

**Research Article****ANALYSIS OF WAITING LINES IN A BANK USING SIMULATION OF DISCRETE EVENTS – CASE STUDY****^{1,*}Rafael Emilio Casadiego Sarmiento, ²Manuel Alfonso Pacheco Brito and ³Nieves Jaime Nava**¹Universidad de Investigación y Desarrollo - UDI, International Business Program, Bucaramanga, Colombia²Santo Tomas University – Bucaramanga, Industrial Engineering Program – Faculty of Industrial Engineering, Bucaramanga, Santander, Colombia³National Technological Institute of Mexico – Celaya Technological Institute, Postgraduate master's degree in industrial engineering, Celaya, Mexico**Received 25th April 2026; Accepted 27th May 2026; Published online 30th June 2026**

Abstract

On a day-to-day basis and anywhere in the world, human beings, industrial sites on production lines, traffic in the city and highways, face waiting lines and understanding them has been essential to design jobs, optimize resources, manage and guarantee the quality of a product or service, among other aspects. Therefore, it is of interest for our research incubator to see how it affects the processes in a banking entity where the respective data were taken and what is its performance in its service value chain, for which it not only includes visualizing the respective deterministic calculations with the known mathematical models but also simulating them through discrete events with the FlexSim software, which allowed us to visualize other aspects, variables and characteristics not contemplated, which due to their characteristics and virtual environment oriented to 3D objects, can be appreciated with great similarity to the real scenario of the financial institution where this research was carried out and its corresponding results.

Keywords: Backgrounds, Delay, Layout, modeling, Output, ProcessFlow, Stochastic, layout, Waiting line, Sequencing, Throughput.

INTRODUCTION

Customer service, as a fundamental part of business management, has undergone substantial changes with technological advancements. This has forced companies to develop new strategies to remain competitive in the industry, as evidenced by the need for efficient service in lines at banks, supermarkets, government offices, and travel agencies. Waiting times generate economic losses for users and, for companies, lead to a loss of market share and a poor reputation due to low-quality service [1]. Mathematical queuing models help visualize the static scenario and behavior of waiting, particularly in a bank, but not its behavior when it tends to be stochastic, random, and infrequent. Therefore, the usefulness of simulation techniques lies in their ability to anticipate the reaction of a system under study to variations inherent in business reality and the socioeconomic and environmental context, at lower costs compared to experimentation under real-world conditions. This exceptional technique can be used to investigate virtually any type of stochastic system, making it the most widely used operations research technique in studies dealing with these types of systems [2]. Therefore, simulation with FlexSim software has the capacity, quality, and management capabilities to create a scenario so similar to a real-world situation, particularly in the case of quantitative research on queuing behavior at a bank in the city of Bucaramanga. Furthermore, using FlexSim software facilitates and expedites the development of a proposed improvement [3]. This article will demonstrate the advantages of implementing simulation to visualize, compare, and understand waiting times at a bank.

LITERATURE REVIEW

Simulation with FlexSim allows for better interpretation and visualization of the model, as it provides a greater number of statistics, generating more information about the system being replicated [4]. However, in this work, the simulation was applied to a queuing scenario for entering a movie theater. It was primarily based on calculations performed with deterministic mathematical models of queuing and lacked the application of FlexSim powerful ProcessFlow interface. Nevertheless, in other studies, such as one applied to a blood bank, ProcessFlow was used. Its programming essentially allows for the easy creation and management of complex operations with the help of activities organized in a flow for process simulation [5]. In another case, the functions in a banking entity representing the system were presented as a queue and the teller providing the service. The flow of entities follows this direction, and to continue with the next stage of the methodology, it was necessary to use a tool that facilitated the construction of the computer simulation model using FlexSim and ProcessFlow [6]. In this review, we found work where the processing of data collected in real scenarios was used, and two servers were proposed for a financial entity [7], using FlexSim, but in a basic way without using its ProcessFlow tool.

Based on the above and the literature review conducted, it is worth mentioning that the ProcessFlow model, or alternative process flow model in FlexSim, demonstrates that by addressing the waiting or delay problem, it helps replace object functions and measure the performance of other objects [8]. Therefore, ProcessFlow allows the integration of 3D objects and block programming to ensure better real-time simulation, emulating the respective scenarios being studied, such as waiting lines in a bank.

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PROBLEM DESCRIPTION

Queuing theory is a tool characterized by its systematic approach and its application in models that analyze the behavior of waiting lines. Poor queuing management stems from the disparity between the company's service capacity and the demand [9]. Therefore, in a bank, customers access multiple services, such as ATMs, payments, deposits, and cash deposits at tellers staffed by bank employees, as well as customer service, among others. To ensure adequate service, it was necessary to identify, using data collected on the bank floor, the waiting time for each of these services. This data was then transferred to a table, along with its statistical inferential trend using poisson distribution. The Poisson distribution is particularly suitable for determining the number of people arriving at a store, bank, or airport within a given time [10]. Since the time determined when people arrive at the banking entity takes into account their working hours, on bi-weekly days and due to needs requested by this banking entity to carry out the study, it was precisely to visualize the current scenario by simulating it with FlexSim and the results reinforce the strategic role of simulation modeling as a mechanism to support decision making [11].

