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Improving Patient Chart Flow at St.Vincent Hospital

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Acknowledgements

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Abstract

In this project lean methods were applied to reduce delays and wastes in a selected section of the Same-Day Surgery Chart Preparation Process at St. Vincent Hospital. The methodology included observation and interviews, data collection and analysis, analysis of Undesirable Effects, development of potential solutions, and vetting of solutions at a Kaizen event. The project generated cost-effective recommendations for improving communication, coordination and information management in the target process. Implementation of the recommendations will result in significant savings in labor and reduction of delays.
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1. **Introduction**

Saint Vincent Hospital is a 321 bed acute care hospital located in Worcester, Massachusetts. Saint Vincent Hospital offers a variety of specialty care centers, and an extensive array of outpatient services including same day surgery, radiation oncology and a pain clinic. As part of Saint Vincent Hospital, Same Day Surgery (SDS) provides quality care for 40 to 70 patients each day. The hospital devotes considerable resources to ensure the smooth operation of the patient admission process, of which patient chart preparation is an essential part.

St. Vincent uses paper-based charts for storing and communicating patient medical information. Completing chart preparation is essential to the patient admission process, which is necessary before an operation can begin. Therefore, delays and wastes in this target process not only affects efficiency, but also the overall patient flow in SDS. The performance status of the current process is unknown, due to the lack of data. However, it was a common understanding among the management and the staff that the hospital could benefit from more efforts to improve the current chart preparation process, as the delays and wastes could be investigated and reduced.

The scope of this project includes the chart preparation process before the patient is admitted, which is performed by the secretary and the registered nurses (RNs). The scope excludes tasks done in the Pre-Admission Testing office and patient admission processes.

The objective of this project was to identify and reduce wastes and other sources of delay in this process, thus reducing lead time. In particular, the intent of this project was to generate cost-effective recommendations to improve communication, coordination and information management in the process.
In order to achieve the objective, the goals below were pursued:

- Observe the specific steps in the target process, and identify key issues in the process
- Measure and analyze key issues in the process, and
- Develop solutions and recommend implementation plans.

The ultimate customers of this process are the patients, while the primary customers are the RNs and the hospital. The RNs and the hospital need to assemble and verify information relevant to the surgery to assist preparation of the surgery and adhere to standard procedures.

This project incorporated practical methodologies that are appropriate at St. Vincent Hospital. Observation and brief interviews were used to define the problem, which enables the team to determine key metrics and conduct data collection related to the defined metrics. The results of the data analysis were used to further justify the problem definition, and to develop potential solutions. A kaizen event was organized to acquire inputs from the staff, develop solutions and implement solutions.

This report is organized as following. Chapter 2 presents the background of this project, and a literature review on relevant topics. Chapter 3 presents the methodology used in this project, while Chapter 4 describe the results of the main project and two smaller projects completed by the team. Finally, an overall conclusion and recommendation is provided in Chapter 5, summarizing the impacts of the project.
2. **Background and Literature Review**

In order to ensure success of the project, a literature review of several key lean methodologies adopted by St. Vincent was conducted, two smaller lean projects were completed by the team with the intent to familiarize the team with the work process at St. Vincent, and initial observations of the target process were conducted. This section describes the results of these activities. The literature review contains a brief introduction, major steps and discussion of advantages and disadvantages for each of the lean methodology discussed.

2.1 **Lean Methodologies at St. Vincent Hospital**

The core idea of lean is to maximize customer value while minimizing waste. Although lean concepts were initially developed to improve car production, a study by Womack and Jones showed that the lean principles could be applied to virtually any manufacturing system (Womack and Jones, 1996). Nowadays, lean applications reach well beyond the manufacturing industry, for example to the service and healthcare delivery industries.

Numerous case studies and reports on lean implementation in healthcare from the past decade suggest that lean healthcare is an effective way of improving healthcare organizations. The Institute for Healthcare Improvement ("IHI") states that there is growing agreement “among healthcare leaders that Lean principles can reduce the waste that is pervasive in the U.S. healthcare system...Adoption of Lean management strategies — while not a simple task — can help healthcare organizations improve processes and outcomes, reduce cost, and increase satisfaction among patients, providers and staff (Miller, D., 2005, p.3).”

Lean thinking is a technique for creating change. As is the case in most organizations, healthcare professionals can become complacent and begin to believe that their way of doing
things is the best (Kotter, 2008). Lean thinking challenges this belief by asking individuals, departments, and administrators to examine the value being produced for the customer and then engaging in the practice of continual improvement.

The Kaizen Promotion Office at St. Vincent Hospital was established in 2010 to facilitate process improvement initiatives. A selection of lean methodologies is incorporated into various initiatives that address issues in the hospital’s daily function. The Kaizen Coach is responsible for organizing and providing professional assistance to lean projects. The projects facilitated by the office have various scopes. For example, the front-line staff is encouraged to apply lean thinking to reorganize their workspaces in small lean projects. Large-scale projects include multi-day Kaizen events to streamline existing processes, and long term efforts to improve operations in certain functions. The staff involved learns about lean thinking during the problem solving process, and the adoption of lean methodologies is reinforced by perceivable benefits.

At St. Vincent Hospital, A3 forms are commonly used to manage process improvement projects. Clear objectives and milestones are needed to complete an A3 form. The A3 process is a Toyota-pioneered practice of getting the problem, the analysis, the corrective actions, and the action plan down on a single sheet of A3 sized paper.

Value stream mapping and undesirable effects are often used as problem analysis tools at St. Vincent Hospital. Value stream mapping (VSM) is a common lean tool to visually document and improve the material flow and information flow in a process. As one of the tools in the Jonah thinking process in the Theory of Constraints, identifying and analyzing undesirable effects (UDEs) sets the foundation of problem solving.
Kaizen is used as a tool to involve relevant individuals in intense and effective problem discovery and solving at St. Vincent. A Kaizen Event is a focused and structured continuous improvement activity. It utilizes a dedicated cross-functional team to address a targeted operation, and to achieve specific objectives (Farris et al., 2008; Hamel, 2010).

This section includes the description, advantages and disadvantages of these key lean methodologies.

2.1.1 A3 Problem Solving

The A3 Problem-Solving Report aims to address the root causes of a problem, so as to prevent recurrence. The report articulates eleven steps to proceed from problem identification to resolution. It records the results of investigation and planning in a concise document, in a fashion that fosters knowledge sharing and collaboration.

At St. Vincent Hospital, A3 report cards are used in almost all process improvement projects, as a tool for project planning and documentation. Extracted from internal communication with the Kaizen Coach at St. Vincent, the steps for implementing A3 problem-solving at St. Vincent are listed below:

Step 1: Identify a problem or need
Step 2: Conduct research to understand the current situation
Step 3: Conduct root cause analysis
Step 4: Devise countermeasures to address root causes
Step 5: Develop a target state
Step 6: Create an implementation plan
Step 7: Develop a follow-up plan with predicted outcomes
Step 8: Discuss plans with all affected parties
Step 9: Obtain approval for implementation
Step 10: Implement plans
Step 11: Evaluate the results

Use of the A3 tool is prevalent in healthcare settings for its many advantages. The A3 tool is efficient, as the report starts with observing the actual work, which raises accuracy and efficiency of the process. It also reduces staff hours required, as it can be done by a few representatives of the affected parties in a short time. It is easy to learn, as it does not require special training and can be filled out using a pencil. It promotes knowledge sharing, as it can be easily displayed and reviewed in a group to clearly communicate project progresses. The tool can be used by frontline workers, as it is easy to learn and to teach.

However, there are a few limitations of the A3 tool. It needs to be used in conjunction with other tools in order to observe details of interruption and delays, and to make the process reengineering a success. The statements in an A3 are arbitrary since they are subjective conclusions. (A3 Process)

2.1.2 Value Stream Mapping

Value stream mapping (VSM) captures and presents the target process from end to end in a way that is easy to understand. It captures the current issues and presents a realistic picture; a future state can be defined and formulated as well. The method encourages a team approach, and through the capture of performance measurement data. It provides a mechanism to constructively critique activities in the process. (VSM How to Guide)

VSM aims to improve processes by highlighting areas of waste within a process. VSM categorizes process activity into three main types - value adding, non-value adding and waste. A value-adding activity increases the value received by the customers; a non-value adding activity
does not add new value for the customer, but it is necessary; and wastes are the activities that are neither value-adding nor necessary. (VSM How to Guide)

The typical information needed to create a current state map includes: how long the particular process takes, current materials or inventory, and the resources (e.g. staff) at each stage. The map needs to document common problems, and the key performance measurements as defined by the group. The group also needs to define a set of icons to transcribe the process. On the future state map, the output and demand at each stage need to be noted. The map also has to incorporate criticisms of the process raised in the previous step, and goals of key performance indicators. (VSM How to Guide)

At St. Vincent, VSM is often done during a Kaizen event coordinated by the Kaizen Coach. The Kaizen Coach often asks detailed questions regarding the process and documents the map with post-it notes on a whiteboard. The group actively contributes and learns about lean concepts while mapping the process.

