MAGAZINE INCAING
ISSN 2448 9131

Importance of having a business plan for an MSME.

M.Sc.A. To Carlos Roberto Ibáñez Juárez1 and M.I Nancy Roxana Ruiz Chávez[2], Itzel Larissa Fernández Mijangos[3] [1,2.] members of the Faculty of Engineering,[3] Industrial Engineering Student Benemérita Universidad Autónoma de Puebla

Summary - This project shows a simulation **model based on waiting lines of one and two servers in** a convenience **store,** in order to determine **which is the optimal option** for **the company** to **decide if** it **is** necessary **to** open **a second cash register within the establishment based on what is the average waiting time and if** it **is within the permissible limit of the** company and for this establish the average time of the service **to a cliente, the times between arrivals of the clients, the** comparison of the simulation of **a** server and two **servers,** with the data obtained decide if with a server the establishment is **supplied** not exceeding the waiting time limits or two servers **are** necessary to reduce the waiting **times. This project is carried out under the methodology of Problem-Based Learning, where through practical projects it is sought that students put their knowledge into practice in** class in a real situation and look for **different solutions for their analysis.**

Term Index - Simulation model of a server

I. INSERTCION

One of the main factors influencing the decision to a customer when buying in an establishment is the time that Has What wait for be Attended this Come in in almost all the establishments and can be decisive in whether or not you have clients the position inside of the market e Including how one

competitive advantage over other companies; the present project focuses on a waiting line within a convenience store todetermine whether or not it is convenient to open the second cash register based on the permissible waiting time limits. It is important to emphasize that to make a decision like this, an analysis is required that involves taking times, pilot tests and most importantly a simulation model that will allow us to see an overview of how the behavior of a real situation is, for this the data collection will be carried out one day in the shift that covers the peak hours of the establishment, this schedule is from 7:00 A.M to 3:00 P.M. in which the times between arrivals of the clients will be taken, the average service time; it is important to emphasize thatthe data collection is for the construction of our simulation model so based on it the waiting time of the clients will be determined and decide if a cash register is sufficient or it is necessaryto open a second box to reduce waiting times and be below the permissible limit of the company's criteria.

A. Location

The establishment of which the analysis will be done is the OXXO of lomas de Angelópolis located at the address Av. del Castillo 1, Lomas de Angelópolis, 72830 Acatepec, Puebla

Document received on January 9, 2021. This work was without financial funding.

M. Sc. To Carlos Roberto Ibáñez Juárez, researcher and professor at the Benemérita Universidad Autónoma de Puebla; cell: 222-806-5261; e-mail: carlos.ibanez@correo.buap.mx.

M.I Nancy Roxana Ruiz Chávez, researcher and professor at the Benemérita Universidad Autónoma de Puebla; Cellphone: 222-532-9171; e-mail: nroxana.ruiz@correo.buap.mx

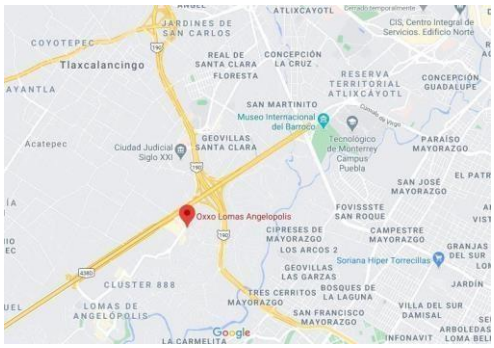


Fig 1. Convenience Store Location

Source: Google Maps. (n.d.). *Map of Oxxo* Lomas *de Angelopolis, Puebla*. Retrieved November 22, 2020, from https://www.google.com/maps/place/Oxxo+Lomas+Angelopolis/@19.005799,-

B. *Objectives*

1) *General* Objective

Design a simulation model of waiting lines to determine if one or two servers are necessary to be in the permissible limit of waiting time of a client in the OXXO establishment of Lomas de Angelópolis.

