UNIVERSIDAD RICARDO PALMA

COLLEGE OF ENGINEERING

PROFESSIONAL DEPARTMENT OF INDUSTRIAL ENGINEERING

PROTOTYPE OF AUTOMATION IN THE CAR WASH PROCESS IN THE DISTRICT OF SANTIAGO DE SURCO

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Code: IN-0903

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SUMMARY

The present work was created with the purpose of developing, implementing and providing a suitable and innovative tool in automatic mode for a prototype of a car wash, focused on modern applied technologies.

Automation is defined as the study of methods whose main objective is the replacement of the human operator by an automatic one in the generation of a duly programmed physical or mental activity.

To develop automation requires the application of multiple systems, in this project the PLC is used as controller of the various movements to carry out this task, it was decided by this system because it has among its important features to store programs for their next and quick use, the transformation of or variation of the same which generates in its effectiveness is evident mainly in processes in which there are needs such as: small space, production processes that change repeatedly, sequential processes and extensive programming reviews.

In order to develop the automation of this project, an automated model will be designed in the Logo Soft system, which will receive the data from the Logo PLC, in which the different theoretical-practical knowledge acquired in the development of the industrial automation course will be used.

Keywords: Prototype, Methods, Car wash, PLC, Sequential processes.

ABSTRACT

This job was created to the purpose to develop, implement and provide a suitable and innovative tool in automatic mode for a prototype of a car wash, focused on modern applied technologies.

Automation is defined as the study of methods whose main objective is the replacement of the human operator by an automatic one in the generation of a physical or mental activity properly programmed.

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INTRODUCTION

Transportation is one of the most important sectors in our country, and to have a good transportation system, it is necessary for it to be in good condition, that is to say, well maintained both technically and in terms of hygiene.

After having investigated the various requirements needed for optimum performance, we focused on the hygiene of the same, since not being adequate, often present major technical problems in the future either by the accumulation of dust, grease, etc.. so that in this way can be prevented further costs in the future.

This time we take as a reference the car washing process as the type of project we will develop, adapting it to an automated prototype consisting of four processes with their respective stations integrating a conveyor belt, which simulates the real path of a car.

- The first station is a shampoo and water injection system, this emulsion will be injected through pipes with the impulse of a pump, this first system aims to cover the exterior bodywork with foam.
- The second station is a scrubbing system, which basically consists of producing the friction of rollers with the bodywork, and the foam from the previous process, in order to remove the remains of dust and grease.
- The third station is a rinsing system, which consists of rinsing the bodywork by means of pumps and hoses, as it needs to remove the remains of foam and dirt at a certain pressure.
- The fourth station is a drying system, for this process a fan has been incorporated that drives the ambient air, with the purpose of concluding the washing, obtaining a clean and dry bodywork.
- To transport the car body from the beginning to the end of the process, there is a 1.20 m conveyor belt, which will operate for 40 seconds, which is the time that the total car wash process will last.

CHAPTER I: THEORETICAL FRAMEWORK

1.1 Theoretical basis

The project has been developed as a prototype of an automated car wash for customers in the district of Santiago de Surco, taking into account a reference point where this service could be provided, placing Benavides Avenue as a potential market, due to the purchasing power of the area, but especially because of the large flow of cars that pass through it.

We developed an automated car wash, because by not having to rely on many staff, investment costs are reduced, generating higher profits to the company, apart from a machine tends to have fewer failures, which generates a higher quality service, and in less time.

This project will have a positive impact by setting a precedent for a new car wash system that goes beyond the traditional car wash, offering an optimal cleaning service that meets the needs of customers.

Before making the prototype, certain points must be taken into account, such as the elementary definitions of some terms that we will use in the development of the project.

- **Actuators:** Actuators work in any machine to achieve motion. Actuators help to perform movements in industrial machines or devices, transforming electrical, hydraulic or pneumatic energy into mechanical force.
  It is the interface between information processing and mechanical processes, since they transform energy signals to carry out a process (Olivares et al., n.d.).
- **Testing:** Before achieving the development of the plc circuit, pilot tests must be taken, this is known as testing, which allows to verify that the Software process is correct, it takes greater relevance when achieving to identify failures, which allows to create a feedback in order to offer a software that runs with the applications without problem. (Arias, 2018).

- **Automated system:**
  - This system is attributed this name because, when programmed, it replaces the work of operators, it is widely used in Industry 4.0, and it is composed of a command phase and an operational phase (it makes it move and perform operations because it is composed of sensors).
  - The purpose of the automated process is to control industrial processes, without the participation of operators, or in any case to allow their intervention only for the command phase, since the replaced actions are repetitive, which is why the number of manual workers is reduced (González-Filgueira & Permuy, 2018).

    The three types of systems that are implemented by companies are classified into:

    a. Programmable automation
    b. Fixed automation
    c. Flexible automation

- **Control systems:** This type of system works together with the operations system, the control system analyzes the results obtained in a given process, the advantage of this is that it has direct control over the final product, which leads to an improvement in quality, productivity and better quality of products and / or services offered by the industry (Leal, 2018).

- **Sensors:** Sensors are devices designed to pick up a stimulus from their environment and translate the information they receive

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1.2 Research objectives

1.2.1. Main objective

To automate the car wash process in the Santiago de Surco District.

