Program English for Engineers
Engineering Faculty
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Final Inspection: A process, that slows assembly plates in the company "IDEACE". An application of queuing theory

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1. Abstract

This article aims to show and analyze the results of work done in the metalworking company called "IDEACE". This work was performed with classical queuing model where the times between arrivals followed an exponential distribution, these are the times taken interarrival time to the server and the time it takes for the server to perform the operation. It was determined the minimum number of servers to the system from collapsing.

Keywords: Queue, distribution, time, serves.

2. Introduction

In everyday life, man has had to deal with many situations that often become a "problem", many of these situations have been taken by several experts to be modeled in order to observe the behavior of these under different circumstances and completely random conditions, and find a solution to the problem studied.

Stochastic processes analysis and decision making have become fundamental fields of study and research for the analysis of probabilistic events. In the case of stochastic processes, we have a set of random variables that develop over time, an example of these processes are Markov chains that satisfy the property of memory loss. According to the situation in question Markov chains have different states, which are assigned certain probabilities to the occurrence of a change of state.

Within the stochastic processes we find queuing theory which is a branch of the IO which studies everything related to the expected lines. This process has an input source, a number of servers, a queue and an output of the system. The process must have an exponential distribution. This seeks to see the average time in the system of customers, the queue size and possible improvements to the system that contributes to the effectiveness of the service.

The analysis in decision-making is basically choosing the best option among the different alternatives that are presented to the decision maker, which truthfully does not know the consequences of choosing any of the options presented. To see more clearly what might happen to choose some most recommended alternative is to make a graph of situations that could arise. At the time of choosing the "best alternative" depends solely on what the decision maker sees fit, since there are different criteria to know what the most advisable decision. (If the decision maker is a pessimist, optimist or do not like taking risks person) (Hiller & Lieberman, 2010). (David Ray Anderson, 2011).

In IDEACE co. are deficiencies in the performance of some processes, among which we identified, only the assembly process can be adjusted to a queuing model to find a solution, why, among all the manufacturing processes for veneer and shields representing bottlenecks, the above assembly is where you decide to work in order to give the supervisor a solution making it more efficient, is fully consistent with the resources available to plan.

3. Problem statement

IDEACE Company currently has a variety of products that provide security to the Colombian home, through the manufacture of locks and plates. There are various processes by which it has to pass the raw material to give the customer a quality product that meets all your expectations.

On several visits to the company we were closer to the various processes to develop the manufacture of door locks and noting that a problem arises when doing quality control to each of the locks assembled. This process is performed by several operators which act as servers, their function is to check that each of the products is properly assembled and prove that the keys properly open and close each of the parts.

Operators are to inspect the locks through a conveyor belt, which serves as the bridge between this process and the process that which is above lubrication product. Responsible for lubricating locks do their job quickly and efficiently so send more locks that an inspector may receive several pieces leaving pending which creates a queue in the system.
The problem basically is that operators do not have the capacity to inspect all parts that come in the conveyor belt which makes this process is slower than the other thus creating a line of products for inspection which will have a time arrival is when the inspector leaves the band and a service time that is when placed back in the band do to reach the final process is the packing of the locks.
The packaging process is also affected as the delay of the pieces directly affects this because not until the whole lot these may not be sealed in the box.

4. Methods

By detecting within the assembly process such aforementioned problem, began to establish how queuing theory so that would give an optimal solution for the wait at the final inspection process was quite large would apply.
Once defined as going to take the time between arriving at the system and service, we proceeded to take such times, in total there were 50 service times and 50 also between inputs which an average was derived for the average rate arrivals and the average service rate.

At these rates the utilization factor of the system, which shows what, was already detected in ground and that is going to look carefully at the next point is. Hence the minimum amount required to efficiently operate the server process was determined, once the situation posed this model is analyzed and suggestions that may improve the performance of this assembly process locks are made.
Significantly, the addition of a new server, does not involve the hiring of new staff, it is suggested that this new server is an operator that is in the process of packing, and this changing periodically between the process of inspection and packaging when the queue in the system so requires. From this suggestion, it is recommended that personnel pack these locks; this trained to perform the inspection process.

The review of the literature was made through the website Scopus, which allows scientists document search various topics. This search can be filtered according to the criteria that you create more convenient, for this case that the items sought were in the areas of engineering, decision making, math and social studies.

In addition to the above restrictions, the decision was limited to only consult paper conferences and scientific articles.

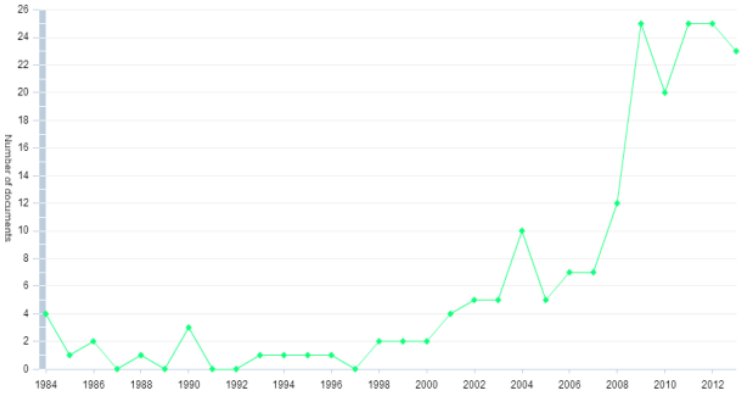


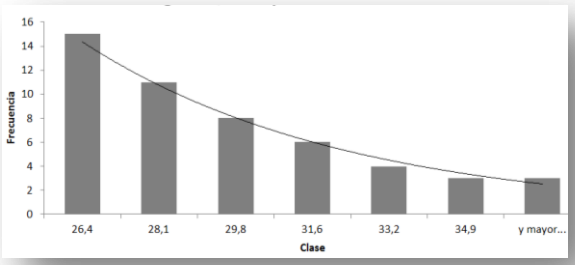
Figure 1. Number of publications per year

When analyzing Figure 1, the growth in the number of applications per year is seen, due to technological advances in programs to simulate this type of stochastic processes.

