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METHODOLOGY TO IMPROVE INVENTORY MANAGEMENT THROUGH THE SYSTEMIC APPROACH: DESIGN OF A MOBILE APPLICATION FOR THE REGISTRATION AND COUNTING OF ITEMS

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Abstract: The completion of this work is based on the application of the systems analysis and design (ADS) methodology, contemplating a multi and interdisciplinary approach that involves all areas of influence, both human resources and knowledge in the application of computer technology, design of processes, as well as evaluation of alternatives that provide the best solution to improve inventory management. Information and Communication Technologies (ICT) directly influence the continuous improvement of business processes, so their implementation must be analyzed and evaluated in a broad context to obtain the best use. For this reason, it is a priority to work collaboratively with a methodology that maintains a comprehensive approach to the global panorama of any organizational problem, where not only the work of software programmers is taken into account for the sole reason of being a computational solution, but The ADS methodology is put into practice within the framework of the systemic approach of general systems theory (GST). In the case of SMEs in the commerce sector, it is very important and necessary to have technological tools that directly affect the optimization of their processes. Given this context, the design of a prototype for a mobile application is proposed as support in inventory management, to record the count and location of items within the warehouse administration, integrating the systemic approach and the application of ICT.
Keywords: ICT, Systemic approach, Mobile application, Inventory.

INTRODUCTION

BACKGROUND

For the development of an organization's business processes, it is necessary to have the knowledge of knowing how, as well as understanding the why of the design of the processes. This involves putting into practice a level of thinking that includes elements that allow you to think about business processes in an innovative, different and systemic way. The systemic approach integrates a new way of seeing processes and presents integrative perspectives for solving problems and structuring value processes [1]. The systemic approach, also called systems thinking, is defined as the ability to understand the relationships between the various components of an organizational system that obtains results based on the execution of certain interrelated processes [2]. In the context of business organization, the systemic approach redefines it based on the changes that are currently occurring, in aspects such as information and communication technology (ICT) and in global markets, in the application of knowledge, innovation and organizational learning. The business organization is framed as a system that exchanges energy, matter, information and all types of resources, with its relationships of inputs (inputs), outputs (products or services) and feedback, in order to foster conditions to create new systems or to modify existing systems [3].

As a reference to Mexican SMEs and their relationship with computer applications, it has been found that the majority of SMEs are not taking full advantage of the potential of ICT [4], therefore, it must be emphasized that the mere application of the ICT in production processes does not produce an improvement in productivity, since two main aspects that promote productivity in companies must be considered: first, investment in ICT, and

second, investment in the human factor. This highlights the need for a system analysis and design (ADS) methodology that considers an integrative systemic approach, simultaneously considering decisions regarding technology, software application development, as well as personnel skills. in relation to ICT, in order to achieve adequate use of resources oriented to business processes [5]. Establishing SMEs in the commerce sector as a framework of reference, it is clear that inventory management is among the various business processes carried out. A company's inventories are defined as the purchases of items in salable condition. Merchandise inventories are found in businesses that have wholesale and retail sales [6]. Another definition of inventory is the one provided by Chase (2009), which defines inventory as the units of a good such as raw materials, products in process and finished products of the organization.and are available for use in the warehouse or on the production floor [7]. In that sense, inventories are the stocks of a part or resource used in an organization. Likewise, they point out that an inventory system is the set of policies and controls that monitor the inventory levels that must be maintained, as well as knowing when it is necessary to replenish it and how large the orders must be [8]. As can be seen, several processes are involved in inventory management, such as purchases, sales, supply and stock control policies, among some others, each with its function to maintain optimal inventory functioning. Inventory management can become so complex in proportion to the number of entities involved for this purpose. For example, the simple fact of not having a process for assigning locations for products can affect efficiency when locating a product and that in turn affect customer service time, which can have a negative impact on the service quality, etc., can generate an avalanche of unwanted situations for the organization. It cannot be denied that inventory management is a complex scenario that involves the interrelation of cause-effect events that directly influence the total performance of the system. For this reason, the purpose of this research is to put into practice the application of the systemic approach to propose an adequate solution that integrates the application of ICT to the problems generated by some processes involved in inventory management.It cannot be denied that inventory management is a complex scenario that involves the interrelation of cause-effect events that directly influence the total performance of the system. For this reason, the purpose of this research is to put into practice the application of the systemic approach to propose an adequate solution that integrates the application of ICT to the problems generated by some processes involved in inventory management.It cannot be denied that inventory management is a complex scenario that involves the interrelation of cause-effect events that directly influence the total performance of the system. For this reason, the purpose of this research is to put into practice the application of the systemic approach to propose an adequate solution that integrates the application of ICT to the problems generated by some processes involved in inventory management.

