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COLLEGE OF ENGINEERING

PROFESSIONAL DEPARTMENT OF INDUSTRIAL ENGINEERING

RESEARCH WORK

INDUSTRIAL AUTOMATION

AUTOMATED METAL CLASSIFIER

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SUMMARY

This research work is divided into two parts where the current process that is being carried out in different industries when classifying metallic and non-metallic materials is shown, as well as an improvement proposal to optimize work times and reduce costs through automation. of process.

In the current process, the operator transfers different types of parts manually, classifying them into either of the two containers as appropriate, having a direct deficiency for the operator due to injuries associated with repetitive movements, in the same way for the company since there are downtimes when The operator moves from his workplace for his meal times, to go to toilets or to rest, as the case may be.

For this reason, we propose an automated process controlled by a PLC in which the pieces are transported along a conveyor belt, reaching an inductive sensor that, if it recognizes a metallic material, will send it to storage with the help of a pneumatic cylinder; If it is a non-metallic material, it will continue along the belt until it reaches the optical sensor. Once the light is obstructed, the piston expands and will fall into the storage of non-metallic materials, thereby achieving an increase in productivity and performance among all the benefits that can provide.

Keywords: PLC, conveyor belt, inductive sensor, pneumatic cylinder, automation, optical sensor, piston.

ABSTRACT

The present research work is divided into two parts where the current process that has been carried out in different industries when classifying metallic and non-metallic materials is shown, as well as an improvement proposal to optimize working times and reduce costs through automation. of process.

In the current process, the operator moves different types of parts manually, classifying them in any of the two containers as appropriate, having a direct deficiency to the operator due to injuries associated with repetitive movements, in the same way for the company since there are downtimes when the operator travels from his place of work for his meal schedules, to go to restrooms or rest as the case may be.

For this reason, we propose an automated process controlled by a PLC in which the pieces are transported by a conveyor belt reaching an inductive sensor that, if it recognizes a metallic material, will send it to storage with the help of a pneumatic cylinder; If it is a non-metallic material, it will continue along the belt until it reaches the optical sensor. Once the light is blocked, the piston expands and will fail to the storage of non-metallic materials, thus achieving an increase in productivity and performance among all the benefits that can provide.

Keywords: PLC, conveyor belt, inductive sensor, pneumatic cylinder, automation, optical sensor, piston.

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INTRODUCTION

Currently there are companies that obtain income from the recycling of organic waste and the sale of methane gas obtained from inorganic waste. The company must carry out a good study to see if the income that will be obtained from them can cover its operating costs and expenses. That is why they are forced to optimize many of their processes in order to reduce material, indirect and labor costs.

There are numerous ways to optimize processes in a recycling plant, but it is vitally important to know if their implementation will really make the company more competitive in the market. Therefore, the importance of measuring results with indicators that show the benefits of using them.

It is also of real importance not only to observe, through the indicators, the economic benefits but also the social and environmental responsibility that the company must have towards society and the state.

That is why the proposal of this research work is the development of a metal classifier system so that the company can improve aspects such as quality in detection, precision, reduction of time and savings in reduction of labor costs. With this, the company that can incorporate it into its processing line will be more competitive in the market.

In this research work we will show in the first chapter the theoretical aspects covered by our variables and the measurement indicators that we use and then observe the benefits that will be obtained in their application.

In chapter 2 we mention the current situation, and in chapter 3 the current design, both cases making special references to how the classification of inorganic waste is developing at a national and international level. Likewise, to facilitate the reader's observation of the current situation, we made a graphic representation using numerous software.

In chapter 4 we develop the classifier and thus its simulation in Promodel and Inventor to graphically show the improvements that will be obtained in its implementation. The results obtained with their respective indicators will show us whether or not the development and subsequent implementation will make the company more competitive, reflected in improved precision, cost reduction, and time reduction.

CHAPTER I: THEORETICAL FRAMEWORK

1.1. Theoretical fundament

Industrial pneumatics:

About industrial pneumatics Pawar (2020) defines the following:

The English word pneumatic and its associated noun pneumatics are derived from the Greek "pneuma" meaning breath or air. Originally coined to give a name to the science of the motions and properties of air. Compressed air is a vital utility- just like water, gas and electricity used in countless ways to benefit everyday life. Pneumatics is application of compressed air (pressurized air) to power machine or control or regulate machines. Simply put, Pneumatics may be defined as branch of engineering science which deals with the study of the behavior and application of compressed air. Pneumatics can also be defined as the branch of fluid power technology that deals with generation, transmission and control of power using pressurized air. Gas in a pneumatic system behaves like a spring since it is compressible.

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Control systems

About control systems Frank (2018) describes the following:

A system changes over time, the standard description of dynamics. One can often describe changes over time as a combination of the different frequencies at which those changes occur. The duality between temporal and frequency perspectives sets the classical perspective in the study of control.

Open-loop control directly alters how a system transforms inputs into outputs. Prior knowledge of the system's intrinsic dynamics allows one

to design a control process that modulates the input–output relationship to meet one's goals. By contrast, closed-loop feedback control allows a system to correct for lack of complete knowledge about intrinsic system dynamics and for unpredictable perturbations to the system. Feedback alters the input to be the error difference between the system's output and the system's desired target output. By feeding back the error into the system, one can modulate the process to move in the direction that reduces error. Such self-correction by feedback is the single greatest principle of design in both human-engineered systems and naturally evolved biological systems.

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Sensors:

About sensors Manesis, S. & Nikolakopulus, G. (2018) state the following:

Sensors are devices that, when exposed to a physical phenomenon (temperature, pressure, displacement, force, etc.), produce an output signal capable of being processed by the automation system. The terms “transducer” and “meter” are often used synonymously with sensors, while simultaneously some sensors are combined with the term “switch”, causing confusion about the correct terminology. Furthermore, some writers consider that “sensor” is only the sensing element that detects the physical magnitude and not the whole device that, together with the sensing element, transforms the physical variable into a form of electrical signal. Let's define the meaning of these terms as they will be used in this textbook. In general, sensors transform the variation of a physical quantity into an electrical output signal, which may be an analog or digital one. In the first case, the sensor produces a continuous output signal that is proportionally varied to the sensed parameter. For example, a pressure sensor may produce a 4–20 mA DC, or 0–10 V DC output signal for a 0–725 psi pressure variation. In the second case, the sensor produces a discrete output signal in the form of an ON or OFF, usually causing a SPDT contact to change state when the physical quantity gets over a predefined value. Sensors with analog output may also be called transducers, while sensors with discrete (or binary or digital) output are called switches, eg, “proximity sensor or switch”. When transducers include an analog-to-digital converter (ADC), then they are called digital transducers, since their output can be directly fitted to a digital controller, and should not be confused with the binary or digital sensors of a switch operation type.

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Valves:

About valves Pawar (2020) defines the following:

One of the most important considerations in any fluid power system is control. If control components are not properly selected, the entire system does not function as required. In fluid power, controlling elements are called valves.

A valve is a device that receives an external signal (mechanical, fluid pilot signal, electrical or electronics) to release, stop or redirect the fluid that flows through it. The function of a DCV is to control the direction of fluid flow in any hydraulic system. A DCV does this by changing the position of internal movable parts. Any valve contains ports that are external openings through which a fluid can enter and exit via connecting pipelines. The number of ports on a DCV is identified using the term “way.” Thus, a valve with four ports is a four-way valve A DCV consists of a valve body or valve housing and a valve mechanism usually mounted on a sub-plate. The ports of a sub-plate are threaded to hold the tube fittings which connect the valve to the fluid conductor lines. The valve mechanism directs the fluid to selected output ports or stops the fluid from passing through the valve. DCVs can be classified based on fluid path, design characteristics, control methods and construction.

[One of the most important considerations in any fluid power system is control. If the control components are not selected properly, the entire system will not function as required. In fluid power, the control elements are called valves.

A valve is a device that receives an external signal (mechanical, fluid pilot signal, electrical or electronic) to release, stop or redirect fluid flowing through it. The function of a directional control valve (DCV) is to control the direction of fluid flow in any hydraulic system. A DCV accomplishes this by changing the position of its internal moving parts.

Any valve contains ports, which are external openings through which a fluid can enter and exit via connecting pipes. The number of ports on a DCV is identified using the term "way." Therefore, a valve with four ports is called a four-way valve. A DCV is composed of a valve body or valve housing and a valve mechanism usually mounted on a base plate. The ports on a base plate have threads to hold the tube connections that connect the valve to the fluid carrying lines. The valve mechanism directs fluid to selected outlet ports or stops fluid from passing through the valve.

DCVs can be classified based on fluid path, design features, control methods, and construction.] (p. 44 -45)

Robotics:

About robotics Hamman (2018) describes the following:

America defines a robot as “a reprogrammable, multifunction manipulator” (1979)1 and the European Common Market defines a robot as “an independently acting and self controlling machine.” When we define a robot based on what it needs to be complete, we can say that a robot needs manipulators to change either its own position within the environment or to change its environment. A robot also needs sensors to (partially) perceive the current state of the environment, it needs a computer to process these inputs, and it needs to calculate actuator values that control the robot's motors. Usually, one adds that the robot should be a multipurpose machine, that is, it can be applied not only for exactly one task but many different tasks. We distinguish three classes of robots: mere manipulators, mobile robots, and hybrid robots. The manipulators are basically robot arms. The typical industrial robot is a robot arm and commonly found in many industrial settings.

