appointment schedule.

The bottleneck activity is identified by measuring the time of individual activities throughout the service process. Entering the prescription into the computer takes the longest time (55 seconds). This bottleneck spawns a long queue of patients at the pharmacy. The activities for internal medicine are presented in the flow diagram shown in Fig. 3. It includes information flow, patient flow, and flow of staff. The

![Flow Diagram within Internal Medicine at the Medium Sized Hospital](image)

*Fig. 3: The Flow Diagram within Internal Medicine at the Medium Sized Hospital*
overall picture of the internal medicine sub-department such as number of staff, location of service stations and layout is also presented.

4.2 Comparison of Different Sized Hospitals
In the second stage of our analysis, we compare three hospitals that differ in size. Our objective was to reveal the defining characteristics of various size hospitals by exploring, more broadly, the elements of the model identified in the first stage. Process flow analysis was used to identify the steps in mapping the value stream of tasks.

To understand the process, we observed and measured times for the operational steps in patient flow for a month at each hospital. The average observed time throughout the process of the three hospitals is in Table 2. The details of activities and routing are revealed using a flow diagram that also includes the floor plan. Figure 3 shows by way of example, the places of interaction (i.e., service steps) between outpatient and hospital personnel, the flow of staff and the locations of services. Figure 4 shows the flow paths for common activities in internal medicine. There are two flow patterns: unbroken and dotted lines denote patients with and without appointments, respectively.

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Service capacity for each step within internal medicine</th>
<th>Total (sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>we re bp w in ex ke pl co ins dl</td>
<td></td>
</tr>
<tr>
<td>Medium</td>
<td>26 26 22 9 42 27 55 31 22 17 24</td>
<td>301</td>
</tr>
<tr>
<td>Med-large</td>
<td>34 45 67 59 14 28 22 26</td>
<td>295</td>
</tr>
<tr>
<td>Large</td>
<td>32 17 35 11 22 22 22 22 22  22 205</td>
<td></td>
</tr>
</tbody>
</table>

welfare desk (we), registration (re), records weight (w), blood pressure measuring (bp), interview by a nurse (in), examined by a doctor (ex), key prescription order (ke), stick sticker on envelope (pl), collect medicine (co), inspected by a pharmacist (ins), dispatching (dl)

The daily outpatients' session at each hospital lasts four hours (14400 second). The average numbers of patients and doctors in internal medicine, and the cycle times, are shown in Table 3. Cycle time concerns staffing, whereas flow time concerns the time that patients take to pass through the system—from registration to completion of all services. It is defined as the maximal time for processing one patient at a workstation. For example, at the medium sized hospital, on average, the system must process a patient every 27 seconds.

Consider the flow between the workstation for measuring blood pressure and the nurses' stations. For both services there are four persons servicing patients, and hence the service times in Table 2 are a quarter of the processing times shown.
Fig. 4: The Common Flow of Operations within Internal Medicine

Table 3
Result of the Cycle Time Calculation

<table>
<thead>
<tr>
<th>Hospital size</th>
<th>No. of patients daily</th>
<th>No. of doctors in internal medicine</th>
<th>Cycle time (second)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>533</td>
<td>5</td>
<td>27</td>
</tr>
<tr>
<td>Medium-large</td>
<td>207</td>
<td>4</td>
<td>70</td>
</tr>
<tr>
<td>Large</td>
<td>550</td>
<td>33</td>
<td>26</td>
</tr>
</tbody>
</table>
in Fig. 1. The service time $\left( \frac{1}{\lambda} \right)$ of 22 seconds, or 0.37 minutes, for reading blood pressure sets the arrival rate for the nurses' station ($\lambda = \frac{1}{0.37} = 2.7$ patients per minute). Likewise, the service time for interviewing by a nurse is given by $\frac{1}{\mu} = 42$ seconds or 0.7 minutes, and the service rate, $\mu$, is 1.43 patients per minute. Hence, the queue of patients waiting to be interviewed builds up over the morning outpatients' session and patients are left waiting at the completion of the allotted time. Consequently, it is standard practice to extend the session into the afternoon with minimal staff.

