UNIVERSIDAD RICARDO PALMA

COLLEGE OF ENGINEERING

PROFESSIONAL DEPARTMENT OF ENGINEERING INDUSTRIAL

RESEARCH WORK

Automated Potato Chopper Prototype

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Summary

This project is an automation proposal for a potato chopper that aims to optimize productivity and efficiency. Given the educational context of the project, a descriptive research was carried out by reviewing research documents such as educational programs and scientific journals on the topic. Direct observation of the machine condition was also carried out for diagnostic purposes. The information was discussed with third parties (the teachers involved in the construction of the machine) to subsequently obtain information that would allow the construction and design of the grater automation system, which involved the following procedure: the description of the system implemented for automation where The electrical system was manually designed with PLC and the structure was graphed in CAD. And finally he proceeded to do tests to check its operation.

Keywords: implementation, improvement, production system, Grater, PLC, use, automation.

Abstract

The present project is an automation proposal for a grater machine that aims to optimize productivity and efficiency. Given the educational context of the project, a descriptive research was carried out by reviewing research documents such as educational programs and scientific journals on the subject. Direct observation of the condition of the machine was also carried out for diagnostic purposes. The information was discussed with third parties (teachers involved in the construction of the machine) to subsequently obtain information that would allow the construction and design of the automation system of the grater, which involved the following procedure: the description of the system implemented for automation where the electrical system was designed manually with PLC and plotting the structure in CAD. And finally proceeded to make tests to check its operation.

Key words: implementation, improvement, production system, Grater, PLC, utilization, automation.

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INTRODUCTION

In a world increasingly focused on efficiency and process optimization, automation has become a key tool in the food industry. In particular, the automation of potato mashers has changed the way many restaurants and food companies process this staple food.

A potato chopper is an essential tool for cooking a variety of dishes such as French fries, mashed potatoes, baked potatoes, and more. However, doing this process manually is physically demanding and can be time-consuming. This is where automation comes in, which brings important benefits in terms of efficiency, quality and profitability.

This automation can simplify manufacturing, reduce operating costs, improve cutting consistency, and ensure a high-quality final product. Additionally, it is important to understand how this innovation can change the way this important ingredient is handled and processed. With the right tools and technology, processes can be optimized, productivity can increase, and ultimately, quality products can be delivered to consumers more efficiently.

This project aims to implement the automation design of a potato chopper. Therefore, the concepts and definitions of each element that makes up this project and a review of the theoretical background related to the project will be explained in a general way.
Subsequently, a description of the automated process and its structural design will be made.

CHAPTER 1 – THEORETICAL FRAMEWORK

- **Theoretical foundation**

-Automation

In technical terms, automation refers to the automatic operation of a machine or group of machines designed for a single purpose, allowing various industrial, administrative or research tasks to be performed with little human intervention. The term automation is also used to describe non-manufacturing systems in which programmed or automated machines can operate independently or partially independent of human control.

-Automated potato chopper

-Importance

An automated potato chopper has several advantages and importance where it is done quickly and efficiently, increasing productivity. Some of the reasons why an automated grater isimportant are as follows:

- Time savings: Automation allows cutting potatoes quickly and accurately, eliminating the need to perform this task manually. This saves considerable time in production, as large quantities of potatoes can be processed in a short period.
- Increased efficiency: By eliminating manual intervention in the chopping process, errors and inconsistencies in the size and shape of cuts are reduced. This ensures greater uniformity in the final product, which in turn improves the presentation and qualityof prepared foods.
- Reduced operating costs: Potato chopper automation can helpreduce labor costs associated with manual chopping. In addition, by minimizing errors and waste, the use of ingredients is optimized, which contributes to a reduction of production costs.
- Increased production capacity: With an automated potato chopper, it is possible to process a larger quantity of potatoes in a given period of time. This allows production capacity to be increased without compromising quality and ensures a faster response to market demand.
- Improved safety and hygiene: By automating the chopping process, the risks associated with manual handling of cutting tools are reduced. This helps improve worker safety and minimizes the possibility of injury.

