A bank service process diagnostic using a simulation tool

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Abstract
The time waste by clients is one of the most frequent complaints at the bank services. This study aims to analyze the service process in a bank agency in Brazil using process mapping and computer simulation. In this way, it pretends to short the customers waiting time
Key-words: simulation, queue theory; bank service.

Introduction
The proposal of this study is to analyze the service process in a bank agency in Brazil´s city, Mossoró, using the process mapping and the computer simulation tools. It was observed three characteristics that support the agency choice to apply this experiment: the high demand, the layout favorable to observing and to collecting data and the major interest on continuing improvement service process.

The study also investigates the capacity of the bank agency ability to comply the municipal law n. 2.737/2011, that defines the maximum waiting time should not exceed 30 minutes in normal days and 45 minutes in paydays and in holyday´s eve. After the results of this study, the agency fails to attend the law and it will be created scenarios to improve the potential results. In these scenarios, the number of attendants and their work regime will be changed.

For the simulation activity, it was chosen the programing language Python 2.7 and the module SimPy 2.3 was used. It was chosen because it is open-source and well know.

Simulation
The simulation of a system is the operation of a model of the system (MARIA, 1997). In this way, the modeler first builds the model of a System, and then he will make all the changes needed to find the best configuration with which the system will became optimized. The simulation can be considered a representation of the system operation or process over time (SADOUN, 1999).

The central role of simulation is an experiment that uses the constructed and tested model (HOLLICKS, 2000). The simulation could be divided in three main types (SADOUN, 1999):

(a) Monte Carlos Simulation: it is a static simulation technique which does not have a times axis;

(b) Trace driven simulation: a trace is defined as a time-ordered record of events that is

collected by running an application program of part of it on the real system, and;

(c) Discrete-event simulation.

The system that was studied in this paper had discrete-event characteristics, so it will be explain in details bellow.

Discrete-event simulation

A discrete-event simulation is one in which the state of a model changes at only a discrete, but possibly random, set of simulated time points (SCHRIBER and BRUNNER, 1997). This discrete model change could be understood as the duration of it and may be ignored, face to the duration of the system.

In this study, wherein the system is represented by a bank system, the events are the customer´s arrival, the service´s beginning and the service´s ending, because its duration are smaller than the hole duration. The event as the attendant´s absence will not be considered in this study.

Metodology

In general way, the methodology that was used follows the same of used in Operational Research. In this way, the sequence of activities , is shown at Figure 1 (LAW & KELTON, 1991).

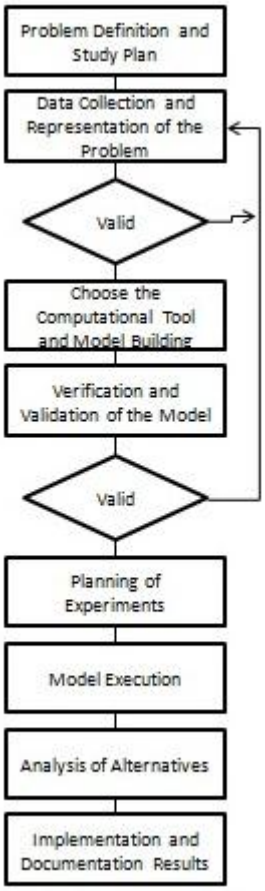

Figure 1: Simulation process stages

The activities needed to do a full simulation job are:

- Problem definition and study plan: To solve a problem, it is necessary to deeply known. In this activity, the goals are known, also the system constrains and complexity. This step is important face the others below.
- Data collection and modeling: After the problem definition and study plan, the next activity is to make a model of the System represented and collect data. The model is created by the logical flow diagram. Generally, the data collection consumes a lot of time, so, as soon as possible, this activity may be started. The goals, which were discussed in activity above, set the type of data.
- Computational tool choice and building of the model: The computational model conception is mainly connected to the computational tool chosen. The computational tool will show the development velocity, within the model complexity and the modeler experience. In this activity, the simulation code will be created.
- Verification and validation of simulation model: in this activity, the model results will be analyzed against to real system. A number of tests will be done to the model for ensure the correctness of it.
- Experiments planning: The experiments planning will show how the model could be run a lot of time within the smaller cost and as faster as it can. The planning will have two stages: the stage of long-term the stage of medium term. In the first one, the experiments will be planned and the scenarios will be defined. In the second one, it will be observed how each one will be running.
- Running model: Here, it will be chosen which scenarios will be running based on the results variation. In this activity, each test will be released.
- Action alternative analysis: In this activity, the conclusions are obtained. It will be analyzed the results of the running model above.
- Documentation and results implementation: The documentation is high connected to implementation, because it helps in potential changes.