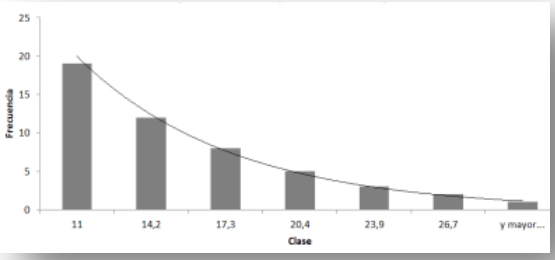
5. Results

The results obtained by analyzing the time taken in the process evaluated is shown, as is today, before showing how the process would behave if the alternative solution proposed in the previous section is implemented.

The average time between arrivals and average service times, were removed from 50 observations for each average, to check if the data come from an exponential distribution, a histogram for inter-arrival times was performed and one for service times, which are presented below:



Graph 1. Histogram Service times.



Graph 2. Histogram, inter-arrival times.

As shown in Figures 1 and 2, the histograms follow an exponential trend line, so we can assume that the data follow an exponential distribution.
For the case in which the number of servers is two, the utilization factor was calculated from the system:

$$\rho = \frac{\lambda}{s\mu} = \frac{0{,}071}{2(0{,}035)} = 1{,}014 > 1 \qquad (1)$$

With:
λ = average arrival rate (in locks / second)
μ= average service rate throughout the system
s= number of operators in the inspection process
$\rho =$ Utilization of the service facility. (Hiller & Lieberman, 2010).

As shown in equation (1), the utilization factor of the system is greater than 1, thus the steady state condition is reached, so as the system would have long term infinite

queue, unless they are changes in rates or in the number of servers. In reality an infinite tail is formed, what happens in IDEACE is that the process is slowed in the later stages the inspection, which generates lower production of the lock.

From this result we proceed to make the necessary calculations to improve the process, and you do not believe this "infinite tail" on the conveyor belt.

First the minimum required number of operators is determined to reach the steady state condition:

$$s > \frac{\lambda}{\mu} = \frac{0{,}071}{(0{,}035)} = 2{,}3$$

$$s > 2{,}3 \qquad (2)$$

Noting the above result we can determine the minimum number of servers required is three.

With this result we proceed to calculate indicators queuing system:

$$P_0 = 0{,}10647$$

$$L_q = 0{,}96$$

$$L = 2{,}99$$

$$W_q = 13{,}50$$

$$W = 42{,}10$$

With:

P_0= Probability that the system has zero locks
L= expected number of locks in the system.
Lq = expected queue length
W= waiting time in the system
Wq= waiting time in the queue.
(Hiller & Lieberman, 2010).

Thus it can be determined that with s = 3, the line decreases drastically, since it is expected that there is a sheet in the queue, the queuing time a sheet is expected to be 13.50 seconds, which is a number relatively small in relation to the time it takes an operator to revise a lock.

6. Discussion

With stochastic processes and queuing theory allowed the company to identify the problem that generates Ideace process quality inspection of each of the locks as it is too slow, leaving many pieces pending a review. This problem was analyzed according to their arrival times and service of each product and raises the solutions showed above.
The improvement in the inspection process is very important to the production of veneer, because the efficiency of this process also depends on the output of new products to be brought to the customer.

The improvement in the inspection process is key to the production of veneer, because the efficiency of this process also depends on the output of new products to be brought to the customer.

The inspection process within the entire assembly process is subject to changes that may occur in before this, so it is important to note that the bottleneck may vary and the operators should be trained for different threads.

7. **Bibliography**

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8. **Annexes**

Data taken for the calculations

sample number	interarrival time	Service time	sample number	interarrival time	Service time
1	7.75	24.71	26	12.05	27.99
2	7.89	25.13	27	12.41	28.02
3	7.98	25.24	28	13.13	28.44
4	8.05	25.25	29	13.88	28.45
5	8.33	25.26	30	14.5	28.79
6	8.34	25.34	31	15.43	28.95
7	8.46	25.36	32	15.53	29.06
8	8.58	25.72	33	15.83	29.27
9	8.66	25.74	34	16.39	29.65
10	8.92	25.76	35	16.41	29.86
11	8.97	25.82	36	16.67	30.08
12	8.99	25.83	37	17.2	30.09
13	9.13	25.87	38	17.41	30.65
14	9.21	25.89	39	17.79	30.71
15	9.91	25.96	40	18.16	31.32
16	9.96	25.99	41	19.21	31.54
17	10.54	26.18	42	20.14	32.14
18	10.6	26.44	43	20.48	32.78
19	10.86	26.54	44	21.71	33.50
20	11.16	26.54	45	23.16	33.59
21	11.21	26.64	46	23.19	33.63
22	11.33	26.88	47	23.51	33.84
23	11.68	26.89	48	23.61	35.27

24	11.81	26.89	49	26.65	36.44
25	11.98	27.32	50	29.85	36.58