AIM

The objective of this work is to propose a methodology that puts into practice the application of the systemic approach in the design of a prototype of a mobile application software as support in inventory management, to record the count and location of items within the warehouse administration of a company in the commerce sector.

FRAMEWORK

ABOUT THE COMPANY FOR THE CASE STUDY

First, the current situation of the company for the case study is disclosed. The research work was carried out in a company in the commercial sector of the hardware industry called "FERRELECTRICA DE CABORCA", located in the city of Caborca, Sonora, Mexico. There are a total of 30 employees, who carry out the necessary operations and activities, both operational and administrative. The sales catalog is made up of a total of 21,780 products, classified into 25 lines or families and covers 680 brands from various suppliers. The company fulfills a very important commercial function in the region of Caborca, Sonora, since it is part of the supply chain of the mining and agricultural sector, as well as serving the construction, electrical and plumbing sectors at both an industrial and residential level.

CURRENT SITUATION OF THE SALES PROCESS

The company has its own ERP (Enterprise Resource Planning) system that it uses in its daily sales operations to serve its customers. This computer system is based on client-server technology installed on a network operating system. The sales area is served by seven users at the counter and one user in the cashier area. There is an area for delivering the merchandise to the customer.

This activity consists of comparing the items described in the sales document with the available items ready to be delivered to the customer.

In relation to the application of the proposed methodology, the current situation of the problem of the inventory gathering process is described below.

CURRENT SITUATION OF THE SALES EXHIBITION AREA AND WAREHOUSE ORGANIZATION

Different types of shelving are used to locate merchandise both in the sales area and in the warehouse. In the case of the customer service sales area, slotted panel displays are used, which are installed on the walls. In the sales floor area, gondolas are used, which are distributed forming corridors between them that facilitate the movement of people. Likewise, industrial racks are used in the warehouse area, which have a more robust structure (See figure 1).

THEORETICAL FRAMEWORK: THE SYSTEMS APPROACH AND INVENTORY MANAGEMENT

The objective of the systems approach is to achieve a more complete understanding of the elements of the system as a whole, that is, determining their connections and identifying the synergies that result from them [9]. The application of the systemic approach begins to gain importance due to the need to study business organizations as an open system, taking into account that there are inputs of information (input) which is transformed through certain processes and will then become information. output, maintaining an exchange of information with the environment and exercising its own feedback to maintain or improve its performance[10]. In relation to inventory management, its objective is to support sales being made based on the availability of merchandise, ensuring that sellers have timely information regarding the stocks and location of the items in the respective storage locations. Inventory management involves two very important basic parts: inventory management and inventory control (See Figure 2). Inventory management refers to the acquisition of merchandise based on the minimum and

Figure 1: Different types of shelving for organization and location of merchandise.

maximum stock, as well as input and output statistics to generate purchase orders to suppliers. Likewise, it has the objective of minimizing inventory maintenance costs. The other part related to inventory control has to do with the direct relationship with the warehouse organization for the location of the merchandise, as well as the counting and recording of product stocks [11].

Taking into consideration, the application of the systemic approach and the need to resolve the disadvantages of inventory control of the current system, a system analysis and design methodology (ADS) is proposed oriented to the analysis of requirements, taking advantage of ICT with the use of the Internet. as a means of communication and the development of mobile application software that records data capture in real time in the current ERP system through smartphones (also called smartphones, cell phones or mobile phones).

