

Case 9.8.5: Performance Analysis and Improvement of an Internet Ordering Process

Executive Summary

The objective of this report was to analyze and optimize the performance of a software company's web order processing system. A simulation model was developed based on the provided information, and various performance metrics were collected and analyzed.

The initial analysis of the current process revealed a bottleneck in the clerk section, with high utilization and long wait times. To address this, an additional clerk was added to the process. The results showed significant improvements in efficiency, with reduced cycle times and a more balanced workload for the clerks.

Further optimization was performed by setting constraints on the total number of resources. Using an optimizer block, the optimal number of resources was determined to be 4 clerks and 3 accountants. This configuration minimized cycle times and improved overall efficiency.

The simulation model provided valuable insights into the performance of the web order processing system. It demonstrated the impact of adding an additional clerk and identified the optimal number of resources to achieve maximum customer service benefits. The analysis and optimization of the process will aid management in making informed decisions about resource allocation and improving customer service.

The findings of this report highlight the importance of continuous process improvement and the value of simulation modeling in identifying bottlenecks and optimizing system performance. By implementing the recommended changes, the software company can enhance its web order processing efficiency, reduce customer wait times, and ultimately improve customer satisfaction.

Introduction and Motivation:

To analyze and optimize the performance of a software company's web order processing system, we will first go through the process step-by-step with the help of a flowchart. We then build a simulation model for this process with the help of the flowchart created initially. For a 15-day working model, we will analyze the performance measures and then identify the bottlenecks. Once the bottlenecks are identified, the model is updated by recovering the bottleneck, and results are obtained. A comparative study between these two models is performed. This model is also optimized using the optimizer block, and the analysis is done.

Models and methods

The below figure is the flowchart of the entire process for the web processing system.

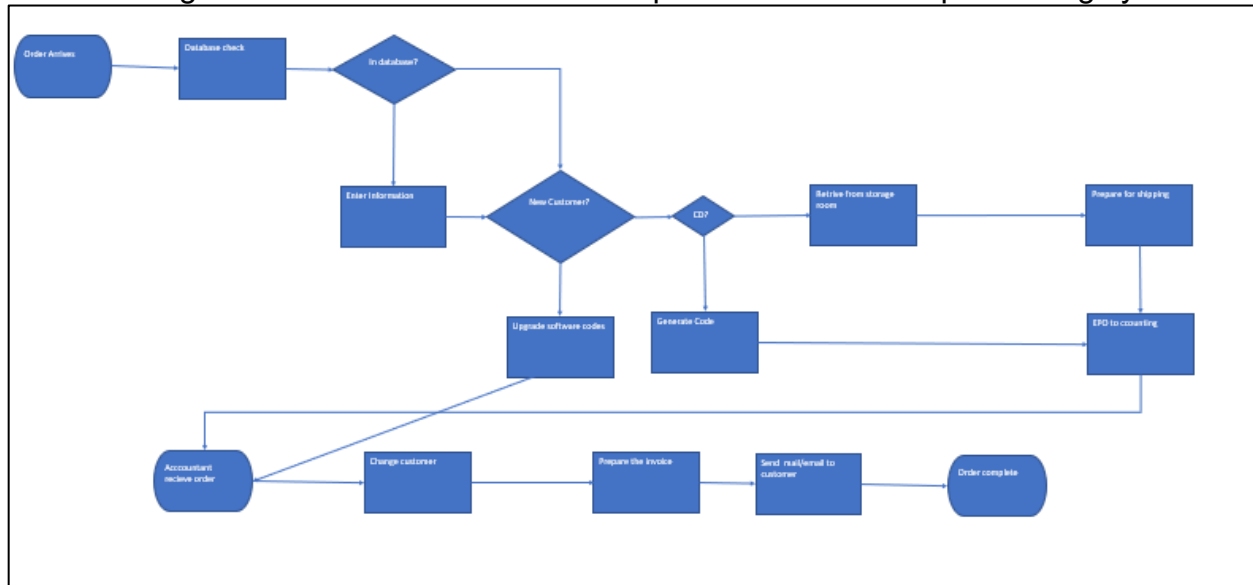


Figure 1: Flowchart of web processing system

We look into this flowchart into two parts – one is clerk's process and the other is the accountants. Hence, our model is divided into two as clerks and accountants for further analysis.