2) *Specific* objectives

-- Collect times between arrivals of customers at the establishment in the morning shift.
-- Take service time from average customers at the property on the morning shift.
-- Create two MM1 and MM2 simulation models of waiting lines.

II. PROBLEM

One of the concerns of commercial chains, especially convenience store chains, is the service they offer their customers, a service that is radically marked by the waiting time in them. For this reason each establishment of this large chain determines its permissible waiting times according to its needs.

A convenience establishment is located in Lomas de Angelópolis that has 3 shifts, is currently working with an ATM, that is, under a model of simulation of waiting line with a server (MM1), it is also known that, the waiting time Permissible set is 4 minutes, while the service time is 2 minutos and the time between arrivals is in a range of 0 to 4.5 minutes. The data obtained from the time between arrivals and service times throughout the first shift, that is, from 7 to 15 hours, are also presented.

You want to know if the line simulation model of waiting for a server (MM1) that you are working with currently it is optimal or if it is necessary to adopt a model waiting line with two servers (MM2), to be able to fulfill with the time of Hold on permissible already established enel first shift, which is where the peak hours are located and by end greater quantity of clients.

III. JUSTIFICATION OF THE MODEL TO BE USED

In the present project, the MM1 and MM2 standby line models are used, haciendor a comparison to see if it is necessary to implement a waiting line model with two servers [2], since the establishment is currently working only with a server, for this reason first a simulation model of a single server is made, to see how it is currently working and then we make a model with 2 servers in order to see what benefits the implementation of a second caja.

A. *M/M/1 queuing* systems

In this model, the arrival process in many business situations follows a Poisson distribution. If, in addition, service times can be properly modeled with the exponential distribution and there is only one employee, we speak of an M/M/1 queuing system. Examples of queues modeled as M/M/1 systems include some small banks, rural post offices, and prepared food stores [3].

This modelo is based on the following assumptions:

-- The arrival of each unit follows a Poisson probability distribution with delegated rate λ.
-- Service times follow an exponential probability distribution, with service rates μ.
-- The population of units seeking to be served is finite.

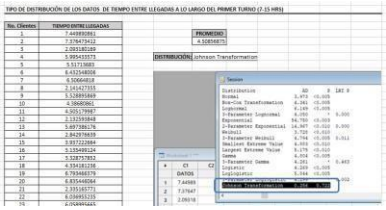
B. *M/M/K queuing* systems

A multi-channel standby line is made up of two or more service channels that are assumed to be identical based on serviceability. Typical examples of M/M/K queuing systems include banks with multiple ATMs, post offices with multiple service windows, and fast food restaurants with multiple boxes.

In the multi-channel system, arriving units wait on a single line and then head to the first available channel to be served [4]. This model presents the following characteristics:

-- Arrivals follow a Poisson probability distribution.
-- The service time of each channel follows an exponential probability distribution.
-- The rate of μ services is the same for each channel.
-- Arrivals wait in a single waiting line and then head to the first open channel to be served [5].

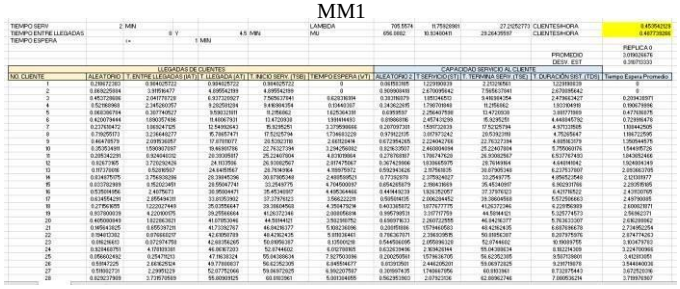
TABLA I
ANÁLISIS DE LA DISTRIBUCIÓN ESTADÍSTICA



Source: Own elaboration

1) Justification: It is known that when working with standby line simulation models, our data follows a normal distribution. In this case it can be observed that our data, with a sample size of 320, present a *Johnson Transformation* distribution [6] and [7], in this situation it can be inferredthat it is due to the fact that the data were obtained on an atypical day (Monday), that is, a day where the demand is not very high compared to other days of the week.

