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Elaboration of a production planning system for a snack manufacturing company

Elaboración de un sistema de la planeación de la producción en una empresa manufacturera de botanas

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Abstract

A Production Planning System is elaborated for a snack production Company by the development of a MRP system in order to increase the present production and to meet the demand. The methodology used was Material Requirement Planning (MRP) that basically consists in a logic system able to manage and control material requirement planning based on a number of pieces, components and material needed for manufacturing, in other words, it is a production planning system. The outcome of the Project has been an application with MRP features, with complements such as line balance, purchasing Budget of raw materials, among other things. The application relies on protection of information and backup by the same. The executable application of MRP system has contributed to reduce 50% the production breach at the company, as well as reducing waste in a 40%, idle time in a 50% and raw material costs in a 25%, achieving the stated goal.

Material requirement planning (MRP), Supplies, Waste

Resumen

Se elaboró un sistema de planeación de la producción para una empresa productora de botanas, mediante el desarrollo de un sistema MRP con el objetivo de incrementar la producción actual y dar cumplimiento a la demanda. La metodología empleada fue Material Requirement Planning (MRP) que básicamente consiste en un sistema lógico capaz de gestionar y controlar la planeación de requerimientos de material con base al número de piezas, componentes y materiales necesarios para la manufactura, es decir, es un sistema de planeación de la producción. El resultado del proyecto ha sido una aplicación con funciones de un sistema de planeación de la producción MRP, con complementos como el balanceo de línea, presupuesto de materia prima, nivelado de la producción, entre otros. La aplicación cuenta con protección a la información y respaldo de la misma. La aplicación ejecutable de sistema MRP ha contribuido a reducir en un 50% el incumplimiento de la producción en la empresa, así como, reducir merma generada en un 40%, tiempos muertos en un 50% y gastos de materia prima en un 25%, logrando el objetivo planteado.

Planeación de Requerimientos de material (MRP), Insumos, Merma

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Introduction

Microenterprises in Mexico present a series of deficiencies derived from the lack of methodologies, techniques and tools that optimize the operation of their processes. Studies have been conducted where it was obtained that innovation, technology and strategic planning, are determining factors in their competitiveness (Hirsch, J., *et al*, 2015).

While it is true that there is software on the market that facilitates the planning and control of inputs and processes (Poma, J. M. R., Pernia, E. O., & Quiroz, J. P., 2014). , many of these companies do not have the economic capacity to acquire them and there is little clarity about the advantages that these can bring (Cisneros, M. A. I., *et al*, 2016). That is why, within the objectives of this work, a production planning system was developed for a Mexican microenterprise, dedicated to the elaboration of snacks, which does not have a planning and control system for raw materials that requires for the elaboration of your product. The foregoing causes non-compliance with the demand for input deficits or overproduction due to lack of planning.

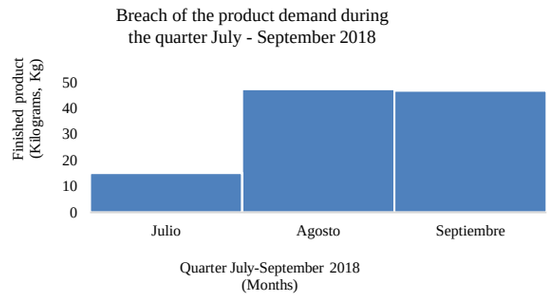
Among the advantages and disadvantages of the Planning of the Resources of the Company, the integration of supply chain, production and production process stand out, as well as its purchase is very expensive and its customization even more (Heizer, J. H. y Render, B., 2014). To address this problem, the methodology used was a Production Planning System, by its acronym known as MRP (Material Requirement Planning). Subsequently, as part of the objectives of this work, an application for Personal Computer and Tablet was developed based on the MRP and the specific requirements of the company, capable of determining the net demand of raw material, determining material costs, among other functions.