VSM has many advantages in process improvement. It integrates material and information flows, and links various functions within the process together. It also provides additional and customized icons that are not included in the standardized process maps. It forms the basis of process improvement by providing detailed time break down. (Kaale, 2005)

Despite the wide application of VSM, it has some limitations, including the failure to capture a few concepts: multiple products with different material flow maps, transportation and queuing delays, changes in batch sizes, capacity constraints, and worthwhile economic measures of value. It also lacks the spatial structure of the facility. VSM tends to bias system designers towards continuous flow, pull scheduling, and other methods that are suitable mainly for high
volume and low variety systems. Another disadvantage of applying VSM in health care is that the data sample size is usually smaller than ideal, since it is inconvenient to collect time data when the patient is present. (Kaale, 2005)

2.1.3 Undesirable Effects

The Theory of Constraints (TOC) is a set of holistic processes and insights, all based on a systems approach that simplifies the improving and managing of complex organizations by focusing on the few physical and logical constraining “leverage” points. The Theory of Constraints is centered on increasing throughput by reducing bottlenecks.

According to the theory, undesired effects (UDEs) are caused by a compromise of necessary conditions, and almost all UDEs can be traced back a single root cause. A solution for each UDE is needed to resolve the problem in the system. (Theory of Constraints-an Overview) The UDEs are used to construct a current reality tree, which is an analysis of many systematic or organizational problems at once, while the current reality tree provides a basis for improvement. (Theory of Constraints-an Overview)

At St. Vincent, UDEs are discussed at meetings where relevant personnel reach agreement on plans for process improvement. Generating UDEs is an intuitive approach to identify areas to work on. After brainstorming UDEs, the Kaizen Coach organizes the identified UDEs by their areas, and prompts attendees for solutions to each UDE. When a major solution is raised and agreed upon, the Kaizen Coach asks for an implementation champion and approximate timelines for the major milestones. Then the liaison asks if the solution will resolve any other UDEs and take these UDEs off the list.
TOC adopts a mechanical view of the relationship between measurement and behavior, as workers will change their behavior strictly on how they are measured. Therefore, the solutions to the UDEs are often aimed at increasing throughput by changing the tools and measurement of the workers. In this case, quality, which is critical to health care, can often be overlooked. (Theory of Constraints-an Overview)

2.1.4 Kaizen

Process improvement efforts have been applied in healthcare with the focus on multiple performance components in the care delivery process, such as patient satisfaction, cost, and quality of care. Successful application and sustained performance improvement require diligent and continued efforts, i.e. continuous improvement. Kaizen, which is the Japanese term for the continuous improvement mechanism, has gradually found its way into the healthcare sector.

Goals for Kaizen Events arise from deficiencies identified in specific processes. Furthermore, a typical Kaizen Event follows a methodical process of identifying waste from a lean perspective, implementing solutions, measuring results, and standardization of work practices (Stone, 2010).

Kaizen events differ from the improvement methods employed by U.S. industry in the past. Traditionally, organizations in the U.S. have relied on major leaps of improvement from large scale projects, often originating from the top levels of an organization. While these large projects can certainly result in great improvements, organizations have realized that significant gains can be made via smaller steps through Kaizen events (Manos, 2007). The ability of Kaizen Events’ to empower frontline employees by engaging them in process improvement efforts provides opportunities not only to address day-to-day operations, but also to establish a
“community of practice”, defined as sharing knowledge through the organization to respond to customer needs (Lave and Wenger, 1991) in a fast paced work environment.

Kaizen events in healthcare have the potential to result in improvements in patient safety, quality of treatment, lead time or patient flow, employee productivity, and the analysis of medical errors (Wennecke, 2008). However, difficulties in staffing schedules and day-to-day operations adjustments sometimes force healthcare management to modify the time frame and resource commitment in a typical Kaizen event. An alternative approach to a Kaizen Event is to implement activities in traditional Kaizen Events in strategically arranged Kaizen Sessions, lasting two to four hours, to overcome the aforementioned constraints (Culcuoglu et al., 2012).

Continual improvement requires small, incremental changes to be routinely applied and sustained over a long period, in order to result in significant improvements. The kaizen strategy involves personnel from multiple functions and levels in addressing a problem or improving a process. Analytical techniques, such as value stream mapping and "the 5 whys", are used to identify opportunities to eliminate waste quickly. “The 5 whys” is a question-asking technique used to explore the casual relationships underlying a particular problem, and to subsequently determine the root cause. The solutions typically do not involve large capital outlays. Periodic follow-up events need to be scheduled to ensure that improvements from kaizen events are sustained over time. (Kaizen Method)

The Kaizen events at St. Vincent Hospital help develop mutual understanding among different functions within the organization, as well as encourage collaboration and creative problem solving. The length of Kaizen events at St. Vincent Hospital can vary from four hours
to 5 business days. During the events, the Kaizen Coach explains the key concepts, and guides the team through the steps listed below.

Step 1: Clearly define the problem and its scope
Step 2: Create a detailed flow map of the entire process
Step 3: Each person contributes in the steps that is most familiar to him/her, and breaks down the process with the liaison’s help
Step 4: Brainstorms for undesirable effects in the work process, and analyze root causes
Step 5: Examine each step in the process flow map and decide whether it is value-adding
Step 6: Brainstorm for metrics to measure the process
Step 7: Brainstorm for solutions to resolve the undesirable effects
Step 8: Plan actions to implement the solutions. Each action will have a deadline
(Kaizen Method)

2.2 Learning Lean Methodology through Small Projects at St. Vincent Hospital

At the initial background investigation stage of our project, we chose to gain organizational experience by assisting with problem solving processes at the hospital. The team became familiar with St. Vincent’s culture, common procedures and lean methodologies by conducting two small projects. This section contains the background, procedure, analysis and results of the projects completed.

2.2.1 Transport Data Interpretation Project

At St. Vincent Hospital, the transport team is in charge of transporting patients to various locations when needed. The current overall transport time is longer than the ideal state, and significant variations exist in the process. Our team observed the improvement meetings for the patient transport process, and assisted by analyzing data and presenting the results and recommendations.
First, we helped categorize the undesirable effects mentioned at the project meeting into three major types: miscommunication, missing components, and technical delay.

We then conducted data analysis and created a presentation containing the key parameters of the system using August’s job timestamp information: distribution of total transport time, distribution of time for each step within the process, average amount of requests for each hour and each day of the week, average transport time for each destination, origin, and route, and information on transporters’ performances.

Figure 1 shows the distribution of total transport time. The figure also shows that average total transport time is 28.8 minutes, the goal the team has set is 25 min, and that 95% of jobs are done within 1 hour. The data has been affected by staff documenting before completing the job, and the actual curve should be shifted to the right.

![Figure 1 Distribution of Each Job’s Total Transport Time](image-url)
The average number of requests and average transport time of all the jobs completed on each day of the week are computed and illustrated in Figure 2. Average requests are notably higher on weekdays than weekend days; jobs take longer to complete on Mondays and Thursdays, and they take the least time to complete on Saturdays.

One potential cause of variation in average total time on each day of the week is the variation in average utilization rate of the transporters during the time period, as during some shifts the transporters are “busier” than usual. The average transporter utilization rate can be computed with information extracted from the data provided: utilization rate is total utilized man-hours divided by total available man-hours. Average total available man-hours can be found by counting the transporters working on each shift, and the total hours of work done by the transporter can be found from the number of jobs done during the shift, assuming 2.5 jobs to be done per hour per person. Table 1 shows the calculated transporter utilization rates for each shift on each day of the week, all data points acquired in August 2012 contributed to this calculation.

The team recommended staffing to be increased on busier shifts, the average total transport time on these shifts is expected to decrease. The six shifts with highest utilization rate...
are highlighted in Table 1. The team recommended that additional staffing to be allocated to these shifts. The new data can be used to analyze the impact of this potential cause; the other causes of the variation in average total time are yet to be discovered. These shifts are: 3\textsuperscript{rd} shift on Monday, all three shifts on Thursday, 2\textsuperscript{nd} shift on Friday, and 1\textsuperscript{st} shift on Saturday.

