Implantation of the RFID System: an Application in a Plant Company in the Forest Zone of Minas Gerais State

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Abstract

The aim of this article is to analyze the RFID system implantation in the orders separation from a plant company in the Forest Zone of Minas Gerais State in order to reduce the failures committed in this phase, improving the company's shipping process. For this, a prototype of the RFID system was developed to demonstrate its operation. With it, it is possible to identify the plants orders qualities and quantities, enabling them to be conferred. This way, it will avoid the failures in the shipping process, ensuring that the company does not stop billing the plants not sent as requested by the customer. In addition, the financial analysis, using the discounted payback method, was performed to the proposed vimplantation of this system, noting that the return will occur in 4 years, 4 months and 13 days.

Keywords: *Shipping process, RFID, Prototype.*

I. INTRODUCTION

According to [1], over the years logistics has become one of the main tools in the search for competitiveness. Some questions that involve the importance of logistics and their processes have a sudden impact on the way which companies are seen in the market, being visible in their level of service. Organizations are looking for tools and strategies that extend services to their customers, streamlining the informative process in the supply chain.

According to [2], the orders separation plays an important role in serving the needs of customers, since this task must ensure the correct handling of the goods. This activity accounts for 60% of the distribution center costs.

The companies, according to [2], have adopted the use of technology to improve processes, products and services, which adjusted with equipment and structure can proceed an improvement in the level of service provided to the client, signals in a better result for the company. In this context, using RFID (Radio Frequency Identification) it is possible to automate the identification of items.

The general aim of the present study was to propose the RFID system implantation in the orders separation from a plant company in the Forest Zone of Minas Gerais State to minimize the mistakes made during this phase, improving the company's shipping process. In addition, a prototype was made with the purpose of demonstrating the operation of the same. The specific aims were to verify how many orders are with its variety and quantity divergent from the one requested by the customer at the time of logistics, to determine the amount that was not invoiced due to the separation errors in and to carry out the financial analysis for the RFID system implantation.

II. MATERIALS AND METHODS

For the development of the article in question, bibliographical research was carried out which according to [3], includes the collection of data through books, journals, articles, academic and specialized websites, from April to October 2018. The company under study is located in the Forest Zone of Minas Gerais State and operates in the plants production and commercialization area.

Data collection in this company occurred from June to August 2018, where it was possible to understand the shipping process of the same. For this purpose, a flow chart of the process was elaborated using the software Excel 10, which according to [4], allows the organization and visualization of the information in a facilitated way through the inclusion of graphic elements, besides the insertion of formulas and functions to perform calculations. The flow chart according to [5], comprises the graphical representation of easy understanding that portrays the sequence of an activity, demonstrating the process stages. In addition, data collection enabled the total number of requests received and how many of these at the time of logistics are with its quantity or variety divergent from the requested by the customer. As a result, it is possible to determine the value not invoiced with the plants that were not sent.

For this calculation, each request is analyzed with respect to the value and quantity of a particular variety not sent, and then multiply the value by the

quantity to obtain the unbilled value for that variety. In addition, the sum of all values calculated by variety is taken to obtain the total value that is no longer invoiced.

As a proposal to solve the problem, a prototype was constructed to demonstrate the performance of an RFID system. The prototype, according to [6], aims to demonstrate the realization of the projected functions of an object, so that the tests are done in their non stable environments, real or similar to real environments. For the construction of the prototype, the following components were used:

- Arduino Board One;
- USB cable for Arduino;
- RFID-RC522 reader module;
- 13.56Mhz RFID key ring tag;
- 16x2 LCD display;
- 400-point protoboard board (2 units)
- Male-male jumpers;
- Potentiometer B 10k;

The Arduino, according to [7], acts as a microcontroller, allowing to optimize electronic resources and improve the quality and final cost of the products. It is characterized as an embedded platform with inputs and outputs, as shown in Fig. 1, which enables it to be programmed to perform various functions. The USB cable for arduino, shown in Fig. 2, was used to connect the arduino to the computer. The C / C ++ language is used as the basis for the programming developed in this platform.