Methodology

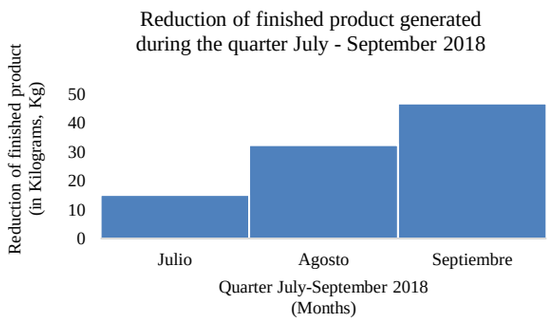
During the diagnostic phase of the present work, it was detected that the record of historical data that evidenced the aforementioned problem was lacking, therefore, it began with the acquisition of data and the following graphs of the indicators were prepared:

A. Breach of the demand product
B. Reduction of finished
C. Days not worked

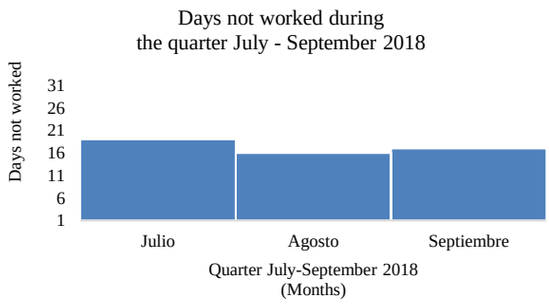
In Figures 1 and 2 there is an increase in non-compliance in demand and in losses in a quarter, respectively. Figure 3 shows more than 40% of unused working time.



Graphic 1 Breach of the demand for finished product in the quarter July - September 2018



Graphic 2 Waste of finished product in the quarter July - September 2018



Graphic 3 Days not worked in the quarter July - September 2018

MRP General

MRP is a dependent demand technique that uses a structured list of materials, inventory, expected billing and a master production schedule to determine material requirements (Heizer, J. H. and Render, B., 2014). The MRP also provides a program to specify when these materials, parts and components must be produced or ordered..

MRP structure

The structure of a production planning system with the MRP methodology consists of different data obtained from different departments and simple formulas, Figure 1 shows the basic components of the structure of an MRP (Chase, RB, Jacobs, FR, Aquilano, NJ, 2018).

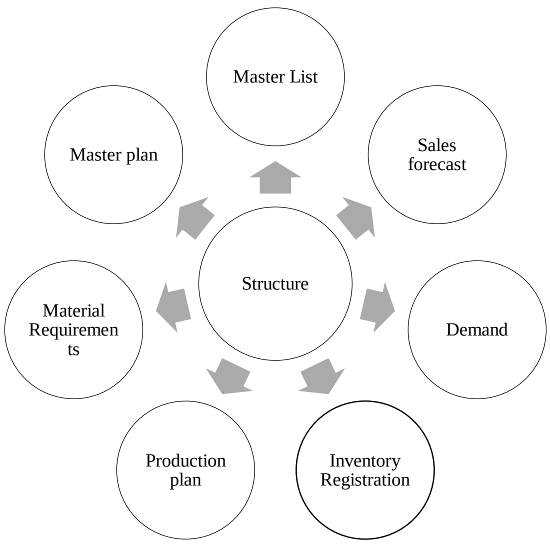


Figure 1 Main components of an MRP

Master list

It contains the complete description of the products and notes materials, parts and components, in addition to the sequence in which the products are made (Cuatrecasas Arbós, L., 2011). Indicates the components that enter a complete product unit (Hopeman, R. J., 2006).

Sales forecast

It is an estimate of short or medium-term sales, this, with the help of quantitative and qualitative sales forecasting methods.

Demand

Demand comes mainly from two sources. The first are known customers who make specific orders, such as those generated by sales staff. These orders usually have a promised delivery date. The second source is the forecasted demand, which covers independent demand orders. The demand of known customers and the forecasted demand combine and become the basis for the master production program.

In the case of the second source, demand is calculated from the sales forecast. For this, it is necessary to calculate the balance for each period (demand balance calculation) (Chase, R.B., Jacobs, F.R., Aquilano, N.J., 2018):

$$\text{Balance}_n = \text{Sales Forecast - Inventory} \quad (1)$$

Subsequently, the net demand or corrected plan in a period n is obtained as follows (demand calculation) in equation 2:

[illegible]
[illegible]
[illegible]
[illegible]
balance > zero (2)

Whereas, if there is excess of inventory, it is calculated as Corrected Balance of a period n (SC_n), as follows, as shown in equation 3:

$$SC_n = \text{Demand + Inventory-Sales Forecast} \quad (3)$$

Inventory Registration

The MRP program opens the status segment of the registry according to specific periods. These records are consulted as needed during program execution. Since, the MRP program performs its analysis of the product structure in descending order and calculates the needs level by level.