The transporters are “busier” on these shifts, which might lead to longer waiting time for the jobs. According to the data analysis, the tasks from dispatch to patient arrival, which are handled mainly by transporters, take 20.3 minutes on average. For 35\% of the jobs, these tasks take between 24 minutes and 44 minutes. The transport management estimated that each transporter handles 2.5 jobs per hour. Therefore, it could be assumed that each job takes 24 minute for one transporter, and it can be derived that at least 35\% of the jobs waited for available transporters for up to 20 minutes, and 5\% of the jobs waited over 20 minutes.

Queuing theory indicated that the utilization of capacity is directly related to average customer waiting time. And the cases with very long wait time can be significantly reduced by keeping the utilization rate under 80\%. The detailed explanation is included in Appendix B. In the meantime, note that this analysis took the assumption that each job take 24 minutes for each transporter to complete. Therefore, efforts to reduce this time can eliminate long wait time as well.

<table>
<thead>
<tr>
<th>Table 1 Transporter Utilization Rate by Shift and Day of the Week</th>
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<tbody>
<tr>
<td>Transporter Utilization Rate by Shift and Day of the Week (assume 2.5 jobs per hour per person)</td>
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Error! Reference source not found. is created by ranking the transport routes by average total transport time. It was discovered that the slowest routes are often from patients’ rooms to tests and care units, and the fastest ones are often the return trips. The returning routes are often around 1/3 of the time to a test or care unit, or 12 to 17 minutes faster. For example, the average transport time of the route from “35 North” to “CT Scan” is 34.24 minutes, and average transport time of the corresponding returning route is 19.21 minutes. The route pair is highlighted in the Error! Reference source not found. in blue. Potential explanations could be delays in getting patients ready in patient rooms, and queues at testing rooms. The recommendations based on our data analysis include:

- Train personnel to accurately document time for task completion, in order to ensure realistic data.
- Arrange capacity according to historical demand: increase the number of transporters during the shifts where transporters have higher utilization rates.
- To improve understanding of the issues in the process, further investigate causes of the discrepancies in transport time for the routes. Specifically, study the process for routes with high average total time in the respect of how the time is spent and the causes of delays.
- The hospital can benefit from a Kaizen event that rapidly identify and address the undesirable effects in the transport process.
### Table 2 Fastest and Slowest Routes

<table>
<thead>
<tr>
<th>Slowest Routes</th>
<th>Average Total Time (min)</th>
<th>Fastest Routes</th>
<th>Average Total Time (min)</th>
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<tr>
<td><strong>Route</strong></td>
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<td><strong>Route</strong></td>
<td><strong>Average Total Time</strong></td>
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<td>CT SCA --&gt; 35 Nor</td>
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<td>24 Nor --&gt; CT SCA</td>
<td>39.51</td>
<td>ER RA --&gt; 23 Sou</td>
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<td>22 Sou --&gt; CT SCA</td>
<td>38.03</td>
<td>ER RA --&gt; 24 Nor</td>
<td>20.67</td>
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<tr>
<td>24 Nor --&gt; ER RA</td>
<td>37.08</td>
<td>ER RA --&gt; 34 Nor</td>
<td>20.91</td>
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<tr>
<td>36 Nor --&gt; CT SCA</td>
<td>36.76</td>
<td>CT SCA --&gt; 36 Nor</td>
<td>22.15</td>
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<tr>
<td>22 Sou --&gt; ER RA</td>
<td>36.07</td>
<td>24 Nor --&gt; NORTH</td>
<td>22.55</td>
</tr>
<tr>
<td>34 Nor --&gt; CT SCA</td>
<td>35.39</td>
<td>SPD 93 --&gt; 35 NOR</td>
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<tr>
<td>36 Nor --&gt; ER RA</td>
<td>35.36</td>
<td>MRI 52 --&gt; 24 Nor</td>
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### 2.2.2 Patient Bed Board Redesign Project

The patient bed board is an information board pre-printed with a layout. It is designed for staff to fill in relevant information for each patient with erasable markers during the patient’s stay. The current design of the patient bed board is an A3 sized board, containing basic information such as patient name, room phone number, RN and PCA’s name and doctor’s name. In order to fully utilize the board to improve the patients’ and families’ experiences during the stay, the bed board needs to be redesigned to include more critical information.

Selected components of similar patient bed boards provided by the Kaizen Promotion office were evaluated with respect to value to the staff, and to patients and families.

An initial draft was created to incorporate the most valuable and essential components on an A-3 board, as shown in the left-hand picture in Figure 3. Some of the selected components...
stay the same during the patient’s stay; these components include patient name, communication information, diet, names of the patients’ care team members, and essential phone numbers. Some components are updated daily; these components include pain management information and treatment plans for each day. The questions and concerns section is reserved for the patient and the family to leave notes for the care team. The layout was then adjusted to ensure readability and sufficient writing space.

Figure 3 Initial Bed Board Layout Design and Final Bed Board Design

The initial design was critiqued by management personnel of nursing. At the meeting, the “transfer information” section was added to the design; this section enables the transportation staff to quickly understand the patient’s relevant needs. Minor changes were made to the contents at the meeting, and the preference for the appearance was discussed. The design was then modified to create the final version according to the requirements determined at the
meeting. The final version is shown in the right hand picture in Figure 3. The final version is more professional as well as aesthetically pleasing.

2.3 The Target Process for Improvement: the Chart Preparation Process in Same-Day Surgery

The main focus of the project is to improve the chart preparation process in Same-Day Surgery, which is a part of the Same-Day Surgery process. The general same-day surgery process at St. Vincent is shown in Figure 4. The patient needs to be admitted and prepared in the same-day surgery area before being sent into the operating room for a procedure. After the operation, the patient is sent back to the same-day surgery area to complete discharge procedures.

![Figure 4 Same-Day Surgery Process](image)

The target process for improvement, chart preparation, begins on the morning before the scheduled appointment when the same-day surgery (SDS) secretary receives relevant material, and ends before the registered nurse (RN) admits the patient on the day of surgery. The SDS secretary processes the charts the day before the surgery. On the day of the surgery, the SDS RNs process charts in two separate SDS areas. The steps and requirements for the chart preparation process are identical in both areas, but practices may differ.

The current procedure for the target process is undocumented, and no measured data exists. Previous efforts to improve the process yielded some satisfactory results. For example, a previous Kaizen event addressing issues related to incomplete consent forms has changed some of the surgeons’ habits in dealing with consent forms. However, there has been no systematic quantitative study done on the target process.
3. Methodology

To improve the performance of patient chart flow through the target process, namely reducing patient wait time and chart processing time, the team conducted the following steps.

Step 1: Conduct observations and interviews to generate a detailed description of the current process and identify potential issues

Step 2: Collect data to form a quantitative understanding of the performance of the current process

Step 3: Analyze identified undesirable effects to produce potential solutions, and

Step 4: Conduct a Kaizen event to further analyze the key undesirable effects, to develop concrete solutions and implementation plans of the solutions.

This section contains the specific methods for each step.

3.1 Observation and Interview

In order to form an understanding of the target process, the team observed the work of the SDS secretary and four SDS RNs at the beginning of the project. During the observations, the team documented the major steps of the process.

Five SDS RNs were interviewed briefly. The team asked the RNs to comment on the areas of the process which they would like to see improved. The following is a list of our questions:

1. What information is redundant or repetitive in the current chart design?
2. What is the main cause of delays and wastes in the current process?
3. What are some of the opportunities to reduce redundancies in the current chart design?
4. What are some of the opportunities to reduce delays and wastes in the current process without altering the chart design?
During the data collection process, which will be explained in the next section, more specific questions were asked to the RNs. The information acquired from the RNs was used to assist solution development and initial discussion of feasibility.

3.2 Data Collection

Manual data collection was conducted by the team to acquire measurements from 22 different chart preparation processes done by RNs between October 24th and November 15th, 2012. The data contains 12 samples acquired during “rush hours”, that is, between 5am and 8am, and 10 samples during “non-rush hours”, that is, after 8am. The metrics measured during data collection for each chart tracked are total time from beginning to completion, total time spent filling out the forms, time duration of each delay, and the reason for each delay.

The data was collected manually by three different team members. Manual reading of time from watches was used on over half of the samples when stop watches were unavailable, which gave the readings a precision of 1 minute. The error induced by using watch readings can be as much as 10% in each individual sample, which limits the accuracy of the entire data set. Due to the relatively high variance in the small-sized sample, the data cannot serve as the basis for proving statistically significant improvement when compared to a similar set of data collected in the future. Therefore, the collected data is only appropriate for generating descriptive statistics of the current process performance, such as average, distribution and standard deviation of each measured metric.

