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Simulation model in ProModel to generate proposals for improving the H_2O purification process

Modelo de simulación en ProModel para generar propuestas de mejora del proceso de purificación de H_2O

RUIZ-DIAZ, Montserrat†*, SOTO-LEYVA, Yasmin, BONES-MARTÍNEZ, Rosalía, and SANTOS-OSORIO, Arturo

Tecnológico Nacional de México / Instituto Tecnológico Superior de Huauchinango

ID 1st Author: *Montserrat, Ruiz-Diaz* / **ORC ID**: 0009-0008-3146-6213, **CVU CONAHCYT ID**: IT23B214

ID 1st Co-author: *Yasmin, Soto-Leyva* / **ORC ID**: 0000-0003-2652-7065, **CVU CONAHCYT ID**: 951464

ID 2nd Co-author: *Rosalía, Bones-Martínez* / **ORC ID**: 0000-0001-8829-9737, **CVU CONAHCYT ID**: 368744

ID 3rd Co-author: *Arturo, Santos-Osorio* / **ORC ID**: 0000-0003-3643-5770, **CVU CONAHCYT ID**: 951024

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Abstract

For purification companies, the optimization of H2O purification processes is of utmost importance because it contributes to the good flow and development of internal operations to satisfy the needs of customers who purchase the vital purified liquid. These organizations take into account that production lines must be used at their maximum capacity, which is why it is necessary to detect the main problems that cause bottlenecks, which generate delays and interruptions in the production cycle. Now, in the purifiers located in the region of Nuevo Necaxa, Puebla, the existence of this type of interruptions has been detected, for which a solution methodology was generated that includes the following phases: 1) Field investigation, 2) Establishment of operational times, 3) Representative layout development in ProModel, 4) Simulation model of the water purification production system, these phases evaluated the compliance of the transformation cycle with the programmed times, detecting the bottlenecks that delay the process, with the main objective of weighting and propose a solution that helps improve and optimize the production of the current management system in purifiers, based on statistical results provided by the ProModel software.

H_2O Purification, Optimization, ProModel Software

Resumen

Para las empresas purificadoras la optimización de los procesos de purificación del H_2O, es de suma importancia porque aporta al buen flujo y desarrollo de las operaciones internas para satisfacer las necesidades de los clientes que adquieran el vital líquido purificado. Estas organizaciones tienen en cuenta que las líneas de producción deben ser utilizadas en su máxima capacidad, por lo cual resulta necesario detectar las problemáticas principales que ocasionan los cuellos de botellas, mismos que generan atrasos e interrupciones en el ciclo productivo. Ahora bien en las purificadoras ubicadas en la región de Nuevo Necaxa, Puebla se ha detectado la existencia de este tipo de interrupciones, por lo cual se generó una metodología de solución que incluye las siguientes fases: 1) Investigación de campo, 2) Establecimiento de tiempos operativos, 3) Desarrollo de layout representativo en ProModel, 4) Modelo de simulación del sistema de producción de purificadoras de agua, estas fases evaluaron el cumplimiento del ciclo de trasformación con los tiempos programados, detectando los cuellos de botella que atrasan el proceso, teniendo como objetivo principal ponderar y plantear una solución que ayude a la mejora y optimización de la producción del sistema de gestión actual en las purificadoras, basándose en resultados estadísticos que proporcione el software de ProModel.

Purificación de H_2O, Optimización, Software ProModel

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* Author's Correspondence (e-mail: montserrat.rd@huauchinango.tecnm.mx)
† Researcher contributing as first author.

Introduction

The water purifiers geographically located in Nuevo Necaxa Puebla supply the vital liquid to a total of 10,213 inhabitants, approximately 2,500 families in the municipal capital. 95% of these purifying companies are dedicated to the proper treatment of water, and 5% only to its distribution and commercialization. However, to ingest this vital liquid, in the experience of Venegas, Tello, Cepeda and Molina (2023), a purification process is required through which bacteria or microorganisms that harm health are completely eliminated. of consumers, taking into account customer satisfaction, quality, effectiveness and efficiency in each of its processes as a priority (Loor, Wilson, Zambrano and Mosquera, 2020).