Computer-based systems for managing inventories and scheduling the delivery of raw materials and tools are called material requirements planning systems. The MRP is also considered as an inventory control method and involves keeping complete records (Kalpakjian, S., Schmid, S.R., 2014)

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Master Production Program (MPS) or production plan

Specify the exact quantities and production times of each finished item in a production system (Nahmias, S., 2014), establishing the net needs of the finished product, this, after considering the sales forecast, demand and coverage It gives production. The term coverage refers to the extra production of finished product in order to advance the production of the following period.

Material requirement

It lets you know the needs you have regarding the components of each product. Its obtaining is with a simple multiplication (requirement per period of time), which is shown in equation 4:

$$Request_n = Demand_n * \text{No. pieces in product} \quad (4)$$

The number of parts in product refers to how many equal components are used for a common product, that is, in the case of a car, four equal tires are needed.

In this way, for each quantity of finished products, it is possible to obtain the requirements by stages for each level (Chase, R.B., Jacobs, F.R., Aquilano, N.J., 2018).

Net needs

The volume of components or materials that will have to be obtained to dispose of gross needs at the end of a period (Cuatrecasas Arbós, L., 2011).

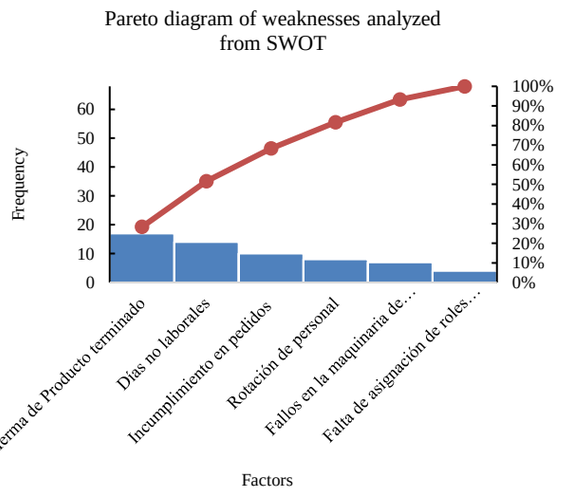
Master program

It is the net material requirement for the elaboration of different products in the short or medium term, in which the equal components of all the products are added, taking into consideration, the previous calculations of forecasts, inventories, demand and material requirements.

This mechanism enables the translation of actual and projected customer orders into specific production orders. (Chapman, S.N., 2006).

Pareto diagram of the i compliance with producti

A Pareto Di agram was mi data obtained from the area (Graphic 4).



Graph Pare to diagram of the co problems

The diagram allowed to and the cumulative perce and to identify that th incidence were:

– Breach of orders.
– Days not worked.
– Final product decline

These indicators are company's production. Wh orders constitutes the m with 28%; rk nod ays and the final product, with an a 16%, respectively.

Cau- Ef fect m Di fa gr n the d- e l a y compliance in company or

Based on the previous i Effect Diagram was made the company's historica records to determine the affect the fr aqu n (Figu r e

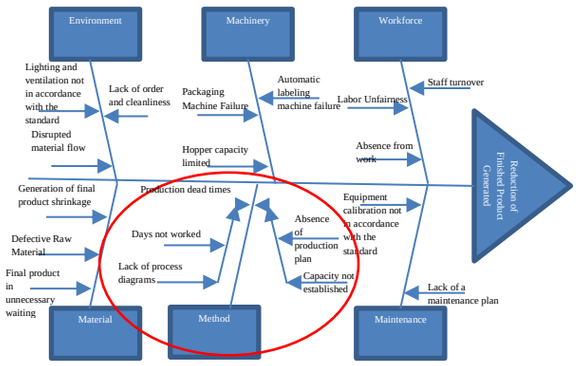


Figure 2 Cause-Effect Diagram of non-compliance in production

From Figure 2, the lack of production planning in the company is highlighted, so, the proposal of this project will be based on offer an alternative solution to these incidents.