In the clerk section, the buyer enters the clerk's queue, and the clerk checks the buyer's name in the company's database. If the buyer is not found in the database, the clerk enters the buyer's information. We determine whether the order is for an upgrade or from a first-time buyer. Approximately 30 percent of the orders are for upgrades, in which case the clerk simply enters a code in the electronic purchase order.

For first-time buyers, we check whether they want the CD version or software version. If the CD version is chosen, the clerk retrieves it from the storage room, taking an average of 5 minutes with a standard deviation of 1 minute (normally distributed). The clerk then prepares the software for shipping, which takes between 3 and 6 minutes (uniform distribution). If the buyer prefers to download the software, the clerk enters the appropriate code in the electronic purchase order. This code entry process takes an exponentially distributed time with a mean of 1 minute. Once all activities are completed, the clerk is released using the resource pool release block.

In the accounting section, after completing the clerk's activities, the buyer enters the queue of the accountant. The accountant performs three activities: charging the purchase to a credit card, preparing the invoice, and mailing it to the buyers.

To calculate work in progress (WIP), we have added math blocks, select an item out blocks, and mean and variance blocks. Information blocks have been incorporated to calculate average cycle times. Additionally, the invoice data has been analyzed using the *statfit* block, which indicates that the best-fit distribution is the Weibull distribution.

