MN50753-Simulation

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Word Count - 2090

CONTENTS:

Project Aim

This project aims to simulate a small-scale call center to analyse its operational performance and identify areas for improvement. By modelling customer arrivals, server interactions, feedback handling, and resource utilisation, the objective is to evaluate key performance metrics such as waiting times, server utilisation, customer satisfaction, and feedback analysis efficiency. Through this analysis, the project seeks to provide insights and recommendations to enhance the call center's efficiency and effectiveness in delivering quality service to its customers.

Understanding the system

System Overview: Customers and Servers

In the simulated call center, two types of customers are served: Premium and Standard. Premium customers arrive at a rate of 6 calls per hour, while Standard customers arrive at 8 calls per hour. Premium customers receive priority, with 40% directed to experienced servers and the rest to rookie servers, while all Standard customers are directed to rookie servers. Premium customer calls take a Triangular(5,7,10) distribution of service times, with a peak around 7 minutes, whereas Standard customer calls follow an exponential distribution with a mean service time of 3 minutes.

Operation Policy

In the call center's operational policy, if a customer’s average wait time exceeds its tolerance (10-minute), it triggers a decision to escalate the call to experienced servers for further assistance. These transferred calls take an additional uniform time delay between 3 to 5 minutes beyond the initial 10-minute wait. Importantly, these escalated calls are given priority over premium calls in the queue for experienced servers.

Feedback Analysis

A total of 50 observations were taken into account. The inter-arrival rate is calculated using Input Analyser. The delay type is set to "Triangular," which is a probability distribution used here to model the time taken to complete the process. The parameters for the Triangular distribution are 5.06, 6.09 and 9.86 minutes

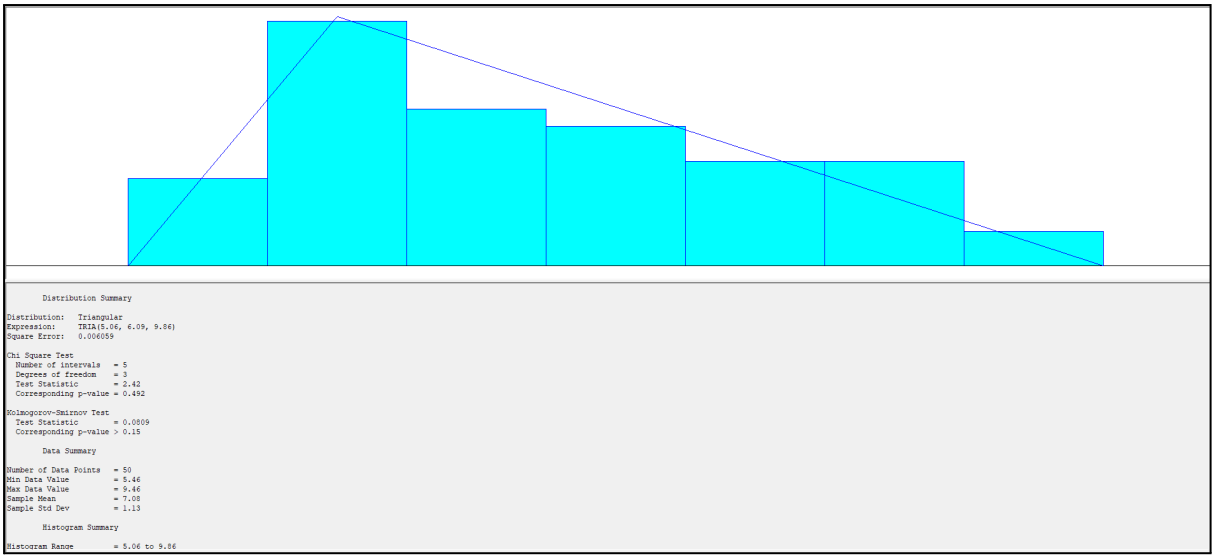

Fig 1: Fitted observations in Input Analyzer

Building the Arena Model

Considering all the aspects under which the call center works, an Arena model is built which mimics the current working of a call center. The model is run for 8 hours and 40 replications.