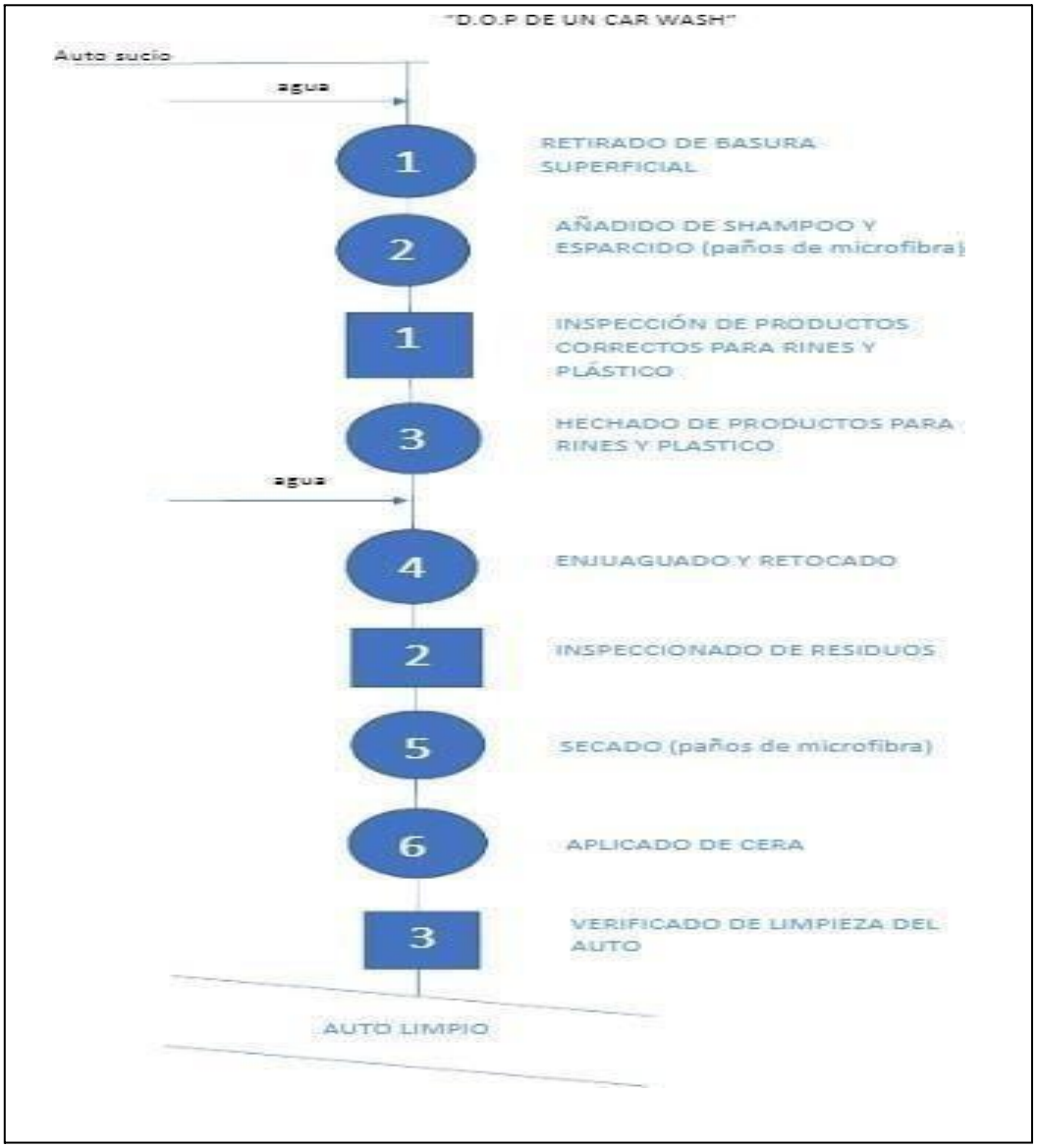
1.2.2. Specific objectives

- Analyze the current system of the car wash process in the District of Santiago de Surco.
- To develop an automated model for the car wash process in the Districtof Santiago de Surco.
- Optimize the car wash process in the District of Santiago de Surco.
- Verify the correct operation of the automated model for the car washprocess in the District of Santiago de Surco.

CHAPTER II: DETAILED DESCRIPTION OF THE CURRENT PROCESS

The process begins when orders are accepted at the company. It is worth mentioning that the company is dedicated to providing car wash services and the sale of automotive components. In the first instance the car is delivered to the personnel, having the car the superficial garbage is removed, then it is taken to put water with shampoo to start the process of washing the car, as a second step to perform the worker is the lathering with products for the rims and plastic of the car in its entirety with sponges.

Following the above, the car is washed again by the Car Wash operators using a high pressure water gun to remove all the soap that is left over in the most difficult areas to clean and finally in this process the drying is done at room temperature in a certain period of time until it is completely dry and can be delivered to its owner with the verification of having completed the process satisfactorily.



Operaciones	6
Inspecciones	3

Figure 1: Current PDO without automation

Source: Own elaboration

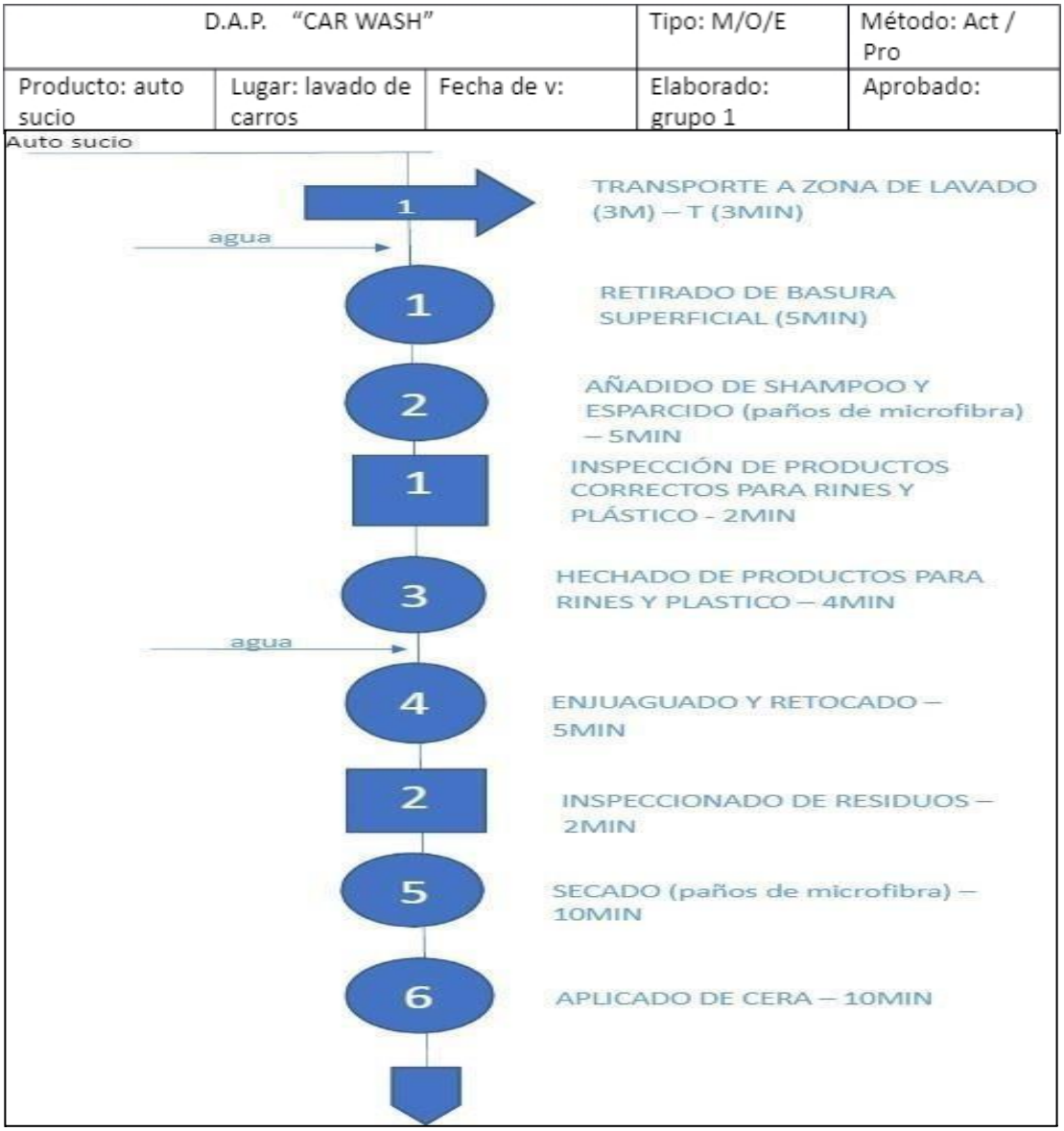
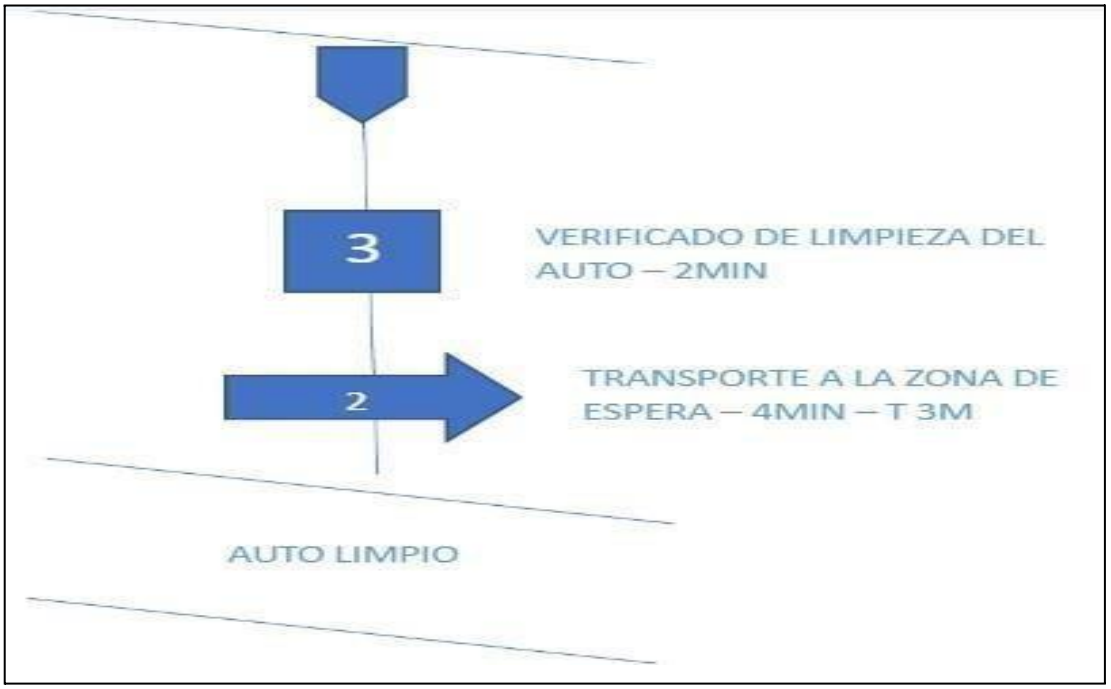