One important metric of the performance of the overall SDS preparation process is the percentage of patients not ready for surgery when the operating room (OR) secretary calls the SDS preparation area to send in the patient, which is referred to as “the percentage of patients late for surgeries” in this project. Late patients cause waste in resources as the surgical personnel
and facilities are idle until the patient is ready. A high percentage of patients late for surgeries indicate an opportunity for improvements in the overall SDS preparation process.

The OR secretary collected 347 data points during the week of November 5th, the week of November 26th, and the week of December 3rd. The data contains the count of patients on time for operations after the preparation process in the SDS area each week, and the count of patients late for operations after the preparation process in the SDS area each week, and the count of appointments canceled or rescheduled.

A standard data collection sheet was provided to the OR secretary to record data for a week; each time when she called the SDS preparation area to send in the patient, a hash mark was added to the corresponding cell indicating the hour of the scheduled appointment and the patient status.

The data was used to generate overall “percentage of patients late for surgery” for each week, and to screen for strong patterns in the distribution of hourly “percentage of patients late for surgery”. As a result of the small sample size, only strong correlations can be detected from the collected data.

3.3 Analysis of Undesirable Effects and Generation of Potential Solutions

The information acquired from observations and interviews formed a basis for the UDE analysis. The most common issues reflected are selected as the UDEs to focus on, while the knowledge of the constraints was used to extract the causes of the UDEs.

During the UDE analysis, the causes of the UDEs were identified and discussed. Causes of the identified causes were then identified, and the analysis continued in this manner until each of the listed causes appeared resolvable.
Through brainstorming, potential solutions were generated to address the resolvable causes of UDEs. The knowledge obtained from St. Vincent Hospital’s operations assisted the team to select relatively feasible potential solutions with which to move forward. An initial feasibility study was done on selected solutions by interviewing the management staff of St. Vincent Hospital.

3.4 Kaizen

In order to gain further insights into the identified UDEs and produce a feasible action plan within a short time scope, a four-hour Kaizen event was conducted on December 7\textsuperscript{th}, 2012.

The data analysis done prior to the Kaizen event was presented at the event and used as a basis for discussions. The event focused on each of the two major issues for two hours. A detailed agenda was distributed to the participants, the agenda contained discussion topics and deliverable goals for each of the pre-defined section throughout the event.

The team members rotated to serve as the host and facilitator for each section. The host led the section to achieve the deliverable goals, while the facilitator monitored the discussion and intervenes when the group digressed. The agenda is included in Appendix A.

Two management staff, two RNs and the SDS Secretary participated to discuss the following items:

- Process of handling of incomplete paperwork
- Process of handling of allergy information
- Potential solutions to the delays caused by incomplete paperwork
- Potential solutions to redundant work completing allergy forms
- Discussion of benefit, risk, cost and feasibility of the potential solutions
- Action plan for each selected solution
4. Results

The team generated a detailed description of the current pre-surgery paperwork process and identified undesirable effects; formed a quantitative description of the current process performance; formed an analysis of identified undesirable effects; and produced potential solutions. The solidified solutions were generated and implemented at the Kaizen event conducted by the team with the support from St. Vincent Hospital. The original measured data is located in Appendix B.

4.1 The Current Process

A patient chart is initially assembled by the Pre-Admission Testing (PAT) secretary by pulling relevant information from databases and outside sources. Staff members from the PAT and anesthesia departments then add information using their clinical knowledge.

On the morning before the day of surgery, the SDS secretary receives the patient charts from the Pre-Admission Testing office (PAT) and a log of appointment ordered by name in alphabetical order, which is colloquially referred to by the staff as “the slate”. Each patient’s chart is contained in a three-ring binder, where pages can be added and removed. In addition to the patient charts, all information related to the patient, such as progress notes, physical examination records, is also included in the binder.

The first step the secretary takes is to separate the patient charts by surgery floor. For each patient, the secretary finds the required charts for the specific patient type and procedure and applies pre-printed patient information stickers on each sheet of the charts. The secretary then verifies the presence of valid consent (signed within 90 days), a valid physical (performed within 30 days), a completed anesthesia chart, and an allergy chart; if any items are incomplete,
the secretary records this on a checklist or a post-it note. Afterwards, the secretary punches holes in the charts and inserts them in a binder. The binder is then stored on a rack until the RNs retrieve it on the morning of surgery.

On the day of surgery, SDS RNs retrieve patient charts from storage. The charts are then put onto racks located at each RN station on the floor. The RNs process the patient charts by the order of the appointment time. The RNs need to verify that all necessary paperwork items as mentioned in previous paragraph are complete, and contact responsible personnel for each missing item. The RNs also fill in the charts with information provided in the binder. A significant portion of the paperwork needs to be completed before the admission process.

From 5 am to 8 am, the RNs’ chart processing allows little delay, as the chart needs to be ready by the time the patient arrives. After 8 am, more flexibility is allowed, as the RNs have ample time to multitask.

The time value map in Figure 5 shows the approximate process time for each chart at each step of the process. As shown in Figure 5, during most of the time on the day before surgery and on the day of surgery, the chart is waiting to be processed.

![Figure 5 Patient Chart Preparation Time Value Map](image)
4.2 Performance of Current Process

Statistical analysis performed with the data collected facilitated quantitative understanding of the current process. This section presents the results of our data analysis, as well as interpretations.

4.2.1 Value-Adding Time and Total Time

On the day of surgery, the time between 5am and 8am is referred to as “rush hours” in this project, since completing charts and admitting patients is the top priority over other tasks for RNs during these hours. After 8am, during “non-rush hours”, the nurses have time to engage in other tasks while still being able to have the patients ready for scheduled surgeries.

In this process, value adding activities include retrieving information from the charts, and entering information into the charts. Average value-adding time and total time for the process during rush hours, non-rush hours and all hours are listed in Table 3. The information is extracted from 22 samples measured between October 24th and November 15th.

<table>
<thead>
<tr>
<th></th>
<th>Value-Adding Time (min)</th>
<th>Total Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rush Hours Average</td>
<td>12</td>
<td>15.3</td>
</tr>
<tr>
<td>Non Rush Hours Average</td>
<td>10.7</td>
<td>20.5</td>
</tr>
<tr>
<td>Overall average</td>
<td>11.4</td>
<td>17.7</td>
</tr>
</tbody>
</table>

During “rush hours”, the percentage of value-adding time is 85%, which is significantly higher than the percentage during non-rush hours, which is 66%. One reason for the difference is that during “non-rush hours” the RNs can be interrupted by other tasks without affecting the patient admission process.
Observed time spent searching through the chart and writing on the chart ranges between 7 and 21 minutes per chart. The distribution of value adding time is shown in Figure 6. A major cause of variation in this case is the number of allergies and the length of the medical history of the patient, as a chart with a very short allergy list and medical history often takes under 10 minutes to complete, while a long allergy list and/or medical history may require more time to manually input and cross-check.

![Distribution of Value Adding Time per Chart](image)

**Figure 6 Distribution of Value Adding Time for Each Chart**

### 4.2.2 Interruptions during Chart Preparation and Delays Caused by Incomplete Paperwork

Interruptions are very likely to happen during chart preparation, where the RN briefly pauses the chart process. Some of the most common reasons for interruptions include: admitting patients, assisting another RN on the floor, assisting others on the phone, getting and administering medicine to patients, and investigating incomplete paperwork. Aside from the last interruption, all others are necessary and valuable to patients or other internal customers.
During rush hours, 2/3 of the observed chart preparations were uninterrupted; this rate is significantly higher than the portion of charts that are uninterrupted during non-rush hours, which is 2/5. During rush hours, the interruptions were almost always less than 5 minutes, while 1/3 of observed interruptions during non-rush hours were over 15 minutes.

In the data collected, missing paperwork occurs 14% of the time (3 out of 22 samples), resulting in delay of 20 to 40 minutes for each instance. All three observed charts with missing paperwork had incomplete consent forms.

### 4.2.3 Percentage of Patients Late for Scheduled Surgery

According to 347 samples collected by the OR secretary during the week of November 5\textsuperscript{th}, the week of November 26\textsuperscript{th}, and the week of December 3\textsuperscript{rd}, on average 16.4% of the patients are late for surgery. A patient is considered late if the patient is not ready by the time the SDS secretary calls the SDS admission area to transport the patient to the operating room. The percentage of patients late for surgery during each of these two weeks are listed in Table 4, the reasons for the delays are unclear. The rates for these three weeks fall in the same range.