[The Robotics Institute of America defines a robot as "a reprogrammable, multifunctional manipulator" (1979)1, and the European Common Market defines a robot as "a self-controlled, independent action machine." When we define a robot based on what it needs to be complete, we can say that a robot needs manipulators to change its own position within the environment or change its environment. A robot also needs sensors to (partially) perceive the current state of the environment, it needs a computer to process these inputs, and it needs to calculate the values of the actuators that control the robot's motors. It is usually added that the robot must be a multipurpose machine, that is, it can be applied not only to one specific task but to many different tasks.

We distinguish three classes of robots: mere manipulators, mobile robots and hybrid robots. Manipulators are basically robotic arms. The typical industrial robot is a robotic arm and is commonly found in many industrial environments.] (p. 35-36)

Programming:

About programming Bell (2019) states the following:

Programming is essentially about solving problems. Each program you write must satisfy a specific need, which eventually makes work easier. Before you set out to write a program, you must first understand the issue at hand. Ask yourself what you are trying to solve. One of the best things about using computers is that they are programmed to solve repetitive assignments. You can use your calculator and work out answers to a given series of problems. It might take you a long time, but you will get it done eventually. However, with your computer, all you need is to create a formula and work out all the answers in seconds. Most problems have more than one possible solution. Some solutions are longer, others are shorter. However, at the end of the day you have an answer. Through programming, you solve problems in the shortest possible way. Programming is about useful resource allocation. You save time solving problems through the programs you write instead of going about them the manual way. Computer programs are nothing more than a set of instructions that perform a unique instruction when instructed by the computer.

[Programming is mainly about solving problems. Each program you write must satisfy a specific need, which eventually makes the job easier. Before you start writing a program, you must first understand the problem at hand. Ask yourself what you are trying to solve. One of the best things about using computers is that they are programmed to solve repetitive tasks. You can use your calculator and get answers to a series of given problems. It may take a long time, but you will eventually get there. However, with your computer, all you need to do is create a formula and get all the answers in a matter of seconds.

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Productivity

According to Bernal, Claudia (2019) "Productivity in any system of goods or services is based on the relationship between the results achieved and the resources used." Productivity is a concept widely used to denote how much we have improved or worsened. This aspect is crucial since if it is favorable, it will allow us to remain in an increasingly competitive market. This idea has led companies to implement different control methods with the aim of improving their performance and optimizing their operating indicators.

Pneumatic systems

Duque, Rafael (2022) defines it as "a technological field that focuses on the study and application of compressed air to generate movement or perform a task." The main objective is to use air pressure as a source of energy to control and activate different components that can be valves, cylinders and motors. These systems are widely used in industry and other areas due to their simplicity, low cost, ease of maintenance, and ability to generate precise movements and controlled forces. Pneumatics has applications in industrial automation, robotics, transportation, and the use of pneumatic tools.

1.2. Problem formulation

Currently, the proper management of solid waste is a headache for many nations. This generated a need that was being covered by companies that saw solid waste management as a new source of income by taking advantage of the metallic waste or the suction of methane gas from organic waste. The increase in waste management companies goes hand in hand with the increase in organic and inorganic waste, which is reflected in the study published by the MINAM in which it shows that of the 7781904.29 tons of waste produced in 2019, 22.49 % are inorganic waste. This means that Peruvian companies that manage solid waste like Petramas need to automate their waste processing lines in order to classify more than 1750458.41 tons each year. In this way, you will be able to reduce processing times, improve the quality of waste detection and reduce production costs.

1.2.1. General problem

- To what degree will implementing an automated system improve efficiency on a manual metal and non-metal sorting line?

1.2.2. Specific problems

- To what degree will the development of an automatic sorting system reduce production times in a metal and non-metal processing line?
- To what extent will the development of an automatic classifier system improve the accuracy of metal and non-metal detection?
- To what degree will the development of an automatic sorting system reduce production costs in a metal and non-metal processing line?

1.3. Objective

1.3.1. General objective

Develop an automatic classifier system to improve productivity in a metal and non-metal processing line

1.3.2. Specific objectives

- Implement an automatic classifier system to reduce production times in a metal and non-metal processing line.
- Develop an automatic classifier system to improve the precision in the detection of metals and non-metals.
- Develop an automatic classifier system to reduce production costs in a metal and non-metal processing line.

CHAPTER II: DETAILED DESCRIPTION OF THE CURRENT PROCESS

2.1. Process description

According to a report by Intercultural Communication Services (SERVINDI, 2022), in Peru an average of 21 million tons of solid waste is generated per day, which makes the classification and recycling of this a constant challenge as well as an opportunity for improve the methods in the processes carried out so that they are more efficient.

In the current recycling plant, the metal and non-metal classification process is carried out manually, using a conveyor belt as a means of handling solid waste. In this process, the waste is deposited on the conveyor belt and it is the workers who are in charge of classification, separating the materials into two main categories: metals and non-metals. Objects identified as metals are placed in a specific container, while non-metals are placed in another container designated for them.

However, this manual classification approach has some limitations. First of all, it is not very efficient, since it requires the participation of several people to carry out the task. Additionally, this manual method is time-consuming, which can affect the overall productivity of the recycling plant. In addition, there is the possibility of errors in sorting due to subjectivity and worker fatigue, which could lead to inappropriate mixing of materials and a decrease in the quality of the final products obtained from recycling.

Fig 1: Classification of solid waste.
Source: Lima recycling plant, Voices for the climate

2.2. Description and details of production indicators before automation

In the process of sorting metallic and non-metallic waste at the Lima plants, where it is mainly carried out manually, different production indicators are used to measure the efficiency and performance of the process. These indicators make it possible to evaluate the performance of the plants and make improvements in waste management. Below are some of the production indicators used in this process:

Tons processed: This indicator measures the total amount of metallic and non-metallic waste that is processed in sorting plants. It provides an overview of the volume of waste being handled and can be used to establish production goals and evaluate the capacity of plants to handle demand.

Staff efficiency: This indicator evaluates the performance and productivity of the personnel involved in the classification process. It can be measured using different metrics, such as the amount of waste sorted per operator in a given period of time or the number of errors made. Proper training, performance monitoring, and constant feedback can help improve staff efficiency.

Processing time per unit: This indicator measures the average time it takes to process each unit of waste. It can be useful to evaluate the productivity and efficiency of the sorting process. Lower processing time per unit indicates greater waste handling capacity and greater operational efficiency.

Recovery rate: Recovery rate refers to the amount of valuable materials that are recovered from waste during the sorting process. It is calculated by dividing the amount of recycled or reused materials by the total amount of waste processed. This indicator reflects the efficiency in the separation and recovery of metals and other valuable materials.

Percentage of waste diverted from landfills: This indicator measures the proportion of waste that is diverted from landfills and sent to recycling or recovery processes. A high percentage indicates more sustainable waste management, since final disposal in landfills is avoided and recycling and reuse of materials is promoted.

These production indicators in the process of sorting metallic and non-metallic waste in plants in Lima help monitor and improve the performance of the plants, promoting more efficient and sustainable waste management. In addition, they contribute to the reduction of the extraction of natural resources and the conservation of the environment.

CHAPTER III: CURRENT PROCESS DESIGN

3.1. 3D CAD plans of the current situation or video of the current situation.

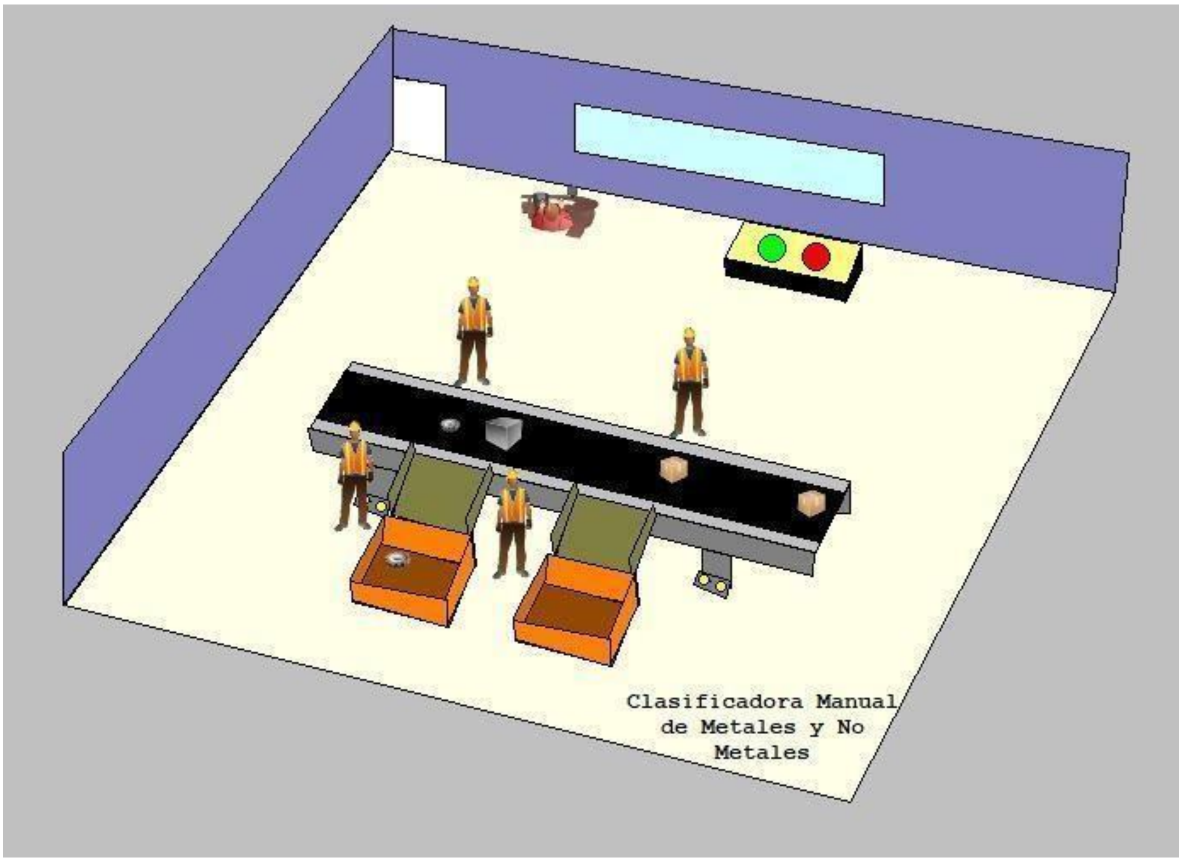


Fig 2: Current metal and non-metal classification process simulated in the Promodel software.