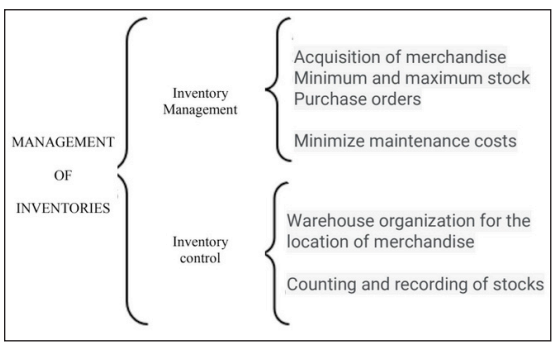

Figure 2: The two basic parts of inventory management.

METHODOLOGY

The proposed methodology is based on the systemic approach applied to systems analysis and design. It consists of five stages, which are stated below:

Stage 1: Know the current situation of the problem.

Stage 2: Requirements analysis.

Stage 3: Solution design.

Stage 4: Implementation of the solution.

Stage 5: Feedback.

Each of the stages feeds off each other during the application of the methodology, jointly contemplating all activities related to processes, people and the use of ICT.

BREAKDOWN OF THE METHODOLOGY

STAGE 1: KNOW THE CURRENT SITUATION OF THE PROBLEM

To achieve compliance with this stage, a work team was formed made up of the following personnel: company manager, warehouse managers, salespeople and systems analyst. A consensus was reached andn reference to the study area for the preparation of this work, describing some points related to the inventory management process:

a. The ERP system has a process for exporting information in electronic Excel sheet format.

b. The exported information is printed and delivered to the people in charge of collecting the inventory. A team of two people works to keep track of the count and verify the data captured manually on the printed sheets.

c. The manually captured data from the count is recorded on the computers in the Excel file. Once the counting of the total items has been completed, the Excel file is imported through the ERP system's own process.

d. This method of inventory collection has some considerable disadvantages: frequent writing errors occur by staff during physical counting and data recording. It is a very slow process, since it takes up to four days to complete the count of all the products. This delay time represents considerable losses for the company, since no sales are made because it is closed to the public.

e. There is no defined structure for the location of items in the warehouse or in the sales area.

Once the study of the situation of the company's current problems was carried out, we proceeded to the next stage.

STAGE 2: REQUIREMENTS ANALYSIS

Based on the analysis of requirements to meet the stated objective, and emphasizing the application of a systemic approach in all the aspects involved to provide a solution to the problem presented, it was considered as a solution that a mobile application must be available taking advantage of the use of ICT to achieve the connection with the current ERP system. The analysis of previous requirements necessary for the design of a prototype and implementation of a mobile application software was carried out.as support in inventory management, to record the count and location of items within the warehouse administration. The requirements established based on the analysis are the following:

a. Defining an item location structure.

b. Add modifications to the current system in the fields required to capture data related to inventory control.

a. Defining an item location structure

Working meetings were held with the staff of the warehouse control area and the sales area to analyze and define a structure for the location of items. For this, the industrial rack shelving used in the warehouse was taken as a reference. The proposed structure was the following:

a.1).- A consecutive number is assigned to each rack in the warehouse, starting with the letter R and a number. For example: R1, R2, R3…

a.2).- The rack is divided into numbered sections: Section1, Section2, Section3...

a.3).- Each section is divided into different height levels, starting with the letter "A" and consecutively with the letters of the alphabet until the necessary levels that have been established in that rack are covered (See figure 3).

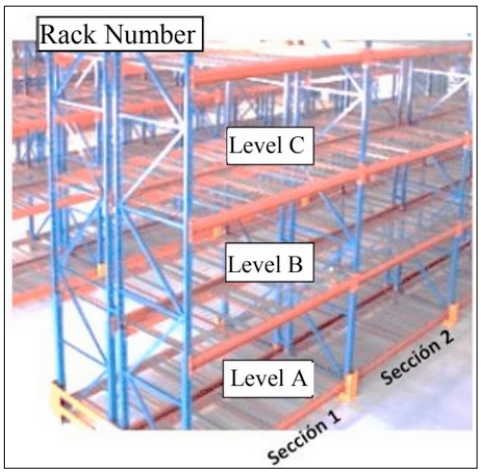

Figure 3: Location structure.