The Case

Problem definition

The agency where this study was developed is located in Mossoró city, in Brazil. There are five attendants working at the same time. Every day, they have as mainly goal the attendance service of 80 clients. All collected data was done from July to August 2012.

The main services offered by the agency are: payment of bank billet, withdraw and deposit. Besides, other services offered are capitalization, cards requirements, password renewal, among others. In this study, the simulation will focus the attendance improve in the main services.

Through simulation, the objective is to diagnose the real situation in the agency's attendance about the behavior of the queue, with respect to the number of customers in queue, waiting time, length of service and rate of occupancy. After the data collected, it will be checked whether or not confirm compliance with the agency's maximum waiting in bank queues required by law.

Finally, if it is found not the fulfillment of the law, will be proposed enhancements with changes in the settings of the service and these scenarios may come to be simulated as a guarantee of efficiency in reducing the waiting time of customers in queue.

Data Collection and Representation of the problem

According to the study objectives, was developed a spreadsheet to collect and organize the data, those relating to: customer arrival time, start and end of service, length of service and type of service provided as can be verified in following table:

Table 1 – Data collect spreadsheet. Font: Authors.

Data collect spreadsheet				
Attendant			Booking office	
Sequence	Arrival time	Start time of service	End time of service	Service type

After this process, the data was analyzed by the Microsoft Office Excel ® tool and the probability functions were stipulated in relation to the time of duration of service and clients´ arrival interval of the types of services evaluated: payments, deposit and withdrawal amounts.

Subsequently, the statistical treatment of the data collected was made with the support of Input Analyzer software, software Arena ® version 11.0 for students tool. This treatment aims to identify which type of distribution (Normal, Beta, Uniform, Triangular, Exponential, Erlang, Gamma, Log Normal and Weibull) each data set would follow. By the known distributions, it was modeled on a program Python software, through the module Simpy that once properly verified and validated, several simulations will be applicable to real system model. Thus, the data inputs were grouped with the following distributions:

Table 2 – Input data. Font: Authors.

Input data			
Services	Variables	Distribution type	Function of probability
Payment	Arrival Interval	LOGNORMAL	-0.001 + LOGN(0.00185, 0.00173)
	Duration of service	BETA	BETA(1.46, 1.71327)
Deposit	Arrival Interval	BETA	-0.001+1.39*BETA(0.0322,0.545)
	Duration of service	WEIBULL	WEIB(0.175,0.703)
withdrawal amounts	Arrival Interval	WEIBULL	-0.001+WEIB(0.0192,0.407)
	Duration of service	BETA	0.05 + 0.6 * BETA(0.773, 1.4)

Computational tool choice and model development

Through the observation of the service system, a model was able to be developed for the attendants of the bank agency, which can be seen below:

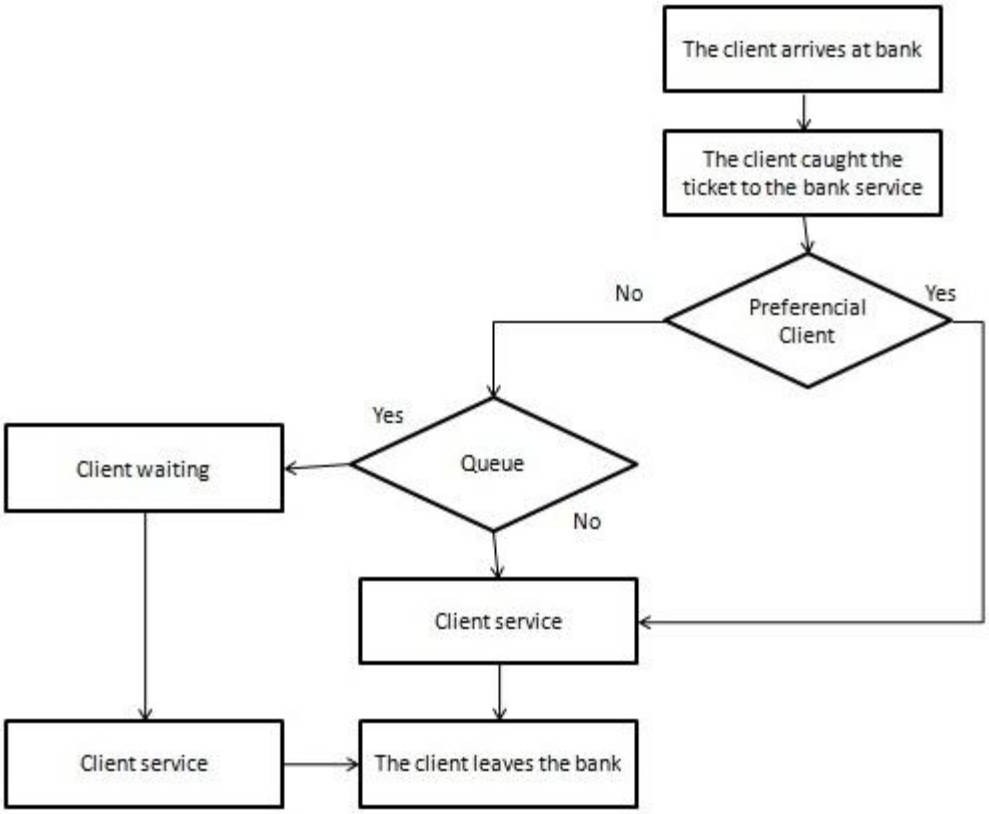

Figure 1 – Attending service flow from a bank agency. Font: Authors.