SHEET II
SIMULACIÓN DEL MODELO DE LÍNEA DE ESPERA MM1



Source: Own elaboration

TABLE III
RÉPLICAS DEL MODELO DE SIMULACIÓN

	REPLICA 1	REPLICA 2	REPLICA 3	REPLICA 4	REPLICA 5
PROMEDIO	2.604203317	4.327730504	4.221515164	2.704806736	2.471017931
DESV. EST	0.609249486	1.029381585	1.077627808	0.813298318	0.441177405
	Tiempo Espera Promedio	Tiempo Espera Promedio	Tiempo Espera Prom	Tiempo Espera Promedio	Tiempo Espera Promedio
	0	0	0	0	0
	0.009463962	0.462572917	1.008952397	0	0
	0.008309308	0.308381944	0.672635531	0.270657149	0.597675168
	0.130011833	0.680994742	1.002492418	0.910523707	1.153328757
	0.388446786	1.159968617	1.509518632	1.187770847	1.400578139
	0.862447751	1.495138374	1.97576867	1.446588368	1.498029954
	1.159610295	1.32126688	2.450182591	1.5512029	1.284025675
	1.315235077	1.404671905	2.715412438	1.52902985	1.131947194
	1.561150969	1.248597249	2.724518562	1.424941133	1.014853594
	1.643020731	1.229687019	2.663071546	1.28244702	0.913368234
	1.605046893	1.14740982	2.737237103	1.165860927	0.830334758
	1.472026135	1.051792335	2.727888959	1.06870585	0.849074627
	1.440353428	0.970885232	2.753015696	0.986497708	0.895607628
	1.376250831	0.981320517	2.850253167	0.916033586	0.967056511
	1.284500776	0.990276274	3.102156239	0.975906034	1.173899548
	1.204219477	1.096090579	3.436826791	0.954396598	1.418439183
	1.133383037	1.13819252	3.629183813	1.018486257	1.699363029
	1.070417313	1.095462239	3.918438514	1.226786418	1.844358476
	1.01551238	1.037806332	4.077306193	1.475386517	1.877340944
	0.964736761	0.985916015	4.233853437	1.711200672	1.894271085
	0.951752609	0.928967633	4.350877521	1.872500039	1.95005943
	0.908491126	0.896287286	4.378407794	2.000798198	2.079934414
	0.874174749	0.857318274	4.323816537	2.01961589	2.103965744
	0.837750801	0.821596679	4.344661945	2.096197082	2.100906106
	0.813495439	0.788732812	4.336766882	2.189516709	2.088935844
	0.782207153	0.758396935	4.346228873	2.314907037	2.094398688
	0.753236518	0.745634959	4.291311432	2.346374338	2.132974713

Source: Own elaboration

TABLA IV
RESUMEN DEL MODELO ESTADÍSTICO

No. De Clientes esperando	260
Probabilidad de Espera	10.94%
Tiempo de espera Promedio	5.308975922
Tiempo de Espera máximo	19.1809506

Source: Own elaboration

Through the graph it can be seen that the data do not present stability, the results do not follow a linear relationship, the random part demands that over time it stabilizes for the creation of a more reliable model and that allows from that stability to make decisions.

Therefore, it is necessary to perform a normality test to calculate a new sample size.