Additionally, automation can also include cleaning and disinfection features, which improves the hygiene of the process.

- Space optimization: Automated potato choppers usually have a compact and efficient design, which helps to make the most of the available space in the kitchen or production area. This is especially beneficial in dining establishments with limited space.

-Recommendations for use

- Perform regular maintenance: Follow the manufacturer's recommendations for routine maintenance of the automatic potato chopper. This may include cleaning, lubricating moving parts, and checking for wear or damage. Proper maintenance extends the useful life of the equipment and ensures its correct operation.
- Train personnel: Be sure to provide appropriate training to all employees responsible for using the automated potato chipper. This includes knowledge of controls, proper potato filling, necessary adjustments, and safety procedures. Propertraining can reduce errors and reduce the risk of accidents.
- Maintain proper cleanliness: Hygiene is crucial in the food industry. Be sure to regularly clean and disinfect your automatic potato masher according to the manufacturer's instructions and recommendations. This will help prevent cross contamination and ensure food safety.
- Monitor operation: It is important to monitor the operation of the automated chopper during use. This will allow you to identify possible problems or failures in the process and take corrective measures in a timely manner. Additionally, constant supervision will help ensure the safety of operators and the quality of the final product.
- Familiarize yourself with its operation: Read and understand the instructions for use of the automated potato chopper before using it. Make sure you understand how to properly set up and operatethe equipment.
- Safety: Be sure to follow safety precautions and use any guards or safety equipment provided with the automatedchopper.

-Production system

The automation production system refers to the integration of different components and technologies to carry out the manufacturing or production of goods or services in an automated manner. This system is designed to optimize production processes, improve efficiency, reduce costs and minimize human intervention in repetitive and low value-added tasks.

- **PLC**

According to DIEEC (2021) "A programmable logic controller, commonly known as PLC (Programmable Logic Controller) in English, is basically a computer that is used in automation engineering for industries, that is, for the control of manufacturing machinery. a factory or mechanical situations.

These are programmable electronic devices that can be adapted to the needs of your company or factory, especially in production lines. There are different providers that will help program each of these devices, with the aim that it works correctly, but, above all, that it is personalized for the use of your company.

It is also known as an electronic brain, responsible for driving other machinery components to carry out actions that could be dangerous for human beings or very slow if done manually.

They are currently used for industrial applications, although there are already casesin which they are applied for domestic or commercial uses.

- **Sensors**

According to Torres and Fernandez (2019), sensors are electromechanical instruments that transform physical magnitudes into quantifiable values of those magnitudes. It is a device designed to capture a stimulus from its environment and translate that information it receives. This information received is normally converted to an electrical impulse that is subsequently processed by a series of circuits that generate a predetermined action in a device, system or machine. It is an artifact that in some applications transforms one type of information into another that you want to measure or control.

Sensors react to changes in physical conditions by altering their electrical

properties. Therefore, most of these industrial devices depend on electronic systems to capture, analyze and transmit information aboutthe environment. These electronic systems are based on the same principles as circuits electrical to function, so the ability to control the flow of electrical energy is very important. That is, a sensor converts stimuli such as heat, light, sound and movement into electrical signals. These signals are passed through an interface that converts them into binary code and passes it to a computer for processing.

- **Actuators**

According to Sicma21 (2022) An industrial actuator is a device responsible for generating movement by converting the energy and signals it receives within the system. Depending on their design and function, actuators can produce rotary or linear motion.

The actuator consists of a closed cylinder with a piston inside that slides and transmits its movement to the outside through a rod. It consists of the rear and front covers, the sleeve where the piston moves, the piston itself, the static and dynamic piston seals and the scraper ring that cleans the stem of dirt. Actuators, regardless of their construction, represent the most common actuators used in pneumatic circuits.

There are two fundamental types from which special constructions are derived.

- Single acting cylinders, with an air inlet to produce a working stroke in one direction.
- Double-acting cylinders, with two air inlets to produce output and reverse working strokes.