Source: self made

CHAPTER IV: PROPOSAL DESIGN TO AUTOMATE THE PROCESS

4.1. Detailed description of the proposed process

In this research work we develop the automated metal and non-metal classifier where to start we lift the switch lever, placing it on On and proceed to press the green button for the classification process to begin.

Next, the pieces of metal and other material will be placed one by one on the conveyor belt that will circulate near the sensors to be detected. If the piece being transported is metallic, it will be detected by the first sensor, being the inductive one. It issued an alert for the piston to activate and expand with the purpose of diverting the piece towards its corresponding compartment, then it automatically retracts to its original position while the piece has fallen into the container of metallic materials.

However, if the piece being transported is made of another material, it passes through the first inductive sensor and, since it does not detect anything, the piece continues its course towards the second sensor, which is the optical one, since it does not have the passage of light, it will issue an alert. causing the piston to activate and expand to change the course of the material moving through its corresponding compartment, falling into the container of non-metallic materials.

Finally, once all the required pieces have been passed along the conveyor belt, we complete the process by pressing the red button to turn off our components and lowering the switch lever to off.

4.2. Flowchart

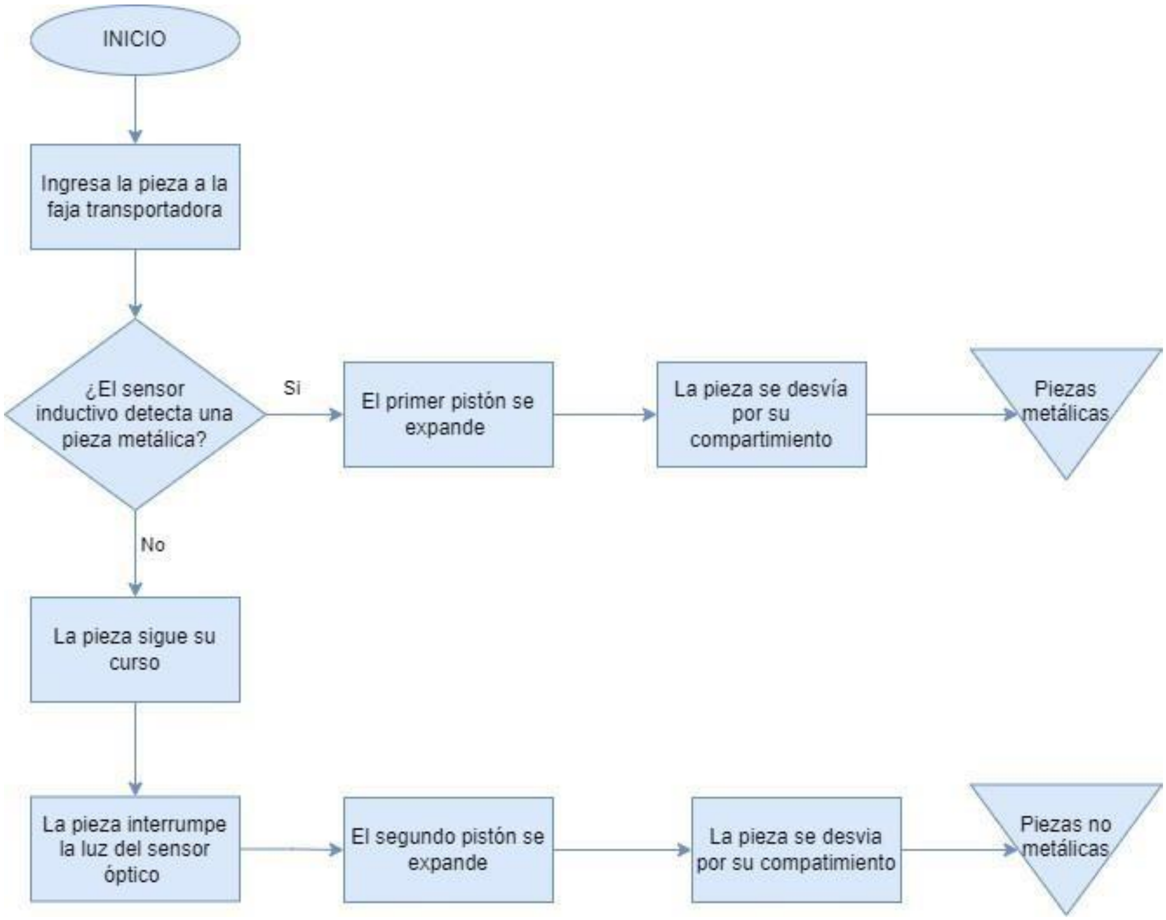


Fig. 3: Process flow diagram

Source: self made

4.3. Process analysis diagram

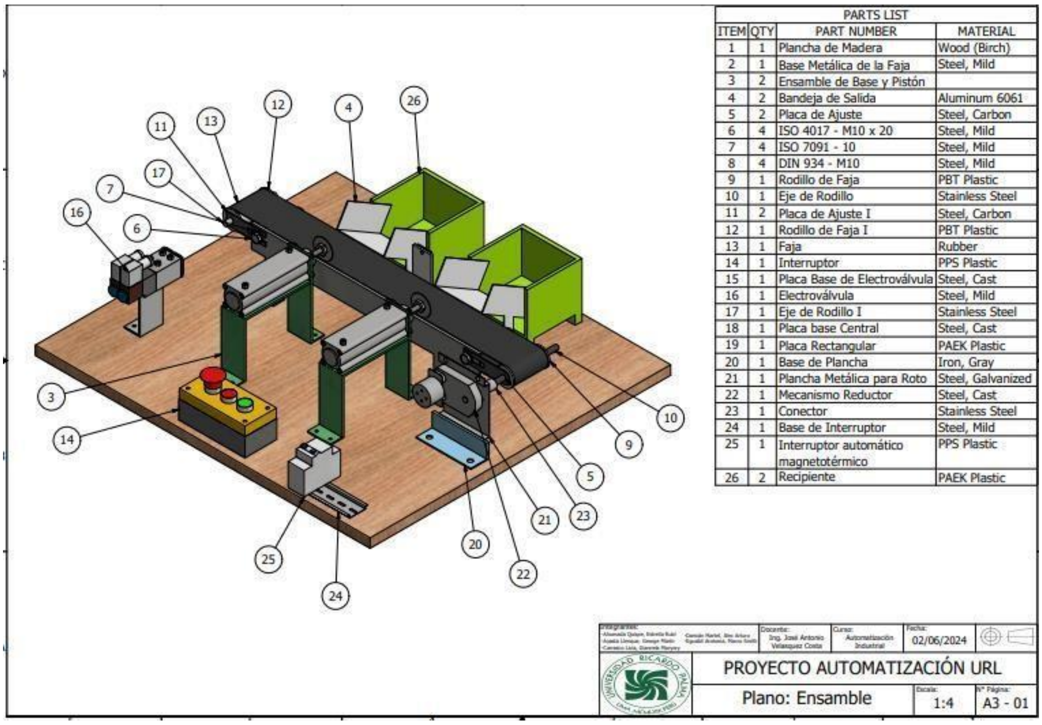
Descripcion	○	⇨	D	□	▽	Tiempo	Observaciones
Ingreso de pieza desconocida	●					1	Las piezas ingresan uno en uno
Pieza pasa por la faja transportadora		●				2	
Sensor reconoce material no metalico			●			4	No tiene accionamiento
Pieza sigue por la faja transportadora		●				3	
La pieza obstruye la luz del sensor			●			3	
El piston acciona	●					2	Se expande
L a pieza pasa por su compartimiento		●				1	
Cae al almacen correspondiente					●	0	
TOTAL	2	3	2	0	1	16	