Figure 2: Current WTP without automation

Source: Own elaboration



EVENTO	CANTIDAD	TIEMPO	DISTANCIA
OPERACIONES	6	44min	-
INSPECCIONES	3	-	-
TRANSPORTE	2	8 min	6m
DEMORAS	0	-	-
ALMACENAJE	0	-	-
		Total : 52min	6metros

Figure 2: Current WTP without automation

Source: Own elaboration

CHAPTER III: CURRENT PROCESS DESIGN

3.1 3D CAD drawings of the current situation or video of the current situation

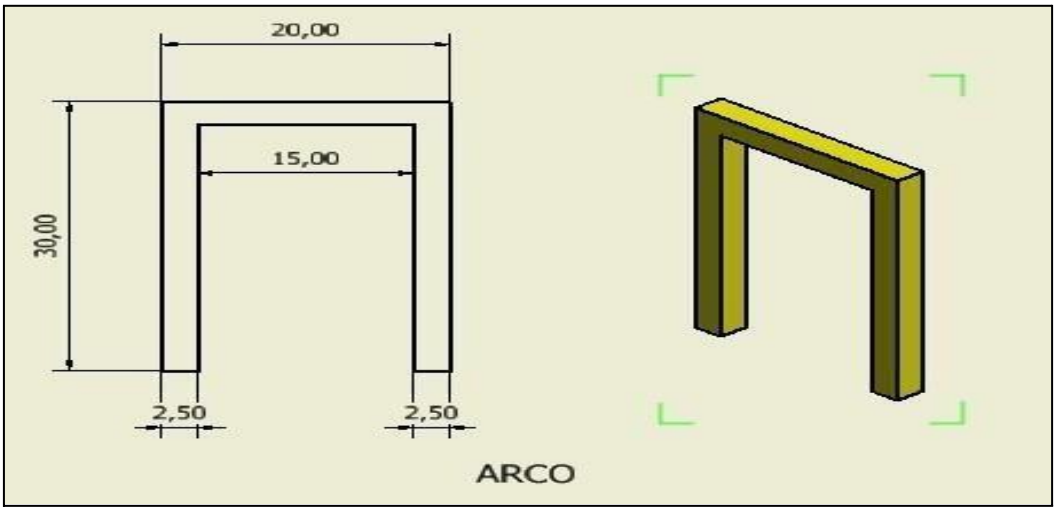


Figure 3: Map of the Arch