Single-acting cylinders A single-acting cylinder performs work in only one direction. The plunger is returned by means of an internal spring or by some other external means such as loads, mechanical movements, etc. It can be "normally in" or "normally out" type. Single acting cylinders are used for clamping, marking, ejecting, etc. They have somewhat lower air consumption than a double-acting cylinder of the same size. However, there is a reduction in momentum due to the counterforce of the spring, so it may be a somewhat larger internal diameter is necessary to achieve the same force. Also the adaptation of the spring results in a longer overall length and a limited stroke length, due to dead space.

- **Programming**

According to Pérez-Palencia (2017), programming is considered a technical activity intended mainly for a group of the population in the field of computer and computer engineering. This is mainly due to the high level of abstraction it requires and the complexity necessary for its development. However, for some time now efforts have been made to overcome these limitations through programming that has a visual language, as well as facilitating any type of projects and activities, sharing and disseminating them, and promoting the use of multimedia resources. In addition, objects are created that materialize these abstract codes, making what is planned visible and promoting student motivation by seeing their progress.

- **Ladder language**

The ladder language is widely used in industrial automation due to its graphical nature and similarity to traditional electrical schematic diagrams. It allows PLC programmers to intuitively design and debug control programs because it resembles circuits used in industry. It is worth noting that while the ladder diagram language is widely used, there are other PLC programming languages, such as Basic Instruction Language (BIL) and Structured Text Languages (ST), which are also used in various automation environments and applications.

Normally open contact (E1): if the associated variable E1 is '0', the contact remains open, and if it is '1' it closes.

- Normally closed contact (E2): if the associated variable E1 is '1', the contact remains open, and if it is '0' it closes.
- Output, coil or relay (S1): the associated variable S1 will take the value of the variable (or combination of variables) that is at its input (left side connection

  point). It can also be locked or unlocked, indicated with an S or R as indicated in the cases of S2 and S3.

Objective

The project aims to design and implement an automated kitchen instrument that can simplify tasks in the kitchen in order to reduce the time when chopping for production lines that use this raw material and reduce the intervention of operators and thus reduce the risk of cuts.

General objective

Develop an automated system for chopping potatoes.

Specific objectives

a. Implement actuators, sensors and control technology to automatically monitor and adjust the speed and pressure of chopping, ensuring the quality and safety of the process.
b. Program and develop a system to control the automated system, facilitating its operation.
c. Optimize the automated system to maximize productivity and thus reduce potato chopping time.

CHAPTER 2 – DETAILED DESCRIPTION OF THE CURRENT PROCESS

Currently, restaurants do not have machinery that satisfies the process of chopping potatoes in the same item, which causes misuse of resources such as time, space and money when carrying out this task.

This task in restaurants ranges from receiving potatoes in restaurants, manual operation of washing and peeling potatoes and chopping them so that they are ready to be cooked, which takes more time and sometimes does not satisfy market demand.

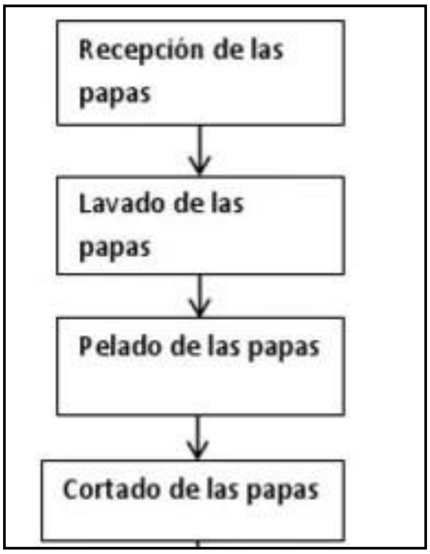

Figure 02 Operation diagram of the manual potato chopping process.

