APPENDIX - Discrete Event Simulation of a Coffee Shop: Simulation Setup and Data Analysis Details

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MSDS 476 2024, Cohort 5
Northwestern University, Business Process Analytics
14/02/2024

Research Report

1. **Abstract**

The abstract provides an executive summary of the research conducted to analyze customer service operations in coffee shops using discrete event simulation. By employing SimPy within the KNIME environment, the study investigates various factors influencing service quality, including barista availability, customer demand, and balking behaviours. Through extensive simulation runs and data analysis, the research aims to uncover insights into optimizing staffing levels, managing customer flow, and reducing wait times to enhance overall service efficiency and customer satisfaction. The findings contribute valuable recommendations for improving service processes in coffee shop environments, aligning with the ongoing pursuit of exceptional service delivery.

2. **Introduction**

The introduction highlights the importance of analyzing customer service in coffee shops amid evolving consumer preferences. Utilizing discrete event simulation, the study aims to explore customer interactions, barista service, and balking behaviors. Understanding these dynamics is vital for identifying areas for improvement and implementing effective strategies. By contributing to service optimization discussions, the research aims to offer valuable insights and recommendations to coffee shop practitioners, helping them exceed customer expectations in service delivery.

3. **Literature Review**

The literature review explores discrete event simulation's relevance to service processes, focusing on its application in coffee shop operations. It acknowledges Buss's foundational work (1996) on event graphs and their role in simulation modeling. Additionally, it emphasizes the versatility of the SimPy package in simulating complex systems, including customer service environments. Integrating SimPy into the KNIME environment enables researchers to create simulations capturing customer arrivals, service dynamics, and balking behaviors in coffee shops. This review helps for employing simulation methodologies to analyze and optimize service operations effectively.

4. **Methods**

The methods section outlines the approach taken to conduct the research.

- **Simulation Setup**: The study utilizes the Python Extension in KNIME to implement a discrete event simulation of a coffee shop environment. Parameters such as barista availability, customer interarrival times, and service durations are configured.
- **Simulation Runs**: The simulation is executed across multiple runs, varying parameters such as barista levels and demand levels. Each run produces a unique set of event logs, allowing for analysis of service dynamics for different scenarios.
- **Data Analysis**: Event logs are analyzed to derive insights into customer wait times, service durations, and the impact of balking behaviours on service efficiency.

5. **Results (**Results from Discrete Event Simulation**)**

1. **At what levels of customer demand would you recommend staffing with 1, 2, or 3 baristas?**

   Staffing recommendations vary based on customer demand: one barista suffices for low demand, particularly when customers arrive every 4 minutes or longer. With two baristas, efficiency extends across a broader spectrum of customer arrival rates, optimal between 1 to 6 minutes on average. Three baristas ensure robust performance across all observed demand levels, efficiently managing workload irrespective of mean interarrival time. These insights from simulation results and Python code guide staffing decisions, balancing operational efficiency with customer satisfaction across varying demand scenarios.

2. **How would the recommended numbers of baristas change if baristas were more efficient (had shorter minimum, mean, and maximum service times)? Suppose Starbucks were to go down the path of robot baristas, à la Jamba**

   Introducing robot baristas at Starbucks would revolutionize service efficiency, impacting staffing levels and operational dynamics. With robot baristas, service times would dramatically decrease due to their consistent high-speed operation, boosting customer throughput. Consequently, Starbucks could potentially maintain service quality with fewer baristas, depending on the balance between customer demand and increased service capacity. This shift necessitates a thorough cost-benefit analysis to gauge the feasibility of implementing robotic systems versus potential savings in labor costs and revenue gains from improved efficiency. Additionally, Starbucks must carefully consider the implications of automation on the customer experience and brand perception, ensuring a harmonious balance between efficiency gains and the preservation of the unique Starbucks ambiance and customer satisfaction.

a. **If robot service times in minutes were less variable (minimum_service_time = 1, mean_service_time = 1.5, maximum_service_time = 3), how would simulation results change at the highest level of demand?**

   In scenarios with more predictable service times, all staffing levels (1, 2, and 3 baristas) show improved efficiency at peak demand. Shorter and consistent service times lead to significant reductions in waiting times: 1 Barista experiences a mean wait of 17.04 seconds, 2 Baristas reduce it to 1.29 seconds, and 3 Baristas virtually eliminate waits with a mean of 0 seconds. These findings indicate that with robot baristas, Starbucks could uphold exceptional service during peak hours with fewer staff, potentially cutting labor costs while satisfying customers.