To comply with each of the variables before mentioned, it is necessary to quantitatively measure the production process, to subsequently detect the sources of origin that cause delays or bottlenecks and implement feasible solutions that resolve the problems or delays of the process or service (Huancas, 2022).

There are various tools that provide viable solutions to the problem described, among which the use of simulation software stands out, being the ProModel software which from the point of view of Dunna, Reyes and Barrón (2006) manages a friendly interface., easily adaptable and specialized to carry out various simulations of transformation, marketing or distribution processes, this technological software is characterized by:

1. Estimate the precise times of the operational/administrative tasks or activities to be carried out (Marmolejo and Marín, 2013).

2. Analyze work days of 8-12-24 hours considering the production levels in each modality.

3. Development of statistical graphs, to generate improvements in the following areas (González y Vivas, 2014):

– Reduce the specific origin of economic risks.

– Reduce delays in order deliveries.

– Calculate the level of impact due to mishaps or bottlenecks that directly affect operation.

Once the benefits of simulating with ProModel were analyzed, it was decided to start an effective simulation process for the H_2O water purification cycle, seeking to detect areas for improvement and the elimination or reduction of the sources that generate the main problems. or bottlenecks, taking into account the following two quantitative variables:

1. The effectiveness of each Workstation.

2. The efficiency of the operational staff, finally a proposal is presented that provides a solution to the detected disadvantage, verifying that the Timely and appropriate use of simulation models contributes to organizational success and the generation of business profits.

General objective

Optimize the water purification process of regional companies through the development of a simulation model in ProModel software to identify bottlenecks or delays in the production process and provide a solution proposal that eliminates/reduces the sources that cause them. the problem.

Specific objectives

1. Identify improvements within the production process management system.

2. Obtain statistical results of the activities carried out within the purifier for subsequent decision making.

3. Apply various tools for process analysis.

4. Eliminate/reduce setbacks, delays and bottlenecks that arise within the purifiers.

Methodology to be developed

The primary objective of the H_2O purifiers is to efficiently and effectively supply the community of Nuevo Necaxa as well as the communities and neighborhoods that are around it and within the area of influence; always seeking continuous improvement in all those activities and systems that intervene within it, such as the supply chain processes and the production process, which intervene directly in the water purification cycle (Cóndor, 2013). Now, the present application is carried out through the methodological development of the following four phases (Figure 1 Applied methodology):

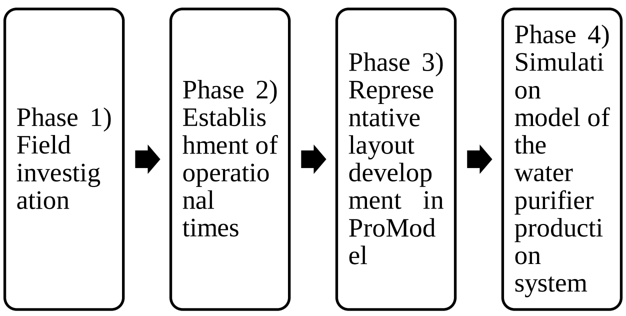


Figure 1 Applied methodology
Source: Own elaboration

Each of the phases mentioned above are described below:

Phase 1) Field investigation:

The previous visit to the purifiers was carried out to observe the operations carried out within these transformation companies, and quantify the stations and/or machines that are used, to identify the monitoring of the entire process that involves purification and processing. water packaging, the result of this first phase, allowed establishing the sequence of standard activities necessary for 100% compliance with the purification process (Figure 2 General Flow Diagram of the purification companies in the area and area of influence).