<table>
<thead>
<tr>
<th>Table 4 Percentage of Patients Late For Surgery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Size</td>
</tr>
<tr>
<td>Week of 11/5</td>
</tr>
<tr>
<td>Week of 11/26</td>
</tr>
<tr>
<td>Week of 12/3</td>
</tr>
<tr>
<td>Overall</td>
</tr>
</tbody>
</table>

The pattern in the weekly overall percentage of patients late for each hour of the day showed strong similarity during the week of November 26th and the week of December 3rd, as shown in Figure 7. The percentage is calculated by dividing the total number of patients late during each hour for the specific week by the sum of number of patients late and number of
patients on time. The data from the week of November 5 is rather incomplete, since the sample size is smaller than the other two data sets. It is not included in the plot as the trend demonstrated is not similar to the other two weeks.

![Figure 7 Overall Percentages of Patients Late during Each Hour of the Day](image)

A strong similarity in the number of scheduled surgeries during each hour during these two weeks was observed as well. Assuming that 50 surgeries are scheduled for each day, the number of scheduled surgery during each hour for the two weeks are derived from collected data, as shown in Figure 8. According to the SDS secretary’s estimation, the total number of surgeries scheduled in SDS each day during Monday to Thursday is close to 50.
Using the data gathered during November 26 to December 6, and the assumption that 50 surgeries are scheduled for each day, the average number of surgeries scheduled during each hour each day is shown in Figure 9 with the red line. Based on the assumption that the average patient arrives to SDS preparation area 2 hours prior to the scheduled surgery, the number of patients in the SDS area is derived and shown in Figure 9 by the green line; the number of patients in the area for preparation service is also directly related to the amount of preparation service needed from the staff during each hour. With this information, the average preparation service demand during a patients’ preparation time can be derived, which is a factor describing how “busy” the RNs are. For example, the second data point on the light blue line indicates that for each patient with a surgery scheduled between 6am and 7am, there are 18 patients being prepared in the SDS preparation area on average at any moment. The gap from 12pm to 1pm is caused by the fact that no surgeries are scheduled during this hour.
As shown in Figure 9, one or two patients are late during each hour in the morning every day. The specific reasons for the lateness in observed samples are unclear. Some potential causes are late patient arrival, lack of capacity to prepare the patients on-time, and delays caused by other reasons. Factors contributing to RNs’ capacity to prepare patients include the discharge workload, other tasks, and the total number of RNs working. More research is needed to understand to causes of the patients being late. The workload of chart preparation takes up resources, yet no significant difference in number of patients late for each hour is observed between “rush” and “non-rush” morning hours, which are 5am to 8am and 8am to 12pm respectively.

![Figure 9 Average Preparation Service Demand during Patients' Preparation Time and Number of Patients Late for Each Hour](image-url)
4.2.4 Summary of the Current Process’s Performance

The performance of the current process was described by data analysis conducted with a relatively small sample of data. The measured current average total time for the process of each chart from the time a RN starts to work on it to its completion is 17.7 minutes. Average work time by RN is 11.4 minutes, during which the RNs are focused on working on the chart. Work time per chart ranges from 7 minutes to 21 minutes. Interruptions of various length occur in almost half of the charts. All observed causes interruption except for reworking incomplete paperwork are valuable to patients or other internal customers. Delays caused by incomplete paperwork occurred in 14% of observed charts and resulted in delays from 20 to 40 minutes. In around 1/5 of the observed cases, the patient was not ready by the time he or she was supposed to be transferred to operation room (OR); the reasons of delays were unclear.

4.3 Analysis of Undesirable Effects in Current Process

The most prominent undesirable effects in the current process fall into two major areas: delays caused by handling incomplete paperwork and redundant work when handling allergy information.

4.3.1 Analysis of Delays Caused by Incomplete Paperwork

When checking for incomplete paperwork items, the RNs check for the same items as the SDS secretary. Incomplete paperwork results in delays of various lengths, as the RNs contacts responsible parties and waits for the paperwork to be reworked. The consent forms missing surgeons’ signatures often lead to significantly long delays, because the surgeons are less available and sometimes unaware of the missing paperwork. A previous Kaizen event successfully highlighted the importance of the issue to the surgeons and altered some surgeons’
habits. However, the hospital could still benefit from more effort to eliminate delays caused by this issue.

A main constraint for improvement in this area is the lack of integration of data. The information about the missing paperwork and the information needed to complete the paperwork is acquired from many sources, stored in various locations, and communicated through different channels. A simple way of recording, storing and communicating useful information is needed.

The current “checklist” is attached to the chart and cannot be aggregated easily. Appointment slates are currently used by the staff in conjunction with the checklist to keep track of chart preparation process. Appointment slates are provided by scheduling staff to staff involved in the chart preparation process to assist their work; the slate contains the latest appointment information, which includes patient information, procedure, surgeon, and scheduled surgery time. The slates are often finalized at noon on the day before the appointments, and distributed then.

This UDE has three main causes: lack of mechanisms for preventing incomplete paperwork from occurring, repeated verification of paperwork completion status, and untimely communication with responsible parties. Root causes of each of the identified items were discussed, as listed in Figure 11.

- Lack of prevention mechanisms for incomplete consent form before the day of surgery
  - Patients sent from outside sources are unavailable to sign consents prior to the day of surgery
  - Lack of reminders or feedbacks to responsible surgeons
- Repeated verification of paperwork completion status
  - Redundancy in procedure and responsibility of paperwork completion verification
  - Lack of a practical tool to keep track of paperwork completion status
- Untimely communication with responsible parties
  - Late discovery of incomplete paperwork
  - Delays and waste caused by communicating by phone
For all the patients who performed pre-admission testing at external facilities, which represents about half of all patients in SDS, the consent form can only be signed on the day of surgery, as the consent form needs to be signed with both the patient and the surgeon present. As a result, for the patients who performed pre-admission testing at external facilities, having incomplete consent forms is unavoidable. The PAT secretary often informs the surgeon if a patient tested at St. Vincent Hospital has an incomplete consent form, and the surgeon can choose between either setting an appointment with the patient before the day of surgery, or else completing the consent form on the day of surgery. When the surgeon chooses to complete the consent form on the day of surgery, a delay on the day of surgery is also unavoidable. In this case, there is an opportunity for the PAT secretary to use the acquired information to produce reminders for the surgeon about the missing paperwork. This part of process is outside the scope of this project, however.

Redundancy in procedure and responsibility regarding paperwork completion verification causes repetitive checking, which is a waste in the process. The PAT secretary, SDS secretary and SDS RNs all check for the same items’ statuses without documenting results in a central location. Verification is non-value-adding if the result is not used directly for reworking; it occurs because verification performed by a colleague cannot be taken for granted. The person at a latter step in the process has the responsibility to cross check the paperwork, since the forms can be removed from the chart binder during the process. In the case of the SDS secretary, verification is non-value-adding and unnecessary in her process, which is contrary to her beliefs.
On the day of surgery, RNs rely on their memory and non-standard notes to keep track of the completion status of charts. Inconsistent use of check lists and other tools to communicate causes inconvenience for RNs and makes it difficult to organize their work flow.

The team has the opportunity to discover incomplete paperwork status before the day of surgery. Because the secretaries do not have the credentials needed to verify all paperwork items, verifying and documenting paperwork completion status cannot be moved earlier in the process, without significantly altering the existing procedure of the SDS secretary. Currently, the SDS secretary’s process is completed by 5pm on the day before surgery, and the RNs’ work day finishes at 3pm. On the other hand, the RNs interviewed by the team stated that the most frequent incomplete items are consent form and anesthesia forms. These two items can be completed only when both patient and the clinician (anesthesiologist, surgeon, etc.) are present, as a result, moving the verification step earlier can generate only a very limited reduction of delay.

Untimely communication caused by the current method of informing responsible parties of the incomplete paperwork is another factor contributing to delays on the day of surgery. The current practice of informing surgeons is to call the operating room secretary and have the secretary locate the surgeon, then have the surgeon call SDS to receive the patient information when the surgeon is available. Because the surgeons are often unaware of the missing consent forms, or they do not have specific information about the patient’s arrival and the patient’s bed number, which is assigned upon the arrival, missing consent forms often lead to long delays.

There is also no organized visual reminder about the incomplete consent forms provided to the surgeons before the day of surgery, so the surgeons are unable to plan ahead.
4.3.2 Analysis of Waste Caused by Manual Input of Allergy List

Allergy information must be filled out by RNs on four different locations on each chart. Manual input of allergy information is one of the major causes of variations in writing and searching time (value-adding time), since long allergy lists requires more writing and cross checking.