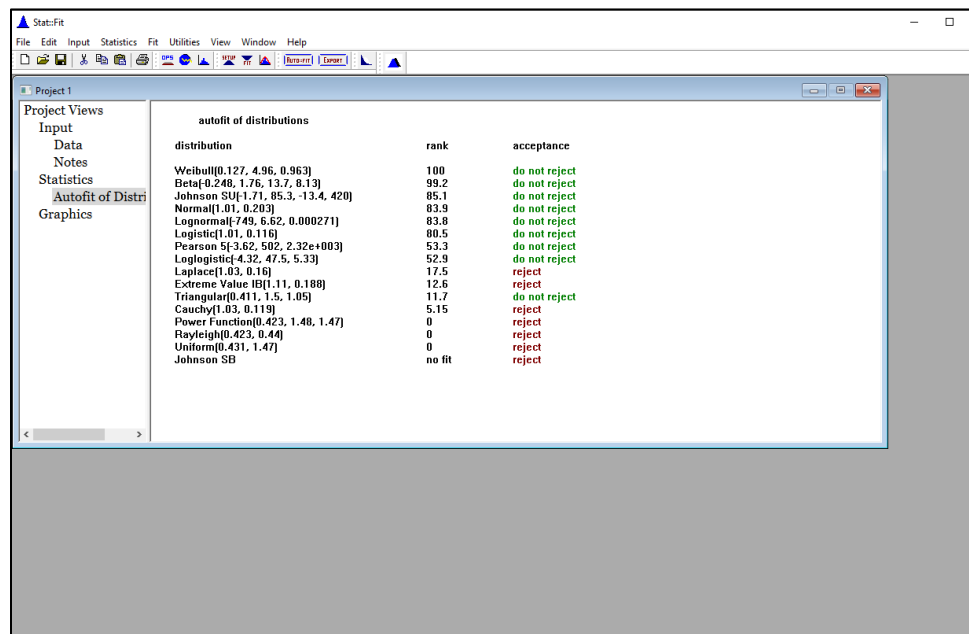


Figure 2: Autofit of Distribution

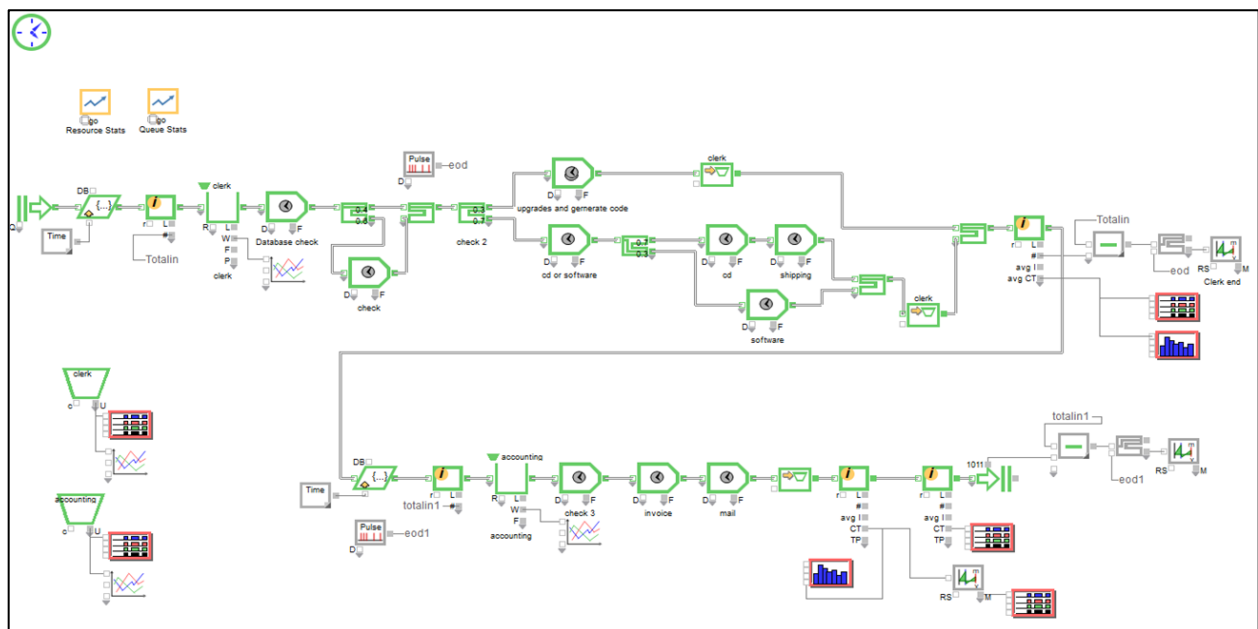


Figure 3: Simulation Model

Analysis and Results:

- *Part 1&2 covered in the introduction & motivation section.*
- **Part 3:**

The model is run for 15 days using a random seed of 34. This gives an average waiting time for the clerk as 58.05 minutes with an average length of 8.22 and the average waiting time for the accountant is 1.96 minutes with an average length of 0.27.

Below is the graph of the waiting times for both resources. We see that the waiting time for clerk is in a transient state, which means that the waiting times vary drastically with time. However, in the case of the accountant, the waiting time seems to be in a steady state.