Source: self made

2.1 Process description

The operation of our project proposal begins by pressing the start button (green), which will cause our sensor to activate in this way it will detect the presence of the object (potato). With the help of compressed air, which will pass through the 6 mm hoses, going to the 5/2 valves, it distributes the compressed air to the actuators; This air will be controlled and regulated by the choke valves to regulate the entry ofair to the actuators. The first actuator will work once the object has been recognized, it will take it towards the chopper, and when the object falls it will return to its original state, the second actuator willexpand when the object is in position on the grid, thus cutting the potatoes and this obtaining a neutral final result. Finally, the second actuator will return to its initial position and we will proceed to press the stop button (red), and this will be the end of the process; The total time it takes to chop is around 6 seconds, from when it recognizes the potato until it chops it, the force applied by the cutter will depend on the air that enters through the actuator, the more air that enters, the more force it will have. the actuator and will cut the potatofaster.

2.3 Description and details of production indicators beforea utomation

- **Production time:**This production indicator, known as cycle time, allows measuring the duration necessary to produce potatoes. To calculate it, the moment in which the production order is started is taken as the starting point and the moment in which the product is considered finished as the end point.

  In the case of the project in question, this indicator is high before the implementation of automation. This is because manual activities require more time to complete, due to planned or unplanned stops, as well as imprecise movements that slow down the process.

- **Quality performance:**In this case, the production key performance indicator (KPI) focuses on analyzing the percentage of potatoes chopped without errors. This involves determining the number of chopped potatoes that meet the quality standards established at the end of the production chain. Because the process is manual, there is a greater probability of human error occurring during chopping, since the precision is not constant. These errors can negatively affect yield, decreasing the quality of already chopped potatoes.

- **Rejection rate:**The rejection rate is a key performance indicator (KPI) that evaluates the number of potatoes that do not meet established quality standards.

  In non-automated processes, this indicator tends to be high due to the lack of precise and uniform scheduling that ensures that products are manufactured exactly within the parameters established for an acceptable product. This leads to a greater number of poorly chopped potatoes, since the required quality criteria are not met.

CHAPTER 3 – CURRENT PROCESS DESIGN

3.1 Image of the current situation of the manual process of chopping potatoes.

Figure 03 Current way of chopping potatoes in restaurants

Source: Dreamstime

CHAPTER 4 – PROPOSAL DESIGN TO AUTOMATE THE PROCESS

4.1 Detailed description of the proposed process

The project will start by pressing the start button (green), which will cause our sensor to activate in this way it will detect the presence of the object (potato). With the help of compressed air, which will pass through the 6 mm hoses, going to the 5/2 valves, it will distribute the compressed air to the actuators; This air will be controlled and regulated by the choke valves to regulate the entry of air to the actuators.

The first actuator will work once the object has been recognized, it will take it towards the chopper, and when the object falls it will return to its original state, the second actuator will expand when the object is in position on the grid, thus cutting the potatoes and thus obtaining our final result. Finally, the second actuator will return to its initial position and we will proceed to press the stop button (red), and this will be the end of the process; The total time it takes to chop is around 6 seconds, from when it recognizes the potato until it chops it, the force applied by the cutter will depend on the air that enters through the actuator, the more air that enters, the more force it will have. the actuator and will cut the potato faster.