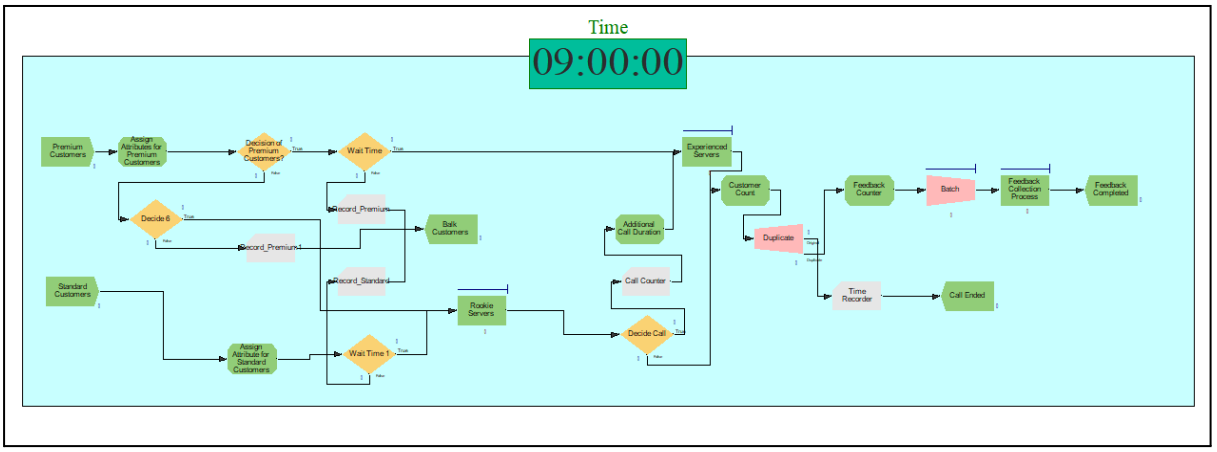

Fig 2: Call-Center Model

The call center model is designed to efficiently manage incoming calls from Premium and Standard customers. Premium customers, arriving at a rate of 6 calls per hour, are distributed between experienced and rookie servers, with a priority system ensuring prompt service. Meanwhile, Standard customers, arriving at a rate of 8 calls per hour, are directed to rookie servers. Both types of servers handle calls, with experienced servers taking over calls exceeding 10 minutes. The duration of Premium calls follows a Triangular distribution, while Standard calls follow an exponential distribution. Calls exceeding the handling time threshold are transferred to experienced servers for additional assistance. Additionally, a feedback process collects customer input after each call, aiding in service improvement. Through

careful queue management and server allocation, the model aims to optimize customer satisfaction and operational efficiency within the call center environment.

Simulation Result Analysis: Understanding Call Center Performance

Parameters	Values
Average waiting time in the rookie server queue	0.021781781
Average waiting time in the experienced server queue	0.008365096
Average Utilisation of the rookie servers	0.322221426
Average Utilisation of the experienced servers	0.171700558
Average waiting time of a premium customer	0.012310681
Average waiting time of standard customer	0.024919925
Average Time spent in the system by a customer (independent of the type)	4.896427567
Number of calls directed to experienced servers from rookie servers	4.125
Number of premium/standard customers that balk	0.025
Average Utilisation of Alan and Mary	0.054199969

Table 1: Call-Center Model

Average Waiting Time in Server Queues:

- The average waiting time in the rookie server queue is approximately 0.022 units of time, indicating that customers typically wait for a short duration before their calls are addressed by rookie servers.
- In contrast, the average waiting time in the experienced server queue is lower, at around 0.008 units of time, suggesting faster service for customers directed to experienced servers. This suggests efficient call handling and resource allocation.

Server Utilisation:

- The average utilisation of rookie servers is approximately 32.22%, implying that these resources are moderately utilised during the simulation period.
- Experienced servers exhibit lower utilisation, with an average of around 17.17%, indicating potential capacity for handling more calls or improving efficiency.

Customer Waiting Time:

- Premium customers experience an average waiting time of about 0.012 units of time, indicating relatively prompt service delivery due to their priority status.
- Standard customers, on the other hand, have a slightly longer average waiting time of approximately 0.025 units of time, reflecting the impact of prioritising premium customers.

Overall Customer Experience:

- The average time spent in the system by a customer, regardless of their type, is approximately 4.896 units of time. This metric provides an overall perspective on the duration customers interact with the call center from arrival to call resolution.

Call Routing and Transfers:

- A notable finding is the average number of calls directed to experienced servers from rookie servers, which is approximately 4.125. This suggests that a considerable

portion of calls initially handled by rookie servers require additional assistance from experienced resources.

Customer Satisfaction and Service Level Adherence:

- The simulation indicates a low incidence of customer balk, with only around 0.025 premium or standard customers choosing to abandon their calls due to delays or dissatisfaction.
- Moreover, Alan and Mary, the individuals tasked with analysing customer feedback, exhibit an approximate utilisation rate of 5.42%, indicating effective use of their time in evaluating customer responses.

The confidence interval of 95% suggests that in repeated simulations, the true population parameter is likely to fall within this range about 95% of the time. For instance, the average utilisation of Alan and Mary is 0.054, its 95% confidence interval is (0.057975111, 0.050751559), indicating that we are 95% confident that the true average waiting time falls between these values. This applies to other parameters such as the average waiting time of premium customers providing a range where the true values are likely to lie with 95% confidence.