5. RESULTS

The five steps within internal medicine that are directly connected to the serving of patients are: checking patient welfare, registration, measuring weight and blood pressure, interviewing by a nurse, and examining by a doctor, and dispatching medicine. Three hospitals have the same pattern of service steps (Fig. 4). Pathology testing is excluded for the following reasons. Firstly, it does not apply to all patients. For instance, patients suffering hypertension do not routinely undergo pathology testing, whereas all diabetics do. Secondly, a doctor must have results from pathology before examining a patient. So that results are available when doctors start to examine patients, registration of patients and pathology testing commence early in the morning. Finally, pathology is a service external to the outpatients department.

The working methods within internal medicine differ across the three hospitals. The average time of 369 seconds for the five service steps at the medium sized hospital is more than twice that of the other two hospitals, which have two and three service steps (Fig. 5). There is a positive relationship between the number of service steps and the processing time (Fig. 6). The number of service steps is commensurate with staffing, because at each workstation only one person treats each patient. As the data are sparse, the results are merely indicative of a trend

![Fig. 5: The Service Steps for the three Different Sized Hospitals](image-url)
showing a similar time for the procedures at the medium-large and the large sized hospitals, which is less than 50% of that at the medium sized hospital. Note that the consulting time with a doctor is not included. While generally the objective is to reduce flow time for service steps, times for medical consultation are below accepted norms. Hence, the objective for medical consultation is contrariwise, to increase consultation times to a level that accords with correct diagnosis and treatment; we present the case for this below.

In Table 4, the average total flow time for patients at the medium sized hospital is 143.6 minutes. This is 53.9 minutes less than that at the medium-large sized hospital. The time difference is due to the flow time within pathology. It takes 150 minutes for the medium-large sized hospital to process the specimen. This is 60 minutes longer than pathology testing at the medium sized hospital. A holistic perspective may shed light on this inconsistency. Improvements in servicing methods at the registration department have not reduced the flow time of patients.

The service capacities of the medium and medium-large hospitals are similar, excluding pathology. In Fig. 7, the capacity at the large hospital diverges at the examination step. From then onwards, the capacity at the large hospital surpasses the other hospitals. Based on hospital size, workstations at the large hospital have more staff than both the medium and the medium-large hospital. Furthermore, the
Table 4
Comparison of Internal Medicine at the three Hospitals

<table>
<thead>
<tr>
<th>Hospital</th>
<th>Pharmacy dept.</th>
<th>Outpatient department (internal medicine)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sq. m</td>
<td>No. of staff</td>
<td>Consult time (seconds)</td>
<td>Service steps</td>
<td>Patient flow time (minutes)</td>
</tr>
<tr>
<td>Medium</td>
<td>270</td>
<td>13</td>
<td>133</td>
<td>8</td>
<td>143.6</td>
</tr>
<tr>
<td>Medium-large</td>
<td>240</td>
<td>16</td>
<td>268</td>
<td>5</td>
<td>197.5</td>
</tr>
<tr>
<td>Large</td>
<td>96</td>
<td>22</td>
<td>367</td>
<td>6</td>
<td>145.0</td>
</tr>
</tbody>
</table>

Fig. 7: Cumulative Time for Service Process for Internal Medicine at the three Hospitals

The number of physicians in Internal medicine is over six times that of the other two hospitals (see Fig. 10). In regards to the pharmacy, the difference between organisations is more inflated than the figures immediately show, because, unlike the other hospitals, the pharmacy is dedicated to internal medicine. Therefore, the 22 employees in the large hospital’s pharmacy solely serve internal medicine; whereas, the pharmacies in the medium and medium-large hospitals serve the entire hospital, with thirteen and sixteen persons, respectively. Note that the working environment in the large hospital is quite cramped due to its compact size of 96 square metres: a population density between 3.5 and 4.8 times the other hospitals.

The cycle times for the three hospitals (Fig. 8) are 27, 70 and 26 seconds for the medium, the medium-large and the large sized hospitals, respectively. At the
medium-large sized hospital, the times for all steps are less than the cycle times. The steps in Table 2 with service times longer than cycle times are:

1. At the medium sized hospital, the interviewing by the nurse, keying the prescription order into the computer and placing medicine stickers on envelopes
2. At the large sized hospital, the registration and interviewing at the welfare desk, and weighing

However, steady state is not possible for the current situation. As the arrival rate ($\lambda$) is greater than the service rate ($\mu$), the system never clears. The waiting time and the queue length will expand incessantly (Raghavachari, 1982). If the time for each step in serving patients equals the cycle time, patients would move through the system without waiting. For example, at the medium sized hospital, a service time of 27 seconds at each step would balance the line, as Fig. 7 shows. To improve performance, steps that have a service time greater than 27 seconds must have capacity increased until the required service time is met.