For example, a certain item located on a warehouse rack may have the following location structure: R2-1B. This means that the item is located in rack number 2, in section 1 on level B. The same structure defined for the rack was applied to the displays and gondolas in the sales area. In this case, the location structure for the displays begins with the letter E and a number, they are also divided into sections and levels. For example: E5-1A, which means that the item is located in display 5 in section 1 level A. This is how it works for the shelves, starting with the letter G. For example: G3-2A.

Below is a graphic distribution of the warehouse area and the sales area with the representation of the racks, displays and gondolas.

b. Add modifications to the current system in the fields required to capture data related to inventory control.

Once the article location structure was defined, the software programmer was asked to make the necessary changes in the current system to have the location data recorded, as well as the definition of an image type field to add an image of the item. article registered as visual support with the identification of the article (See figure 5).

STAGE 3: SOLUTION DESIGN

Mobile application interface design

Once the analysis of the required data fields in the current system database was completed, the necessary communication protocols were configured to ensure that the mobile application interacted in real time with the system. To capture the data using the mobile phone, a graphical interface was designed that contemplated the user's registration with their respective access code previously defined from the main system, as well as the type of operation performed by the user, which can be be updating locations or starting counting (See figure 6).

Figure 6: Main screen of the mobile application.

If the user selects location update, a new screen appears with the name "LOCATIONS". On this screen the user can write the key of an article and search for it in the article catalog database (see figure 7), if it is found it will show the information related to that article such as its image, its description and the structure. of the location where the item is located, whether in the sales area or in the warehouse. Also in this section, you can read the barcode or QR code of the item and the information related to the item will be displayed in the same way. In this same section you can edit, delete or

add a new location for the article and when you save the locations the system database is automatically updated in real time.

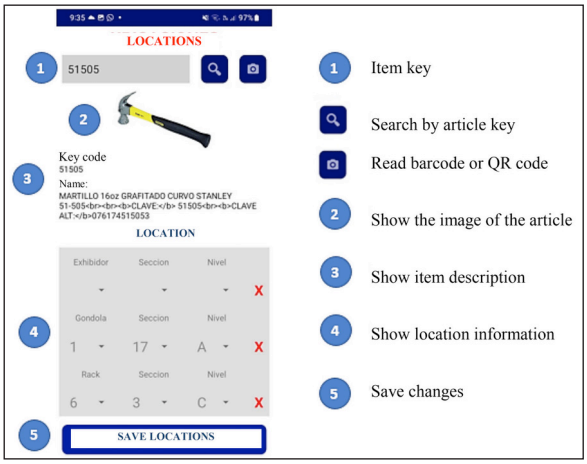

Figure 7: Description of the LOCATIONS screen.

In the main system, locations must be assigned to perform the count; one or more locations can be assigned, in such a way that a record and control is kept over which locations a given user performed the count (see figure 8). If the user selects "START COUNT" and has not previously been assigned a location, they will not be able to perform the count. This allows us to know which location is carrying out the count and who is doing it.

Figure 8: Assignment of LOCATIONS for counting.

If the user selects "START COUNTING" and has a counting location assigned, the following screen will appear (see figure 9). Where you can only select the location that has been assigned to you for the count and only items that belong to that location will appear. This screen uses the phone's camera to read the item code label, physically counts the item quantity, and captures it in the corresponding field. The registered quantity is saved and proceed with another item. When the count of the eighty games is finished, the count is automatically stopped and recorded in real time in the system database, or you can also end the count manually by touching the end count button.

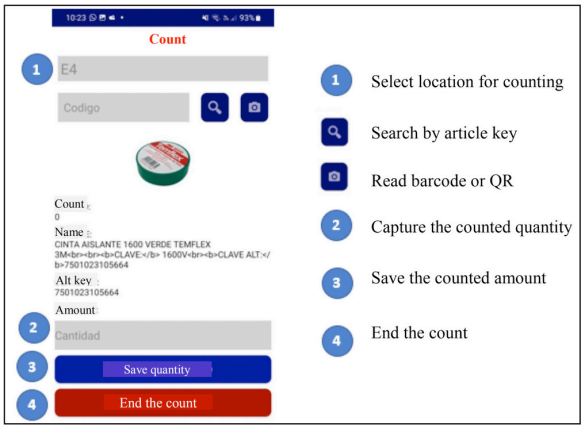

Figure 9: Screen to perform the COUNT.