Table 1 below shows the number of customers using the different services of this bank, as well as equation 1, corresponding to the Poisson distribution.

$$P_{(x)} = \frac{\lambda^x e^{-\lambda}}{x!} \quad (1)$$

Table 1. Data Collected in Bank

Resources	Customers	\bar{X} Attention Time - Seconds
ATM No. 1	67	195
ATM No. 2	64	198
Customer Service (SAC) No. 1	23	578
Customer Service (SAC) No. 2	25	594
Cashier with employee #1	46	245
Cashier with employee #2	39	248

Figure 1 below shows a summary of Table 1.

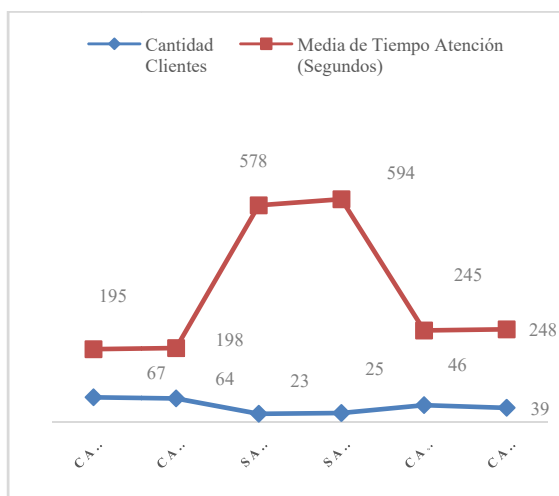


Fig. 1. Summary graph of data from Table 1

STRUCTURE OF THE CASE STUDY AND SIMULATION

To begin the simulation process of the field research, a flowchart was initially created, outlining the process and its

respective probability distributions. This flowchart allowed for the identification of the probability distribution rate for customers during those two-week periods. Figure 2 below shows each block of the flowchart along with the corresponding ProcessFlow blocks.

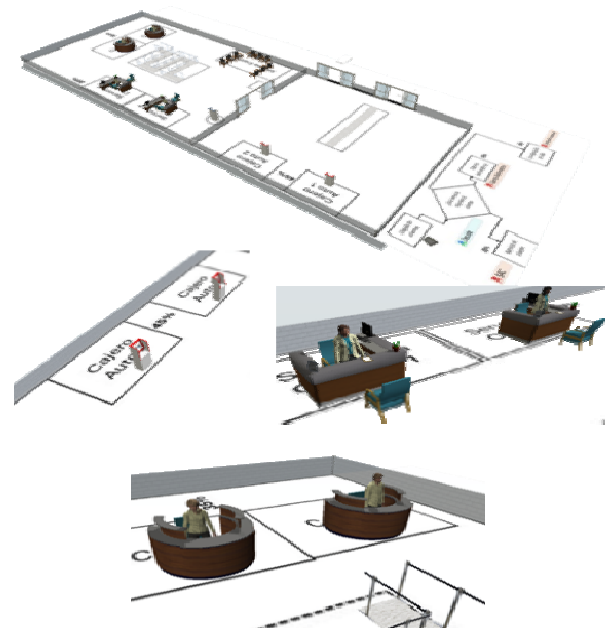


Fig. 2. Initial bank service flowchart

Simulation structure

Customer service is one of the most crucial factors in the services offered by banks, and teller services represent the primary demand within this service. For this reason, the time customers spend waiting in line to be served makes the difference between their perception of good or bad service [11]. Therefore, the bank's layout was designed according to its dimensions, available space, and distribution. This layout was then incorporated into the FlexSim software's background, allowing the inclusion of the software's resources, as shown in Figure 3.

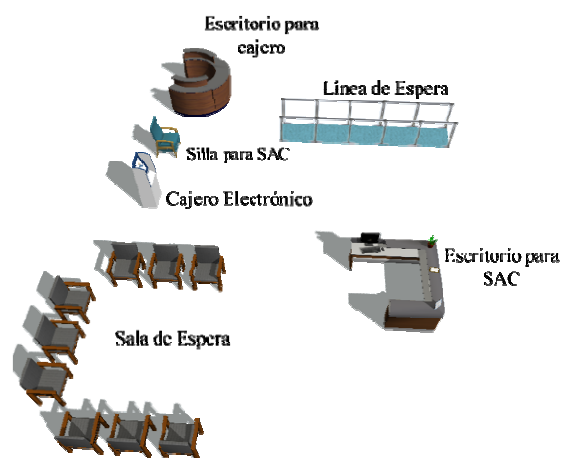


Fig. 3. Locational resources for bank simulation design

With these resources, they are included in the FlexSim software platform, where the respective layout was previously included, which can be seen in the following figure 4, which shows the electronic cashiers, customer service and cashiers attended by employees.