![Fig. 8: Performance of Internal Medicine for three Hospitals](image)

6. DISCUSSION

Having considered our findings (Fig. 9), the outpatients departments of the three hospitals have already relocated facilities serving patients. They placed departments that strongly interact next to each other. In effect, they applied principles of cellular manufacturing without comprehending lean techniques. The relative location of facilities affects a patient’s interaction with the system. At the large sized hospital,
Blood pressure - weight record and interview by a nurse (Bp-W-In).

Fig. 9: Applying U-shape Cell in Studying the Layout of the three Hospitals

nurses collect specimens from patients near the outpatients department and then send them in batches to pathology for analysis. At the medium sized hospital, patients must walk a considerable distance from the outpatients department to the pathology. Considering patient convenience, the medium-large sized hospital located the laboratory for pathology next to the examining rooms of the outpatients department. Although the medium-large sized hospital has fewer patients per session than either the medium sized hospital or the large sized hospital. It has the longest flow time for pathology: more than two hours. This implies that the application of theory needs to be done properly. Using cellular manufacturing techniques alone does not improve flow. Other theoretical tools are also needed for analysing the system for areas of improvement. Applying lean techniques cannot improve the quality of medical consultation. Time pressure may breed error. Lean thinking coupled with CRM may be a potent means for combining improvement in performance with quality.

The presence of numerous patients is the major factor that forces doctors to restrict consultation times. In Thailand, hospitals never turn down patients. All patients that attend a hospital are treated; even those who do not have an appointment. A patient’s appointment is for a specific clinic within internal medicine. The treatment times for the same symptoms vary significantly across the three hospitals. For example, the medium-large sized hospital has four doctors with 207 patients visiting a day. They spend on average 4.5 minutes on a consultation. In comparison, the medium sized hospital with five doctors treating 533 patients,
average 2.2 minutes (Fig. 10). Are these times adequate for proper healthcare? They are far less than the standard consulting time of 12.18 minutes observed by general practitioners in rural Australia (Walters et al., 2008), the 19 minutes reported by the Australia Medical Association (Beilby, 2003), and the 20.6 minutes of face-to-face consulting time by physicians in internal medicine observed at a Japanese hospital by Liu et al. (2007).

![Comparison of Hospitals](image)

**Fig. 10: Comparison of Hospitals**

7. CONCLUSION

An analysis of the three outpatients departments identifies a shared service pattern for outpatients. The activities in the service pattern are all the same, but the processes within individual department are different in each hospital studied. It is evident that the medium-large sized and the large sized hospitals have empowered the outpatients department by setting up work cells within one area, based on cellular manufacturing.

The results of the pilot study indicate that there is much opportunity for improvement in patient flow, especially reduction in waiting time. The application of techniques from lean manufacturing may allow hospital to serve more patients through productivity improvement. However, applying lean concepts may be to the detriment of patient welfare. Reducing service times may result in more errors in diagnosis and treatment. Patients may take longer to recover and, consequently, placing workload demands on the hospital over a longer period. Staff, pushed to work faster, may become dissatisfied and disaffected. The various tools applied
can support the understanding of the service process for Internal medicine for three different sized hospitals.

8. FURTHER STUDY

Further data collection from more hospitals is required in order to establish scalability. The next stage of our research is the development of a model or models by using the analytical tools from industrial engineering and, in particular, lean operations. Developments of a model depends on us identifying the functions of personnel and the possibility for reallocation of tasks — for example, from medical consultant to triage nurse — so the hospital can become more responsive to the needs of outpatients. Obstacles to patient flow may be reduced, by applying a model that includes human aspects of planning and control of outpatient services. Human-centred planning is essential for the operational improvement of hospitals. The outcome of the further study will be a planning model for reorganising outpatients departments. This model may act as an exemplar for the design and development of hospitals across Thailand.

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