The flow attendance follows a simple operational sequence. When the client arrives to the bank, he takes his attending service order and two options are available: the normal or the preferred, which guarantees, by law, the special service to the people with disabilities, the elderly aged more than sixty years, the pregnant women, the lactating women and the people accompanied by children. There are five cashiers in the agency, of which four are intended for standard service. They basically provide the same services: making payments, withdrawals and deposits. There is another attendant who is designed to attend all the other different types, such as: request credit card or debit card, check cashing and unlock passwords. When no preferred customers are in queue, the latter clerk shall serve customers with default attendance.

The available hours of the agency to costumers are from 11 am to 16 pm, Monday through Friday, with there is an hour interval for lunch. After the model simulation, the employees were asked about their validity, which confirmed that it was consistent with reality.

Model verification and validation

The simulation consists mainly of a process that relates the input data, running the model and capture and interpret the output data. Thus, the output data generated refer to the number of clients served, the average time in queue, the average service time and the occupancy percentage of the attendants. For the purpose of this study, the output data that are considered of greatest interest are the number of customers served and the average time in queue.

In this way, there were ten replicates with ten different seeds, which were obtained some values of the output data, as can be seen in the Table 3

Table 3 – Validation of the model

Average time in queue - ATQ	
Replications	
Seed	Average
1	1,74
2	0,88
3	1,15
4	0,92
5	1,48
6	2,1
7	0,96
8	2,58
9	1,44
10	1,02
Average	1,467
Standard Deviation	0,5676
T Student (90%)	1,833
Confidence Interval	[1.1378, 1.7962]
Real ATQ	1,5
1,1378 < 1,5 < 1,7962	

According to Table 3, it can be observed that the mean time in queue is inside the confidence interval using the Student's t 90%, which makes the model valid. On the other hand, if the average queue time was outside the confidence interval, the model would become invalid.

Model implementation

In the Table 4, it was compared the current scenario with other scenarios to be simulated. They were classified into pessimistic and optimistic scenarios. The first one is characterized by an additional attendant and the second one has an attendant less, in face to real system.

Table 4 – Scenarios

Comparison of Scenarios				
Scenario	**Description**	**Service type**	**Number of customers**	**Average time in queue**
Realistic	5 attendants	All services	80	1,74
Pessimistic	4 attendants		80	2,69
Otimista	6 attendants		80	1,15

The Table 5 describes the distribution of attendants configured by type of service offered by the agency, payment, deposit and withdrawal.

Table 5 - attendants configuration according to the service type

Attendants configuration	Average time in queue (ATQ)		
	Payment	Deposit	Withdrawal
2 Payment, 2 Deposit, 1 Withdrawal	0	2,1146	8,5034
2 Payment, 1 Deposit, 2 Withdrawal	0	5,7414	3,1886
1 Payment, 2 Deposit, 2 Withdrawal	0	2,1146	3,1386
1 Payment, 3 Deposit, 1 Withdrawal	0	1,0867	8,5034
1 Payment, 1 Deposit, 3 Withdrawal	0	5,7414	1,3504

Conclusion

A priori, it was found that none of the average time in queue do not exceeds 30 minutes, and this means that the bank agency, object of this study, follows Municipal Law No. 2.737/2011, also known as the Law of Queues.

Subsequently, it was simulated pessimistic and optimistic scenarios that compared with the realistic scenario, show the best option for reducing the average waiting time approximately 54% in the queue of customers is hiring a new attendant, but it is known that this also generates employment an additional cost to the agency.

Another scenario simulations performed is the allocation of attendants per service type, they are: payment, deposit and withdrawal. With this configuration, it is possible to eliminate the queue for service payment, but there is a small overhead on the others attendants. These settings will generate shorter waiting times in the queue that was allocated an attendant to the payment service, two for deposits and withdrawals for two more.

For future work, it is suggested the extension of this study, applying the same to other financial institutions, comparing the results and consequently, obtaining a diagnosis of the situation of waiting in line at the bank in town. Another proposal would be to conduct this study in these institutions at different times of the year, checking the seasonality´s effect.

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