Cycle time reduction based on structured Fist-in-First-out queue management control

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Abstract *— Queue management systems are set up to manage ticket ranking for a service. In this case, tickets received are for engineering software and electronic library issues within the company and all its subsidiaries. The steps to determine a queue management system that best suits business needs are discussed. Current model used consists of assigning a quantity of tickets to each agent which leads to uncertain amount of waiting time. As a result incidents are now attended in the same order they arrived through FIFO, reducing the standard deviation caused by the difference in the "Order incidents were submitted" versus the "Order the incidents are attended".*

Key Terms *— FIFO, Queue, Management systems, Value Stream Map*

INTRODUCTION

Infotech Aerospace Services (IAS) provides engineering outsourcing and other professional services to the Defense, Aerospace, and Power Generation Industries. It is a joint venture established in 2003 between India's Infotech Enterprises Ltd., a global engineering services company and Connecticut-based Pratt & Whitney, a pioneer in flight technology. IAS provides Engineering and Supply Chain services for UTC and Non-UTC companies in the areas of Aerospace Engineering, Mechanical Design, and Software Development for military, commercial, and industrial applications [1].

IAS also offers Electronic Library Helpdesk services. This process involves queue management of customer requests via tickets. A queue is a group of jobs waiting to be executed, an order data structure. Tickets refer to an electronic document of customer queries captured in a database. In this case, tickets received are for engineering software and electronic library issues within the company and all its subsidiaries. There are two main types of queues, structured and unstructured. In the structured, the queues are in a fixed, predictable position similar to a supermarket. On the other hand, the unstructured queues are unpredictable and varying locations and directions. Current model used consists of assigning a quantity of tickets to each expert which leads to uncertain amount of waiting time (Figure 1).

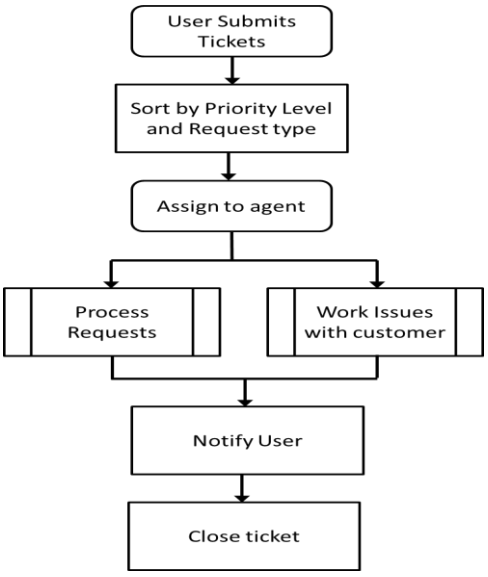

Figure 1
Process Flow Map

Queue management systems are established to address the requests for a service. The correct queue management is fundamental to deliver quality engineering tasks on time. An incorrect handling of the tickets may cause a substantial increase in cycle time, which causes an increase in downtime as well. In a company downtime means profit loss and therefore a negative impact in customer satisfaction.

The intent of this project is to determine a queue management system that best suits business needs. Below are the objectives of the project:

1. Reduce cycle time for each engineering ticket submitted

2. Reduce downtime due to engineering software and electronic library issues

3. Improve end customer satisfaction

LITERATURE REVIEW

A queuing system belongs to a broad range of dynamic systems that are, in turn, generally defined as flow systems in which a commodity moves through one or more channels in order to go from one point to another [2]. It involves entry points, waiting lines, service channels, and exit points. Queuing systems are applicable to a wide variety of problems in many environments such as computer network traffic flow, call flow in a call center, or patient scheduling in a medical setting.

To describe a particular queuing system, several key characteristics are needed: arrival pattern of the customers, service pattern, number of parallel servers, system capacity, queue discipline, and the number of service stages. Another important aspect of the system is the line structure. There are four types of line structures: single-channel/single-phase, single-channel/multi-phase, multi-channel/single-phase and multi-channel/multi-phase. The simplest type of waiting line structure is the single-channel, single-phase. Here, there is only one channel for arriving customers and one phase of the service system [3]. Depending on the design of the queuing system, the facility, or the inherent behavior of the customers, the manner in which a commodity is serviced varies. The most common discipline found in a typical business is first in, first out (FIFO) [2]. FIFO describes the principle of a queue processing technique or servicing conflicting demands by ordering process by first-come, first-served behavior. This means that the persons leave the queue in the order they arrive. The new queue management control method that will be used to achieve one of the project objectives will be based in FIFO.

