Teaching Case
Hippi Care Hospital: Towards Proactive Business Processes in Emergency Room Services

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ABSTRACT

It was 2.35 am on a Saturday morning. Wiki Lim, process specialist from the Process Innovation Centre (PIC) of Hippi Care Hospital (HCH), desperately doodling on her notepad for ideas to improve service delivery at HCH's Emergency Department (ED). HCH has committed to the public that its ED would meet the service quality criterion of serving 90% of A3 and A4 patients, non-emergency patients with moderate to mild symptoms, within 90 minutes of their arrival at the ED. The ED was not able to meet this performance goal and Dr. Edward Kim, the head of the ED at HCH, had approached the PIC team for help. Lim and her team would study the issues and provide possible solutions. The ED experienced demand surges on Sunday evenings and Mondays. On some days, the patients may experience long wait of two hours before seeing a doctor. In these situations, Dr. Edward Kim would request his off-duty colleagues to come and help out with surges - but such requests were often made too late and with little success. Hence, he ended up extending his own shift to attend to the patients. On Mondays, Dr. Kim would often find himself totally exhausted from nearly 16 hours of working in the ED. He could plainly see that this way of operating was unsustainable. A solution was needed – and soon. Mr. Viz., the head of PIC and Lim's boss, was interested in exploring innovative ways to improve ED operations by making only minimal changes to the process. Lim would have to be creative.

Keywords: Decision support system, Health care, Process improvement, Teaching case

1. BACKGROUND

1.1 Hippi Care Hospital

Hippi Country was a 700 square kilometer island with a population of five million people. It was a developed city with strong socio-economic growth. The city had well-developed roads and rail systems.

HCH, founded in 1988, was a government funded public hospital run by an establishment that had managed a chain of hospitals on Hippi Island for several decades. The hospital had recently set up a PIC lead by a newly appointed Chief Innovation Officer, Major Viz. His aim was to ensure that high service quality was provided to patients. Moreover, the centre had already seen success in its dynamic adoption of innovations in emerging decision-support technologies that helped better serve its patients.

1.2 The Emergency Department

As it was the only public hospital on the northeastern part of the island, home to some 600,000 residents, the hospital faced high demand in its ED. An ED typically served as an entry point for critically ill and major trauma patients, but also to patients with a wide range of non-traumatic conditions. It was a medical treatment facility specialising in acute care of patients who presented themselves without a prior appointment, either by their own means or by ambulance. The ED had to provide initial treatment for a broad spectrum of illnesses and injuries, some of which were life-threatening and required immediate attention. The ED operated 24 hours a day, although staffing levels could vary within that time.

Patients in the ED were classified into four levels of acuity, A1 to A4 (refer to Table 1 for detailed definitions of the levels of acuity). A1 and A2 patients were emergency patients while A3 and A4 patients are non-emergencies with moderate to mild symptoms respectively. The management had placed an emphasis on providing high service quality to all ED patients.

Patient care work was segregated into two areas: the critical care area managing critically ill patients with acuity levels A1 and A2 and the ambulatory area managing non-emergency patients with acuity levels A3 and A4 (refer to Figure 1 for how the patients were segregated according to acuity levels). Although A3 and A4 patients in the

ambulatory area were considered lesser emergencies in comparison to A1 and A2 patients, the demand at the ambulatory area represented 70% of the workload in the hospital's ED. This presented a pressing challenge for HCH to meet its service level targets for A3 and A4 patients within a 90 minute length-of-stay. The length-of-stay for a patient was defined from the time-of-arrival to departure from the ED. Departing from the ED could either mean being discharged from the hospital or being admitted as an in-patient.

Patient acuity levels	
A1	Emergency patients who are critically ill and must be attended to immediately.
A2	Emergency patients who are in great pain must be attended within 20 minutes.
A3	Non-emergency patients who have moderate pain or illness.
A4	Non-emergency patients with mild conditions who can be attended to by family clinics.

Table 1: Four acuity levels of patients in the ED

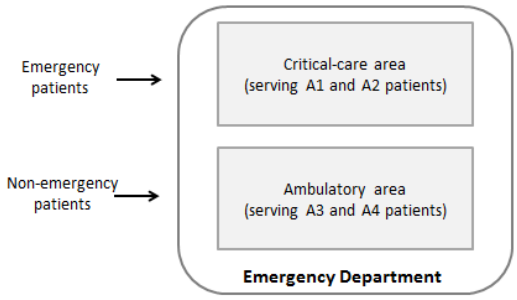

Figure 1: How patients were segregated to different areas according to acuity levels

2. EVOLUTION OF PROCESS AUTOMATION

2.1 Manual Processes to Proactive Processes

When HCH first started operations, many of its processes were paper-based and manual. Only a single Patient Care System was used to keep patient information and dates and times of visits to the ED.