Source: Own elaboration

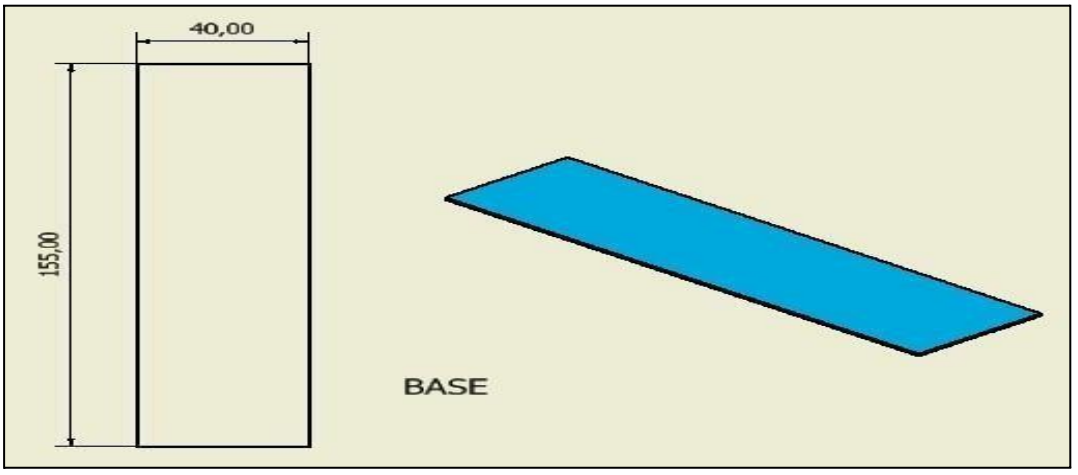


Figure 4: Base Plan

Source:Own elaboration

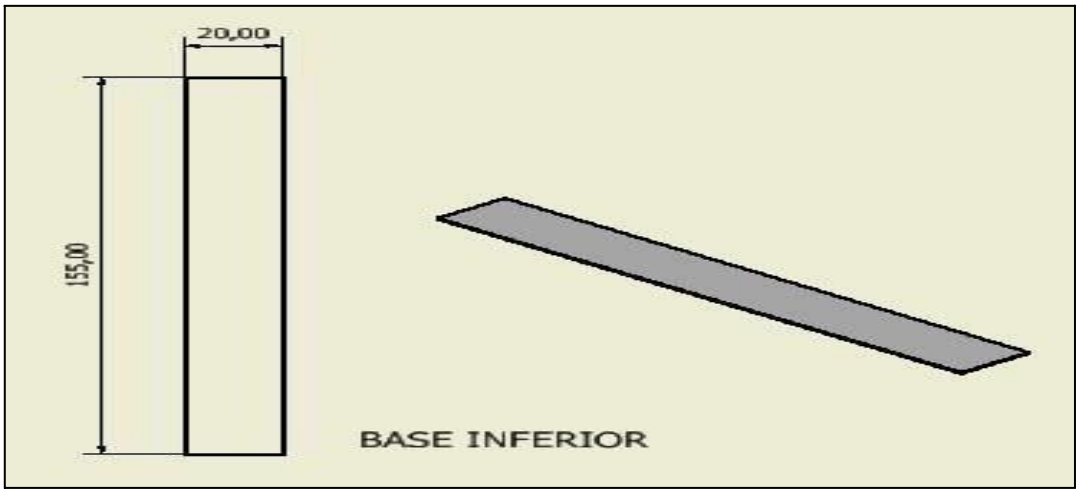


Figure 5: Lower Base Plan

Source:Own elaboration

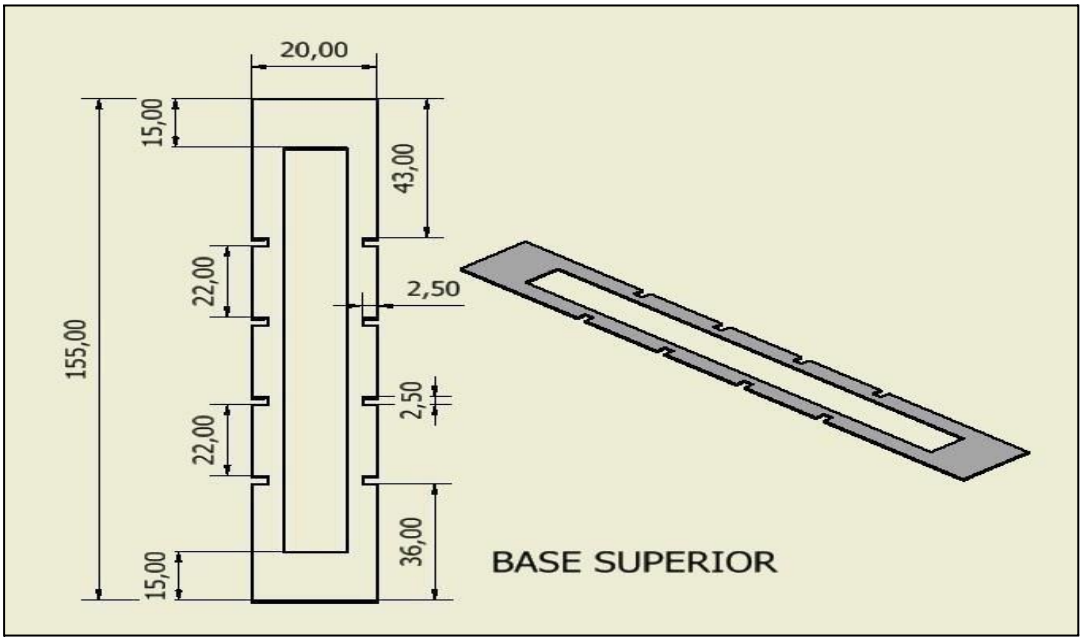


Figure 6: Upper Base Plan

Source:Own elaboration

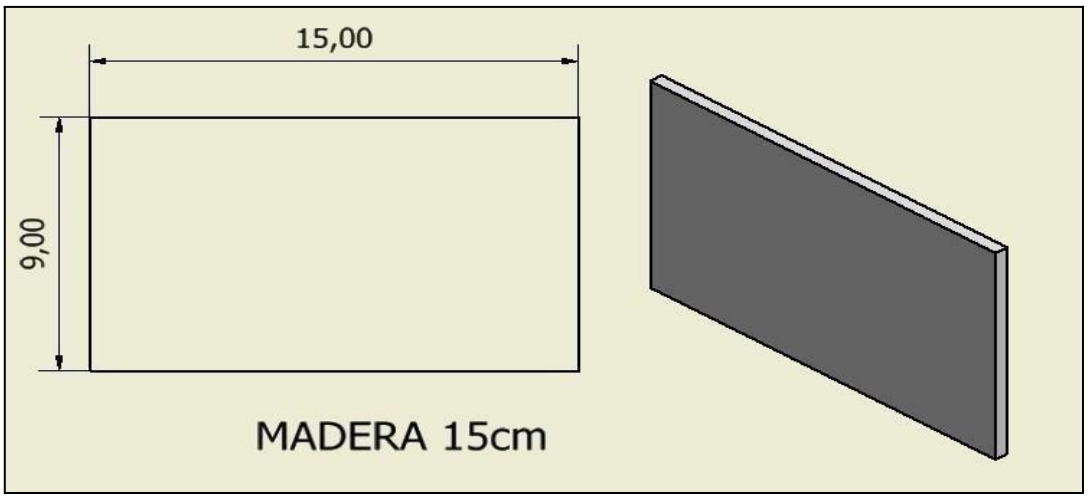


Figure 7: 15 cm wood plane

Source:Own elaboration

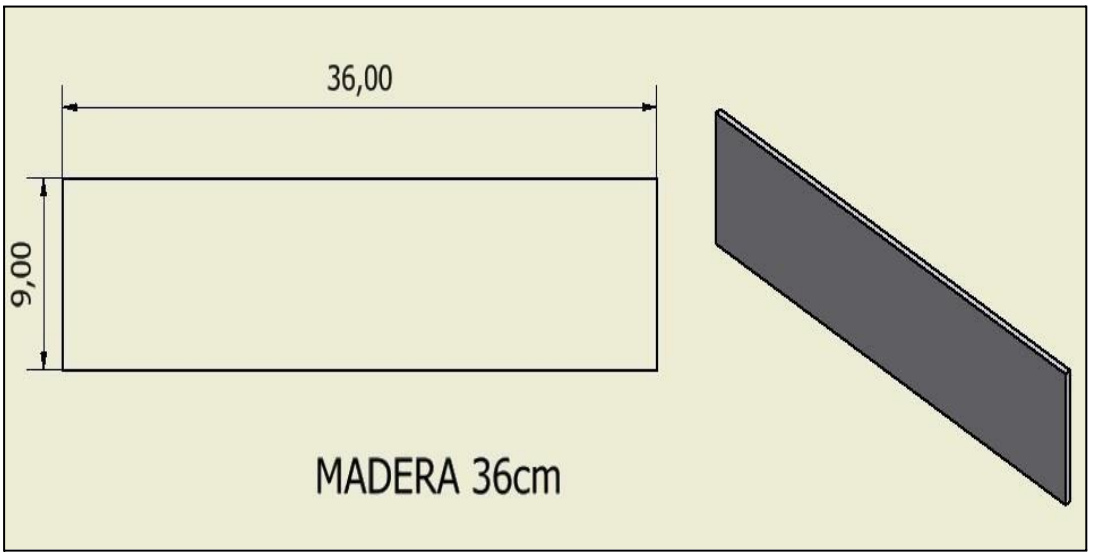


Figure 8: 36 cm wood plane Source:

Own elaboration

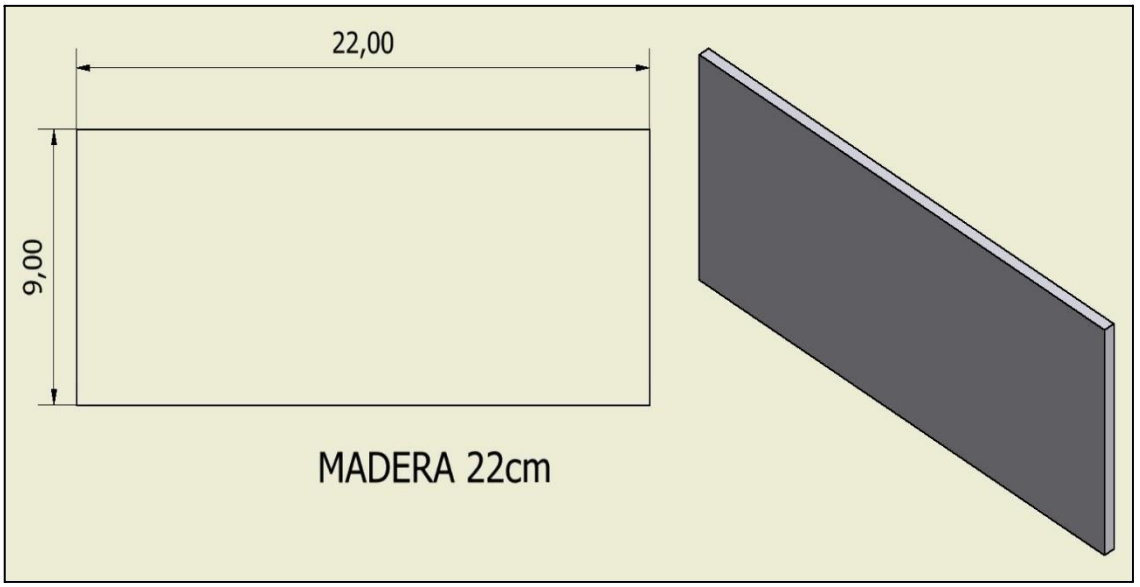


Figure 9: 22 cm wood plane

Source:Own elaboration

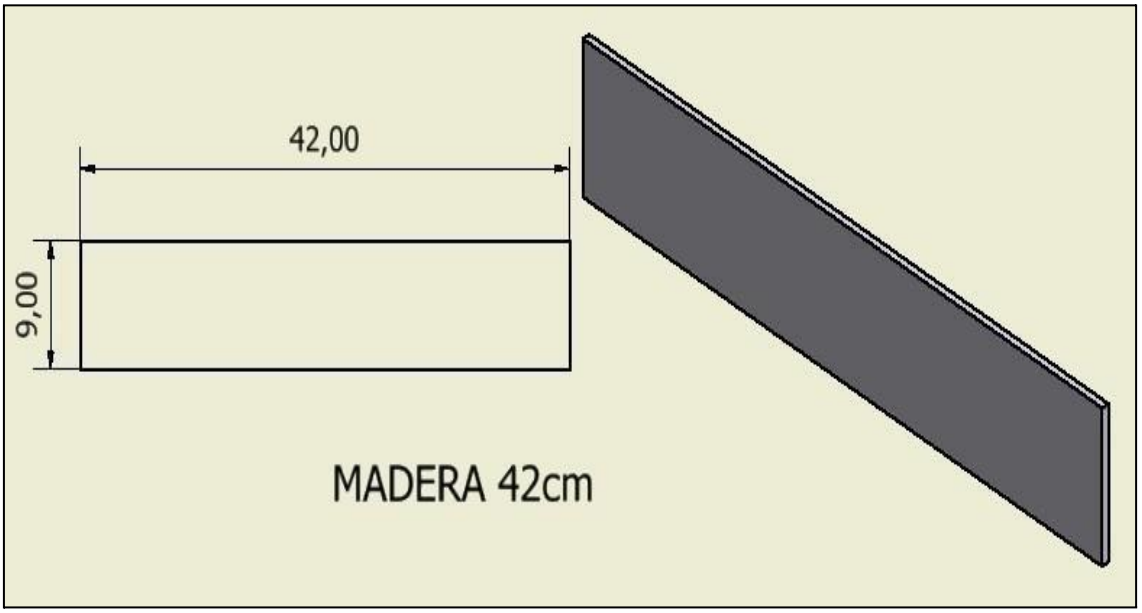


Figure 10: Wood plane of 42 cm

Source: Own elaboration

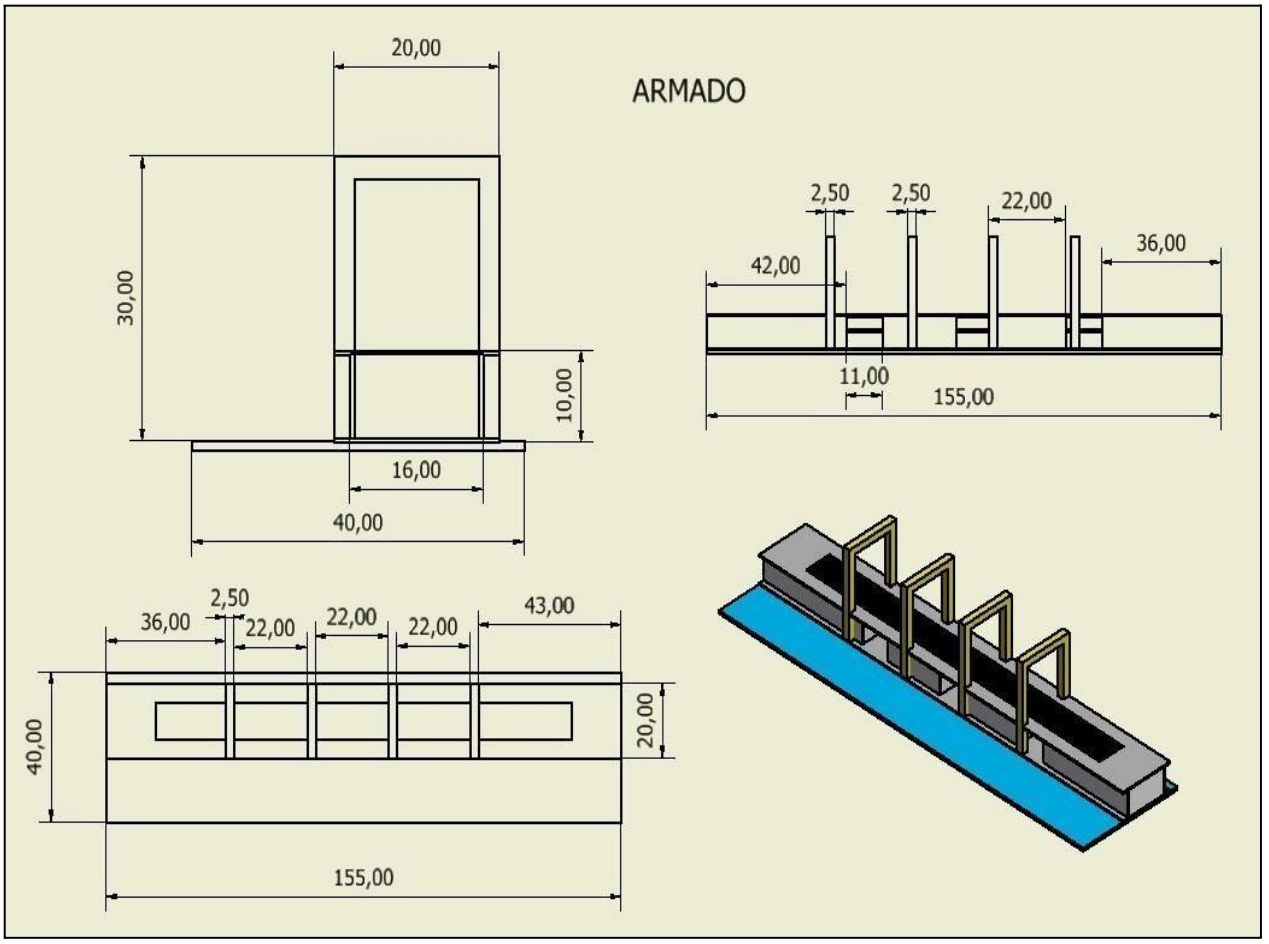


Figure 11: Assembly Plan

Source: Own elaboration

CHAPTER IV: DESIGN OF PROPOSAL TO AUTOMATE THE PROCESS

4.1 Detailed description of the proposed process

4.1.1. Prewash

In this stage the car is moistened in order to soften and even loosen the hardest or adhered dirt, which reduces the risk of generating scratches in the washing stage, this stage can be done by releasing the water with the help of a hose or using a sponge with a bucket of water.

Systems	Time/cars	Liters of water/cars
Automated process	2 minutes	10 liters

Table 1: Pre-wash resource use

4.1.2. Washing

After the car has been pre-washed, it is customary to wash the wheels and then continue washing from top to bottom and from the dirtiest to the cleanest areas, from the windows, hood, sides, leaving the underbody and fenders for the end, in order to avoid that the dirt removed from the upper parts is placed on places that have already been washed, so that the shampoo will fall by gravity to the lowest places.

Systems	Time/cars	Liters of water/cars
Automated process	6 minutes	20 liters

Table 2: Resource use in laundering

4.1.3. Rinsing

After the complete cleaning, it is customary to rinse the car following the same series as in the washing, taking care to eliminate all the remains of shampoo using at times a sponge with a bucket of water or a hose without any type of diffuser or reducer, and with a moderate flow, enough to be uniform without splashing, passing through the whole space slowly, as always starting from the ceiling and from top to bottom, so that the water jet drags the shampoo remains, because once dried they can leave permanent marks on the paintwork.