There are two main types of queues, structured and unstructured. In the structured, the queues are in a fixed, predictable position similar to a supermarket. On the other hand, the unstructured queues are unpredictable and varying locations and directions. The correct queue management is fundamental to deliver quality engineering tasks on time. An incorrect handling of the tickets may cause a substantial increase in cycle time, which causes an increase in downtime as well. In a company, downtime means profit loss and therefore a negative impact in customer satisfaction. In this case, queue management systems are set up to manage ticket ranking for a service. Tickets refer to an electronic document of customer queries captured in a database. The real issue in queue management is not only the actual amount of time that the customer waits in a queue, but also the customer's perception of that wait and his or her associated level of satisfaction. However, a single long or frustrating wait can leave a lasting impression since perception and impression can negatively impact customer satisfaction [4][5].

To understand how to manage a queue, the queuing theory is used. Queuing theory is the mathematical study of waiting in lines, is a branch of operations research because the results often are used when making business decisions about the resources needed to provide service. By understanding queues and learning how to manage them through simple models and equations, it can help improve customer-facing and internal processes to give organizations a competitive advantage [3].

The objectives of this project are reduce the cycle time of the tickets, reduce downtime and improve customer service. In order to achieve these objectives, value stream mapping will be used. Value stream mapping is a lean tool that employs a flow diagram documenting in high detail every step of a process. Many lean practitioners see value

stream mapping as the fundamental tool to identify waste, reduce process cycle times, and implement process improvement [6].

VALUE STREAM MAP

In order to fulfill the objectives, a methodology to analyze the available data was implemented. Data was gathered by the team members for several years. This data was sorted by ticket type and cycle time. Since comparing one ticket to another is very difficult due to the additional variables involved like complexity, data was recreated. The data simulation helps to compare one ticket to another using the different queue management systems. For the simulation, the following variables remained fixed: incident arrival, worked time, resources and incident number. The outputs of the simulation were number of tickets per agent, waiting time per ticket and ticket order.

Once all data was gathered and sorted properly, it was analyzed to determine if in effect there is a significant cycle time reduction with the new queue management control system. The methodology used to identify areas or opportunity and improve the process was value stream mapping. Value stream mapping is a lean tool technique used to analyze and design the flow of materials and information required to bring a product or service to a consumer. It employs a flow diagram documenting in high detail every step of a process. It is a sophisticated flow charting method that uses symbols, metrics, and arrows to help visualize processes and track performance. This method helps determine which steps of a process add value and which do not. This exercise is a fundamental tool to identify waste, reduce process cycle times, and implement process improvement.

The following step was to draw the current sate map. Using the gathered data, the fixed variables for the current state simulation were obtained. The simulation provided baseline values which were compared to the future state results. After running the first simulation and using the process flow map, the current state map was completed. During the current state mapping process it was confirmed that the main area of opportunity is the way the queue is being managed. Figure 2 shows the current state map.