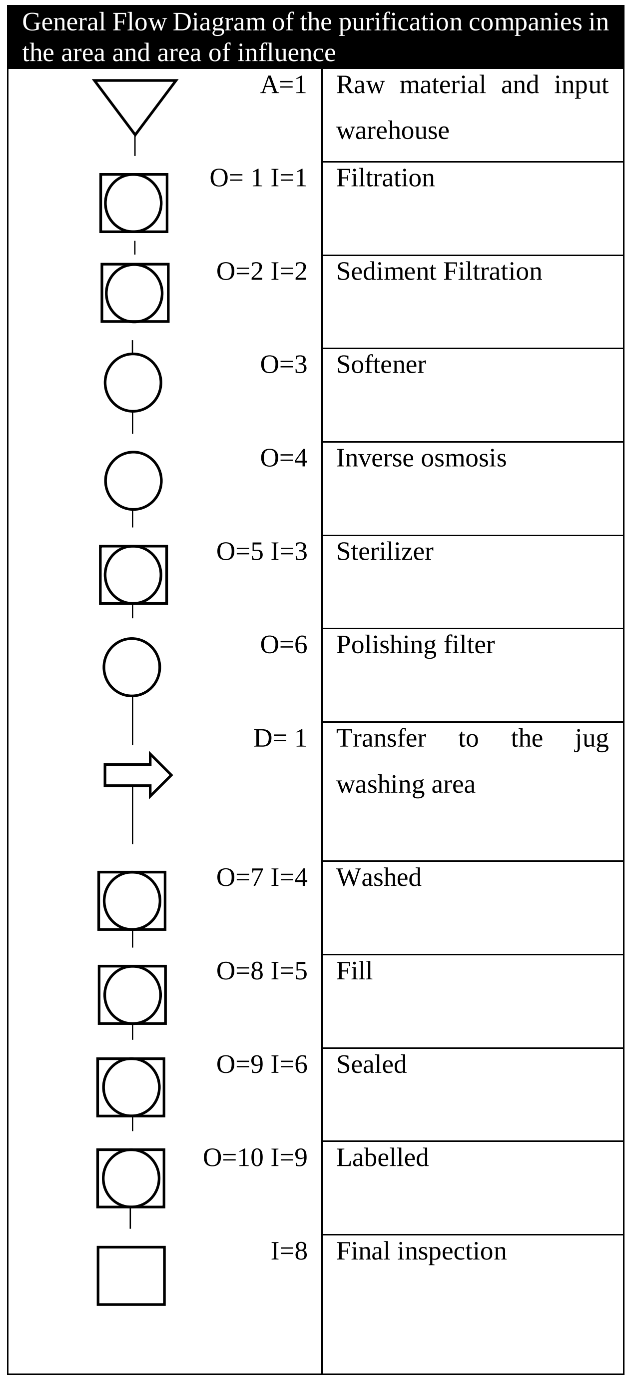


Figure 2 General Flow Diagram of the purification companies in the area and area of influence. **O=Operation I=Inspection D= Movement A=Warehouse
Source: Own Elaboration

Phase 2) Establishment of operational times:

Once they were established each and every operation _ necessary, they proceeded to analyze the water purification process to declare the times suitable for each operation, these times per activity are indicated below (Table 1 Operating times of the H_2O purification process):

Operating times of the H_2O purification process		
No.	Operational activity	Cycle time
1	Raw material and input warehouse	2 min
2	Filtration	2 min
3	Sediment Filtration	2 min
4	Softener	2 min
5	Inverse osmosis	3 min
6	Sterilizer	3 min
7	Polishing filter	2.5 min
8	Transfer to the jug washing area	1 min
9	Washed	4.5 min
10	Fill	1 min
11	Sealed	2 min
12	Labelled	4 min
13	Final inspection	1 min

Table 1 Operating times of the H_2O purification process
Source: Own Elaboration

Phase 3) Representative layout development in ProModel

In the development of this third phase, the representative layout of the production process was created in the ProModel software (Figure 3 Layout of the standard purifier process), taking into account that the recognition of these activities occurred in previous stages. mention that purification companies currently work a single workday of 8 hours for 7 days of work, therefore, in the simulation run, the 56 total hours covered must be met to obtain the weekly simulation.