Currently, the allergy information of patients is acquired through various channels and located in various areas in the files depending on the facility where the pre-admission testing was performed. An allergy sticker is made by PAT for each of the patients whose pre-admission testing is done at St. Vincent Hospital. RNs will copy the allergy information from the sticker and other locations in the chart to the relevant fields. After verifying the list of allergies with the patient during admission process for same-day surgery, changes are made to the filled out fields if necessary, and the information also needs to be updated in Meditech (the main healthcare system used at St. Vincent Hospital).

4.4 Solutions and Implementation Plans

This section describes the solutions and respective implementation plans to resolve or elevate the UDEs explained in the previous section. Potential solutions were prepared prior to the Kaizen event. Finalized solutions were selected at the Kaizen event, and the implementation plans were generated at the Kaizen event as well.

4.4.1 Solutions and Implementation Plans for Delays caused by Incomplete Paperwork

This section proposes three solutions to reduce delays caused by incomplete paperwork. The solutions elaborated in this section address selected undesirable effects: redundancy in the procedure and responsibility for verifying paperwork completion, lack of a practical tool to keep
track of and communicate paperwork completion status, and delays and waste caused by communicating by phone.

The solutions include eliminating waste activities in the SDS secretary’s process, replacing the current practice of informing surgeons of incomplete consent form through the use of pagers, and adopting the practice of attaching a bright-colored sheet of paper on the cover of the charts with incomplete items written on it when the chart contains any incomplete item.

4.4.1.1 Eliminating Waste in SDS Secretary’s Process

The SDS secretary checks a list of paperwork items for which the RNs are responsible during the process, and documents the missing items on a sticker. These activities have been identified as unnecessary and non-value adding by the personnel who attended the Kaizen event, because the items are “signed by others”. The SDS secretary stated that the current procedure she performs and the requirements have not been updated in decades.

The activity of cross-checking allergy information in the charts was eliminated from the SDS secretary’s procedure at the Kaizen event, as the group concluded that the activity was extremely time consuming and unnecessary. However, the risk of eliminating other verification activities in the SDS secretary’s process is unclear; the SDS secretary stated that she sometimes finds mistakes in checked items. It is recommended the risk be fully investigated before implementing this solution. A time savings of an hour per day can be realized from eliminating waste in SDS secretary’s verification process, as the secretary process around 50 charts each day.
4.4.1.2 Use of Pagers

Use of electronic communication tools between surgeons and RNs is suggested as a means to improve communication and thus reduce delay. Viable tools include email, cell phone messages, and pagers.

We believe the use of pagers is the best choice in this specific situation. Using pagers enables the RNs to send all relevant information about the patient’s arrival to the surgeon in a timely manner. The RNs present at the Kaizen event agreed that replacing the current practice by sending messages to surgeons with pagers will increase the efficiency and effectiveness of communication.

The occurrence of missing consent form is 14% (3 out of 22) in our data, resulting in a delay of 20 to 40 minutes per instance. If this solution is implemented, a significant decrease in delay caused by missing consent forms can be expected. As a result, the rate of patients ready by the time that they are supposed to be sent into operating room should increase. The amount of improvement cannot be estimated with the information acquired in this project.

All surgeons are equipped with pagers at St. Vincent Hospital and an instant messaging system is available to nurses. Therefore, no significant investment is required to implement this solution. It needs to be verified with Information Technology (IT) personnel that all surgeons’ pagers, including the outside surgeons’, can be found in the address book in the pager message system.

As the RNs stated at the Kaizen event, the main factors contributing to the resistance to implementing this solution are the existing work habits of RNs and lack of training to use the pager message system. Therefore, efforts to promote RNs’ awareness and mastery of the pager
message system are required. Due to the intuitive nature of this solution, word-of-mouth is a more suitable approach to promote the awareness and interest of the new method. The team recommends that nurses seek assistance from IT personnel if trouble-shooting needs arise, in order to prevent frustration and counter-productive effects.

The team also recommended that an informal follow-up survey to be conducted, to evaluate the adoption progress and the issues encountered in the adoption process. If the progress is unsatisfactory, formal training should be planned.

4.4.1.2 Use of Bright-Colored Sheets of Paper

A practical tool to signify paperwork completion status is needed to assist the RNs’ in organizing their workflow. The existing checklists positioned inside the charts are not suitable for the RNs’ needs and the lists are not sufficiently utilized. The RNs currently use post-it notes and various other stationaries for this purpose.

The potential solutions discussed at the Kaizen event include a smart board with relevant information displayed electronically, a board outside each patient room with a summary of the patients’ paperwork completion status, and a check list attached to the chart that is more practical and effective than the existing ones.

At the Kaizen event, deploying an effective check list tool was rated as the most feasible and convenient option for RNs out of the three potential solutions. The RNs verified that attaching a bright-colored sheet of paper on the cover of each chart with incomplete paperwork items, and documenting the incomplete items on the sheet of paper, is an effective approach to signify paperwork completion status. It is also compatible with the current chart preparation
process. The sheet of paper should be removed and discarded when all incomplete items are resolved.

Compared to the other two solutions, the selected solution is the most economical and easiest to implement and maintain. The cost of one sheet of colored paper is added to each chart, and it does not increase the RNs task load. This solution is dedicated to resolving the undesirable effect of the inconsistent use of check list tools and communication tools among RNs. The sheet is a check list and a convenient tool to signify paperwork completion status to RNs without distracting patients.

This solution can be implemented as soon as the required paper is acquired.

4.4.1.3 Temporarily Unresolved Issues

The paper-based information system imposes constraints on the process design. Redundancy in procedure and responsibility for verification of paperwork completion is unavoidable due to the different practical purposes and requirements in each task in the process, and the clinical credential of the person performing the tasks. There is no simple way of eliminating redundancy in paperwork status verification.

Similarly, the undesirable effect “lack of reminders or feedbacks to surgeons responsible” and “late discovery of incomplete paperwork”, which are not cost-effective to address under the current circumstances, can be easily resolved should an electronic medical record (EMR) system be implemented, as the reports can be quickly generated and delivered by an EMR system.

4.4.2 Waste Caused by Manual Input of Allergy List

The waste caused by the current method of handling allergy lists can be reduced by digitally populating stickers with allergy information and applying them to the forms requiring
the information. The RNs present at the Kaizen event agreed upon a practical procedure for using allergy stickers:

   Step 1: Verify the allergies listed in the chart with the patient during admission process

   Step 2: Enter verified allergies into Meditech

   Step 3: Print out labels from Meditech

   Step 4: Apply stickers to forms

   One constraint is that the spaces for allergy in the charts are shaped differently on different pages. The allergy sticker needs to be made small enough to fit into each different field. As a result, the maximum possible dimension of the sticker is approximately 3 inches by 1 inch. Assistance from the IT department may be needed to configure Meditech to print labels with allergy related information with the desired format.

   As the RNs identified, variation in the lengths of allergy lists is the main factor contributing to the variation in time required to fill out a chart (required work time), while variation in lengths of medical history list is the second major factor. Currently, more than 1/3 of the charts require less than 10 minutes of work time to complete, with a minimum 7 minutes, and around 1/3 of the charts require 13 to 16 minutes. As a result, if both allergy information and medical history can be input with stickers instead of by hand, the team predicted that most charts will require 7 to 10 minutes of work time; the updated average work time can be approximated as 8.5 minutes per chart. Compared to the measured current required work time, which is 11.4 minutes, roughly 2 minutes per chart can be saved from implementing this solution. Overall, 2.4 hours of the RNs’ time can be saved each day by implementing this solution.
4.4.3 Follow-up Plan for Implementation

Efforts to sustain the implemented solutions are necessary to yield satisfactory results.

The actions needed to fully realize the benefits of this project are summarized below.

- Investigate the potential risks of eliminating the verification process from SDS secretary’s work flow. Reduce the unnecessary checking steps if it is safe to do so.

- Investigate and eliminate potential technical difficulties for the RNs to notify surgeons about patients’ arrival with pagers. Provide the system as an opt-in for RNs and surgeons. Promote adoption by encouraging awareness and providing training.

- Follow-up on the implementation of the bright-colored sheet with a survey or a focus group. Evaluate the effectiveness, staff satisfaction and prompt for further comments.