Fig. 1: Arduino

Fig. 2: USB cable

According to [8], RFID is short for Radio Frequency Identification. Using radio waves, this system grants identity to an electronic tag. Tags are able to identify or locate specific information on a given product, and have the potential to store more information than the bar code. Through a reader it is possible to read the information included in the labels and to make the communication between the devices through the radio frequency waves. Fig. 3 illustrates the reader and tag used for the development of the prototype.

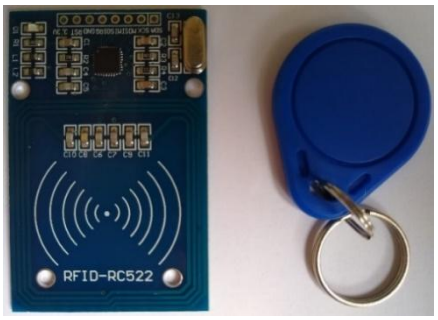

Fig. 3: RFID reader and tag

Since labels can be classified in two ways, according to [9], active, passive and semi-passive. The active ones have a battery to supply the energy that will diffuse the signal. Because they do not have a battery, the passive tags are cheaper and the energy comes from the waves emitted by the reader that causes in the tag antenna a current. Due to this factor, the passives have a restricted reading range which riquires from the readers an increase of the power sent. Althought, to the semi-passive it is essential to use the battery and the waves emitted by the reader.

According to [9] and [10], the companies interest in the RFID technology use has been growing in a notable way in the logistics sector, aiming to improve the efficiency of operations in the storage and handling of materials, besides being a competitive differential for the organizations. [9] states that this system allows the identification of people and objects automatically through the radio waves, which results various types of applicability.

The Liquid Crystal Display (LCD), shown in Fig. 4, according to [11] is the man-machine interface used to perform the communication between the equipment and the user, showing the operations performed on the system.

Fig. 4: LCD display

According to [12], in the protoboard, shown in Fig. 5, the electronic circuits are assembled, which by having a metal plate disposed below the holes connected in horizontal and vertical do not use the weld, it being possible to use the jumpers for the prototyping of the circuits.

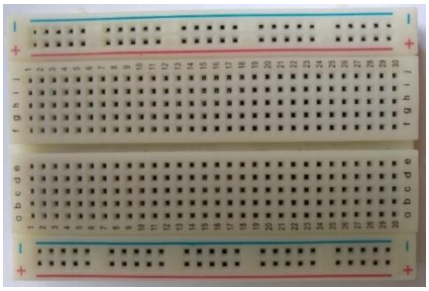

Fig. 5: Protoboard

Still according to [12], the jumpers are composed of a metallic conductive wire covered by an insulating material that has the purpose of making the connection between two distinct points of the electronic circuit, as shown in Fig. 6.

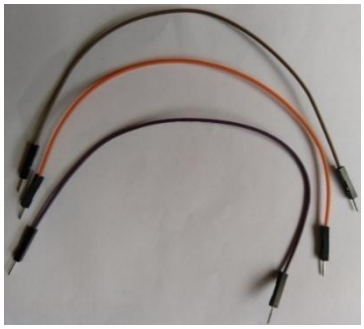

Fig. 6: Jumpers

According to [13], the potentiometer is a variable resistor that in this work will be used to control the luminous intensity of the LCD display, as shown in Fig. 7.

Fig. 7: Potentiometer

For the construction of the prototype the connections were made between the arduino, the LCD and potentiometer. Arduino pins GND and 5V feed, respectively, the negative and positive protoboard. The pins 1, 5 and 16 of the LCD are connected to the negative column of the protoboard, just as the pins 2 and 15 of the LCD are connected to the positive column. The LCD pin 3 is connected to the central pin of the potentiometer. The potentiometer left terminal is connected to the negative protoboard column and the right terminal connected to the positive column of the protoboard. The arduino ports 12, 11, 5, 4, 3, 2 are respectively connected to the pins 4, 6, 11, 12, 13 and 14 of the LCD.