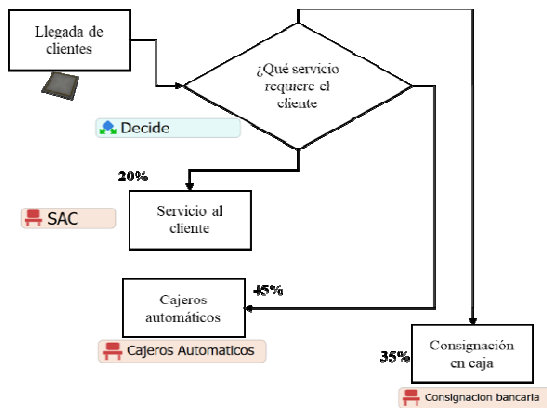


Fig. 4. Distribution of the banking entity

The respective nine simulation runs are performed, obtaining the following performance results or throughput, which are shown in the following figures 7 and 8.

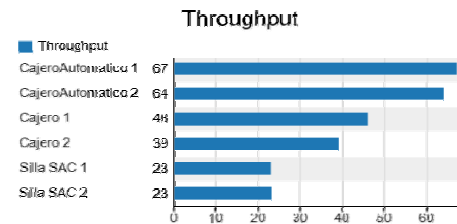


Fig. 7. Throughput or performance in a working day

ProcessFlow structure and simulation run

For the development of the design of the respective simulation and based on the flowchart in figure 2, the respective programming was carried out with ProcessFlow, which provides a step-by-step guide to connect the FlexSim 3D [12].

With this, simulation runs were successfully completed for three months or nine fortnights of customer arrival data, and in the following figure 5, the configuration of the ProcessFlow programming for this quantitative research can be seen.

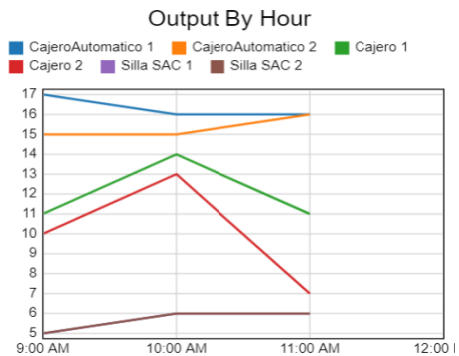


Fig. 8. Output or hourly output of each of the banking services

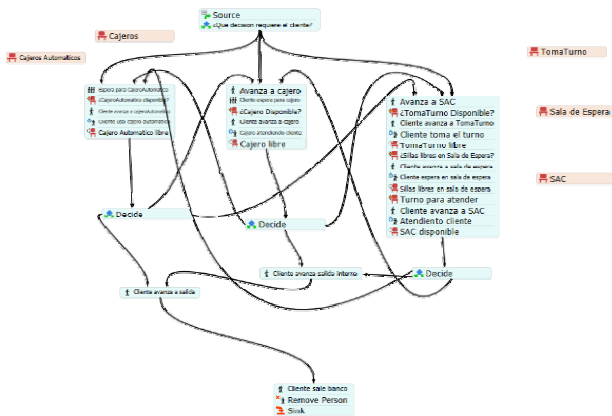


Fig. 5. Programming with Process Flow

CONCLUSION

The advantage of discrete event simulation is that it allowed us to identify opportunities for improvement, without altering the normal processes of the financial institution, to optimize the different banking services. The intuition that comes with block programming Process Flow allowed the emulation of the real banking scenario with the FlexSim software, which allowed the team of students from the research group to experience, just as it happens in the real scenario, the processes that a client must follow when using the different banking services. The testing of the data generated from the simulation with the different existing mathematical models of queuing theory is left in reserve, to standardize some banking processes and propose opportunities for improvement to the host financial institution.

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The advantages of this programming are its ease and logic for integration with the preliminary design of the 3D objects in the financial institution's FlexSim software, closely emulating the bank's real-world environment. However, one of its most powerful features is the ability to integrate the real values from Table 1 and incorporate them into the Poisson distribution of Equation 1 within the ProcessFlow library blocks, specifically the *PeopleBasic* block, as shown in Figure 6.

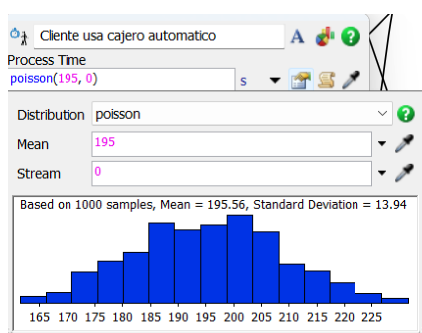


Fig. 6. Poisson distribution included in ProcessFlow, People Basic block, the data of the mean of ATM 1

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