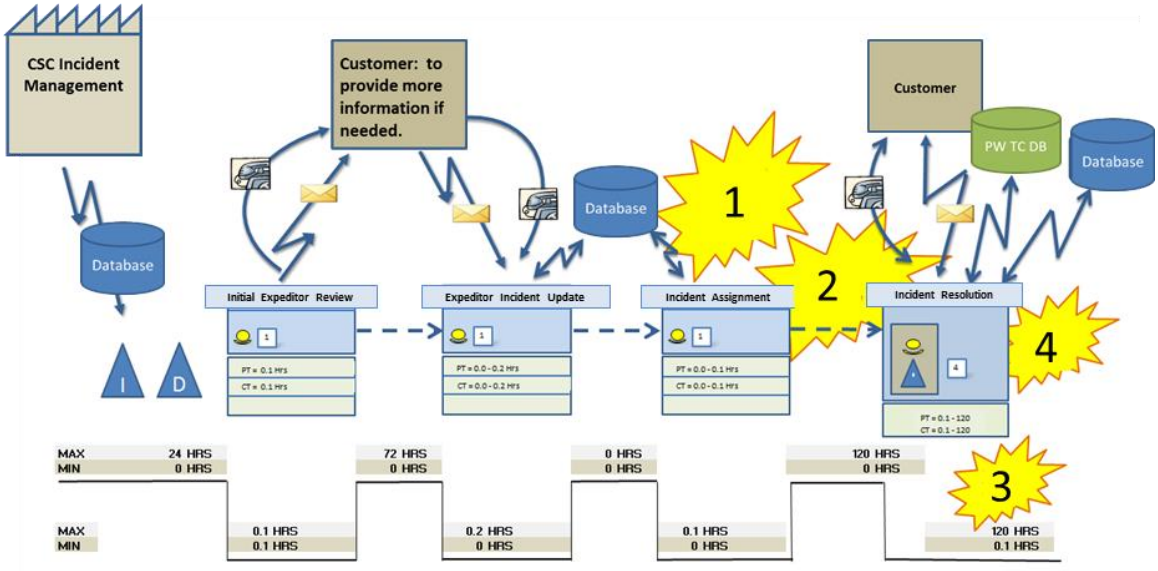

Figure 2
Current State Map

Four kaizen bursts were identified, these are the value stream mapping symbol used to indicate an area of the value stream at which attention from a kaizen workshop should be sought. The first area of opportunity identified was the way tickets were assigned. The question was: Is it necessary to assign an incident when it's not going to be worked right away? The other identified areas were that the process had multiple FIFOS lanes and incidents were not addressed in true order which leads to high waiting time.

Based on the identified areas for improvement, the future state map was completed (Figure 3) and the lean principles were identified. The future state map is a visual tool that shows how a value stream can look after improvements have been implemented. A future-state value stream map is an ideal view of a value stream and represents the goal of a lean initiative. The lean principles used were continuous flow and FIFO. Using the new flow map, new simulation was run.

To run the simulation using the new queue management method, the data was divided in six months. Three simulations were run. As shown in the future state map, the new flow map changes the method that tickets are assigned to the agents. As a result incidents are now attended in the same order they arrived through FIFO.

RESULTS

As mentioned before, two simulations were run, one for the current process and one using the improved queue management process. The results of the simulation using the new queue management method were compared with the current queue management method simulation. Figure 4 is a comparison of waiting times between the current and future management method.