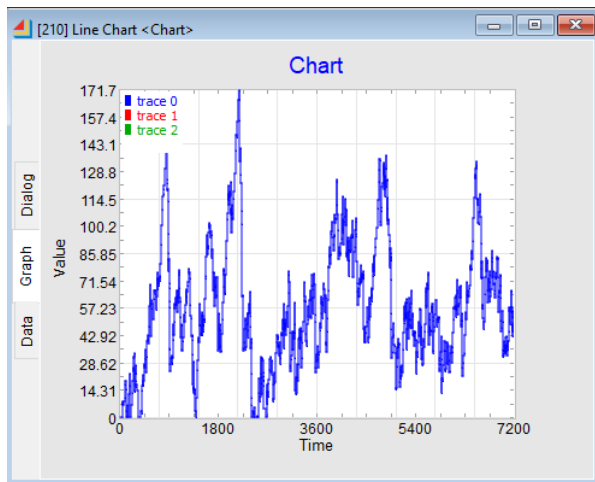


Figure 4: Waiting time of Clerk

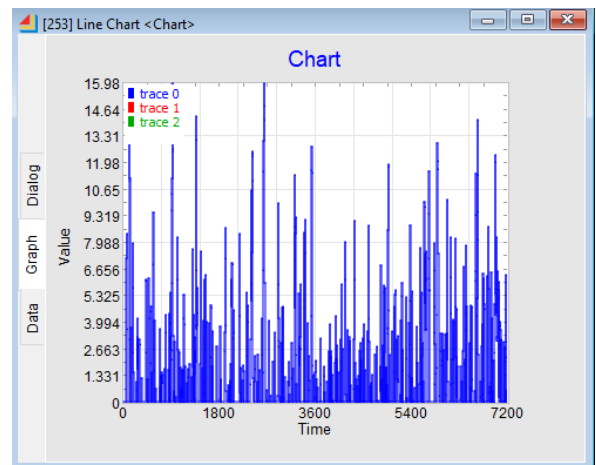


Figure 5: Waiting time of Accountant

Regarding the average cycle time, the clerk takes approximately 64.95 minutes, while the accountant takes around 6.12 minutes. The graph below illustrates the average cycle time over time.

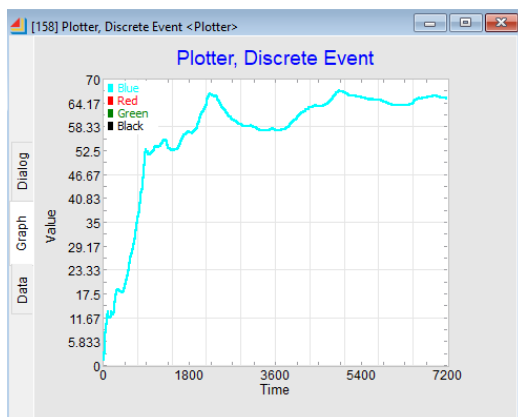


Figure 6: Average cycle time of clerk

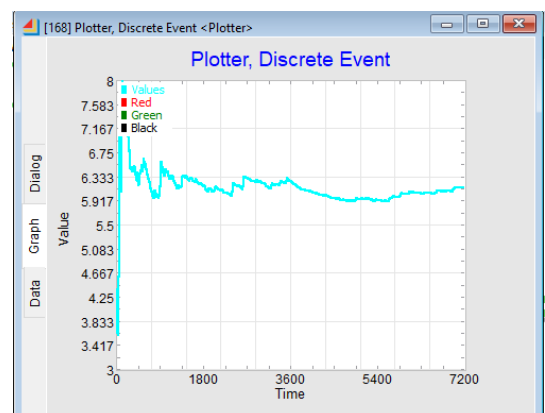


Figure 7: Average cycle time of accountant

The utilization of clerk is around 97.2% and for accountant, it is 58.38%. Work in Progress for clerk is 10.1 and for accountant, it is 1.