Systems	Time/cars	Liters of water/cars
Automated process	5 minutes	24 liters

Table 3: Use of rinsing resources

4.1.4. Drying

Drying is carried out by using special towels to ensure that all the water is removed without leaving traces or lint, but in some circumstances the use of household towels or cloths may cause scratches on the surface of the car, for this stage the time used can vary between 6 to 20 minutes depending on the size of the car, if it will be vacuumed inside, waxed, among other complementary activities.

Systems	Time/cars	Liters of water/towels
Automated process	8 minutes	16 towels

Table 4: Pre-wash resource use

4.2 3D CAD drawings of the proposed situation chosen

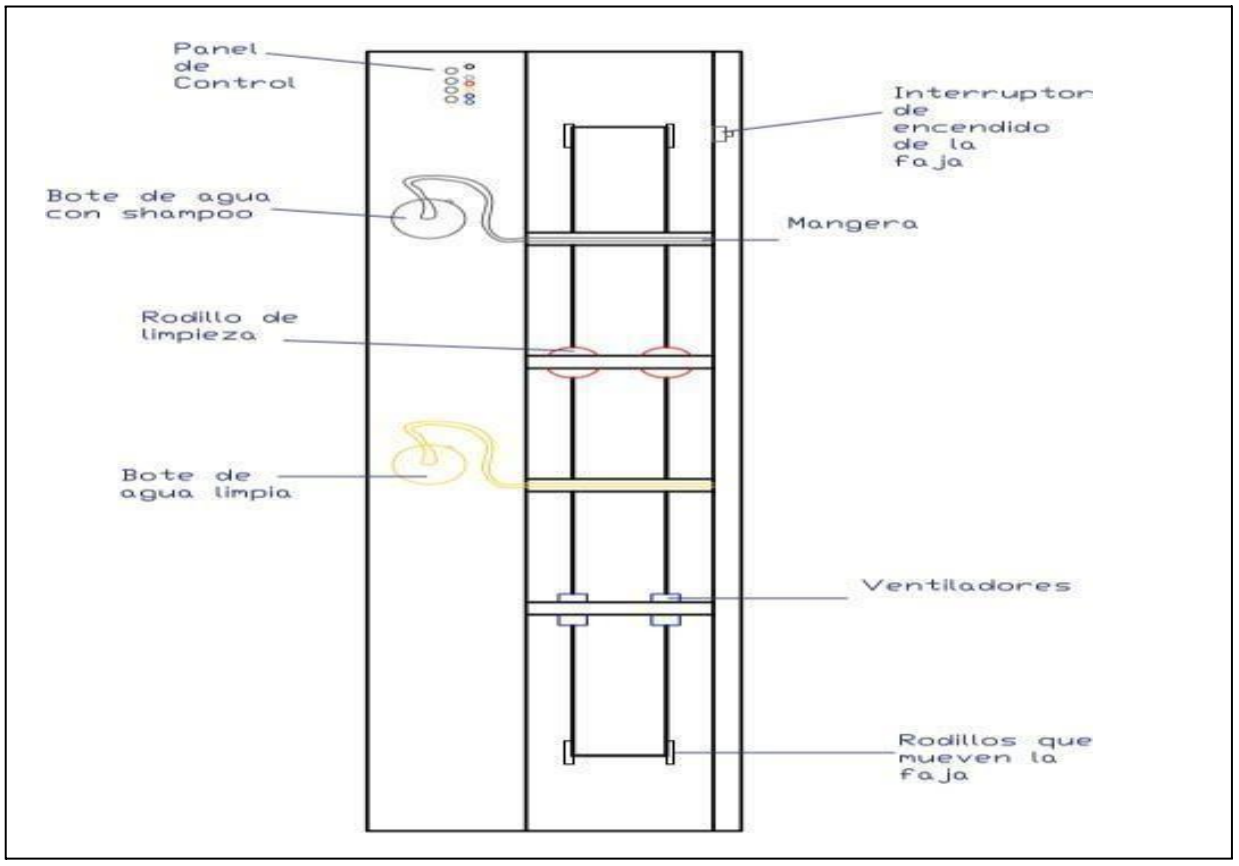


Figure 12: Plan of the proposed situation chosen

Source: Own elaboration

4.3 Diagram of analysis of the proposed process

DIAGRAMA DE ANÁLISIS DEL PROCESO PROPUESTO							
DESCRIPCIÓN DE LA ACTIVIDAD	SÍMBOLOS						TIEMPO(MINUTOS)
Recepsión del automóvil	X						1
Transportar al área de lavado			X				3
Área de lavado (prelavado)	X						2
Aplicación y esparcimiento de shampoo	X						3
Área de lavado	X						5
Transportar al área de enjuagado			X				3
Verificación del lavado completo		X					1
Área de secado	X						3
Verificación del secado completo		X					1
Transportar el automóvil a la salida			X				1
Entregar el automóvil y las llaves	X						1
TOTAL	6	2	3				24

Figure 13: Analysis diagram of the proposed process

Source: Own elaboration

4.4 Detailed description of the materials to be used

1. **Pushbutton (red and green):** The red pushbutton has the function to stop the process, and the green pushbutton has the function to start the process.

Figure 14: Pushbutton (red and green)

2. **12v geared motor:** This is a machine that combines a speed reducer and a motor, this combination is a single machine that helps to reduce the speed automatically.

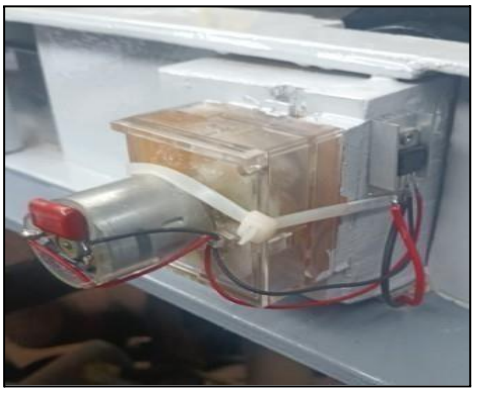


Figure 15: 12v geared motor

3. **Two 12v DC motor:** They work with direct current or also called direct current, it generates an induced magnetic field of the motor, which converts electrical energy into mechanical energy.

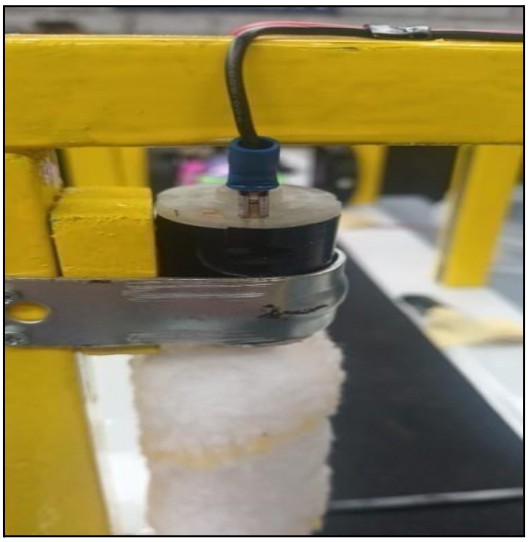


Figure 16: DC motor with two 12v motors

4. **Network cable:** Its purpose is to connect the computer to the PLC.

Figure 17: Network cable

5. **Optical sensor or diffuse photoelectric sensor:** It has the function of detecting if there is the presence of a material, once it has detected that, it continues to carry the material in this case the cart to the next station, which in total are 4.

Figure 18: Optical sensor or diffuse photoelectric sensor

6. **Computer fan:** This device is in charge of expelling air in order to cool the overheating in the PC, in this case the cooling and/or drying of the car.