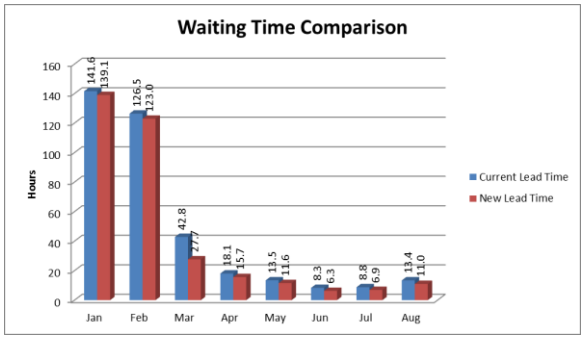

Figure 4
Waiting Times Comparison

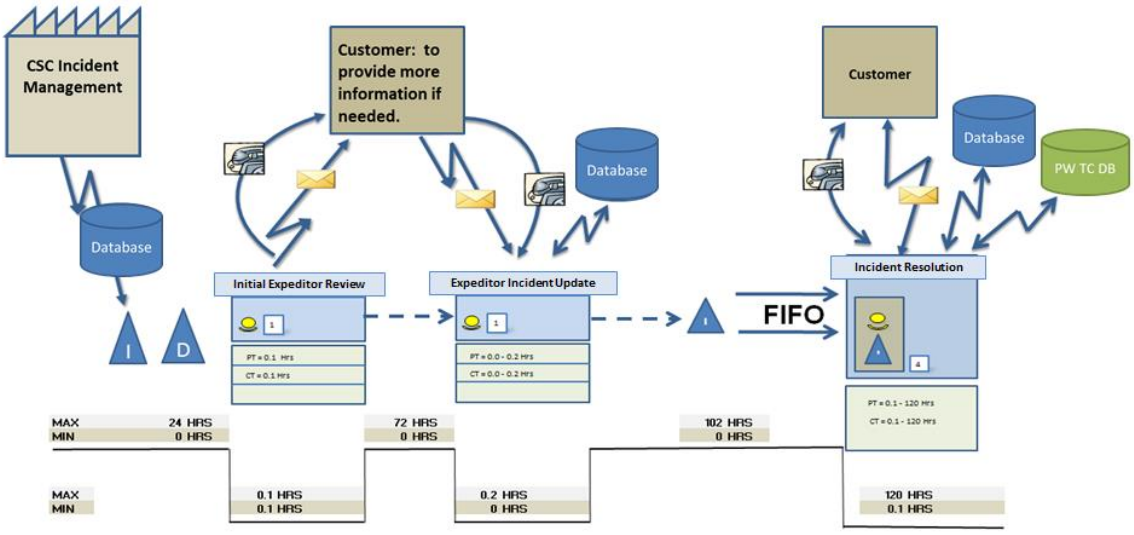

Figure 3
Future State Map

Lead time was also compared and the results were similar. Lead time is the amount of time it takes from the beginning of a project to the completion of a finished part. The analysis indicates that the major time reduction driver is the waiting time. Figure 5 is a comparison of leading times between the current and future management method.

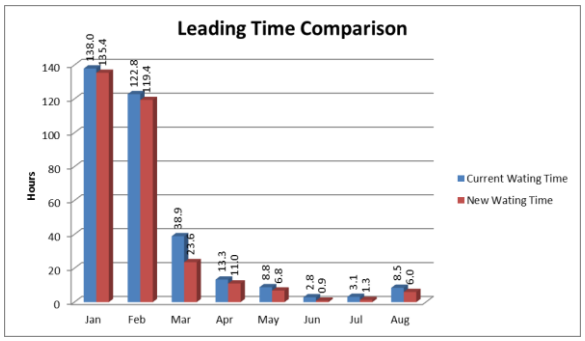

Figure 5
Lead Times Comparison

The new queue management method reduces the standard deviation caused by the difference in the "Order incidents were submitted" versus the "Order the incidents are attended" by 6.71 hours. The standard deviation shows how much variation or dispersion from the average exists. A low standard deviation indicates that the data points tend to be very close to the mean; a high standard deviation indicates that the data points are spread out over a large range of values.

The offset in positions attended is also reduced by 4.13 positions. This means that an average ticket will be resolved around 4 positions ahead when compared with the current queue management control method used. In addition, the method change reduces the average of the 'Waiting Time' by 21.67%, from a max of 120 hours to 94.0 hours.

Another benefit of the improve flow map is a reduction of the Standard Deviation of the waiting time by 12.98% from 17.80 hours to 15.49 hours. Finally the lead time reduces by 7.79%, from a Max of 336.4 hours to 310.2 hours.

The simulation proves that the first two objectives are met. The cycle time for each engineering ticket submitted will be reduced by the changes implemented to the queue management control method. Since the cycle time is reduced, the downtime due to engineering software and electronic library issues is reduced as well. The third objective, improve customer satisfaction cannot be measured at the moment, but it can be implied that by reducing the waiting time there will be an end customer satisfaction improvement.

CONCLUSIONS

Value Stream Mapping is one part of the continuous improvement technique called Lean. Identifying the different parts of the value stream is usually one of the first steps in the Lean process. The value stream map can help get a broader sense of the help desk ticket process and it helped make improvements to the business process with clarity and efficiency. As a result of the value stream mapping employment, a new queue management process was outlined.

Current process assign tickets to agents as soon as they arrived, causing multiple independent queues. The new queue management control method each agent is working one ticket at a time. As soon as the ticket is completed, the agent will pull another from the master queue. This change in the process reduced both the waiting time and lead time by 21.67% and 7.79% respectively.

As a result of this exercise, the new queue management method was implemented. Data will be gathered during six months to ensure that the improved process reduces the ticket resolution lead time and improves the customer satisfaction.

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