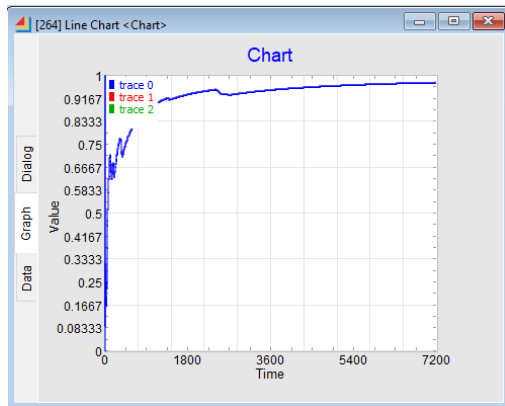


Figure 8: Utilization of Clerk

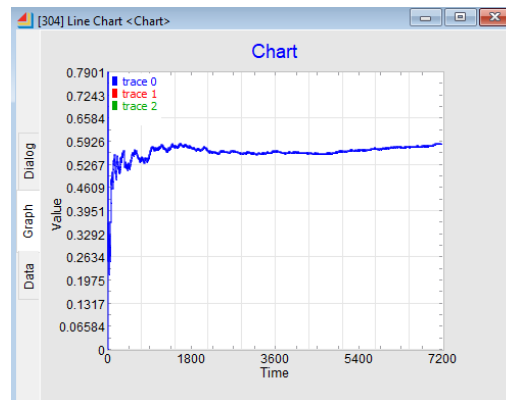


Figure 9: Utilization of Accountant

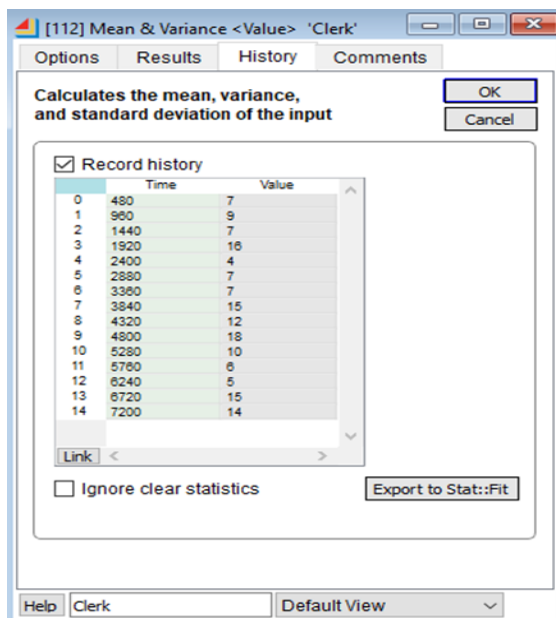


Figure 10: WIP of Clerk

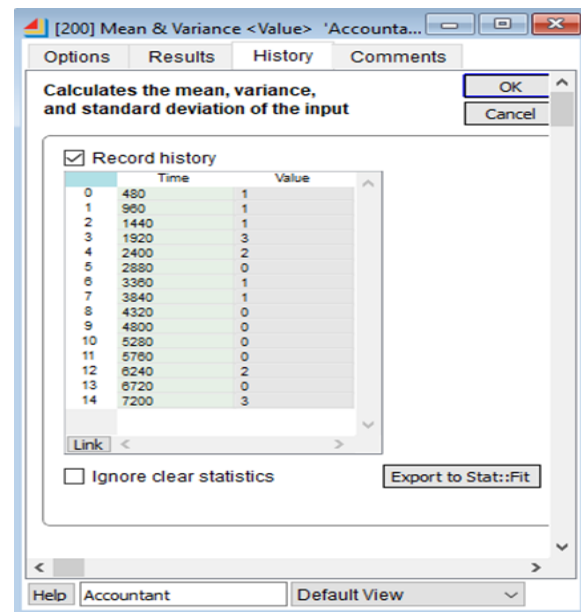


Figure 11: WIP of Accountant

• Part 4:

The clerk has a utilization rate of 97.2%, with an average wait time of 58.04 minutes and an average queue length of 8.22. The work-in-progress (WIP) for the clerk is 10.1.

On the other hand, the accountant has a utilization rate of 58.38%, with an average wait time of 1.96 minutes and an average queue length of 0.27. The WIP for the accountant is 1.

Below are the visualizations for each of the performance parameters.