Connections are also made between the RFID reader and the arduino. The 3.3V and RST ports of the player are connected, respectively, to the 3.3V and 9A ports of the arduino. The reader's GND port is attached to the negative column of the protoboard. The SOI and MOSIMI ports of the reader are connected to pins 12 and 11 of the arduino via the protoboard. The reader's SCK and SDA ports are attached to pins 13 and 10 of the arduino. Figure 8 shows all the connections described above. For this, Fritzing was used, according to [14], is a free software used to model prototypes and electronic circuits.

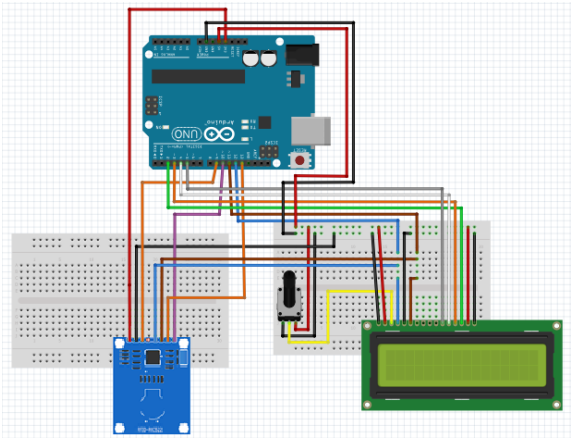

Fig. 8: Connection diagram between components

After the elaboration and performance analysis of the prototype that demonstrates the operation of the RFID system, the financial analysis of its implantation was carried out in the company under study, using the discounted payback to verify the viability of its implantation.

III. LITERATURE REVIEW

A. Logistics

1) **Expedition:** As [15], the logistics proposal is to take the right product, in the right quantity, at the right time, in the right place and at the lowest possible cost.

The expedition, according to [16], is the process of preparation and organization of the material to be filled. Its purpose is to ensure the correct separation and shipment of the goods to the customer within the agreed period. This sector is essential within organizations, since it is the last logistic stage.

As [17] points out, the shipping process includes packaging, identification, weighing and filling. In addition, the shipment is responsible for checking the orders and preparing the billing documents.

Reference [16] says, because it involves several sectors of an organization, problems often occur in the shipping process, which leads to a reduction in the quality of the services provided to the client. These problems involve incorrect quantities of carried material, product changes, merchandise damage, poor

performance of activities, reflecting customer dissatisfaction.

According to [18], in some organizations failures occur at this stage because the processes are executed manually and another factor that influences is the variety of items that the company possesses.

2) **Orders Separation:** According to [19], the separation must be carried out correctly so that there are no differences in the inventory and for the product to be delivered in the quantity requested by the customer and especially on the correct date.

According to [20], the discrete order separation, by zone and by lot, are the three most used forms to carry out such activity. In the discrete separation each operator collects one request at a time. In zone separation each operator is responsible for one section and all products collected in each section are grouped in an area where the original order formation takes place. In the batch separation, which is the one used by the company, each operator collects the quantity of products that is satisfactory to meet a set of orders.

B. Financial Analysis

The financial analysis, according to [21] comprises the study of a company's financial data in detail, and it is possible to detect the strengths and weaknesses of the financial process in order to indicate the possibilities of future decisions to be made.

According to [22], when analyzing the economic viability of an investment, it is possible to project the financial data in order to visualize the possibility of its return.

1) **Discounted Payback Period (DPP):** Reference [22] point out that the discounted payback takes into account the value of money in time, in other words, it is the period of time that it will take for the value invested to be recovered considering the value of the discounted cash flow.

According to [23], to carry out the calculation of the discounted payback, first, one must bring all the inputs to the present value, discounting from these flows the interest rate, which corresponds to the minimum that the company will have of profitability. The result obtained is used as the investment to calculate the next cash inflow until the value of the invested capital is reached.

2) **Net Present Value (NPV):** According to [24], the Net Present Value (NPV) is the difference between its cost and the market value of the investment. This method is characterized by bringing future cash flows into the present, which makes this tool effective.

The value of NPV, according to [25], is defined as the subtraction of the project initial value by the present value of net cash inflows, and a discount rate is reduced.