Assumptions

- **Fixed Arrival Rates:** The model assumes constant arrival rates, overlooking potential call volume fluctuations.
- **Modelled Service Times:** Service times are estimated using specific distributions, potentially oversimplifying real-world variability.
- **Skill Level Differentiation:** Distinction between experienced and rookie servers may not fully capture actual skill variations.
- **Customer Tolerance:** Simplified customer waiting tolerance assumes no negative tolerances, overlooking dynamic satisfaction levels.
- **Feedback Handling:** All customers are assumed to provide feedback, and analysis occurs precisely every 15 forms, which may not align with actual customer behaviour.
- **Lunch Breaks:** Lunch breaks are incorporated but assumed to adhere strictly to schedules, disregarding potential deviations or overlaps.

Limitations

- **Random Variable Modelling:** The model relies on predefined distributions for service times and waiting tolerance, which may not accurately reflect real-world variability. Deviations between assumed and actual distributions can significantly impact simulation outcomes.
- **Server Utilisation:** The simulation assumes a fixed number of servers without considering potential adjustments based on fluctuating demand. This limits the model's ability to simulate dynamic staffing strategies to optimise server utilisation.
- **Customer Prioritisation:** The model strictly prioritises premium customers over standard ones, overlooking potential factors such as queue lengths or specific issue severity that could influence prioritisation in real scenarios.

- **Simplification of Processes:** Complex interactions like server performance improvements over time or external factors such as system outages are simplified or ignored, potentially leading to an oversimplified representation of real-world scenarios.
- **Statistical Independence:** The model assumes independence among various factors like arrival times, service times, and customer tolerance. In reality, these variables may be correlated, affecting the accuracy of simulation results, especially in dynamic environments.

Recommendations for Enhancing Call Center Simulation Model

- **Dynamic Server Allocation:** The call center could benefit from a system that adjusts server numbers based on real-time needs. This dynamic allocation strategy would ensure that during busy periods, more servers are available to handle calls efficiently. Likewise, during quieter times, resources could be scaled back to avoid unnecessary costs. By implementing this approach, the call center can maintain optimal service levels and keep wait times to a minimum, enhancing overall customer satisfaction.
- **Optimising the Batch size:** To enhance the efficiency of feedback analysis in the call center model, it's recommended to optimise the batch size for processing feedback forms. By doubling the batch size from 15 to 30, the system can handle a larger volume of feedback forms in each batch, leading to improved resource utilisation. This change strikes a balance between efficiency and responsiveness, allowing for more feedback forms to be processed in each session while minimising the frequency of analysis intervals.
- **Staggered Feedback Analysis Approach:**A staggered approach to feedback analysis could significantly improve efficiency. Instead of waiting for a set number of feedback forms before starting analysis, Alan and Mary could begin reviewing feedback as soon as a minimum threshold is reached, like 5 or 10 forms. This change would ensure a more continuous process, making better use of their time and enabling quicker responses to customer feedback. Overall, it would enhance the responsiveness and effectiveness of the feedback analysis process, ultimately leading to improved customer satisfaction.

Implementation:

- By doubling the batch size from 15 to 30, the feedback analysis process aims to optimise resource utilisation, particularly for Alan and Mary. This change enables the handling of a larger volume of feedback forms in each batch, reducing the frequency of processing intervals while maintaining a manageable workload per session. The average utilisation decreases from 0.0541 to 0.026. While smaller batch sizes may allow for more frequent analysis, they can lead to higher overhead costs and inefficient resource utilisation. In contrast, larger batch sizes strike a balance between efficiency and responsiveness, enabling more forms to be processed per session while

minimising processing intervals. Overall, this adjustment enhances efficiency by maximising resource utilisation and streamlining the feedback analysis process.

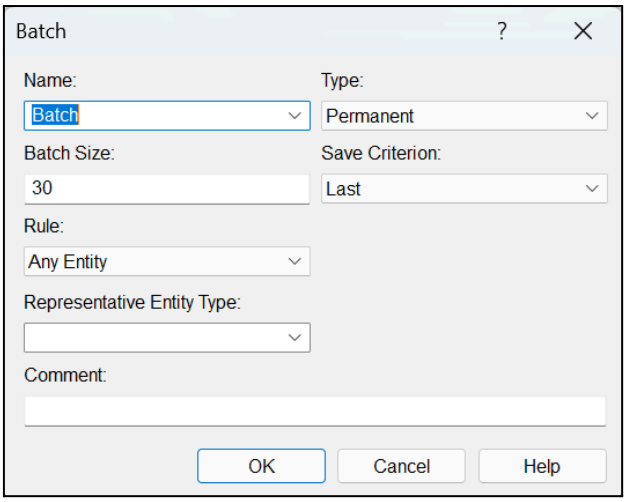

Fig 3: Increasing Batch Size

- The increase in Alan and Mary's average utilisation from 0.054 to 0.1083, while maintaining other parameters, indicates a significant improvement in their engagement in the feedback collection process. With the adoption of a staggered analysis approach and separate resource assignment, they are now continuously involved in analysing feedback, leading to faster response times and enhanced efficiency. This change optimises resource utilisation, ensuring that feedback forms are processed more promptly. However, careful monitoring of their workload is necessary to prevent burnout, highlighting the importance of regular review and adjustment of resource allocation for sustained optimal performance.