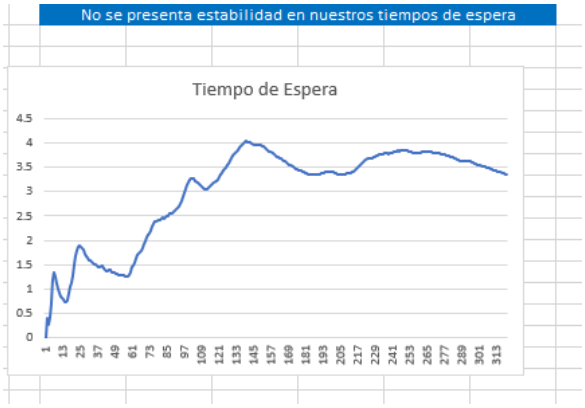


Fig 2. Timeout stability graph
Source: Own elaboration

The normality test is performed with a confidence level of 5%, for the development of a hypothesis test that allows us to verify the new values.

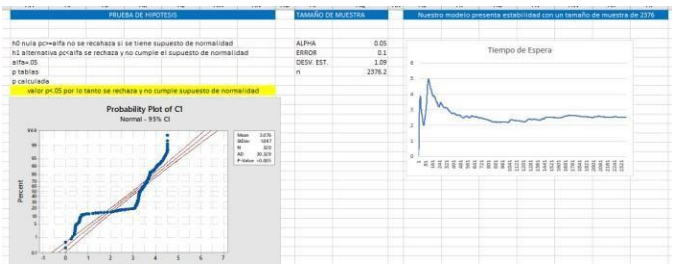


Fig 3. Normal stability test

Source: Own elaboration

With this new normality test, the Ho is rejected and we accept the alternative, which allows us that with the new run an n = 2376.2 is considered and that with this size the normality is fulfilled according to the graph and its stability, so thatwewill alizaremos 5 replicas to evaluate the analysis of normality in a deeper way.

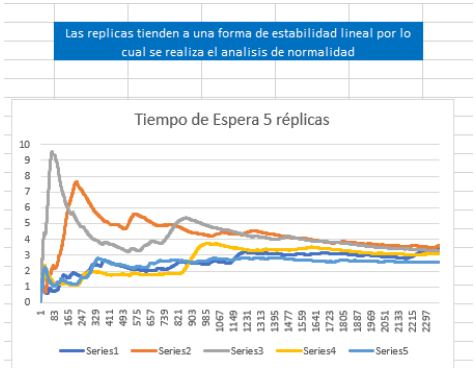


Fig 4. Stability with 5 replicas
Source: Own elaboration

With the above stability analysis, a stability model can be made to determine the behavior of the data referring to the 5 replicas and if they are in the confidence interval as can be seen, the model can be validated.

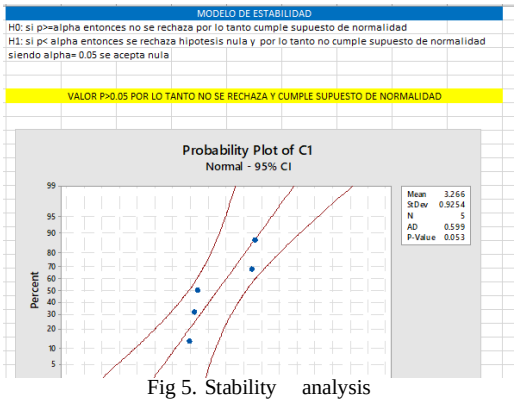


Fig 5. Stability analysis
Source: Own elaboration

According to the established concepts and the stability test, it is concluded that with 95%of Trust, you can have a waiting time for customers at the convenience store in an interval of 2.11 to 4.41 minutes with a single cash register.

INTERVALO DE CONFIANZA			
PROMEDIO	3.266		
DESV.EST	0.9254		
REPICAS	5		
ALPHA	0.05		
ALPHA/2	0.025		
T STUDENT	2.776	2.7764451	
R-1	4		
IC	2.1171483	-	4.4148517

Con un 95% de seguridad podemos decir que nuestro tiempo de espera para los clientes en el OXXO de Lomas de Angelopólis está en un intervalo de 2.11 a 4.41 minutos con una sola caja registradora.