Figure 19: Computer fan

7. **24v source:** Regulates the electricity received so that the operation of the circuits is optimized, without overloads.

Figure 20: 24v source

8. **12 volt 2 piece DC water pump:** These pumps usually come with the motor (which works in alternating current) separately from the body, being able to get configurations with them for all kinds of uses and applications.

Figure 21: 2-piece 12-volt DC water pump

9. **PLC Logo OBA7 Siemens version:** LOGO is a small PLC from Siemens suitable for implementing simple automation tasks in industry and building management systems.

   It is very easy to use and the latest model is equipped with an Ethernet port for both programming and data exchange.

Figure 22: PLC Logo version OBA7 Siemens

10. **Single-ended flat plug:** Also called europlug or household plug, it is a device consisting of two elements that are connected to each other to obtain electric current.

Figure 23: Single inlet flat socket

4.5 Design of the electro-pneumatic circuit of the proposed process.

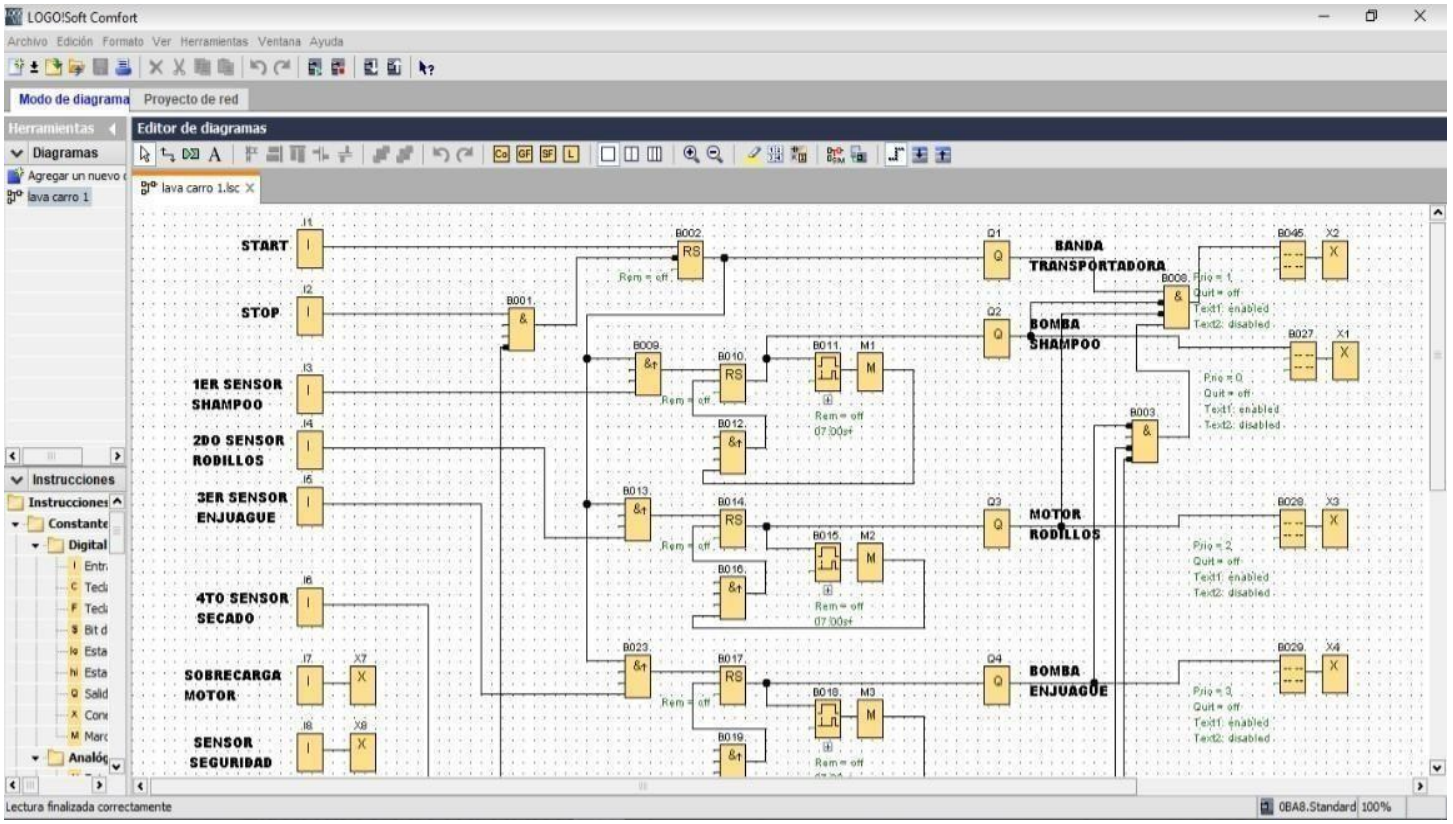


Figure 24: Design of the electro-pneumatic circuit of the proposed process.