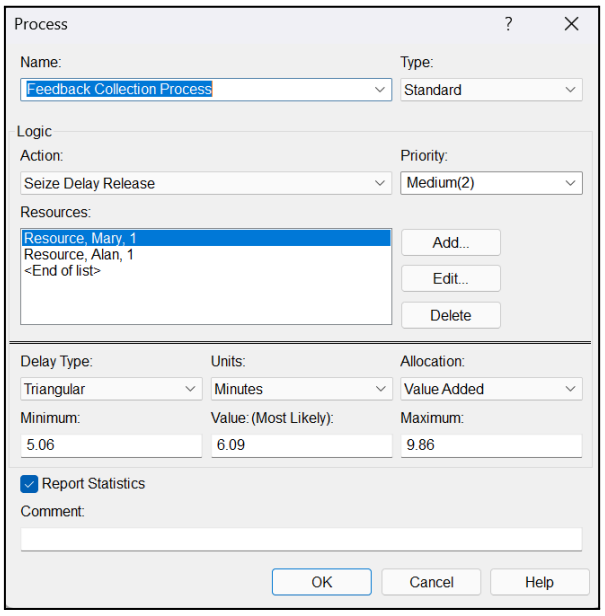

Fig 4: Two separate resources

Therefore in both ways, the model can be enhanced as seen above. It's better to decide how the enhancement can be done based on requirements from the higher officials and management.

Comparative Analysis of the New Model based on Queue Length:

The revised simulation model, implementing a queue-based allocation system for premium customers, led to notable changes in various performance metrics compared to the previous model. While the average waiting time in the rookie server queue increased slightly to 0.0280 minutes, indicating a longer wait for customers, the waiting time in the experienced server queue decreased to 0 minutes, reflecting improved efficiency in experienced server handling. This shift suggests a redistribution of workload towards rookie servers, resulting in increased rookie server utilisation to 42.48%, compared to 32.22% previously, while experienced server utilisation decreased significantly to 0.68% from 17.17%. Despite these changes, both premium and standard customer waiting times experienced slight increases, with premium customer waiting time rising to 0.0162 minutes and standard customer waiting time increasing to 0.0363 minutes. Additionally, the number of calls redirected to experienced servers increased to 6.1 calls, indicating a higher demand for experienced server intervention. However, no instances of customer balking were observed in the revised model, suggesting a potential improvement in overall customer satisfaction.

Parameters	Values_Model 1	Values_Model 2
Average waiting time in the rookie server queue	0.021781781	0.028011085
Average waiting time in the experienced server queue	0.008365096	0
Average Utilisation of the rookie servers	0.322221426	0.424831249
Average Utilisation of the experienced servers	0.171700558	0.00676757
Average waiting time of a premium customer	0.012310681	0.016200554
Average waiting time of standard customer	0.024919925	0.036250575
Average Time spent in the system by a customer (independent of the type)	4.896427567	4.911266252
Number of calls directed to experienced servers from rookie servers	4.125	6.1
Number of premium/standard customers that balk	0.025	0
Average Utilisation of Alan and Mary	0.054199969	0.054086694

Table 2: Comparison between Model 1 and Model 2

Overall, the system has shown improvements in some areas, such as decreased waiting time in the experienced server queue and a redistribution of workload towards rookie servers. However, there are slight increases in waiting times for both premium and standard customers, indicating the need for further optimization. Despite these changes, overall customer satisfaction has potentially improved, with no instances of customer balking observed. Nonetheless, there's still room for enhancement to optimise system efficiency and customer experience.

Conclusion

In conclusion, the simulation of the small-scale call center provided valuable insights into its operational performance and areas for improvement. By modelling various aspects such as customer arrivals, server interactions, feedback handling, and resource utilisation, the project aimed to evaluate key performance metrics and identify opportunities for enhancing efficiency and effectiveness. Through comparative analysis and recommendations, it was observed that certain adjustments, such as dynamic server allocation, optimising feedback batch size, and implementing a staggered feedback analysis approach, could significantly enhance system performance. Additionally, the comparative analysis of the revised model based on queue length allocation highlighted improvements in certain metrics, with slight increases in waiting times for both premium and standard customers. Overall, while the system demonstrated improvements in specific areas, there remains scope for further optimisation to achieve optimal efficiency and enhance customer satisfaction. By considering the recommendations and adapting the model based on specific requirements, the call center can strive towards delivering exceptional service and meeting the evolving needs of its customers.