Before automation, business processes were mostly manual and included multiple paper documents pushed across various departments in the hospital (refer to Figure 2 for process improvement progression). With the emergence of workflow and business process management systems, the focus was on executing specific business processes by using technology to integrate various information systems with very little human intervention. Early approaches focused on analysing existing business processes, identifying bottlenecks, and improving these processes. The emphasis was on one-off efforts to improve processes by removing manual tasks, automating decisions and eliminating error-prone re-entry of information. Enterprise Resource Planning (ERP) systems and integration technologies helped to achieve information integration and business process automation. For example, workflow in a health care organisation such as that involving nurses' leave applications, procuring medical supplies, and bed management, were conducted using the integrated information systems (Shankararaman et al., 2012; Woodside, 2007).

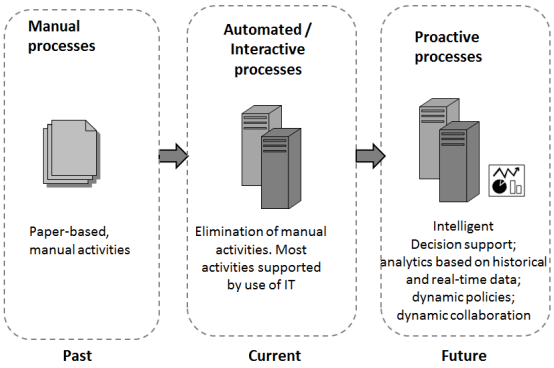

Figure 2: Process improvement progression

Newer approaches focused on continuous improvement and adaption of business processes (Taylor, 2011). The emphasis was on providing "intelligent" decision support by continuously monitoring process data in real time and then combining this data with historical data to identify patterns and suggest strategies for enhancing the process. These strategies could range from dynamic modification of business rules implemented in the process to initiating dynamic collaboration between the various stakeholders involved in the operation of the process.

This made the process proactive as opposed to reactive. Proactive processes combined analytic tools with business process management technology in order to achieve continuous process improvements. Being proactive helped the health care organisation prepare for likely scenarios. In the context of the ED, a proactive process was one that prevented the queue from reaching a point where patients had to wait longer than the time specified by the desired service quality level. In order to provide a proactive process, a set of ED policies had to be put in place that made use of intelligent decision support and analytics based on historical and real-time data so as to react to real-time uncertainties.

From 1997 to 2008, HCH went through three cycles of business process re-engineering and a number of systems were purchased to support the hospital's major departments.

2.2 Information Systems at Hippi Care Hospital

HCH processes were now mostly interactive or automated. The ED process was also supported by some of these systems. During this period, the Patient Care System was enhanced to record patients' conditions and more detailed information about their visits. Since 2008, HCH had still

been using the same set of systems to support the ED operations. Some of these systems included:

Patient Care System: Recorded patient information and details of their visits to the ED. For each visit, information recorded included the registration time; triage start/end times; consultation start/end times; tests and treatments that the doctor had ordered; discharge time; and the illness classifications. In addition, this system also recorded patient information such as name, address, contact details, date-of-birth, sex, and emergency contact details. If a patient previously had multiple visits to the ED in the past, there would be multiple visit records for a single patient's record.

X-Ray System: Stored the radiological images of the X-rays of patients and the analyses of the results.

Laboratory System: Stored the type of blood tests ordered and the test results. In a typical blood test, there were items such as hemoglobin count, platelet count, and whether sugar was present. Such items usually had a normal range. If the patient's result fell within the range for all the items, then the patient's blood test was deemed normal. If a patient's blood test results were not normal, more attention was required by medical professionals to understand why and how it would affect the patient.

SAP Enterprise Resource Planning (ERP) System: Stored detailed patient information for all departments (not just the ED). It handled admissions and contained the bed information of all in-patient wards. SAP ERP also contained the working timetable for doctors, indicating which doctor was on duty and in which shift.

3. THE ED PROCESS

The detailed ED process was highly complex and had a large number of variations (refer to Figure 3 for a simplified ED process with the associated systems that supported the process). The process had five sub-processes, namely registration, triage, consultation with doctor, investigative tests and treatments, and discharge or admission. For example, during triage, a nurse accessed the patient's visit information in the Patient Care System and updated the record by entering the triage start and end times.

In this ED process, when a patient arrived, he/she first registered and then underwent the triage process where a nurse determined the severity of their condition. The patient then consulted a doctor. In some cases, the patients had to remain in the ED after the consultation for further investigative tests, treatment or observation. For such patients, upon completing the tests and treatment or observation, they were to be reviewed by the same doctor again. The patient would re-enter the queue to wait for the doctor. Such patients were called the re-entrants. After the review session, the patient would either be discharged or be admitted to the hospital as an in-patient.