STAGE 4: IMPLEMENTATION OF THE SOLUTION

Implementation of the mobile application in inventory gathering

Once the previous tests of the mobile application and the corresponding training and training of the users had been carried out, the physical inventory was carried out. The procedure for collecting the inventory was as follows:

a) First, the work areas were divided into sections, as well as the locations that each user would be assigned for counting.

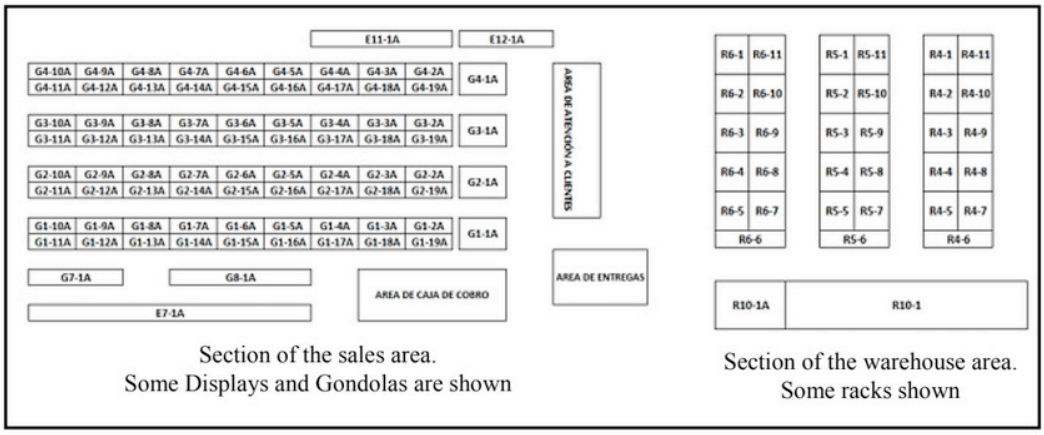

Figure 4: Section of the sales and warehouse area.

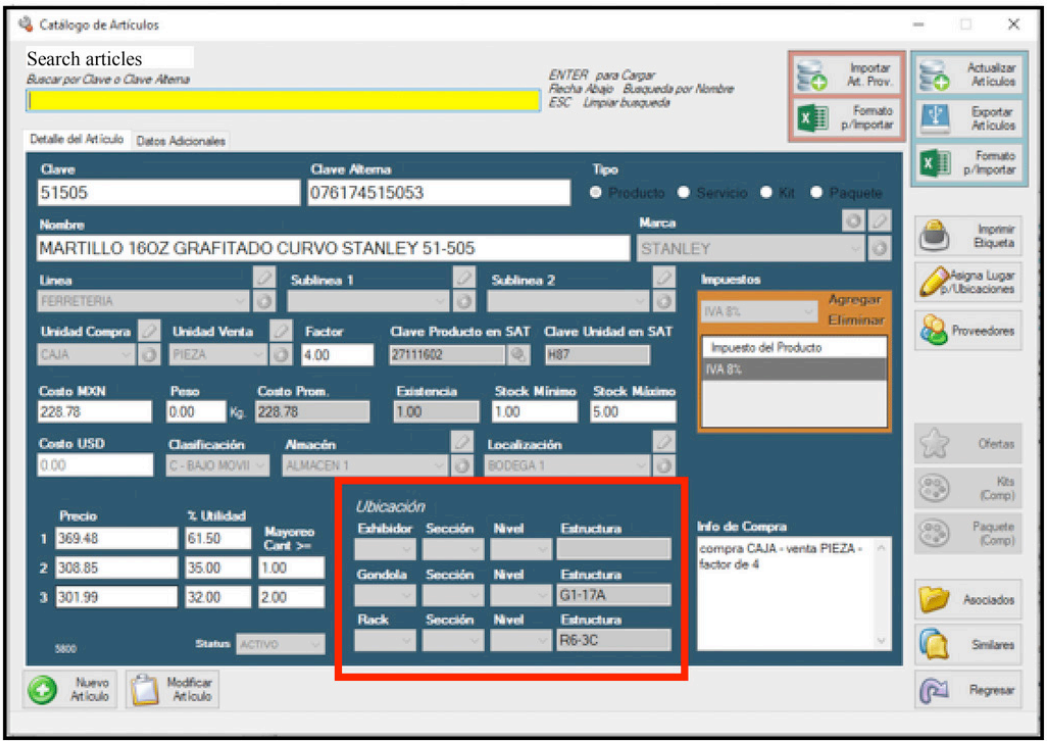

Figure 5: Item information shows the location structure.

