DISCRETE EVENT SIMULATION: A WARRANTY CALL CENTER CASE STUDY

Charles Lamb

Northwestern University, MSDS 460 – Decision Analytics

November 20th, 2023

Abstract

This paper employs discrete-event simulation in modeling call center throughput. The case study focuses on an automotive warranty call center, but could be generalized to accommodate most other types of call centers. Several relevant management questions are presented relating to call center staffing and the paper demonstrates how these questions can be answered using simulation.

Keywords: discrete-event simulation, call center throughput

1. Introduction

This paper presents a case study associated with a call center that handles automotive warranty claims. Many companies operate call centers and are faced with difficult questions regarding how these centers should be staffed. This case study addresses how simulation can be used to answer these questions. Relevant management questions addressed include: what level of staffing is required to achieve minimum service requirements and what is the impact of adding resources on call time metrics.

While this case study focuses on a call center dedicated to warranty claims, the theoretical call center presented in this case study is unique only in the specifics of its theoretical design. A call center operating in another industry may have different rules around customer routing or volume of call intake, but with some effort the methods of this case study could be generalized to adequately describe most other call centers.

2. Literature Review

Discrete-event simulation (DES) originated in the late 1950s and early 1960s as a tool to model manufacturing systems. As the science developed, DES has emerged as a common tool used to address a variety of operational research problems (Bayer 2014). There is a vast amount of published literature applying DES to a variety of different operational problems. Influential to this paper, Tatusko presents a movie theater case study which serves as a foundation for coding in SimPy, a Python based DES framework (2020). While valuable in demonstrating the effective usage of SimPy, Tatusko's movie theater is a relatively simple process and additional complexity was introduced based on other literature. Reneging, the process of customers leaving a queue if wait times become too long, was built into the model based on the bank renege example in the SimPy documentation (Team SimPy, 2020). Balking, the process of customers not joining a queue if the queue is too long, was built into the model based on modified examples provided in the SimPy Classic literature (Team SimPy Classic, 2018).

3. Methods

A discrete-event simulation was built using SimPy. The model is available at: https://github.com/cglamb/MSDS_460/tree/main/DES_Simulation. For simplicity, the model was limited to call center operations associated with handling Guaranteed Asset Protection (GAP) claims, a specific type of automotive warranty. Readers interested in the specifics of GAP as a product are referred to Durkin, Elliehausen, and Miller (2022).

The reader is referred to Appendix A for a detailed event graph describing the simulation. A brief summary of the process simulation is as follows: the process begins when a customer calls the center. Time between calls is modeled using an exponential distribution. The caller joins an initial queue to wait for a First Notice of Loss (FNOL) handler. FNOL handlers are employees within a warranty call center tasked with answering initial calls, collecting basic information, inputting that information into company systems, and then passing the call to a second individual who specializes in the specific type of warranty being addressed on the call. To be specific, a single FNOL department handles all initial incoming calls and then directs GAP calls to the GAP department while all other calls are directed to their respective departments. This initial FNOL queue allows for customers to balk if the numbers of callers ahead in the queue grows too long and also allows for reneging if the caller sits in queue for too long. The model has a resource constraint reflecting the limited number of available FNOL handlers and models the time spent with an FNOL adjuster as a uniform distribution. Patience before reneging is varied by customer and follows a uniform distribution across the call population.

Upon completion of FNOL, the caller is passed to a secondary queue associated with the GAP department. The model anticipates that not all calls in FNOL relate to GAP and thus only passes a portion of the FNOL calls to the GAP department. GAP departments are staffed with employees who specialize in adjudicating GAP claims. These employees are commonly referred to as GAP adjusters or adjudicators and form a second limited resource within the call center. Waiting for a GAP adjuster to become available forms the second queue. This second queue is referred to as an adjudication queue and allows for reneging but not balking. Time spend in GAP adjudication is modeled based on an exponential distribution with a cap on minimum and maximum time spent in adjudication. Patience before reneging is varied by customer and follows a uniform distribution across the call population. A full parameterization of the model is presented in Appendix B.

4. Results

Management has indicated that during the FNOL process, the company's standard for minimum required customer service level dictates that no more than 5% of callers balk or renege while waiting for an FNOL handler. Based on this criteria, the recommendation to management is that no fewer than five FNOL adjusters be on duty at any given time. This result was achieved by iteratively increasing the number of FNOL resources in the model until the minimum required service metric was achieved. Results are presented in Appendix C.

Management would like to understand the average time from initial call to completion of FNOL and how much this service time could be improved by adding additional resources. Management has indicated that the additional expense of adding an FNOL resource would be worthwhile if this service time metrics could be decreased by 20%. By measuring time between the log events of "join fnol que" and "end fnol" we are able to tell the management team that the average service time metric is 3.3 minutes given five FNOL handlers. Adding a sixth FNOL handler improves the service time metric to 3.1 minutes. As this is only a 6.5% improvement, adding a sixth FNOL handler is not recommended.