3) **Internal Rate of Return (IRR):** According to [25], the Internal Rate of Return is the one that characterizes the rate of return on invested capital. When the IRR is used as a discount rate, it results in an NPV equal to zero, which characterizes the economic break-even point of the project.

IV. RESULTS AND DISCUSSIONS

During the visits to the company under study, the entire expedition process was monitored, as described in Fig. 9, and the data collected refer to the period from July 2017 to June 2018.

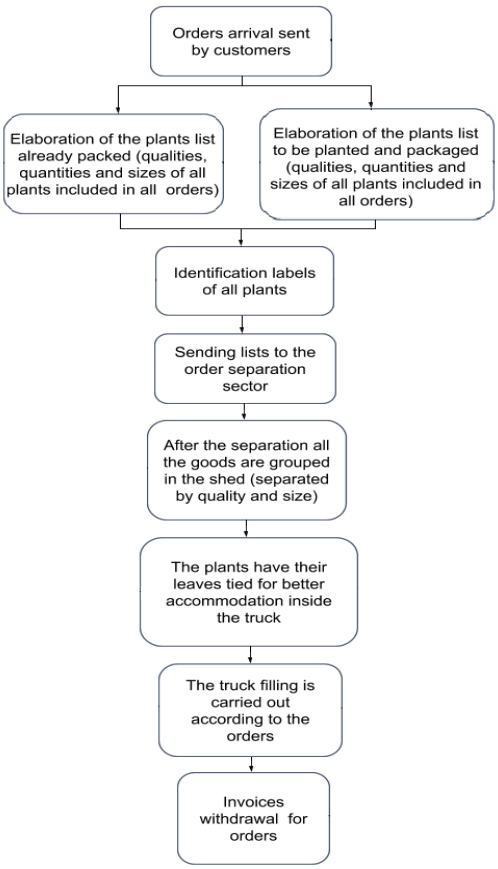

Fig. 9: Flow chart of the shipping process

Accompanied by the visit at the company it was observed that at the time of carrying, on average 48 orders are carried per month, 19 of them present errors in the quantity and / or variety of seedlings requested by the client. This is due to wrong counting in the separation since the process is carried out manually and a checking of the plants left in the shed is not made. Due to these flaws some plants are not sent to the customer, leading to a dead bill for the company.

By analyzing all orders and sales made within a year, it was possible to obtain the values that the company stopped invoicing for the reason mentioned above, according to data presented in Table 1.

Table 1
Values left to bill

MONTH/YEAR	VALUES NOT INVOICED
June 2018	R$ 2.845,00
May 2018	R$ 1.746,00
April 2018	R$ 4.383,00
March 2018	R$ 3.734,00
February 2018	R$ 6.069,00
January 2018	R$ 618,00
December 2018	R$ 2.508,00
November 2017	R$ 1.677,00
October 2017	R$ 2.135,00
September 2017	R$ 2.719,80
August 2017	R$ 1.597,50
July 2017	R$ 1.753,00
Total:	**R$ 31.785,30**

In the analyzed period, the company stopped invoicing the equivalent of R $ 31,785.30 due to these errors occurred in the separation, causing a divergence between what was sent and what was requested by the customers.

Thus, to solve the errors during the separation of the requests, it is proposed to the company carry out the RFID system implantation. For this, all the 200,000 plants in the company would receive the RFID labels, which would only be removed at the time of the truck filling, and can be reused. In addition, the company must also acquire a mobile collector which allows greater mobility to carry out the checking of the plants at the time of separation and after all the merchandise is separated.

The values quoted in October 2018 for the RFID technology implantation were R$ 0.53 for each RFID label and R$ 12,999 for the collector. Therefore, the total investment of the project would be R$ 118,999.00. With this investment, the company would earn R$ 31,785.30, which will be used to pay the investment.

Table 2 demonstrates the feasibility calculation of the RFID system using the discounted payback method. Thus, it is possible to calculate how long the company will have recovered the investment made.