b) The company's 30 employees were registered to carry out the inventory survey. Previously, it was taken into account that each person had a mobile phone where the application software was installed.

c) The start time was set at 7:00 am on the indicated date.

d) Every time a user finished counting an assigned area, they had to notify a supervisor to print their count report and assign them a new location for a next count.

STAGE 5: FEEDBACK

From the beginning of the application of the systems analysis and design methodology, a level of feedback is maintained between all the people involved, the relationships between the activities that make up the

processes are established and revealed, and a close relationship is maintained. with the knowledge and application of technology. Although it is true that it is mentioned as a final stage of the methodology, it is actually an action that is present throughout the entire process, from the study of the current situation of the problem to the implementation of the proposed solution. This feedback action is what maintains the synergy between all the elements that make up the system.

RESULTS

According to the total number of articles that must be counted, which was 21,780, it was calculated that among the 30 users, each user must count 726 articles. Each count was 80 games, resulting in each user having to perform approximately 9 counts of 80 games each. The time for each user to carry out the count was variable, since some users had greater skill in handling the application, and this time was also affected by the type of product that was assigned for the count, since it was not It is the same to count small items that are difficult to grasp such as nuts or screws compared to larger or more volume items such as pliers, hammers or other tools.

BEGINNING AND ENDING OF THE INVENTORY SURVEY

The inventory collection began at 7:00 am and work continued until 1:00 p.m. A break time of 1 hour was taken in the period from 1:00 p.m. to 2:00 p.m. The count was resumed again at 2:00 p.m. and work continued until 9:00 p.m., which was when the last inventory count was recorded. In total, it took 13 hours to collect the inventory. Converting this time into minutes, we have a total of 780 minutes. Comparing this time with the time it took to collect the inventory in the previous way, we have the following:

Previous lifting time = 4 days times 10 hours a day = 40 hours.
Current lifting time = 1 day times 13 hours = 13 hours

Analyzing the time data obtained, there is a very significant difference of 27 hours less in inventory collection. This is practically 3 days of work in 8-hour days, which represents a very significant saving for the company, since during those 3 days the company remains open and no sales are lost. This presents an approximate reduction of 68% in the time to carry out the inventory survey. In addition, duplication of data capture was also avoided, as well as the printing of sheets for manual filling out of the count.

OTHER BENEFITS OF TAKING ADVANTAGE OF INFORMATION

The changes made to the database of the main system for the integration of the mobile application allow detailed reports to be obtained with the application of filters that facilitate the monitoring of users who use the system (see figure 10). Among the most relevant data, I can obtain the date and time in which the user carried out the count, as well as the device used and in which location the count was performed. Another important aspect is the information that appears on the point of sale screen when salespeople are serving a customer, since information regarding the location of the item is displayed, which facilitates location both in the sales area and in the warehouse. reducing customer service time (see figure 11).