The patient stayed in the ED after consultation due to one or more of the following possible actions:

- Laboratory test (e.g., blood test)
- X-ray
- Point-of-care tests, such as a urine test, electrocardiogram, eye test and hearing test
- Procedure, usually on-site treatment such as taking medication or being bandaged
- Observation of symptoms (especially after taking medication)

The investigative test and treatment sub-process could be highly variable and differed greatly between patients. Different patients might have required different investigations (refer to Figure 4 for the types of patients who undertook different routes based on three months' observations in the hospital's ED). The term "basic" referred to the consistent steps that all non-emergency patients had to go through, namely registration, triage, consultation and discharge/in-patient admission. For example, a patient may

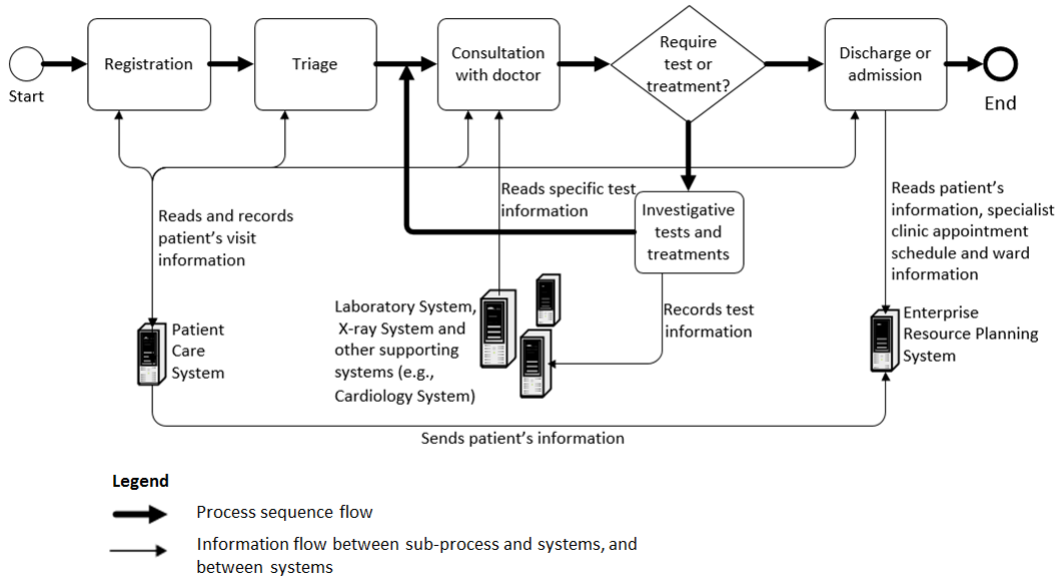

Figure 3: ED process with associated supporting systems

take a path Number 9 "Basic + L + R only". This meant that the patient would go through Triage, a first consultation with doctor, followed by a Lab (blood) test and a Radiology (X-Ray) test (in any sequence), then a review consultation with the doctor before going into the sub-process of in-patient admission or discharge as shown in Figure 3.

1	Basic (i.e. Triage + Consultation) only
2	Basic + POCT (T) only
3	Basic + Lab (L) only
4	Basic + Radiology (R) only
5	Basic + Procedure (P) only
6	Basic + T + L only
7	Basic + T + R only
8	Basic + T + P only
9	Basic + L + R only
10	Basic + L + P only
11	Basic + R + P only
12	Basic + T + L + R only
13	Basic + T + L + P only
14	Basic + L + R + P only
15	Basic + R + P + T only
16	Basic + T + L + R + P only

Legend
T - Point-of-Care Test (POCT)
L - Lab Test
R - Radiology Test
P - Procedure (treatment)

Figure 4: Patients may take different paths after first consultation

4. CHALLENGES

Lim needed to examine three main aspects that were contributing to the reason why the ED was unable to meet its service quality standards – demand, supply and ad hoc surges in demand. Mr. Viz had been advocating a move towards proactive processes in the ED. Although the hospital's employees were not new to process changes, the journey through process changes had not been easy and Dr. Kim believed that the processes in his department had already reached a point that was sufficiently lean. As such, Mr. Viz was interested in exploring innovative ways of making process improvements with minimal changes to the process sequencing, such as applying proactive process concepts instead.