4.2 Lader circuit for PLC function

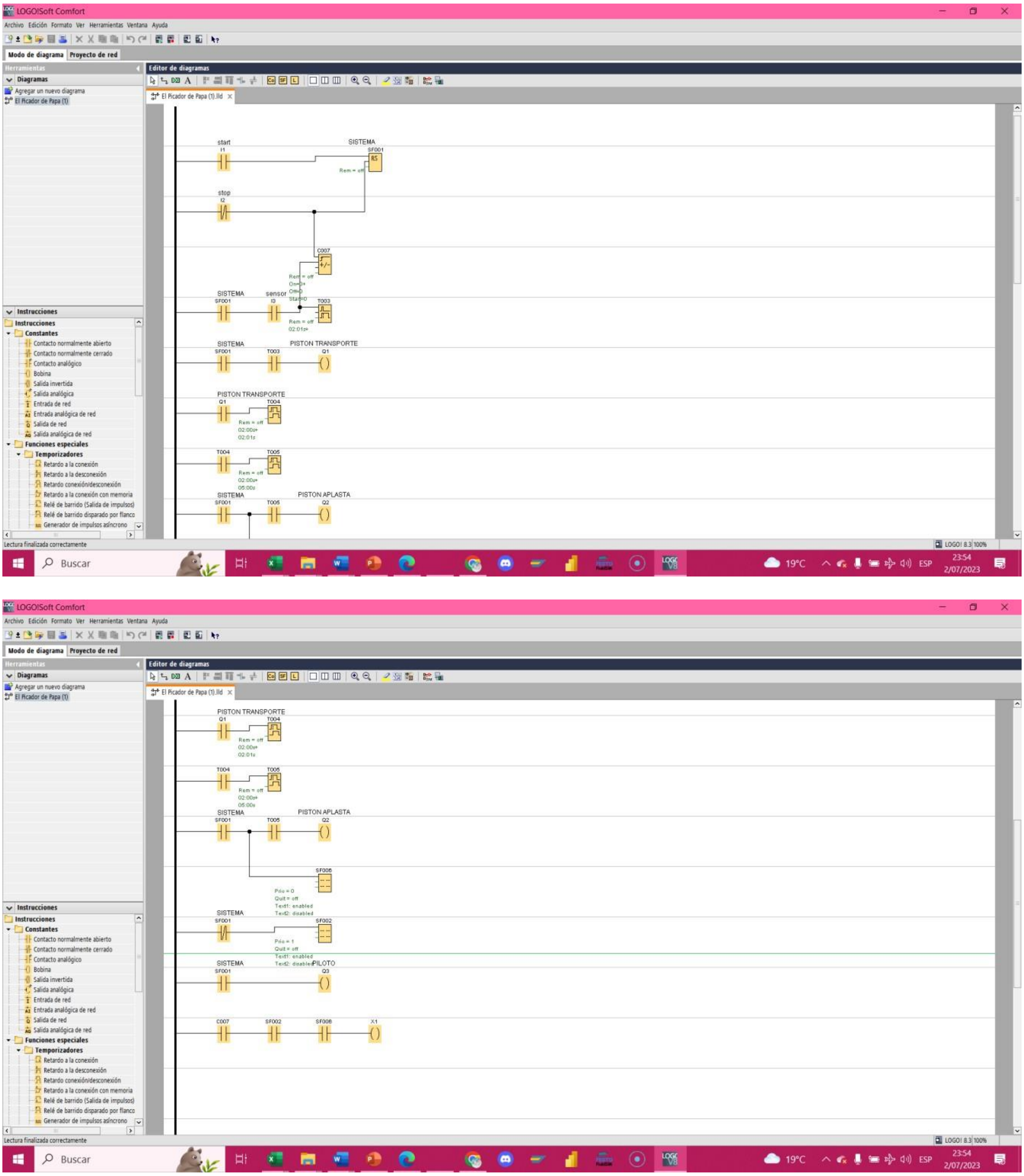

Figure 04 Lader Logo Circuit

Source: self made

The proposal for an improvement design that automates the process is to build an industrial chopper.

For this, the following elements are required:

A tank with side blades, this alternative consists of introducing the potatoes previously peeled in a tank, which has blades located on a wall that serves as support, such as which is shown in the following figure:

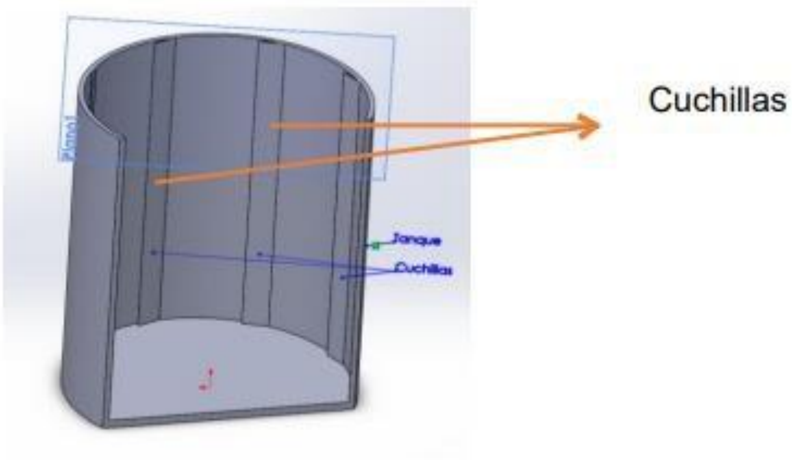

Figure 05 Tank with blades

Inside, if we open the cylinder shown we would have two perpendicular rectangular plates that are responsible for making the potatoes collide with the blades. The dimensions of the cylinder have a thickness that depends on the size and thickness of the potato that we want to obtain. We can observe the following figure of the open cylinder plane:

Figure 06 Internal disk with plates

CHAPTER 5 – INVESTMENT AND OPERATION COSTS

5.1 Cash flow

In the food potato chopping industry, the equipment, machinery and accessories are made of stainless steel. These equipment are depreciable over time and even have a residual effect for the industrial use of them. In this case we will use a prototype of anautomated potato chopper

Table 01: Table of Materials Necessary for the Process

MATERIAL	CANT	UNID	PRECIO	
			UNIT	TOTAL
Actuadores de doble efecto 15 cm	2	Unid	90	180
Electroválvulas de 5/2	1	Unid	60	60
Valvulas de Ahorcamiento	3	Unid	8	24
Sensor Fotoeléctrico	1	Unid	180	180
Base del picador	1	Unid	80	80
Botonera	1	Unid	60	60
Base Soldada	1	Unid	50	50
Tornillos	35	Unid	0.25	8.75
Tuerca	25	Unid	0.3	7.5
PLC Saimens 4 entradas	1	Unid	600	600
Fuente de alimentación de 24V	1	Unid	80	80
Cable multifilar calibre 18	5	mts	1	5
Manqueras de 6	5	mts	3.5	17.5
Cable galvanizado de 18	2.75	mts	2.25	6.1875
Pulsador de botones	1	Unid	50	50
Estructura de metal de picado	1	Unid	40	40
EQUIPOS Y HERRAMIENTAS				
Taladro de mano 12 V	1	Unid	90	90
Destornillador milimetrico	1	Unid	3	3
Destornillador	1	Unid	3.5	3.5
Sierra	1	Unid	2.5	2.5
Cinta	1	Unid	2	2
Silicona	1	Unid	5	5
TOTAL				**1554.9375**

Own Preparation

Intangible assets

This type of investments are made in assets that are constituted by the acquired services or rights that are essential for the implementation of the project and that are susceptible to amortization.

Table 02: Table of Intangible assets

BIENES INTANGIBLES	VALOR
Estudios de proyectos	150
Imprevistos	100
Total	**250**

Own Preparation

Working Capital

For the daily operation of the chopped potato production schedule, working capital is the first early requirement for the start of the process inthe first 3 months.

Table 03: Working Capital Table

	1	2	3
Materia Prima e insumos			
Papas	2000	2000	2000
Mano de Obra			
Operarios	1025	1025	1025
	TOTAL		**3025**

Own Preparation

Investment

Table 04: Total Investment Table

INVERSION	
Activos Tangibles	1554.9375
Activos Intangibles	250
Capital de trabajo	3025
Total	4829.9375

Own Preparation

Table 05: Income Projection

	Año 0	Año 1	Año 2	Año 3	Año 4	Año 5
Proyeccion de la Demanda		2,500	2,500	2,500	2,500	2,500
Precios unitarios de productos		30.00	31.25	32.75	33.25	34.75

Own Preparation

Table 6 and 7 shows the flow of inputs and outputs of the economic operations of the production of grated cheese over the 5-year horizon, considering a residual income in year 5, from the sale of some equipment or machinery that has already been paid for. depreciation effect its price, on the other hand in year zero the investment and costs such as working capital and the value of tangible and intangible fixed assets are considered.