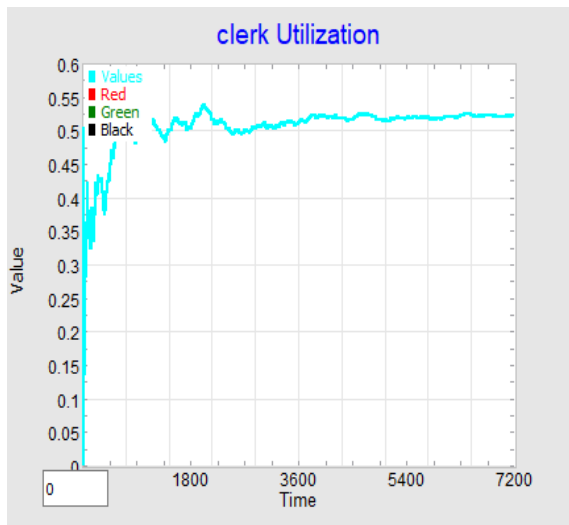


Figure 12: Utilization of Clerk

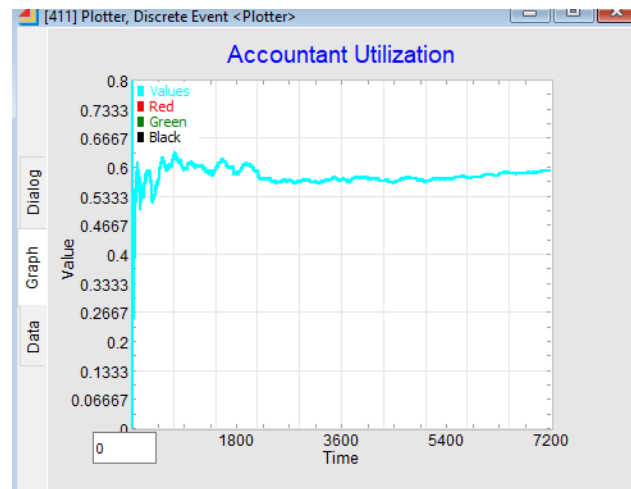


Figure 13: Utilization of Accountant

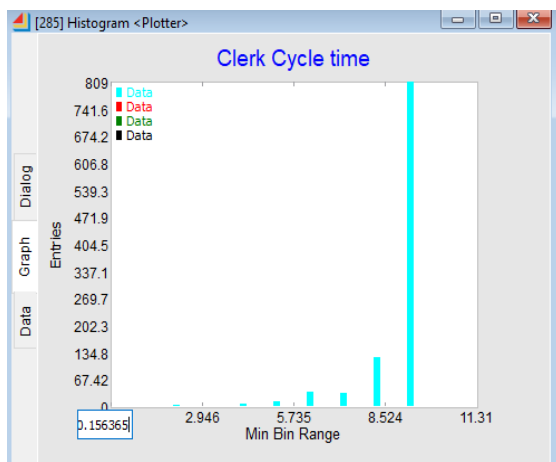


Figure 14: Average cycle time of clerk

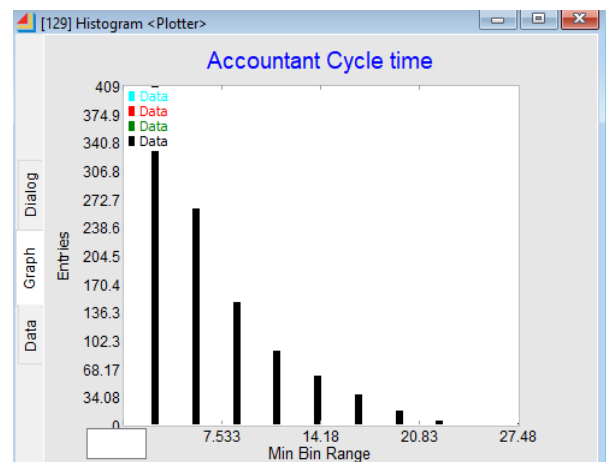


Figure 15: Average cycle time of accountant

• Part 5:

From the above results, we see that the utilization, cycle time and Work in progress is extremely high for clerk when compared to the accountant. This means that there is a bottleneck, and there is a need to add one clerk to this process to make the process efficient. Hence, we added one clerk to our model, and ran it for 15 days.

By adding one additional clerk to the process, we observed significant improvements in efficiency. The utilization of the clerk dropped to 52.06%, indicating a more balanced workload. Similarly, the accountant's utilization remained within a similar range. The cycle time for the clerk decreased significantly from 65 minutes to 10 minutes, leading to a

much more streamlined process. Overall, the addition of a clerk has greatly improved the efficiency of the process.

- **Part 6:**

We optimized this model to obtain a minimum cycle time and added a resource constraint of 8 as the total and maximum resource availability. We add an optimizer block to the original model.

Once the model is optimized, we identify that the optimal number of resources for this process is 4 clerks and 3 accountants. With this, the utilization of both resources has decreased, along with the average cycle time.

The results obtained are shown below table –

RESOURCE	Average Waiting Time	Average Cycle Time	Utilization
Clerk	0.136	7.78	28.89%
Accountant	0.77	5.06	21.58%

Recommendations:

We recommend that the software company allocate 4 clerks and 3 accountants for this workflow process to have a minimum cycle time of 12.84 minutes and a waiting time of approximately 1 minute since this is the most efficient work process.

However, if the company is unable to hire as many resources as mentioned due to cost constraints, the company can consider hiring one additional clerk to the original process to make the original work process more efficient.