Fig. 4: DAP of the process

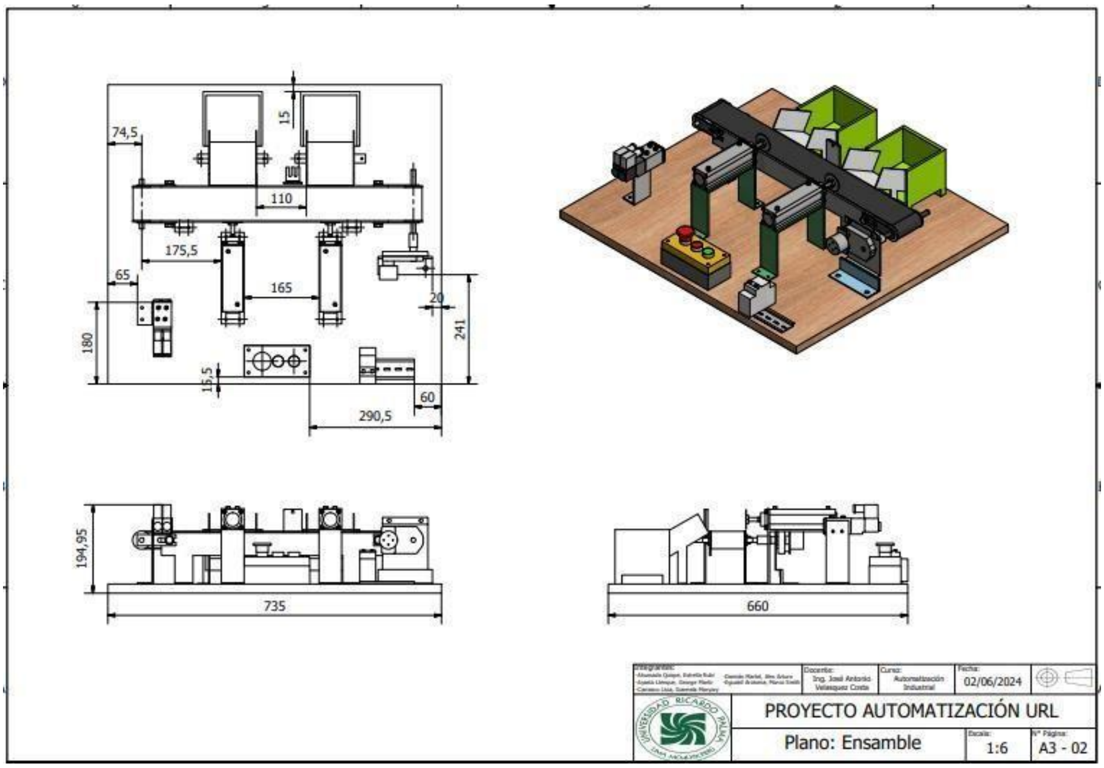
Source: self made

4.4. 3D CAD drawings of the chosen proposed situation (must show each component in a different color) or video of the improved situation

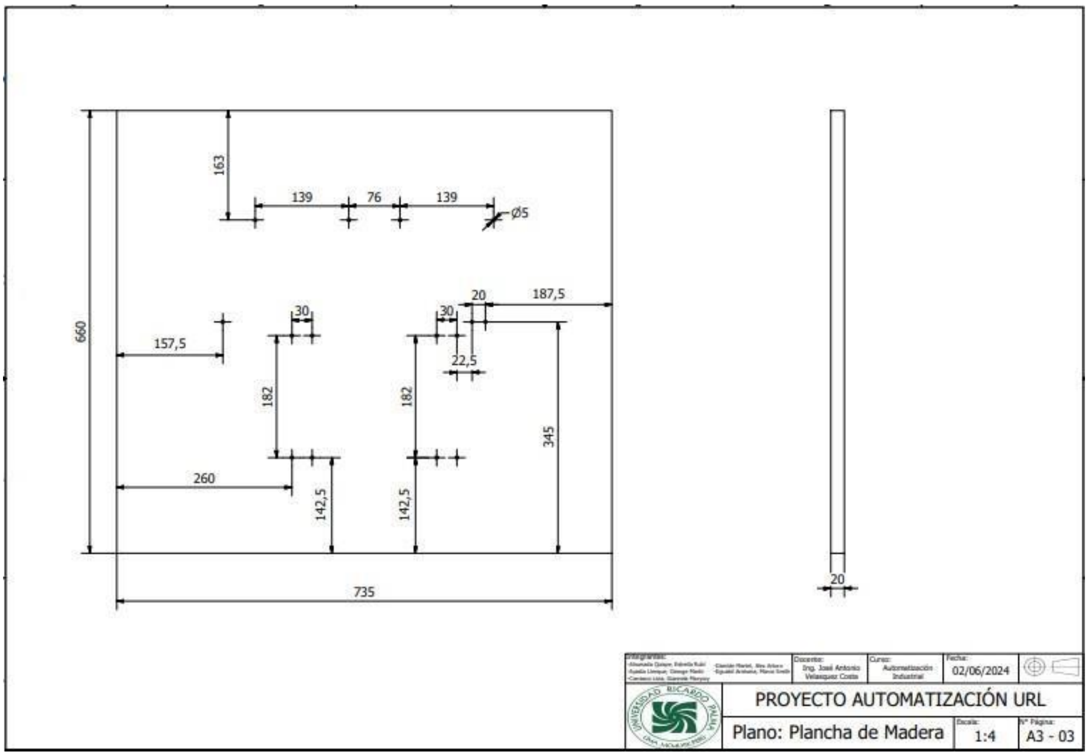
4.4.1. Assembly drawing



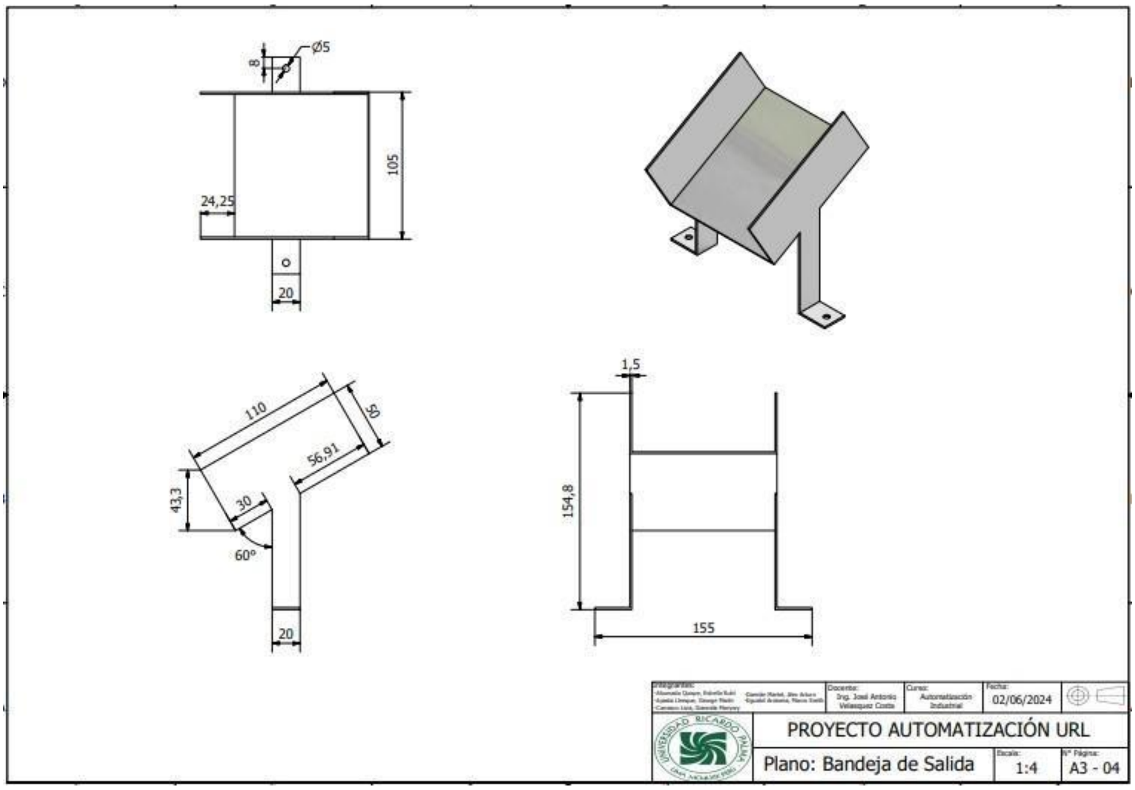
PARTS LIST			
ITEM	QTY	PART NUMBER	MATERIAL
1	1	Plancha de Madera	Wood (Birch)
2	1	Base Metálica de la Faja	Steel, Mild
3	2	Ensamble de Base y Pistón	
4	2	Bandeja de Salida	Aluminum 6061
5	2	Placa de Ajuste	Steel, Carbon
6	4	ISO 4017 - M10 x 20	Steel, Mild
7	4	ISO 7091 - 10	Steel, Mild
8	4	DIN 934 - M10	Steel, Mild
9	1	Rodillo de Faja	PBT Plastic
10	1	Eje de Rodillo	Stainless Steel
11	2	Placa de Ajuste I	Steel, Carbon
12	1	Rodillo de Faja I	PBT Plastic
13	1	Faja	Rubber
14	1	Interruptor	PPS Plastic
15	1	Placa Base de Electroválvula	Steel, Cast
16	1	Electroválvula	Steel, Mild
17	1	Eje de Rodillo I	Stainless Steel
18	1	Placa base Central	Steel, Cast
19	1	Placa Rectangular	PAEK Plastic
20	1	Base de Plancha	Iron, Gray
21	1	Plancha Metálica para Roto	Steel, Galvanized
22	1	Mecanismo Reductor	Steel, Cast
23	1	Conector	Stainless Steel
24	1	Base de Interruptor	Steel, Mild
25	1	Interruptor automático magnetotérmico	PPS Plastic
26	2	Recipiente	PAEK Plastic