4.1 Challenge 1: Managing the Demand

On the Sunday and Monday surge days, patients could experience a long wait of more than two hours before seeing a doctor. The PIC team decided to conduct an analysis of the arrival rates based on data in the Patient Care System and found that the arrival pattern varied not just by day of the week, but also by the time of day. Arrival rate in this case was defined as the number of patients arriving in the ED per hour (an example of a week's average arrival rates observed at the ED was shown in Figure 5). The arrival rates therefore differed by day of the week and times of day, with the highest arrival rates on Sundays and Mondays.

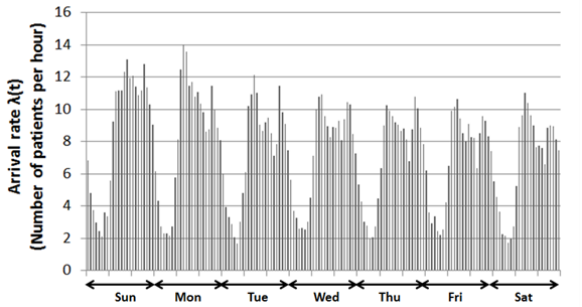

Figure 5: Arrival rates observed at the ED for a week

In addition, a time-motion study in the ED showed that the doctors generally spent less time reviewing a patient with clean test results than a new patient or a patient with test results indicating problems. How could the hospital clear patients who had spent a lot of time in the ED before complaints were received? What could they do to manage the crowd?

4.2 Challenge 2: Managing the Supply

Demand surges were exhausting. Dr. Kim faced tremendous resistance from fellow doctors when he called them in for help during their off-hours since those doctors never knew how long they would be needed for – there was simply no way to know.

The PIC team had done a study and observed that there was sometimes extra capacity in the critical care area even though the ambulatory area was crowded. This was noticed because a senior doctor was always positioned at the critical care area to deal with ad hoc arrivals of A1 and A2 patients. But there was not sufficiently clear knowledge of the queue conditions in the ambulatory area to determine if redeploying the senior doctor could help manage the demand. The team saw the potential to better utilise doctors.

4.3 Challenge 3: Managing The Ad-Hoc Changes In Demand Trends

As Hippi Island was highly urbanised with very limited natural outdoor facilities for physical activities, Hippi residents were passionate about AcroForAll, a mass fitness program that involved both acrobatic and dance movements. Once a month, Hippi Island would have an island-wide AcroForAll outdoor event for all age groups. It was a very popular event and residents were passionate in their participation.

It was typically conducted in specialised indoor studios or gyms. However, private operators had been organising mass AcroForAll sessions in tents. Although rules had been imposed on the AcroForAll operators to take safety into careful consideration, safety measures were taken and official approval received, such events made participants

	Process			Implementation	
	Sequence	Parameter	Stakeholder	Existing System	New systems
Recommendation 1					
Recommendation 2					
...					
Recommendation n					

Figure 6: An example of an analysis template

more prone to injuries and accidents than the indoor sessions.

It had been observed that there could be a 30% increase in the number of A3 patients arriving at the hospital's ED (the number of A1, A2 and A4 patients remained the same) following AcroForAll events. Among the additional A3 patients, 25% suffered from injuries caused by AcroForAll activities. AcroForAll-injured patients would generally require X-rays. Moreover, some of the roads were also closed during AcroForAll events, which coincided with a higher rate of accidents caused by massive traffic jams. The ambulance team reported that these jams slowed their response time in delivering patients to the hospital promptly. Such delays could be life threatening for certain accident victims.

5. PROCESS RECOMMENDATIONS ANALYSIS FRAMEWORK

Mr Viz had recently developed a Process Recommendation Analysis Framework to analyse any recommendations put forward by his members in the PIC. The framework assessed the impact on the existing process so as to carefully manage process changes in the organisation to ensure business continuity. Figure 6 shows a possible process recommendation analysis framework template.

The Process side of the template recorded the impacts of the suggested solutions on process. The impacts included (a) impact on process sequence, to assess if a change in process sequence was required if the suggested solution was to be implemented; (b) impact on process parameters, to assess if a change in process parameters (e.g., number of doctors, number of rooms, opening hours); and (c) impact on stakeholders (e.g., ambulance drivers, registration clerk, doctors) who may be affected by the recommendation.

The Implementation side of the template recorded the impacts of the suggested solutions on the technical implementation. The assessment included IT changes that were required for each of the possible solutions. The solution might require no change in IT systems or changes (enhancement of) the existing IT systems. The solution might also require new IT systems to be developed or purchased in order to support the new process.

6. CONCLUSIONS

Lim and her team had to provide ideas to address the ED's challenges. For each of the team's possible solutions to the challenges, they had to use the Analysis Framework to evaluate the solutions based on the impact on the process, and IT implementation to support the process. Lim had to deliver some feasible ideas on paper before the next press conference by the CEO of HCH, which was just two weeks away.

7. ACKNOWLEDGEMENTS

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