- Investigate and eliminate potential technical difficulties to implementing stickers for allergy information. Provide trainings to RNs, and evaluate the outcome with a survey.
5. Conclusion and Recommendations

The selected target process for this project was the chart preparation process performed by the secretary and the registered nurses (RNs) before admitting the patient for same day surgery at St. Vincent. As an essential process that directly impacts the patient admission process in Same-Day-Surgery, the selected process affects the overall patient flow efficiency. A patient cannot be admitted until the paperwork is completed; the resources will be tied up if the patient admission is delayed. The outcome of this process also affects the patients’ experience of the hospital stay, since waiting can add to the patients’ anxiety.

The RNs and the hospital need to efficiently and effectively organize and verify information related to the surgery, in order to assist in surgery preparation and adhere to standard industry procedures. Previous efforts somewhat reduced delays and wastes in the process, yet systematic quantitative studies need to done on the target process to improve understanding of the issues.

This project generated recommendations to decrease total lead time of the target process by proposing and implementing solutions to reduce delays and wastes in the process. Paper-based charts are used for storing and communicating patient medical information. The current system imposes constraints on the design of the chart preparation process, as well as the current staffing situation and work schedule. Detailed descriptions of the steps in the current process were generated and used as a basis for the project. Data analysis and an analysis of the undesirable effects were conducted to gain useful insights of the process. Potential solutions were developed based on the analyses and information collected through interacting with staff. Final solutions and implementation plans were generated at the Kaizen event organized for this project.
In addition to assembling and rearranging the forms, the SDS secretary had been conducting verification using a list of items. The RNs verify a list of paperwork items and contacts responsible personnel if rework is needed, then the RNs enters information manually into the forms.

The verifications conducted by the SDS secretary were identified as waste activities and were recommended for elimination. The current methods RNs use to keep track of the incomplete items can cause inconvenience, therefore, a new tool was proposed. Consent forms were shown to be the most frequent and impactful item when incomplete, since the surgeons have less flexible schedules and the current method of contacting the surgeons is not effective enough. Pagers were recommended as a practical and effective communication tool for this purpose. Manual input of allergy lists adds to the work required to complete the process, and it is one of the main factors contributing to variations in work time required for each chart. Use of stickers was recommended to reduce work time required per chart.

The impact of implementing the solutions recommended by this project is estimated to result in the following benefits: saving the SDS secretary one hour per day, saving RNs 2.4 hours per day collectively, and increasing the rate of patients ready to be sent to OR at the scheduled time by an undetermined amount.

The project generated cost-effective recommendations to improve communication, coordination and information management in the target process. However, due to the limited scope and the short time frame of this project, further work is needed to fully streamline the SDS paperwork preparation process. The project selected a portion of the process to focus the efforts on, and did not taken into consideration the procedures involving pre-admission testing and other
sources of patient information, or the patient admission and preparation process after the selected process. Future work can explore improvement opportunities in earlier steps of the paperwork preparation process by examining the procedure and the undesirable effects. A thorough study of the patient preparation process can pinpoint the causes of patients being late to surgeries (which was briefly studied in this project), and uncover more opportunities for improvements.

The project focused on generating incremental improvements based on current procedure and current capacities. Opportunities for further utilizing the existing EMR system, Meditech, have not been explored. On the other hand, the sponsor could benefit from a more in-depth study of the delays related to incomplete paperwork. A larger data set of lengths and sources of delay will provide deeper understanding of the current state of the issue. Specifically relating incomplete paperwork with patients being late to surgeries would help to quantify the impact and a detailed survey of the sources and handling of incomplete paperwork would enable reduction of the delays by altering the current practices.

In summary, the potential objectives for future projects and Kaizen events include:

- Identify and eliminate redundancies and sources of delay in pre-admission testing’s chart preparation process.
- Investigate the causes of patients being late to surgeries and eliminate avoidable sources of delays. Specifically investigate the correlation between incomplete paperwork and the patients being late.
- Investigate the root causes of missing paperwork, identify opportunities for improvement and develop actions to reduce the occurrences and impacts of missing paperwork.
The transport project led the team to conclude that the current average total transport time is higher than ideal, and that the consistency in total transport time needs to be improved. The team’s recommendations for future work include:

- Train personnel to accurately document time in the process, in order to improve data quality.
- Increase the number of transporters during the shifts where transporters have higher utilization rates. If the total transport time shows significant improvement, sustain the solution.
- Improve understanding of the undesirable effects surrounding this process. Study how the time is spent in the process, and the causes of delays.
- Conduct a Kaizen event to streamline the process, and address the issues causing delays.

If a significant portion of non-value adding activities can be eliminated from the process, eminent improvement in consistency in total transport time for each job should be observed, and a standard time requirement for transport time could be established.
Works Cited


Miller, D., Womack, J.P., Byrne, A.P., Fiume, O.J., Kaplan, G.S., & Toussaint, J.


Appendix A: Agenda for the conducted Kaizen Event

As shown in Figure 8, the Kaizen event lasted four hours, starting at 10:30 am and concluded at 2:30 pm. Two major issues: delays caused by incomplete paper work and handling of allergy and medical history information were discussed at the event.

<table>
<thead>
<tr>
<th>Discussion Item</th>
<th>Time Table</th>
<th>Deliverable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Getting Started: 30 Min</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kick-off</td>
<td>10:30</td>
<td></td>
</tr>
<tr>
<td>LEAN Activity, Group Photo.</td>
<td>10:40</td>
<td></td>
</tr>
<tr>
<td>Introduction &amp; Review of Agenda</td>
<td>10:50</td>
<td></td>
</tr>
<tr>
<td>Issue 1: Incomplete Paperwork</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Mapping</td>
<td>11:00</td>
<td>Process Map, Defined Value Adding Activities</td>
</tr>
<tr>
<td>Discussion of UDEs</td>
<td>11:15</td>
<td>A List of UDE’s With Impact Rankings</td>
</tr>
<tr>
<td>Brainstorm Potential Solutions</td>
<td>11:30</td>
<td>Potential Solutions</td>
</tr>
<tr>
<td>Evaluation Of Feasibility</td>
<td>12:00</td>
<td>Discussion of Benefit, Risk, Cost, Feasibility of Each Potential Solution</td>
</tr>
<tr>
<td>Lunch</td>
<td>12:30</td>
<td></td>
</tr>
<tr>
<td>Issue 2: Allergy &amp; Medical History Entry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Mapping</td>
<td>13:00</td>
<td>Process Map, Defined Value Adding Activities</td>
</tr>
<tr>
<td>Discussion of UDEs</td>
<td>13:15</td>
<td>A List of UDE’s With Impact Rankings</td>
</tr>
<tr>
<td>Brainstorm Potential Solutions</td>
<td>13:30</td>
<td>Potential Solutions</td>
</tr>
<tr>
<td>Evaluation Of Feasibility</td>
<td>14:00</td>
<td>Discussion of Benefit, Risk, Cost, Feasibility of Each Potential Solution</td>
</tr>
<tr>
<td>Conclusion &amp; Thank You</td>
<td>14:25</td>
<td></td>
</tr>
</tbody>
</table>

Figure 12 Agenda for the Conducted Kaizen Event
Appendix B: Queuing Theory Applied to Transport Project

M/M/N queuing model assumes exponential distribution of job arrivals and service time, and multiple servers. It is an appoporate model to simplify the situation in the transport project.

Average waiting time can be arrived by following relationships:

\[
K = \frac{\sum_{i=0}^{N-1} (\lambda s)^i}{\sum_{i=0}^{N} (\lambda s)^i}
\]

\[
C = \frac{1 - K}{1 - \frac{\lambda s K}{N}}
\]

\[
\rho = \frac{\lambda s}{N}
\]

\[
T_w = \frac{Cs}{N(1 - \rho)}
\]

where K is the intermediate value, N is the number of servers, \(\lambda\) is the average arrival rate, \(s\) is the average service rate, \(C\) is the probability that all servers are busy, \(\rho\) is the utilization rate, and \(T_w\) is the average waiting time.

In the case of the transportatation project, it is apporpoate to assume that \(\lambda = 20\) unit/hour, \(s = 2.5\) unit/hour. The following plots are generated by varying N from 8 to 20. Figure 13 illustrates the relationship between utiliazation rate and average waiting time in this case, and Figure 14 shows the probability of a job waiting 1, 5, 10 and 20 minutes for a transporter with each utilization rate. When utilization rate is 80\%, the average waiting time is 5 minutes, 38\% of the jobs have wait time for over 1 minute, 27\% over 5 minutes, 18\% over 10 minutes, and 8\%
over 20 minutes. This distribution is comparable to the actual current distribution of wait time described in section 2.2.1. When utilization is higher than 80%, the expected average time is significantly higher, therefore, it is recommended that the utilization rate to be kept under 80% over each shift.