Operating Cash Flow

Table 06: Operating Cash Flow

FLUJO DE CAJA						
Descripción	Año 0	Año 1	Año 2	Año 3	Año 4	Año 5
Total de Ingresos		S/ 60,000.00	S/ 61,000.00	S/ 62,000.00	S/ 63,000.00	S/ 64,000.00
Costos		S/ 31,000.00	S/ 32,000.00	S/ 33,000.00	S/ 34,000.00	S/ 35,000.00
Depreciación		S/ 6,222.63	S/ 6,222.63	S/ 6,222.63	S/ 6,222.63	S/ 6,222.63
GANANCIA ANTES DE IMPUESTOS		-S/ 33,510.63	-S/ 35,094.27	-S/ 36,725.41	-S/ 38,405.50	-S/ 40,135.98
Impuesto a la Renta		S/ 4,500.00	S/ 5,100.00	S/ 5,800.00	S/ 6,200.00	S/ 6,300.00
Depreciación		S/ 6,222.63	S/ 6,222.63	S/ 6,222.63	S/ 6,222.63	S/ 6,222.63
Flujo de Caja Operativo		**S/ 31,788.00**	**S/ 33,971.64**	**S/ 36,302.79**	**S/ 38,382.87**	**S/ 40,213.36**

Economic Cash Flow

Table 07: Economic Cash Flow

INVERSIONES						
Activos	-S/ 1,554.00					
Recuperación de Activos		-S/ 1,558.00	-S/ 1,629.00	-S/ 1,692.00	-S/ 1,782.00	-S/ 1,890.00
Capital de Trabajo	-S/ 4,829.00					
Recupero de Capital de Trabajo						
Flujo de Inversiones - FI	-S/ 6,383.00	-S/ 1,558.00	-S/ 1,629.00	-S/ 1,692.00	-S/ 1,782.00	-S/ 1,890.00
Flujo de Caja Económico - FCO	**-S/ 6,383.00**	**S/ 30,230.00**	**S/ 32,342.64**	**S/ 34,610.79**	**S/ 36,600.87**	**S/ 38,323.36**

Own Preparation

5.2 Economic viability (NPV, IRR)

a) Net present value (NPV)

The net present value (NPV) is an investment criterion that consists of updating the net cash flows that the project will generate to know how much will be gained or lost with that investment, discounted at a certain interest.

b) IRR

IRR or Internal Rate of Return is one of the most recommended methods for evaluating investment projects. It is frequently used to analyze the viability of a project and determine the rate of profit or profitability that can be obtained from said investment.

Table 08: Economic viability table

TIRE	***310%***
COK	***20%***
VANE	***S/ 61,125.78***

The IRR and NPV indicators show that they are greater than the shareholder's opportunity cost(COK), meaning that the viability of the investment is profitable.

CONCLUSIONS

1. Our project can increase efficiency in food preparation, because it will reduce time when cutting potatoes. This may be useful in restaurant kitchens or environments where large quantities of chopped potatoes are needed.

2. Additionally, by using the potato chopper, the risk of injury associated with the use ofsharp knives will be minimized.

3. In general, the use of a potato chopper can improve the efficiency, safety and quality of food preparation involving potatoes. However, it is important to consider the costs associated with acquiring and maintaining the machine, as well as the need for proper training for its correct use.

4. It is concluded that the PLC has been a very useful tool for the potato chopper project since it contains the program so that the circuit can be made.

RECOMMENDATIONS

1. It is recommended to do a detailed analysis of the implementation costs, the PLC, the mechanical components, the installation, etc. This is essential to evaluate whether the project is financially viable, however, it should also be taken into account to evaluate the benefits in order to have greater knowledge of whether it is profitable or not.

2. It is recommended to have a preventive and corrective maintenance plan for the automated grater, where maintenance routines are established to ensure that spare parts are obtained and also have trained personnel in case of machine failure.

3. It is recommended to implement a monitoring and tracking system to evaluate the performance of the automated grater; an analysis must be carried out continuously toidentify possible optimization improvements.

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