Preparation proposal for improvement to reduce delays and non compliance with orders and decrease downtime

Description of the snack production process

All the tasks that make up the company's snack production process were defined. Process that is roughly broken down below in Figure 3:

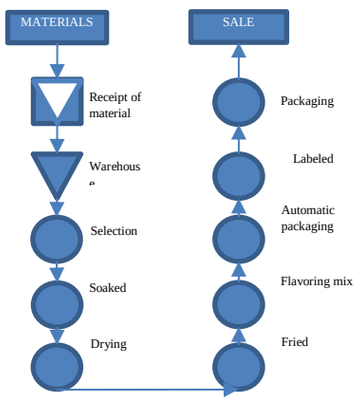


Figure 3 Process Flow Diagram of snack making

Selected from the raw material

Its objective is the separation of the seed from stones, soil, seeds in poor condition or any trash and, it is weighed again to obtain the actual weight of the selected raw material. After selecting the seed, the soaking task is performed.

Soaked

The purpose of soaking is to soften the seed to facilitate its separation and add components that allow conservation; In some cases, like peas, a portion of dye is also added.

Washed

After the task of soaking, the seed is washed, peeled and separated; in the case of the bean or peanut they are separated by halves.

Centrifuged

After soaking, washing, peeling and separating, it is centrifuged to dry the seed; in some cases, it is transported once dry to a cooler.

Fried

This process is used in most of the company's products, where the product is submerged in deep fryers with a capacity ranging from one hundred to one hundred fifty kilograms.

Seasoned or mixed flavors

Once the previous process has been completed, the seed is transported to a dragee drum where the relevant mixture of flavorings is added according to each product.

Automatic packaging

Once the seed is seasoned, it is transported to a packaging machine, where the seed is placed in a hopper. The team distributes the product in proportions of similar weight and packages it.

Labeled

During the labeling process, each of the packaging is inspected verifying that it meets the company's quality standards, that is, that the envelope is not broken, that each bag has the right amount of product and that the expiration date it is not printed in any incorrect section of the packaging, once the envelopes have been inspected, each one is stamped.

Packaging

Finally, the finished product is packaged in boxes of two hundred units, then transported to the warehouse of finished product and delivered to the customer.

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Flowchart of the botanical production process

After knowing each of the tasks of the process, as well as, routes and distances for the preparation of snacks, a Process Flow Diagram was made. The diagram gathers important information about the process of making snacks, such as operations, inspections, transport, delay, storage, distances traveled in transport, times, among other information. This information was obtained from the company's historical records.

In Figure 4, the summary chart of the Process Flow Diagram is highlighted, which provides information to the MRP system.

Summary			
	Number	**Time**	Distance (Meters)
Operations	10	11.56.00	123.5
Transportation	10	01.59.07	
Inspections	2	00.20.00	
Delays	2	Indeterminate	
Storage	1	00.10.00	
Total	25	14.25.07	

Figure 4 Summary of the flowchart processes

Snack production process information flowchart

Based on the tasks of developing snacks and the Process Flow Diagram, an Information Flow Diagram was prepared, which is shown in Figure 5:

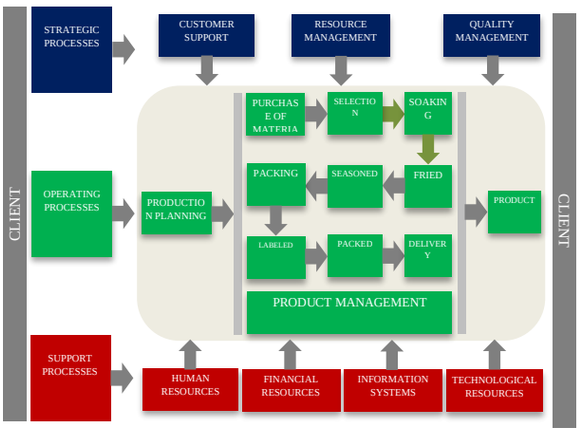

Figure 5 Diagram of Information Flow of the micro enterprise. Oct. 2018

Figure 5 highlights the Support Processes, Strategic Processes and Logistics items, which contribute to the flow and establishment of information sources for the preparation of the MRP.