Fig 6. Confidence interval for a server
Source: Own elaboration

In the case of a model of two MM2 servers [8], a similar analysis is performed where the waiting times are reduced by half, to create an effect of shorter waiting times under the consideration that customers arrive from the same random formthan the previous model, resulting in the following times 7. As a justification it is known that, when working with waiting online simulation models, our data follow a normal distribution [9]. In this case we can see that our data present a Distribution of *Johnson Transformation* type, in this situation it is inferred that this is because the data were obtained on a not very busy day (Monday), where the demand is not very high compared to otherdays ofthe week.

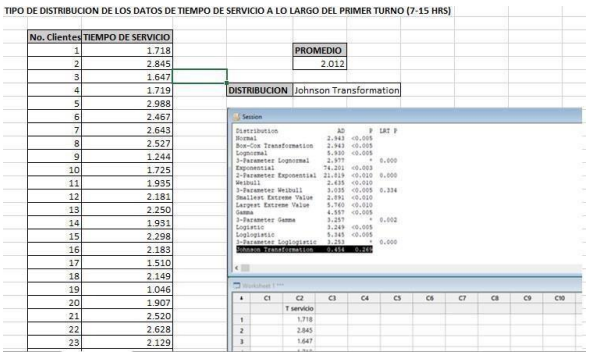


Fig 7. Distributing data during a shift with an MM2 model
Source: Own elaboration

So the simulation model of 2 servers, shows us a small size and with short waiting times for the reason of the use of two servers.

TABLE V
ESTADÍSTICA
MM2

No. De Clientes esperando	87
Probabilidad de Espera	8.82%
Tiempo de espera Promedio	0.0422
Tiempo de Espera máximo	0.3919422

Source: Own elaboration

Through the graph of 5 replicas, it can be observed that the data does not present stability so it is necessary to perform a normality test to calculate a new sample size.

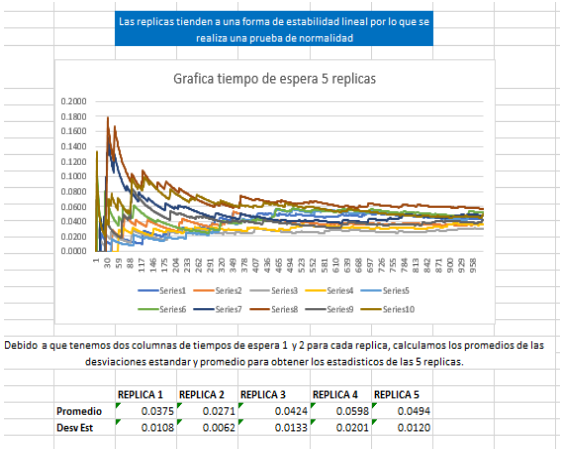


Fig 8. Stability of 5 replicas
Source: Own elaboration

With the 5 replica model, the hypothesis test is performed to determine if it meets the assumption of normality

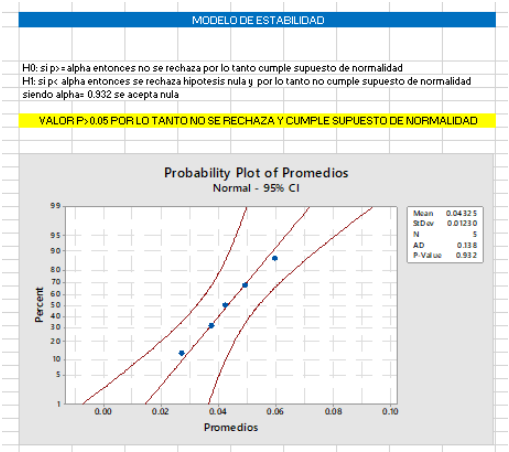


Fig 9. Normality

Checked the Supposed of normality y the test of hypothesis, you already have the model validated, so that the confidence interval determines the timeout and whether it is required the convenience store to propose a second server with timeouts, according to an alpha of 5% between 0.02 Seconds y 0.05 Seconds Fig. 10. Saying time is very small almost despicable.