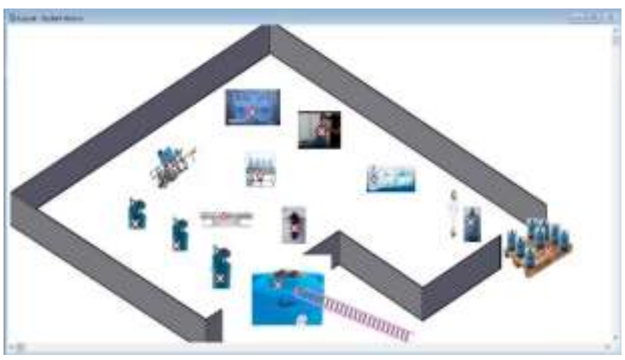


Figure 3 Layout of the standard purifier process
** Prepared in ProModel software
Source: Own Elaboration

Phase 4) Simulation model of the water purifier production system:

Once the times already established in the ProModel software were programmed, the first run was carried out, starting at 00:00:00 hours. until the necessary 56:00:00 hours, going through each work day (Figure 4 Simulation run 14:00:00 hours).

Figure 4 Simulation run 14:00:00 hours
**Developed in ProModel software
Source: Own Elaboration

Results

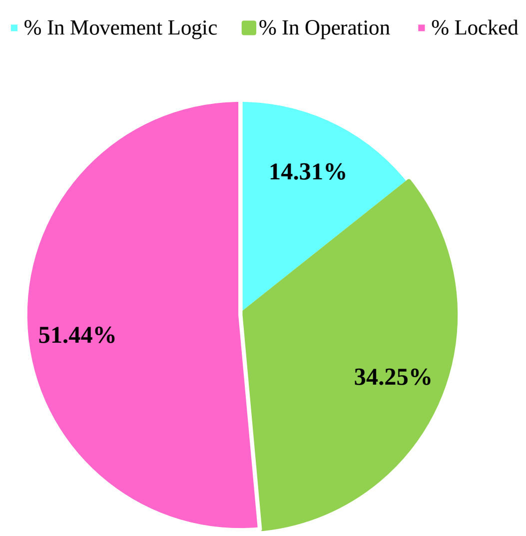
The results obtained from the simulation in the ProModel software are expressed through a series of descriptive statistics, which are explained below:

Result A) Movement logic-Entity locked (Figure 5 Movement logic-Entity locked):

1. Movement logic: The registration of movements is 14.31%, that is, the entity has a total working day of 8 hours, of which 1 hour and 9 minutes is the time in which the jug is in transfer or movement within the cycle. productive.

2. Blocked entity: It is observed that there is a problem, in which it is evident that the production process is unemployed for 51.44% of the working day and only flows for 48.56%, that is, it is flowing for 34.25% and a 14.31% in motion, detecting the existence of a bottleneck that blocks the passage of the entity (water jug) causing downtime in the production cycle, to solve this problem it is suggested to implement a balancing of lines to make the most of the resources human, material and economic that are invested every working day.

Entity States- Carboy



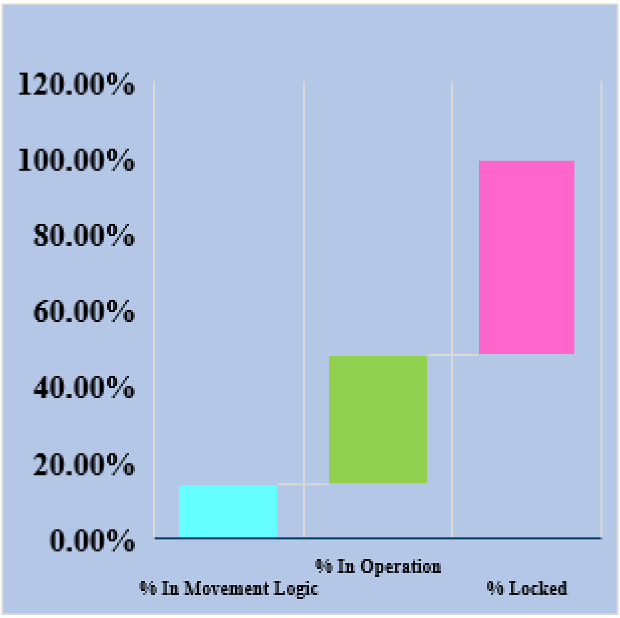


Figure 5 Movement logic-Entity locked
**Prepared in ProModel software
Source: Own elaboration

Result B) Process indicators: The production cycle of the H_2O purification process once the simulation run was carried out records a total time of 3.11 minutes for each full jug, taking into account that the simulation of the process is program for 7 days with a working day of 8 hours a day, the filling of a total of 16,986 weekly is expected, with a record of 2,426.57≈2427 pieces per day, or 303.375≈304 jugs in one hour as required for the production line (Figure 6 Weekly production requirement).