As well as a value added diagram (Value Stream Mapping, VSP), which is shown in Figure 6:

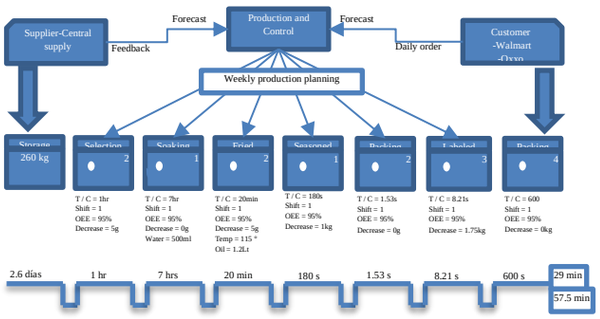

Figure 6 Value-added diagram of the process snack making Oct. 2018

Master list for snack production

The master list that was made (also called catalog) contains all the products and components of each of them (See Figure 7):

Catalogue									
Code	**Description**	**Level**	**Description**	**Quantity**	**Unity**	**Inventory**	**Coverage**	**Team Lot**	**Expiration (Months)**	**Cost**
1	Roasted Peanut with Lemon	PT	With lemon	1	Kg	20	0	1	6	$ 34.00
2	Spicy peanut	PT	Spicy	1	Kg	0	0	1	6	$ 33.00
7	Lentils with lemon	PT	With lemon	1	Kg	0	0	1	6	$ 55.44
8	Chipotle Lentils	PT	With chipotle	1	Kg	0	0	1	6	$ 60.00
11	Chicharitos with lemon	PT	With lemon	1	Kg	0	0	1	6	$ 96.00
12	Chicharitos with chipotle	PT	With chipotle	1	Kg	0	0	1	6	$ 110.00
13	Salt maicitos	PT	With salt	1	Kg	0	0	1	11	$ 115.00
14	Maicitos Chile	PT	With Chile	1	Kg	0	0	1	11	$ 124.00
15	Peas with lemon	PT	With lemon	1	Kg	0	0	1	6	$ 53.04
16	Chipotle teddies	PT	With chipotle	1	Kg	0	0	1	6	$ 45.00
17	Spanish peanut with lemon	PT	With lemon	1	Kg	0	0	1	6	$ 45.00

Figure 7 Master list or catalog. Oc

It has the items of Mother Code, Level, Unit and Price of the master list. The mother code is the finished product code, which has a number between one and fifty-seven. The unit and manufacturing price of the products are also mentioned.

The master list contains a record of the inventory and coverage of the company, which specifies the quantity of finished products currently available.

The master list sends information to the inventory MRP, coverage level, product composition and product units.

Product levels called snack

In the product levels, the finished products in their components have been separated with their respective quantity in kilograms used to produce a kilogram of finished product, which is presented in Figure 8:

Son Code	Product name	Mother code	Code Description	TIME	Quantity	Unity
A101	Roasted Peanut with Lemon	1	Peanut Halves	0	0.980	Kg
A102	Roasted Peanut with Lemon	1	Lemon mix	0	0.020	Kg
A101	Spicy peanut	2	Peanut Halves	0	0.963	Kg
A103	Spicy peanut	2	Chipotle mix	0	0.015	Kg
A102	Spicy peanut	2	Lemon mix	0	0.007	Kg
A104	Spicy peanut	2	Chile Wide	0	0.015	Kg
A105	Lentils with lemon	7	Lentils	0	0.978	Kg
A102	Lentils with lemon	7	Lemon mix	0	0.022	Kg
A105	Chipotle Lentils	8	Lentils	0	0.963	Kg
A103	Chipotle Lentils	8	Chipotle mix	0	0.047	Kg
A106	Chicharitos with lemon	11	Chicharitos	0	0.978	Kg

Figure 8 First level product level. 20/2018

In the second level as seen in Figure 9, the components of the first level mixtures are shown. For example, it is highlighted that 0.012 kilograms of salt, 0.001 kilograms of citric acid and 0.007 kilograms of dried dehydrated lemon juice are needed to make 0.02 kilograms of lemon mixture.