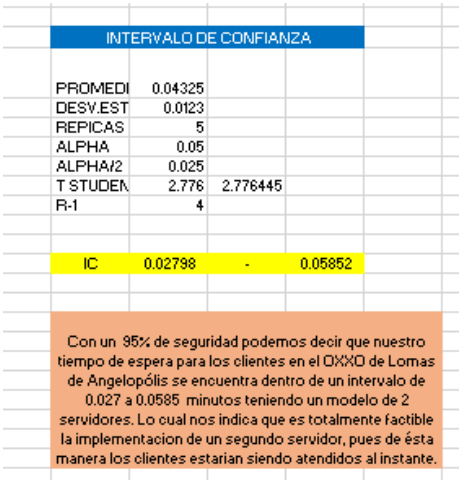


Fig 10. Confidence interval for MM2
Source: Own elaboration

IV. CONCLUSIÓN

Based on the results of both models, it can be concluded that the use of a single cash register is not optimal for proper customer service because the confidence interval obtained tells us that customers would be waiting a while between
2.11 to 4.41 minutes which does not meet the parameter of the waiting time established by the store manager, which is 2 minutes, in addition to this model customers have a probability of 10.94% in which they have to wait to be served. On the contrary, when making the model of dosservidores,we could observe that the waiting time is very small since it is in an interval of between
0.027 and 0.058 minutes, which indicates that customers would be served immediately and would have a probability of waiting of 8.8%, which is reduced compared to the model of a server, so Above mentioned is considered totally feasible the implementation of a second cash register in order to provide the best service to the customers of the convenience store.

Based on the data analyzed for the models, this did not obtain a normal distribution because the data collected were not taken on a day of high or medium productivity because they were taken on a Monday where they were not there is an increase insales, another factor is that the shift we analyze does not cover most of the peak hours in which

the establishment has an increase in customer service, finally that day was close to fortnight so it is stipulated it was not a day of high economic flow.

REFERENCIAS

[1] Google Maps. (n.d.). *Map of Oxxo Lomas de Angelopolis, Puebla*. Retrieved November 22, 2020, from https://www.google.com/maps/place/Oxxo+Lomas+Angelopolis/@19.005799,-98.2675945,17z/data=!3m1!4b1!4m5!3m4!1s0x85cfc7802bb591bb:0xd1c3b6aa90fa5bcd!8 m2!3d19.005799!4d-98.2654058

[2] Anderson, David, Sweeney, D., Camm, J., & Williams, T. (2011). *Quantitative Methods for Business* (Onceava ed.). Mexico D.F, Mexico: Cengage Learning. Retrieved November 21, 2020.

[3] Carro, R., & Gonzalez, D. (n.d.). Models of Waiting Lines. Retrieved November 21, 2020, from http://nulan.mdp.edu.ar/1622/1/17_modelos_lineas_espera.pdf

[4] Caballero, M. E. (2004). *Markov chains: an elementary approach.* Mexican Mathematical Society.

[5] Gómez R., J.M., & Jiménez M., J. A. (2020). Optimal portfolio selection based on first- and second-order Markov chains. Readings from Economics, 92, 33–66.

[6] Sanchez,R., & Barrera, P. (2018). Methodology based on Markov Chains for Demand Prediction and Decision Making in the short term. Case Study: Empresa Eléctrica Quito. (English). *Revista Técnica Energía*, *15*(1), 44–50. https://doi-org.proxydgb.buap.mx/10.37116/revistaenergia.v15.n1.2018.322

[7] Ausín, C. (n.d.). Bayesian analysis of queue systems.

[8] Lorente Marin, To. (n.d.). Discrete-time queuing systems with block inputs and services: theoretical study and comparative simulations.

[9] Discrete-time queuing systems with block inputs and services: theoretical study and comparative simulations. (n.d.).

[10] Amador Pacheco, J. (n.d.). Queuing systems with retry: analysis of blocked and successful events [Universidad Complutense de Madrid, Servicio de Publicaciones.].