Table 2
Discounted payback analysis

YEARS	OIBDA-CapEx	NPV	DPP
0	(118.999,00)	-	(118.999,00)
1	31.785,30	29.986,13	(89.012,87)
2	31.785,30	28.379,73	(60.633,14)
3	31.785,30	26.710,34	(33.922,80)
4	31.785,30	25.226,43	(8.696,37)
5	31.785,30	23.720,37	15.024,00

According to the discounted payback method the company would pay the investment in 4 years, 4 months and 13 days, from that time the company will only profit. The investment becomes feasible, since the company pays the investment only with the money that it ceased to be invoiced due to the failures in the separation.

The prototype of the RFID system presented the expected results for the same and, with its development, it was possible to better understand the operation of the RFID system, as shown in Fig. 10.

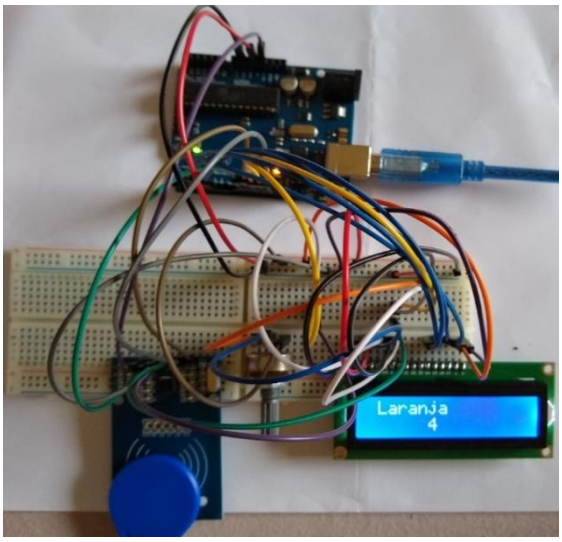

Fig. 10: Prototype in operation

Scorted by the use of arduino to control the system it was possible to verify that when the label is approached the reader identifies the quality of the plant. The identification of the same is indicated on the LCD, with the aid of the potentiometer, which adjusts the luminosity allowing its visualization. Each time the reader identifies the labels of the same quality counts, also being indicated on the LCD.

Fig. 10 shows that the reader counted 4 "Orange" quality plants. In this way, it is possible to identify if the quality and quantity of the plants that were separated is in conformity with what was requested by the customer before filling the truck. If any

divergence is found in this step, there is still time to correct the failure and send the request correctly to the customer.

In order to implement this system in the company under study, it is proposed to use the MC9190-Z Motorola RFID commercial collector, which will be used at the time of the applications separation to check if the quality and quantity of the separated plants complies with what was requested and also before filling the truck a new checking will be held to ensure that there is no divergence of the items requested by the customers and what has been separated.

The collector will communicate with the arduino through the software of the collector itself. This information will communicate with the company's system allowing greater agility in the conference of the requests and provision of the information for withdrawal of the invoice of the products.

V. CONCLUSIONS

This article presents how logistics has become one of the main tools in the search for competitiveness and how the important role of order separation influences the fulfillment of customer needs. In addition, it was highlighted the use of technology in the improvement of the level of service provided to the customer, highlighting RFID.

According to the aim of the study, it was proposed the RFID system implantation to solve the problems during the order separation, identifying if the quality and quantity of plants were separated correctly according to what was requested by the client. Therefore, the prototype of this technology was realized to demonstrate the operation of the same. Thus, for the implantation proposal, an investment of R $ 118,999.00 will be required, which will be paid with the amount that the company will bill after the implantation of RFID of R $ 31,785.30, using the discounted payback method.

The operation of the prototype proved to be satisfactory as expected, demonstrating an improvement in the company's shipping process. For the proposal to implement the RFID system in the company was used the discounted payback method, which it was possible to arrive at the time that company will pay the investment that was 4 years, 4 months and 13 days.

The effective implantation of the RFID system in the company and the data collection regarding the results obtained can be analyzed in future studies.

In this way, after the investment return time of 4 years 4 months and 13 days, the company can fully invoice the amount that was being allocated to the investment.

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