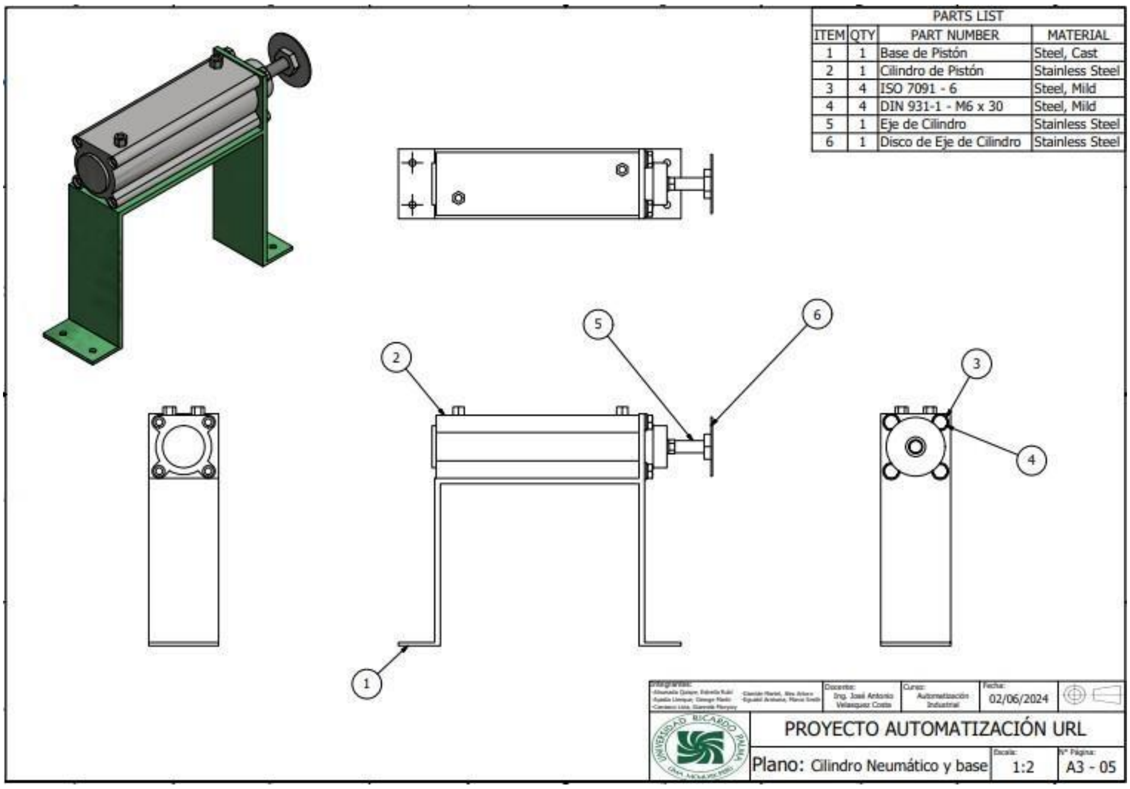
4.4.2. Wooden plank plane

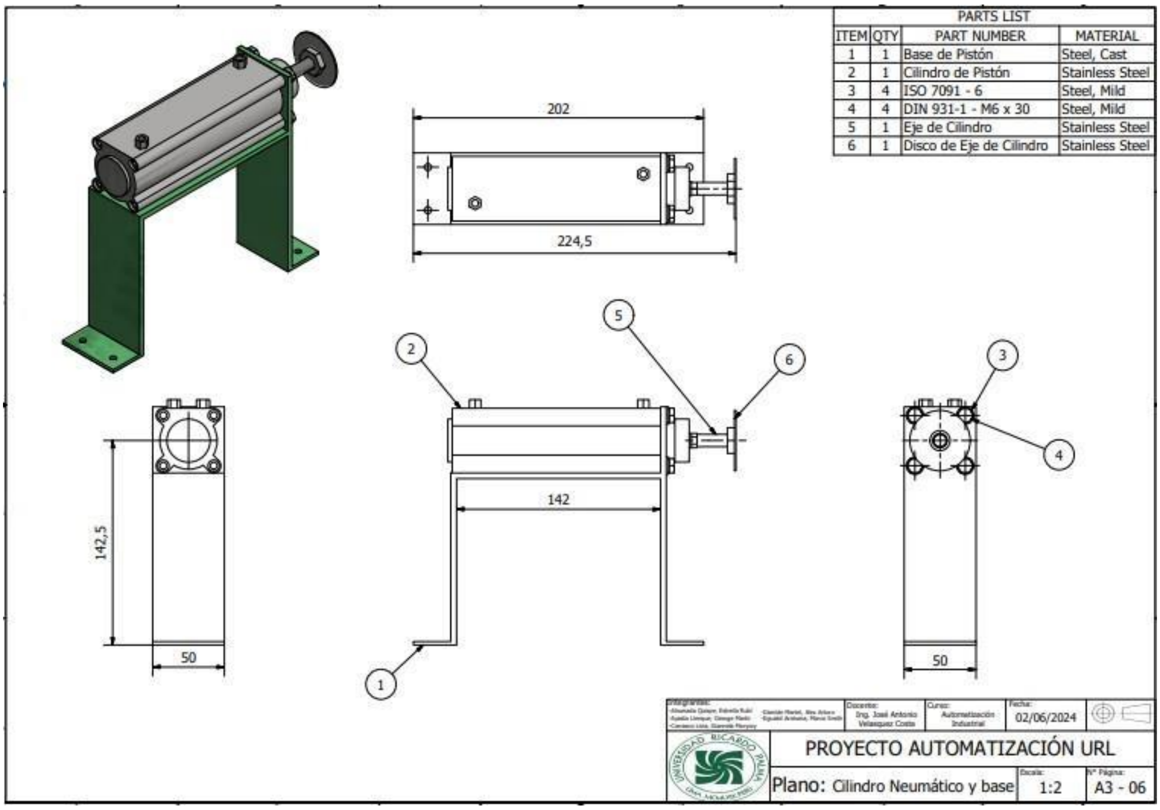


4.4.3. Output tray plane

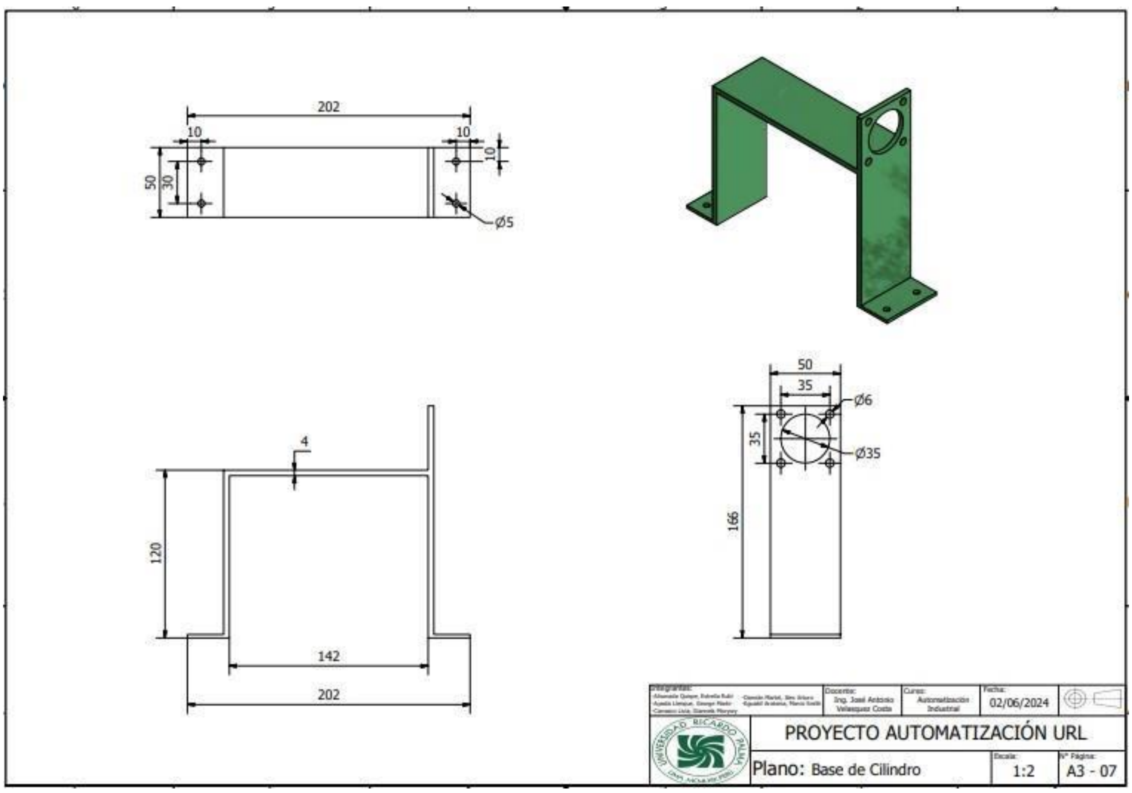


4.4.4. Plane of the pneumatic cylinder and base

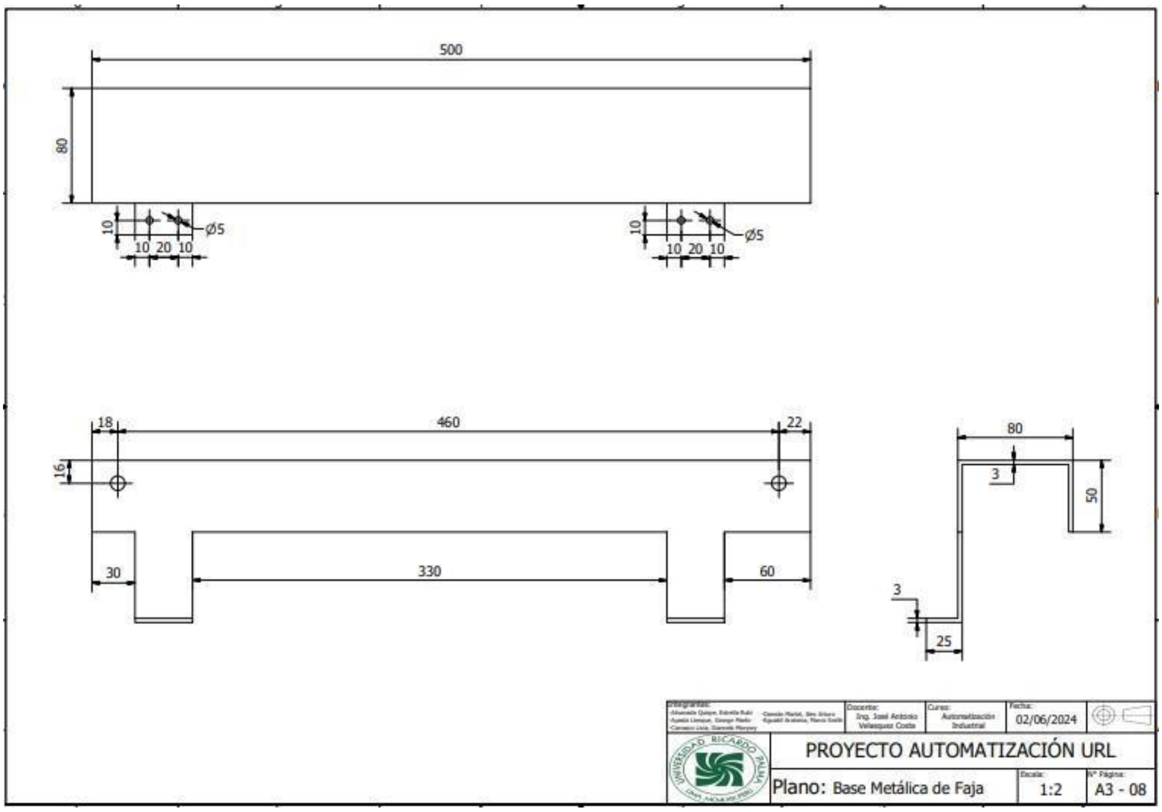




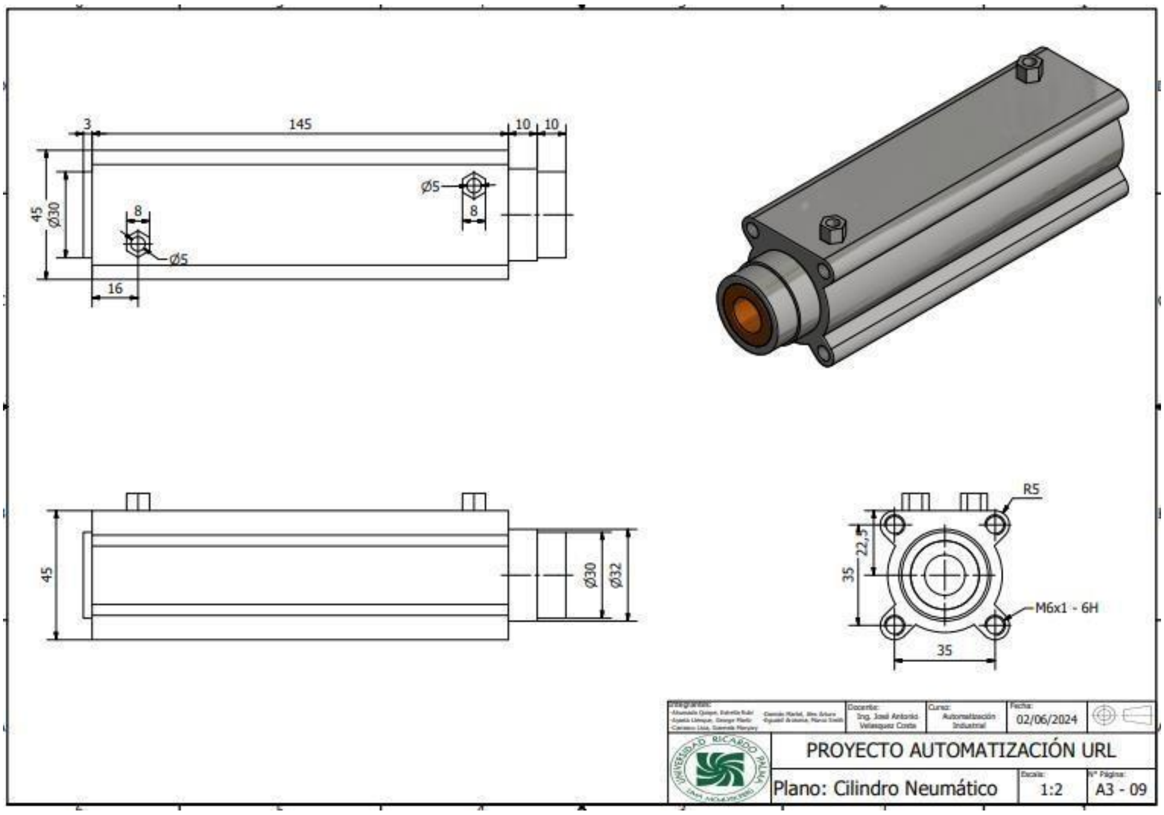
4.4.5. Cylinder base plane



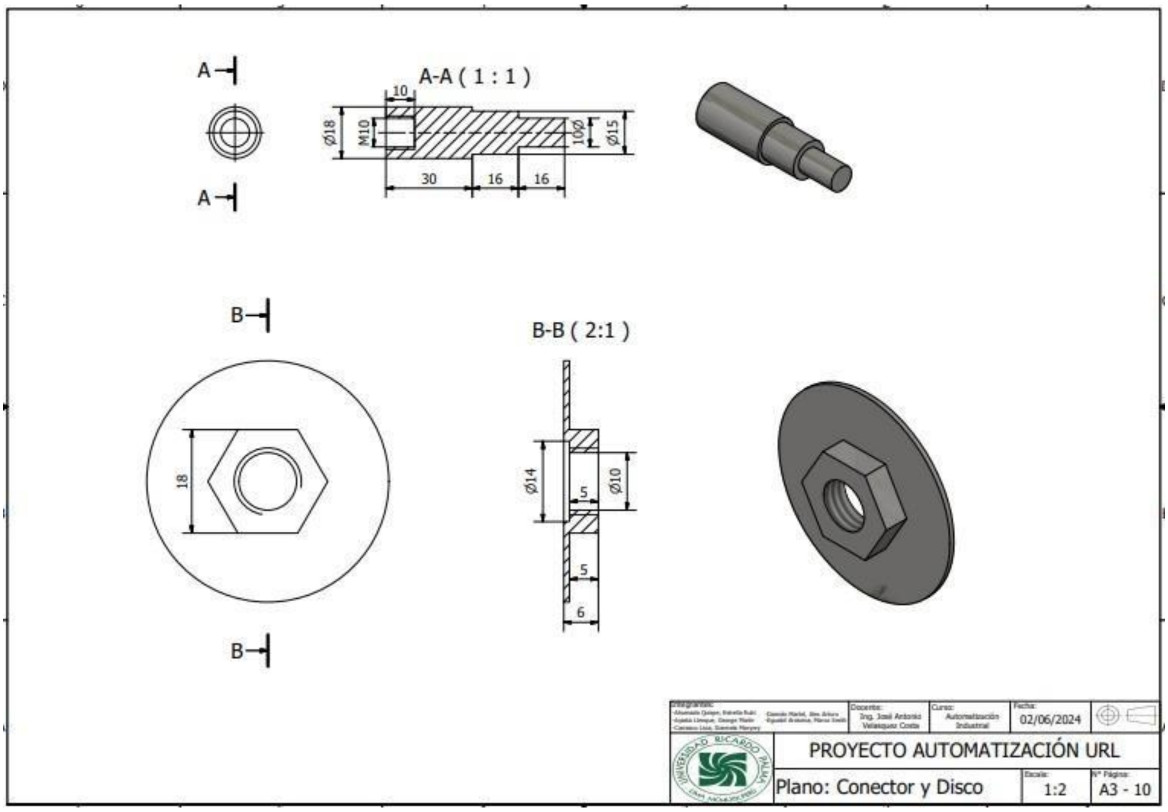
4.4.6. Fascia metal base plan



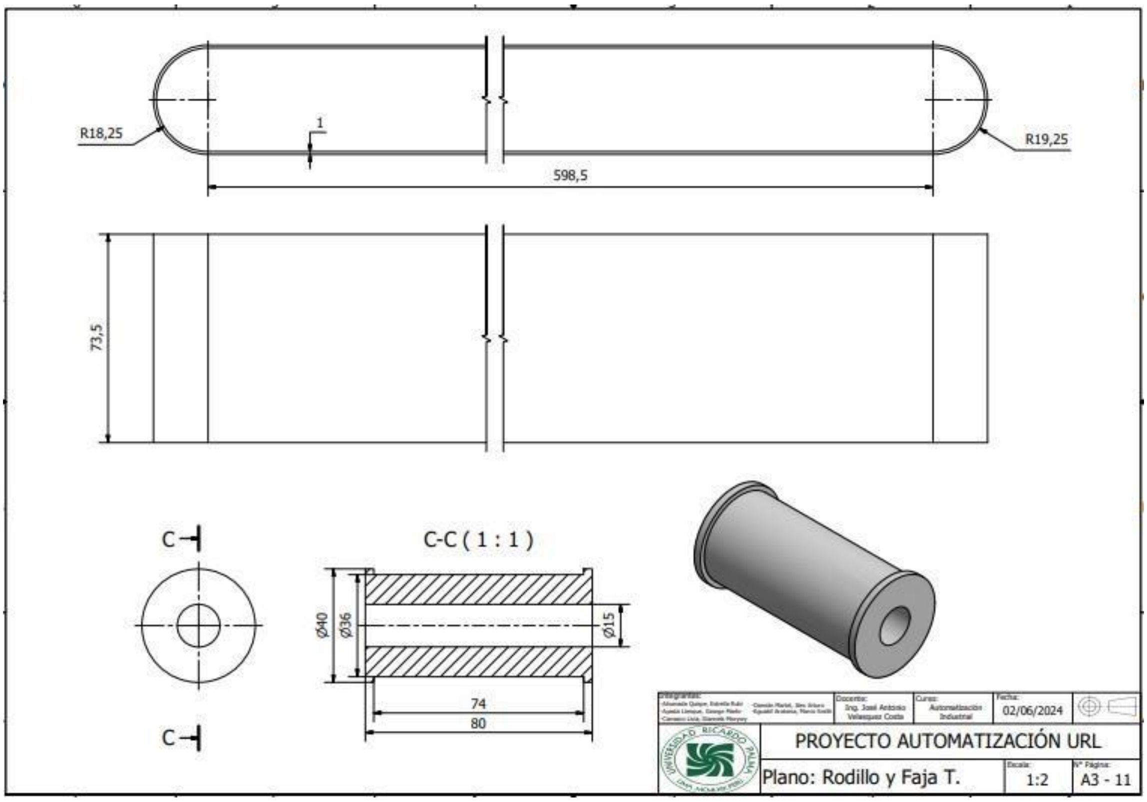
4.4.7. Pneumatic cylinder drawing



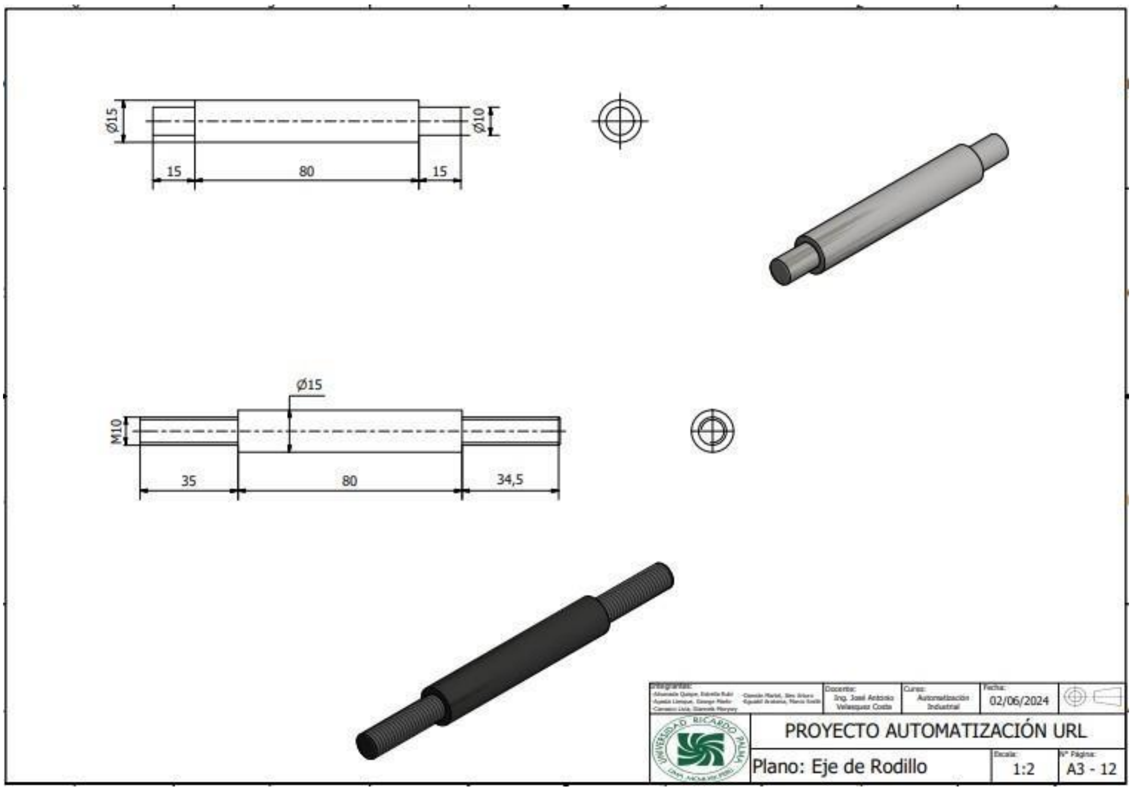
4.4.8. Connector and disk drawing



4.4.9. Roller plane and conveyor belt



4.4.10. Roller shaft plane



4.5. Detailed description of the materials to be used (sensors, pre-actuators, actuators, motors, PLC, etc.)

4.5.1. Pneumatic valves

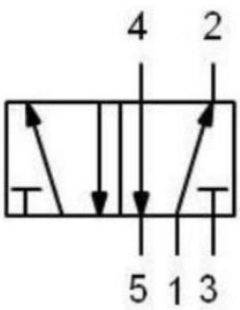
The primary job of pneumatic valves is to distribute and control compressed air within a pneumatic circuit. These control the flow or stop it according to specified instructions. They also determine the course the fluid should take. But as we were programming, we discovered that there are many different types of valves, and it is advisable to fully understand them to acquire the ideal results in both programming and classification.automatic metal and non-metal processes.