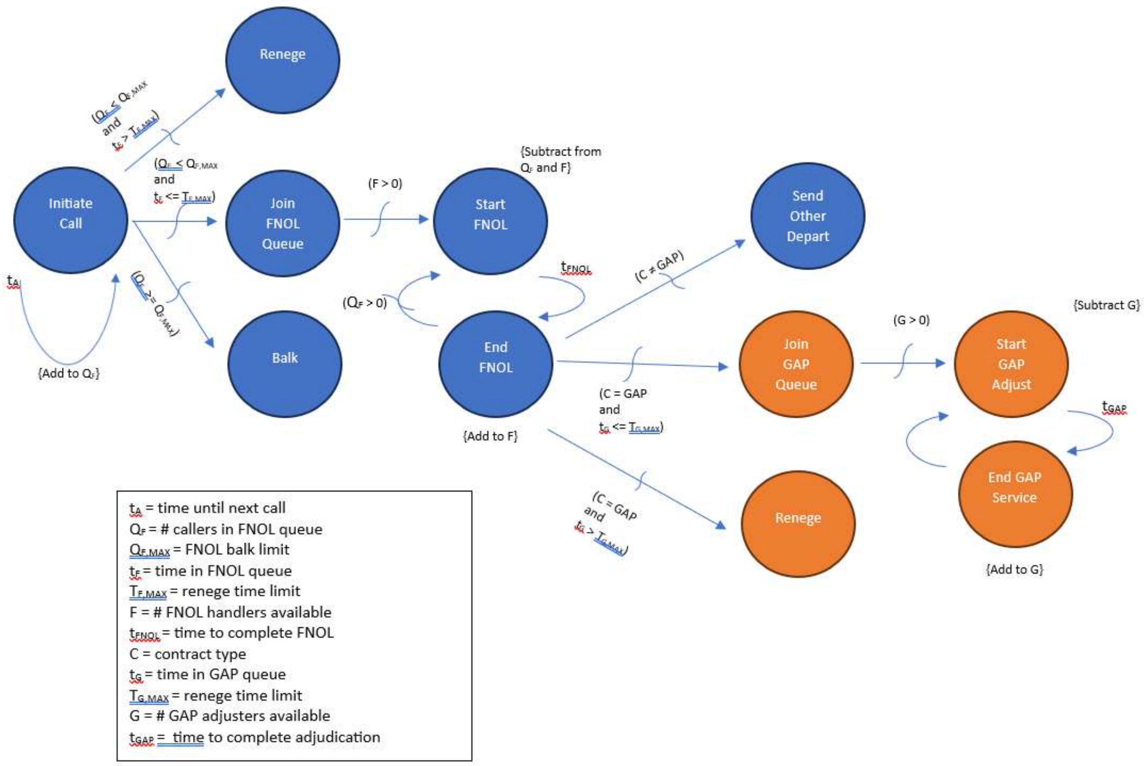
Finally, management notes that the company only currently employees two GAP adjudicators. Management would like to understand how much wait times in the GAP adjudication queue would decrease if an additional adjudicator was hired. They note that decreased wait times of 20% would justify the additional resource being hired. Simulated waiting time in the adjudication queue with two adjusters is 6.2 minutes. Increasing the number of GAP adjudicators to three decreases queue times to 5.0 minutes, a 19.4% improvement. Therefore the recommendation to management is that adding an additional resource does not technically meet their criteria. However given how close the third adjuster gets to the improved queue time threshold, management may want to consider this addition.

5. Conclusions

DES is a useful tool in modeling operational problems. This case study demonstrates the effectiveness of this modeling technique in answering relevant management questions associated with staffing a warranty call center.

A. Appendix

The following event graph describes the process modeled in this case study:



B. Appendix

The following exhibit presents the parameterization used in the DES. All simulations ran for this case study use the following parameterization.

Model Assumptions

	Process	Model	Parameterization
	Incoming Calls	Exponential	Mean number of calls per minute = 1
	FNOL Reneging	Continuous Uniform	a=3 minutes, b=8 minutes
(1)	FNOL Balking Limit	Single Value for All Callers	Balking_Limit = 5
	FNOL Service Time	Continuous Uniform	a=1 minutes, b=5 minutes
	% of FNOL Claims that are GAP	Discrete Uniform	Mean set to 1 in 3 claims being GAP
	Adjudication Reneging	Continuous Uniform	a=6 minutes, b=8 minutes
	Adjudication Service Time	Exponential with min/max cap	Mean service time of 5 mins. Min service time of 2 minutes and max of 10 minutes.
(2)	Seed	N/A	Seed=24
	Runtime	N/A	Model ran for 8 hours

Notes

(1) All caller balk if there are 20 callers ahead in queue

(2) Sets random seed for reproducibility of results

C. Appendix

The following exhibit presents the iterations run to address managements question about the required number of FNOL adjusters to still maintain minimum service levels.

Impact Number of FNOL Handlers has on Service Metric

# FNOL Handlers	Service Metric*
1	36%
2	71%
3	89%
4	96%
5	100%

*Number of callers succefully completing the FNOL process

References

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