Scoreboard		
Name	Total Outputs	Average Sistem Time (min)
Carboy	16,986	3.11

Figure 6 Weekly production requirement
**Developed in ProModel software
Source: Own elaboration

Therefore, the purifiers have a monthly capacity of 72,810 jugs of water equivalent to 1,456,200 liters of purified water monthly.

Result C) Bottlenecks: It is determined that the labeling operational activity is the bottleneck with a saturation % of 49%, while the other operational activities represent a lower level of saturation, it is recommended to analyze the sterilization operations and washing, because once this bottleneck is solved, an assertive solution will be provided to the other bottlenecks, which will arise by eliminating or reducing the main one (Figure 7 Saturation or bottlenecks in the production line).

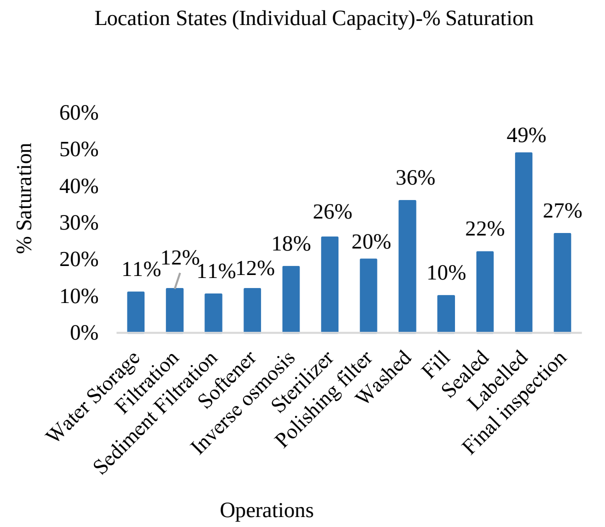


Figure 7 Saturation or bottlenecks on the production line
**Developed in ProModel software
Source: Own elaboration

Result C) Improvement proposal: With 49% of the time that causes delays and bottlenecks, the labeling activity is the one that takes the longest time in the process, which is why the machinery used was analyzed and the corrective maintenance in this area, since the wear of the machinery causes the longest delay time, because the parts that show greater wear do not allow work at higher speeds. Likewise, it is recommended to schedule a monthly preventive maintenance schedule to avoid reprocessing. and stoppages on the production line.

With respect to the operational washing activity, a technique is proposed that consists of the immediate disinfection and use of pressure hoses, because the hoses currently used are handled in slow spray cycles, while for the sterilization area the only improvement possible is to increase the generation of waves without exceeding the limit allowed for the parameters of this process, which indicate a maximum of 253.7 nanometers for the effective disinfection of bacteria, microbes, algae, viruses and biological contaminants that have a propensity to spread rapidly. Although this factor depends directly on the machinery model being handled and the programmable parameters.

Gratitude

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Conclusions

The development of this application allows us to verify the usefulness of ProModel software for the analysis of production systems in real environments. Through the simulation model carried out, the operation of the H_2O purification plants that are located in Nuevo Necaxa Puebla was captured, the optimization of the production process being of vital importance because these transformation companies supply 100% of the population with this vital liquid, taking into account that the standard simulation model developed is and will be very useful for the decision making of these organizations because it will allow the timely detection of the operating stations that generate bottlenecks, which delay the deliveries of orders and cause loss of customers.

It is important to mention that bottlenecks in an H_2O purification system generate significant delays, causing various losses. Specifically, in this application, bottlenecks were detected using the simulation model in the ProModel software, subsequently generating a viable proposal for the solution of the main bottleneck, which exposes a saturation % of 49% and is represented by the operational activity of labeling, in conclusion the use of a standard simulation model provides the process analyst with a means quantitative to assess the efficiency and effectiveness of the operating stations, by calculating the saturation indices and the production requirement scheduled for different working days.

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