They can be divided into four categories by the use of valves: directional, blocking, regulating and sequential. Each one has a particular purpose that is beneficial in some way to the numerous processes already in place.

We will discuss directional valves (also known as distributors) as part of this work because our automatic classification system requires them to distribute compressed air correctly.

There are numerous orientations and locations available for these valves. It is important to realize that the total number of threads and the number of ports on the valve match. The most common combinations are the following:

5/2 Valves (5-way, 2-position): 5/2 valves feature two exhaust connections due to the internal design of the valve, which provides one outlet instead of a common exhaust. The 5/2 valve is most often used to configure a double acting valve so that it moves forward and backward when placed on one valve and remains stationary on the other.



4.5.2. Inductive sensors

One coil, one coreferrite, an oscillator, a circuit detector and a solid state output make up this component. Ferrous components are detected by this sensor.

In the current project, we will use an inductive sensor to distinguish separate metal components in a container.

4.5.3. Optical sensors

The infrared light between an emitter and a receiver acts as a refractive and reflective medium, and when this signal is obstructed by an object, the sensor can detect it.

Optical sensors that can detect counterfeit money and bills are the most common for use.

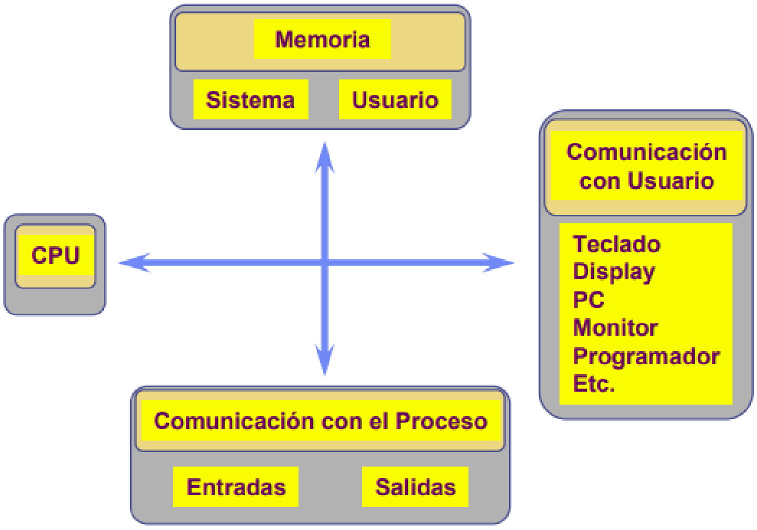
An optical sensor with a mirror will be used, which will detect all the pieces that interrupt the light beam and thus fall into the assigned container to achieve the project objectives.

4.5.4. Programmable Logic Controller-PLC

It is a control system that probes the condition of the equipment or instruments that are attached as inputs. It is required to have a program that manages the instruments or output devices that are connected to it and stores data in memory.

PLC structure:

- CPU
- Memory
- Communication with the Process
- Communication with User



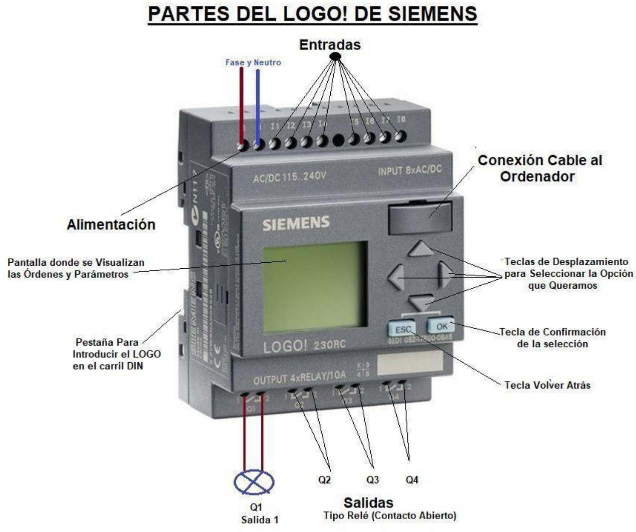
Applications and uses:

- Broadband Technology.
- It can be connected via ADSL or cable.
- The existing network is used.
- Simultaneous transmission of voice and data.
- The trench is not necessary, nor changes, nor wiring.
- Quick and instant action, uses the electrical part already installed for use

Programming a PLC Logo

The technician runs the software described above, which is based on the information collected from the sensors or inputs and takes the necessary actions

(Departures).