4.6 Ladder language programming of the process

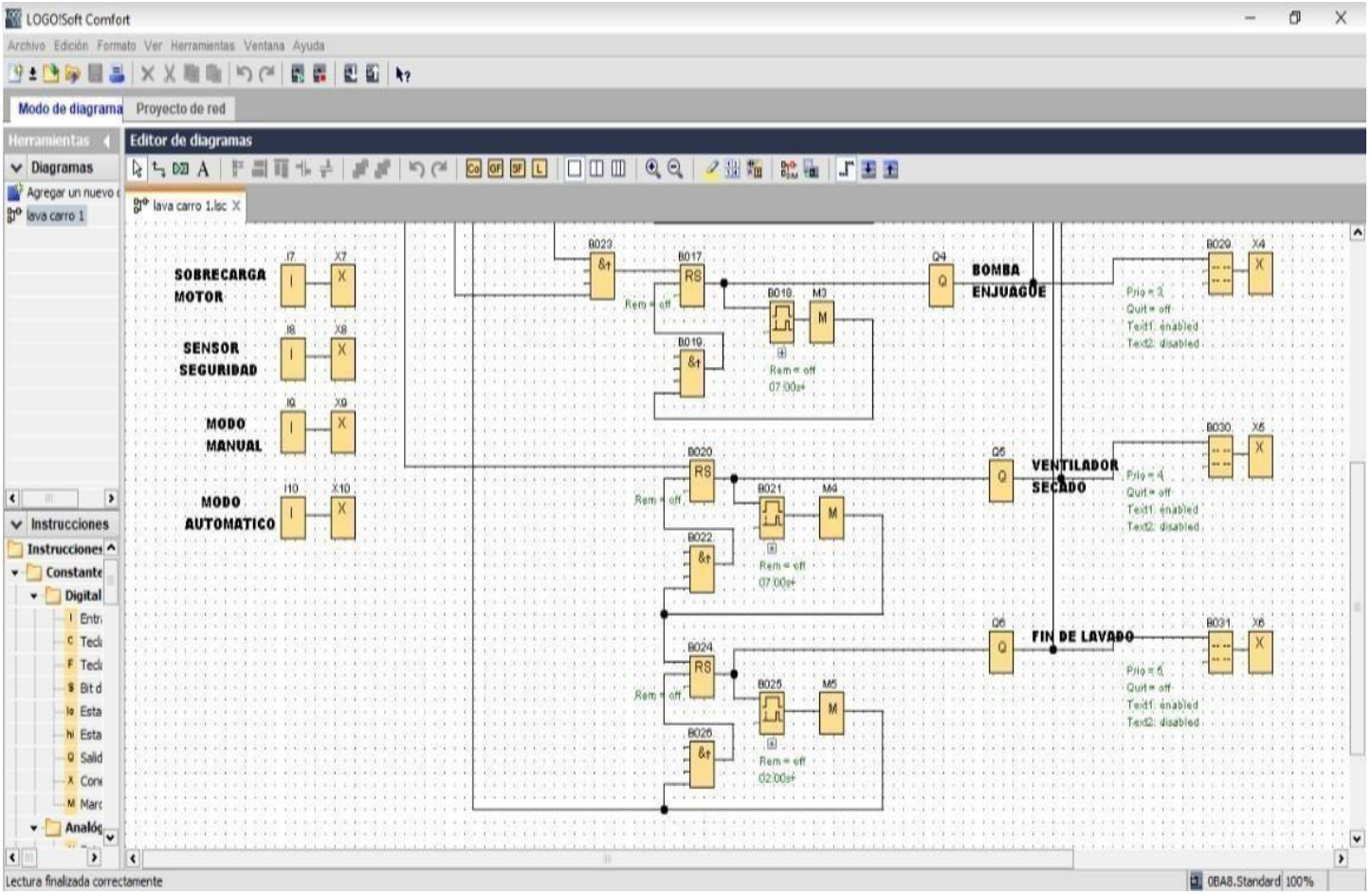


Figure 25: Ladder language programming of the process

4.7 Description and detail of production indicators after automation

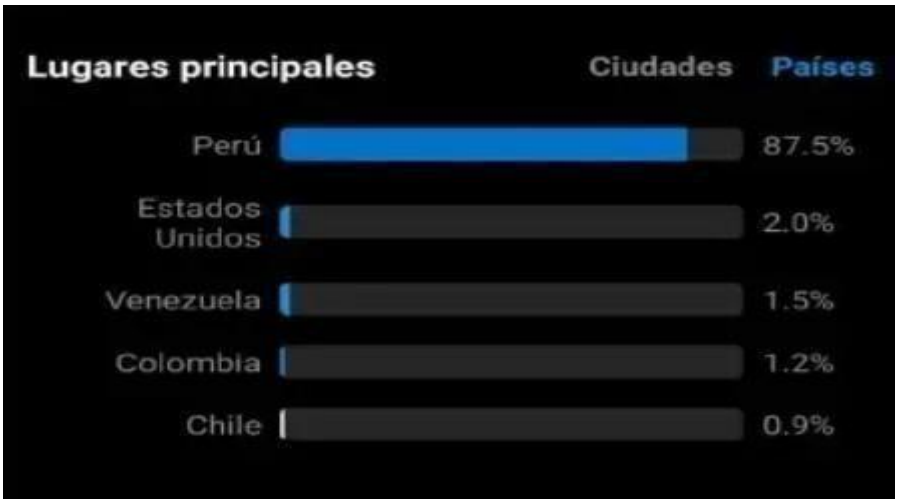


Figure 24: Production Indicators for Latin American Cities

Figure 25: Production indicators for Peruvian cities

CHAPTER V: INVESTMENT AND OPERATING COSTS

5.1 Investment and operating costs

Elemento	Descripción		Coste	Cant.		Importe	Pago
Motores de 12 vol	Soles	S/	35.00	2	S/	70.00	
Bombas de agua de 12 vol	Soles	S/	30.00	2	S/	60.00	
Terminales	Soles	S/	3.00	1	S/	3.00	
Manguera	Soles	S/	9.50	1	S/	9.50	
Depósitos	Soles	S/	6.00	2	S/	12.00	
Faja (Mt elástico 19 cm)	Soles	S/	21.00	1	S/	21.00	
Motor 24 a 12 v	Soles	S/	45.00	1	S/	45.00	
sensores	Soles	S/	50.00	5	S/	250.00	
Total					S/	470.50	

Table 5: Investment and operating costs

5.2 Cash flow

FLUJO DE CAJA		0	1	2	3	4	5	6	7	8	9	10	11
Flujo Operativo													
Ingresos			129.600.000	140.162.400	151.585.636	163.939.865	177.300.964	188.098.593	199.553.797	211.706.623	224.599.556	238.277.669	252.788.780
Costos y Gastos			99.988.000	106.481.272	113.502.973	121.096.147	129.307.346	135.946.774	142.990.022	150.461.666	158.387.780	166.796.024	182.594.071
Utilidad operativa			29.612.000	33.681.128	38.082.662	42.843.718	47.993.618	52.151.819	56.563.775	61.244.957	66.211.777	71.481.646	70.194.709
Participacion de los Trabajadores			2.961.200	3.368.113	3.808.266	4.284.372	4.799.362	5.215.182	5.656.378	6.124.496	6.621.178	7.148.165	7.019.471
Utilidad Antes de Impuestos			26.650.800	30.313.015	34.274.396	38.559.346	43.194.256	46.936.637	50.907.398	55.120.462	59.590.599	64.333.481	63.175.238
Impuesto a la renta	30%		7.995.240	9.093.905	10.282.319	11.567.804	12.958.277	14.080.991	15.272.219	16.536.138	17.877.180	19.300.044	18.952.571
Utilidad Operativa DI			18.655.560	21.219.111	23.992.077	26.991.542	30.235.980	32.855.646	35.635.178	38.584.323	41.713.419	45.033.437	44.222.667
(+) Depreciación			20.000.000	20.000.000	20.000.000	20.000.000	20.000.000	20.000.000	20.000.000	20.000.000	20.000.000	20.000.000	26.878.328
Flujo de Caja de operación			**38.655.560**	**41.219.111**	**43.992.077**	**46.991.542**	**50.235.980**	**52.855.646**	**55.635.178**	**58.584.323**	**61.713.419**	**65.033.437**	**71.100.994**

Table 6: Operating cash flow

Flujo de Inversión												
Inversión en Equipos		-200.000.000										-268.783.276
Gastos Pre operativos		-200.000	15.000	15.000	15.000	15.000						
Inversion en Capital de Trabajo		-19.440.000	-1.584.360	-1.713.485	-1.853.134	-2.004.165	-1.619.644	-1.718.281	-1.822.924	-1.933.940	-2.051.717	-2.176.667
Valor de desecho de los equipos												4.200.000
Valor Residual												612.939.605
Flujo de Caja de Inversion		**-219.640.000**	**-1.569.360**	**-1.698.485**	**-1.838.134**	**-1.989.165**	**-1.619.644**	**-1.718.281**	**-1.822.924**	**-1.933.940**	**-2.051.717**	**346.179.663**
Pago por colocacion de Nuevas acciones comunes		-200.000	60.000									
Flujo de Caja Economico		-219.840.000	37.146.200	39.520.625	42.153.943	45.002.377	48.616.335	51.137.365	53.812.255	56.650.383	59.661.702	411.213.100

Table 7: Investment cash flow

5.3 Economic viability (NPV, IRR)

TIR	22,53%	
Ke	11,60%	
VAN	167.016.089	VAN>0 PY VIABLE

Table 8: Economic feasibility

CONCLUSIONS

- The proposed automated process would optimize the car wash process, reducing costs, time and loss of water and towels for the washing and drying processes.
- It is important to use the appropriate water pressure to ensure that the washing processes are carried out in the best possible way, and water flow control must also be taken into account.
- Using an automated process, it increases productivity and efficiency in the car wash process.
- The development and implementation of a human-machine communication interface of a process or plant simplify monitoring and control, because they maintain a constant line of communication between variables, plant processes and the operator through the use of a computer.

RECOMMENDATIONS

- The use of the Logo PLC controller in a car wash must be properly executed by a proper design and evaluation of the components to be achieved, in order to perform a pre-calculation of the components.
- Acquire the license for the use of the data server for the use of the PLC, which facilitates the activation of the car wash components to perform repetitive activities with precision.
- Adjust the water outlet arrangement so that it does not wet the sensors or the conveyor belt motor.
- Implement hot air drying, as it would make the drying job more optimal.

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