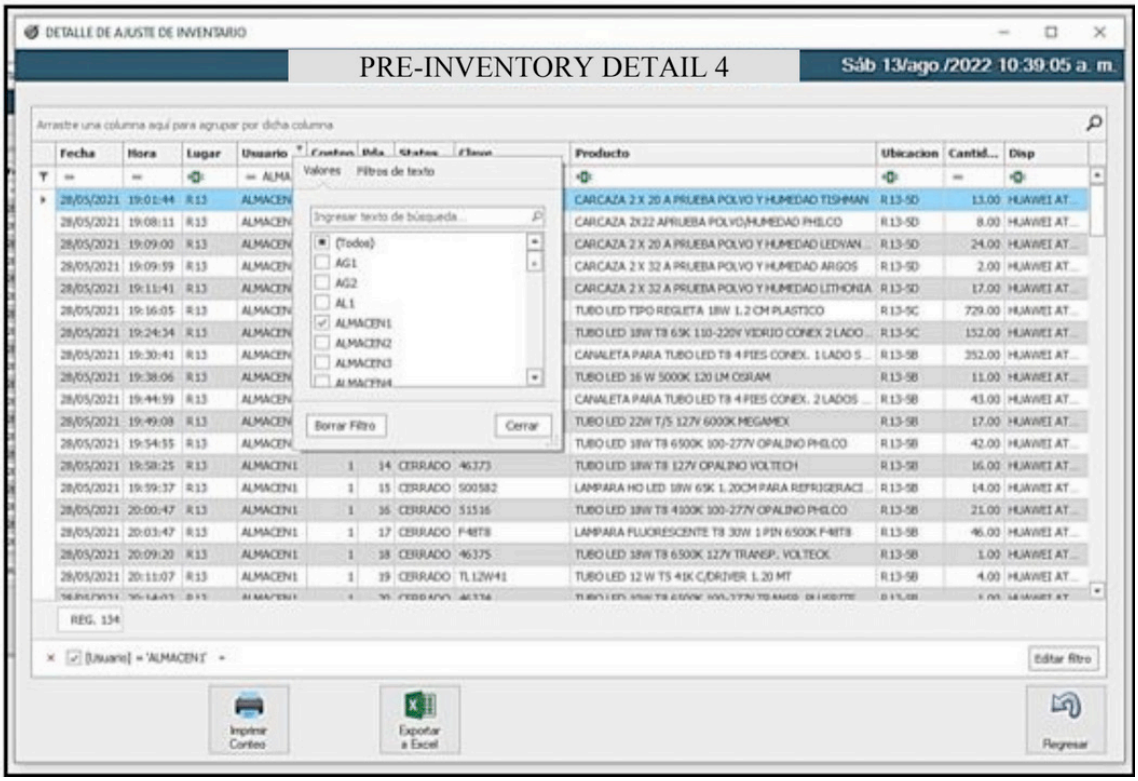

Figure 10: Detail of the inventory survey information.

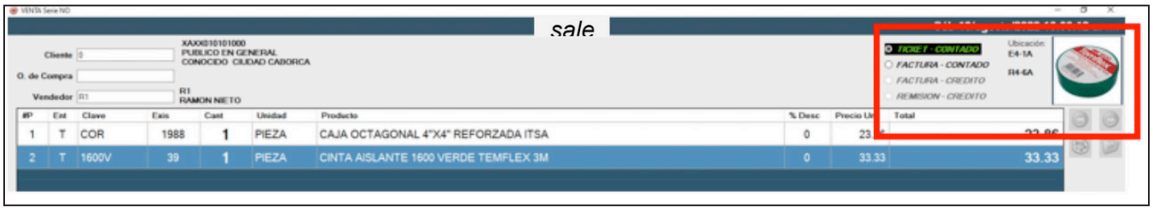

Figure 11: Point of sale screen showing the location of items.

CONCLUSIONS

The systemic approach methodology covers the study of any type of problem in order to find the solution through the work of multidisciplinary teams. With the application of the systemic approach, you can see the adaptability in different business processes to analyze and evaluate the needs of requirements and thereby obtain the greatest use of their implementation. In this case study, one could have thought to "leave all the work in the hands" of the software programmers, and think that since it was a computer implementation, only they would have to take charge. But in reality, the application of the systemic approach allows us to see much further than an IT solution. There are other very important aspects such as knowledge and development of human factor skills that must be taken into account. Aspects related to knowledge of technology and the capabilities that can be used with the implementation of ICT, as well as cost issues in the acquisition of equipment and accessories for information management. To give an example, in this case it was considered to take advantage of the advantages of the use of the smartphone (mobile or cell phone) and the use of the Internet as a means of real-time link with the main system, the use of the digital camera of

the telephone as a barcode reader to read and record the physical counting data of the items, which benefited the company with great savings in time, execution of more precise work with fewer errors and other economic aspects. Consequently, it can be observed with the systemic approach methodology that new teamwork skills are developed and a broader vision is available to propose solutions that have a positive impact on the improvement of processes.

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