3. **Suppose baristas must share a limited resource such as an espresso maker. How would this change the logic of the simulation (as defined in an event graph), and how do you think it would change simulation results? Would you recommend adding limited/shared resources to the discrete event simulation for Starbucks?**
   Introducing a limited resource like an espresso maker would require significant adjustments to the simulation logic, impacting results notably. Baristas' service times would now hinge on espresso maker availability, necessitating new events and potentially altering customer flow. This change could lead to increased wait times, reduced resource utilization, and potential throughput decreases if the espresso maker becomes a bottleneck. Queue dynamics may shift, affecting overall service efficiency. The simulation's insights could prompt staffing or equipment adjustments to optimize operations and satisfaction. It's advisable to integrate limited resources like the espresso maker into the simulation to accurately model Starbucks' operations, aiding in identifying bottlenecks and informing decisions for enhanced efficiency and service. Included a pseudo-code python program to add this function within Zip File.
4. **Suppose there were two types of servers: cashiers and baristas. How would this change the logic of the simulation (as defined in an event graph), and how do you think it would change simulation results? Would you recommend adding server types to the discrete event simulation for Starbucks?**
   Introducing two server types, cashiers and baristas, would overhaul the simulation, offering a more realistic depiction of coffee shop operations. With separate queues for each role, the simulation mirrors real-world processes, enhancing authenticity. Service times vary between cashiers, who handle order-taking, and baristas, responsible for drink preparation. Efficient resource allocation becomes critical, balancing staffing ratios between cashiers and baristas. This change would likely impact key metrics like

wait times and server utilization, providing insights into staffing strategies' effectiveness and operational efficiency. A pseudo-code python program is included to incorporate this feature within the simulation. Included a pseudo-code python program to add this function within Zip File.

5. **What other recommendations do you have for using discrete event simulation to provide advice to Starbucks?**

   Leveraging discrete event simulation, Starbucks can optimize operations effectively with several key strategies. By using simulation, they can continuously refine staffing levels to balance efficiency and cost-effectiveness, ensuring optimal service without unnecessary labor costs. Experimenting with diverse queue management strategies such as multiple service channels or self-service kiosks can minimize wait times and enhance overall customer satisfaction. Extending the simulation model to include factors like seating availability, equipment utilization, and inventory management allows for a comprehensive assessment of resource allocation's impact on operational efficiency. Incorporating customer behavior models into the simulation enables Starbucks to enhance the overall customer experience further.

6. **Conclusions**

The simulation analysis highlights key recommendations: Adjust barista numbers based on customer demand; with high demand, three baristas optimize service, while for lower demand, one or two suffice. Variable service times significantly impact service quality, with less variability leading to shorter waits and improved satisfaction. Introducing multiple server types, like cashiers and baristas, enhances simulation realism, mirroring real Starbucks workflows, where customers interact with cashiers first, then baristas. This nuanced approach ensures accurate modeling and better reflects real-world scenarios, guiding staffing decisions and operational strategies effectively.

References

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- Chapter 8. Designing Service Processes, Chapter introduction through Blueprinting the Restaurant Experience: A Three-Act Performance, pages 260–273. Case 14. Starbucks: Delivering Customer Service, pages 591–605. Prepared by Youngme Moon and John Quelch and published by Harvard Business School in 2003 (updated in 2006). This case documents Starbucks company background and financials, as well as aspects of customer service. At the time of the case, Starbucks was considering responding to recent customer research that suggested the company was not meeting customers' service expectations. Management was thinking about hiring additional baristas, which would cost the company $40 million annually.