![Figure 13 Average Waiting Time with Different Utilization Rate](image1)

![Figure 14 Probability of a Job Waiting 1, 5, 10 And 20 Minutes for a Transporter](image2)
It needs to be noted that the utilization rate varies greatly from hour to hour under current conditions. 10% of the hours recorded have average utilization of over 100%, could lead to increase to queue size and prolonged wait time. These hours appear during different shifts, therefore, an overall increase of staffing is needed to avoid issues caused by these hours.

![Distribution of Hourly Utilization Rate](image)

**Figure 15 Distribution of Hourly Utilization Rate**
Appendix C: Collected Data

Table 5 shows the data collected, with comments about the chart preparation process performed by RNs. The data contains 22 samples obtained between October 24th and November 15th. There are two categories of charts: rush hour charts and non-rush hour charts. Rush hour charts are prepared for the morning surgeries scheduled between the hours of 5 am and 8 am, while normal charts are scheduled after 8 am. Within the two categories, charts were randomly selected.

<table>
<thead>
<tr>
<th>Chart Type</th>
<th>Time Spent Waiting on Missing Paperwork (min)</th>
<th>Time Spent Waiting for Other Reasons (min)</th>
<th>Time Spent On Other Tasks (min)</th>
<th>Time Spent Filling Out Charts (min)</th>
<th>Total Time (min)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Rush</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>8.5</td>
<td>13.5</td>
<td>RN left to assist another RN briefly.</td>
</tr>
<tr>
<td>Non-Rush</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>10</td>
<td>12</td>
<td>This patient has long allergy and med lists. The RN was on the phone for 2 minutes.</td>
</tr>
<tr>
<td>Non-Rush</td>
<td>40</td>
<td>0</td>
<td>0</td>
<td>8.5</td>
<td>48.5</td>
<td>The 40 min wait time for consent occurred 30 minutes before the scheduled surgery time. The patient ended up being about 10</td>
</tr>
<tr>
<td>Rush</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>12.5</td>
<td>15.5</td>
<td>RN left to assist another RN briefly.</td>
</tr>
<tr>
<td>Rush</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>7.5</td>
<td>14.5</td>
<td>7 minutes spent admitting the patient in the middle of the process.</td>
</tr>
<tr>
<td>Rush</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>RN left to assist another RN briefly.</td>
</tr>
<tr>
<td>Rush</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Non-Rush</td>
<td>0</td>
<td>0</td>
<td>19</td>
<td>13</td>
<td>32</td>
<td>Admit a patient</td>
</tr>
<tr>
<td>Non-Rush</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>15</td>
<td>40</td>
<td>Give antibiotics</td>
</tr>
<tr>
<td>Rush</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>13</td>
<td>Consent incomplete</td>
</tr>
<tr>
<td>Rush</td>
<td>22</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>37</td>
<td>Duty in patients' room</td>
</tr>
<tr>
<td>Rush</td>
<td>0</td>
<td>0</td>
<td>2.5</td>
<td>15.5</td>
<td>18</td>
<td>No allergy or med hist</td>
</tr>
<tr>
<td>Rush</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>9</td>
<td>No allergy or med hist</td>
</tr>
<tr>
<td>Rush</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td>11</td>
<td>No allergy or med hist</td>
</tr>
<tr>
<td>Rush</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>21</td>
<td>21</td>
<td>Long med list, need to be cross-checked</td>
</tr>
<tr>
<td>Rush</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>9</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Rush</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>13</td>
<td>Get medicines and wait for medicine restock</td>
</tr>
<tr>
<td>Non-Rush</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>9</td>
<td>12</td>
<td>9</td>
</tr>
<tr>
<td>Non-Rush</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Non-Rush</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>Non-Rush</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>9</td>
<td>10</td>
<td>Spent 1 minute to investigate why further tests is needed &amp; consent still unfinished</td>
</tr>
<tr>
<td>Non-Rush</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>17</td>
<td>17</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 5 Original Data of Measured Metrics of the Process

Table 6 contains data collected from 148 samples during November 2012 of counts of patients on-time and counts of patients late for scheduled surgery. The data was manually collected by the operating room (OR) secretary who calls same-day-surgery preparation area and
asks the patient to be sent in for surgery. The days for data collection during these two weeks were randomly selected by the OR secretary.

### Table 6 Percentage of Patients Late for Surgery

<table>
<thead>
<tr>
<th>Data Acquired During the Week of:</th>
<th>11/5-11/9</th>
<th>Sample Size</th>
<th>66</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time of Scheduled Surgery</strong></td>
<td><strong>Count of Patients On Time</strong></td>
<td><strong>Count of Patients Late</strong></td>
<td><strong>Percentage of Patients Late</strong></td>
</tr>
<tr>
<td>5 am to 6 am</td>
<td>23</td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>6 am to 7 am</td>
<td>5</td>
<td></td>
<td>0%</td>
</tr>
<tr>
<td>7 am to 8 am</td>
<td>10</td>
<td>3</td>
<td>23%</td>
</tr>
<tr>
<td>8 am to 9 am</td>
<td>8</td>
<td>2</td>
<td>20%</td>
</tr>
<tr>
<td>9 am to 10 am</td>
<td>4</td>
<td>2</td>
<td>33%</td>
</tr>
<tr>
<td>10 am to 11 am</td>
<td>5</td>
<td>1</td>
<td>17%</td>
</tr>
<tr>
<td>11 am to 12 am</td>
<td>2</td>
<td>1</td>
<td>33%</td>
</tr>
<tr>
<td>1 pm to 2 pm</td>
<td></td>
<td></td>
<td>Overall Late Percentage 13.6%</td>
</tr>
<tr>
<td>2 pm to 3 pm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 pm to 4 pm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Data Acquired During the Week of: 11/26-11/30**

<table>
<thead>
<tr>
<th>Time of Scheduled Surgery</th>
<th>Count of Patients On Time</th>
<th>Count of Patients Late</th>
<th>Percentage of Patients Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 am to 6 am</td>
<td>13</td>
<td>5</td>
<td>28%</td>
</tr>
<tr>
<td>6 am to 7 am</td>
<td>25</td>
<td>4</td>
<td>14%</td>
</tr>
<tr>
<td>7 am to 8 am</td>
<td>17</td>
<td>2</td>
<td>11%</td>
</tr>
<tr>
<td>8 am to 9 am</td>
<td>15</td>
<td>4</td>
<td>21%</td>
</tr>
<tr>
<td>9 am to 10 am</td>
<td>16</td>
<td>3</td>
<td>16%</td>
</tr>
<tr>
<td>10 am to 11 am</td>
<td>12</td>
<td>1</td>
<td>8%</td>
</tr>
<tr>
<td>11 am to 12 am</td>
<td>8</td>
<td>1</td>
<td>11%</td>
</tr>
<tr>
<td>1 pm to 2 pm</td>
<td>2</td>
<td>2</td>
<td>50%</td>
</tr>
<tr>
<td>2 pm to 3 pm</td>
<td></td>
<td></td>
<td>Overall Late Percentage 16.9%</td>
</tr>
<tr>
<td>3 pm to 4 pm</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Data Acquired During the Week of: 12/3-12/7  
Sample Size: 151

<table>
<thead>
<tr>
<th>Time of Scheduled Surgery</th>
<th>Count of Patients On Time</th>
<th>Count of Patients Late</th>
<th>Percentage of Patients Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 am to 6 am</td>
<td>12</td>
<td>4</td>
<td>25%</td>
</tr>
<tr>
<td>6 am to 7 am</td>
<td>30</td>
<td>5</td>
<td>14%</td>
</tr>
<tr>
<td>7 am to 8 am</td>
<td>22</td>
<td>3</td>
<td>12%</td>
</tr>
<tr>
<td>8 am to 9 am</td>
<td>15</td>
<td>5</td>
<td>25%</td>
</tr>
<tr>
<td>9 am to 10 am</td>
<td>11</td>
<td>3</td>
<td>21%</td>
</tr>
<tr>
<td>10 am to 11 am</td>
<td>17</td>
<td>3</td>
<td>15%</td>
</tr>
<tr>
<td>11 am to 12 am</td>
<td>15</td>
<td>2</td>
<td>12%</td>
</tr>
<tr>
<td>1 pm to 2 pm</td>
<td>3</td>
<td>1</td>
<td>25%</td>
</tr>
<tr>
<td>2 pm to 3 pm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 pm to 4 pm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Overall Late Percentage</strong></td>
<td></td>
<td></td>
<td><strong>17.2%</strong></td>
</tr>
</tbody>
</table>