4.5.5. ActuatorsLinear

Components called "linear actuators" use linear motion to transform the energy of compressed air into mechanical work.

- Cylinders or pistons

  Pneumatic cylinders are what cause the movement, which convert mechanical work energy in a rectilinear way that is divided into forward and backward movement. There are different types of pneumatic cylinders. The three cylinders are divided into groups based on how the rod is retracted, of which there are: single-acting cylinders, double-acting cylinders and rotation cylinder.

  Likewise, for the research work, the use of a double-acting cylinder will be used.

4.5.6. 24v reducer motor

A geared motor is a very small device that combines a motor and a speed reducer. These are put together into a single unit and used to automatically slow down a device. A gear motor is different since it has multiple parts. The main three, however, stand out. We claim that a couple of pairs are required for this machine to spin because they are essential for its ideal operation. The force that causes the equipment to travel at a certain speed is what is being discussed.

The force that drives a motor is the "starting arrow", which is what it is known as while it is active. They use a variety of measurement units, such as kilograms, meters, pounds, etc. The power of a geared motor is defined as the sum of this first component and the fixed duration of the rotation execution.

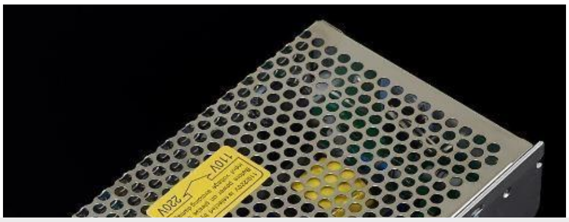
Likewise, the second element along with the speed, allowing the motor to be released. In other words, because torque depends directly on rotational force, the load must be proportional to that force. The power supplied to the gear motor controls how fast the machine rotates.

4.5.7. 220v to 24v source

220v to 24v source also called as power supply, switching supply or 24V electronic device. It is an electronic converter, which is a component that transforms sporadic current into direct current through one or more steps. They function as a unit that raises the voltage to improve the power output as a result of its continuous energization and approval, they move to the next phase, where they lower the voltage once again to increase the power output, when they have reached an acceptable voltage. In addition, the efficiency of switching supplies ranges from 68 to 90%, which reduces the cost of power equipment.

4.5.8. Solenoid valve

Solenoid valves are devices that respond to electrical pulses; it is possible to open or close the valve and thus control the flow of fluids due to the current that passes through the solenoid. A magnetic field attracting the moving core is also produced as current flows through the solenoid. The core returns to its original position once the magnetic field has stopped working, usually as a result of a resource. Software



applications are easier to use for controlling solenoid valves. In addition, a considerable number of industrial systems and divisions use solenoid valves to control fluids such as water, air, steam, light oil, gas, neutrons and others.

4.5.9. Fittings

A pneumatic connector, also known as a pneumatic fitting or connector, is a part used in pneumatic systems to connect its parts, including cylinders, valves, and maintenance units, among others. Although they can occasionally be used with other fluids, their primary purpose is for compressed air. Its link is expert in cooperating with other elements such as hoses, valves and the activation of pneumatic cylinders. The thread type and rigidity of these threads are specified by the NPT standard, also known as National Conical Pipe.

4.5.10. Button panel

The pushbuttons or buttons are made up of a plastic armor that partially protects them from the elements, even if they operate in a similar way to equipment. However, the keypad has 3 buttons which are activated when pressed. For the project, the red button, green button and a wide push emergency stop button were used.

Red Button: The button is operated to stop the devices. This operation does not allow the devices to return to their initial position, which is used to stop the devices.

Green Button: It is activated to start the process and thus begin to operate the devices in normal conditions.

Emergency stop button: Although this button is activated to indicate an emergency, this occurs in the face of danger, which will not only allow the devices to stop but will also return to their initial position.

4.6. Programming in ladder language of the process (comment on each of the segments used in its Ladder programming)

To guarantee the correct performance of the project, the use of a Programmable Logic Controller (PLC) with its corresponding inputs and outputs was required, which were programmed using the LOGO Soft Comfort V8.3 software. For which it was necessary to first define the phases of process.

- Program start:

Start the program and set all the necessary variables and timers.

- Conveyor control:

It uses a coil to start the conveyor motor and makes it move forward continuously.

- Inductive sensor:

It uses a coil to read the state of the inductive sensor.

When the inductive sensor detects a metal part, the coil is activated, sending a signal to start the sorting process for metals.

- Metal classification:

It uses a coil to activate the double-acting cylinder that pushes the metal part towards the metal sorting outlet.

- Photoelectric sensor:

It uses a coil to read the status of the photoelectric sensor.

When the photoelectric sensor detects a non-metallic part, the coil is activated, sending a signal to start the sorting process for non-metals.

- Non-metal classification:

It uses a coil to activate the double-acting cylinder that pushes the non-metallic part towards the non-metal sorting outlet.

- Return to initial state:

Once the sorting process is completed, the system must return to the initial state to wait for the next part.

Timers are set so that there is adequate time between each sorting cycle before the next part is detected and sorted.

- End of program:

The program ends and the execution of the classifier system ends.

4.7. Description and detail of production indicators after automation

- Time

The automated metal and non-metal sorting machine can perform the sorting task faster and more efficiently than manual methods. This can lead to an improvement in sorting efficiency, meaning that a greater amount of materials can be processed in less time.

- Precision

Automating metal and non-metal sorting can reduce human errors that can occur during the manual process. This decreases the chance of improperly mixing materials and improves the overall accuracy of the sorting process.

- Operating Costs

The automated machine can work continuously without fatigue, allowing for consistent material processing and higher output of sorted products.

Although the initial investment in the automated machine may be significant, in the long term it will result in a reduction in operating costs. Automation requires less labor and minimizes costs associated with errors, rework, and downtime.

CHAPTER V: INVESTMENT COSTS

5.1. Budget

AMOUNT	MATERIAL	PRICE
1	24 v gear motor	S/.48.00
1	Polyethylene 30 cm	S/.3.00
2	Bearing 6000	S/.36.00
1	Inductive sensor	S/.55.00
1	Photoelectric proximity sensor	S/.60.00
2	pneumatic piston	S/.600.00
2	Solenoid valve 5/2 24V	S/.140.00
6	Solenoid valve fittings - 6mm hose	S/.60.00
1	3m hose	S/.6.00
1	Button box	S/.25.00
2	Button	S/.12.00
1	Safety button	S/.15.00
1	thermal key	S/.45.00
twenty	Screws	S/.6.00
1	3m cable	S/.10.00
10	Headbands	S/.2.00
3	spray	S/.21.00
1	melamine	S/.80.00
1	Metallic structure	S/.210.00
1	Wad of bills	S/.10.00
2	chokes	S/.30.00
3	Packaging	S/.10.00
	TOTAL	S/.1,484.00

CONCLUSIONS

- The implementation of the automated system on the metal and non-metal sorting line has resulted in a significant improvement in process efficiency. The automated system allows for greater speed and accuracy in the identification and separation of metals and non-metals, which has led to an increase in productivity and a considerable reduction in the time required to complete the process. This has enabled faster processing and greater capacity to handle higher volumes of waste, resulting in an overall improvement in the project's operational efficiency.

- The implementation of the automated system has improved the quality of the recovered materials. By eliminating the subjectivity and fatigue associated with the manual process, greater precision has been achieved in the separation of metals and non-metals, avoiding cross-contamination and improving the purity of the recovered materials. This has resulted in higher quality end products and an increase in the value of recycled materials, contributing to greater economic profitability in the project.

- The implementation of the automated system has reduced the dependence on manual labor in the sorting process. This has led to a decrease in labor costs and increased workplace safety by reducing workers' exposure to potentially dangerous situations. Additionally, by freeing workers from repetitive and monotonous tasks, their well-being has been improved and the opportunity to perform more specialized and higher-value roles in other areas of the project has been provided.

- The implementation of the automated system has promoted more efficient and sustainable waste management. By increasing speed, precision and processing capacity, the amount of waste reaching landfills has been reduced, contributing to the conservation of natural resources and the protection of the environment. Additionally, by improving the quality of recovered materials, it encourages the use of recycled resources instead of extracting new materials, promoting the circular economy and long-term sustainability.

RECOMMENDATIONS

- Conduct a periodic evaluation of the automated system to identify possible areas of improvement. It is important to conduct system performance and efficiency analysis to detect potential deficiencies and optimization opportunities. This will allow for continuous adjustments and improvements to the automated system, ensuring an efficient and accurate sorting process.
- Establish a regular maintenance plan for the automated system. Adequate and periodic maintenance of the system is essential to ensure its correct functioning in the long term. Regular inspections, cleanings and calibrations should be scheduled, as well as repair or replacement of worn parts and components. This will help prevent unexpected breakdowns and maximize system life.
- Implement a real-time monitoring system to proactively detect and resolve issues. Installing sensors and monitoring tools on the automated sorting line will make it possible to quickly detect and respond to any anomalies or malfunctions. This will help minimize downtime and optimize operational efficiency.
- Provide ongoing training to personnel involved in the operation and maintenance of the automated system. As the system evolves and is updated, it is important for operators and maintenance personnel to stay up to date with new features and functionality. Ongoing training will ensure a solid understanding of the system and allow you to take full advantage of its capabilities.

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