Mother Code	Son Code	Son Component	Nieto Code	Nieto component	Quantity	Unity
1	A102	Lemon mix	A160	Salt	0.012	Kg
1	A102	Lemon mix	B102	Citric acid	0.001	Kg
1	A102	Lemon mix	B103	Dehydrated Lemon Juice	0.007	Kg
2	A103	Chipotle mix	B104	Chipotle pepper	0.007	Kg
2	A103	Chipotle mix	A104	Chile Wide	0.004	Kg
2	A103	Chipotle mix	B106	Tree chili	0.002	Kg
2	A102	Lemon mix	A160	Salt	0.006	Kg
2	A102	Lemon mix	B103	Dehydrated Lemon Juice	0.003	Kg
2	A102	Lemon mix	B102	Citric acid	0.001	Kg

Figure 9 Product level to second level Oct 2018

The levels are directly related to the master list and it is precisely how the necessary proportions of each component are obtained to meet the demand for the final product.

Materials requirement for snack production

The division of the finished product in levels and two sends information on the quantity of ra material to obtain a specific final product to material requirement sheet.

The material requirement basically multiplies the amount necessary of raw material ne to produce a product by the total demand of th finished product. Considering that the product range is wide, the system searches and adds th raw material in common that some products have.

In Figure 10, part requirement calculation ob addition of the material de week-the product is highlighted. T was made both for the fi the respective levels of

Mothe Code	Son Cod	Descript	Quant	Unit	Specifi	Week	Week
1	A10	Peanut H	0.98	Kg	98%	0.00	0.00
1	A10	Lemon mi	0.02	Kg	2%	0.00	0.00
2	A10	Peanut H	0.96	Kg	96%	0.00	0.00
2	A10	Chipotle	0.01	Kg	2%	0.00	0.00
2	A10	Lemon mi	0.00	Kg	1%	0.00	0.00
2	A10	Chile Wi	0.01	Kg	2%	0.00	0.00
7	A10	Lentils	0.97	Kg	98%	0.00	0.00
7	A10	Lemon mi	0.02	Kg	2%	0.00	0.00

Figure 10 Requirement master section made 2018

Leveling of snack produc

As a complement to the system, a production lev that is, that the leaf d the snack proportionally weeks.

Level		WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	WEEK 7	WEEK 8
	Plan	138	138	138	138	138	138	138	138
	Balan	-63	-125	-188	-250	-313	-375	-438	-400
	Cob	-0.3	-0.6	-0.9	-1.2	-1.5	-1.8	-4.3	-4.0

Figure 11 Production leveling

Figure 11 shows the leveling of production of a product the plan indicates the q each week to level the p made to reduce days and production to be distrib

Creation of executable file in Excel and Visual Basic

After completing the spr version) of the MRP, it ability to perform autom the editable mode or Ex used, with which the ne application were develop

This executable file same way to protect the i the source code and as th avoid modifications.

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The objective of programming in Visual Basic is to add an interface that allows to protect the information that the system has, for this, a UserForm1 was added in Visual Basic, where two TextBox and two CommandButton were added.

The UserForm is a customizable user interface in Visual Basic, in the UserForm the forms or objects that allow access to information for the program to provide a response or output are attached. As shown in Figure 12, VisualBasic shows the UserForm and the attached tab of the items that can be added.

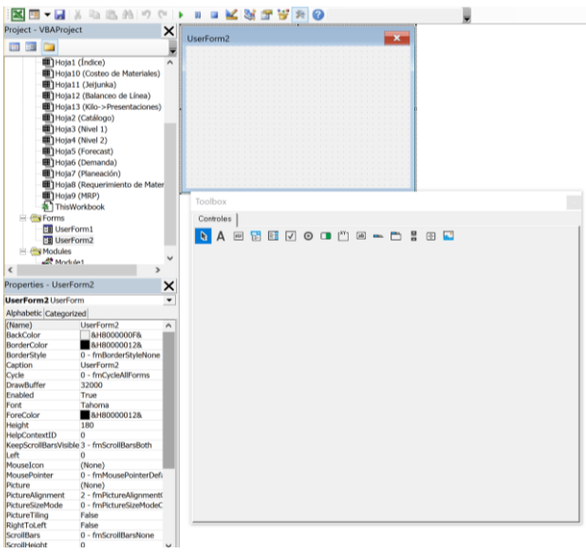


Figure 12 Use Form in Visual Basic Oct. 2018

TextBox allows the user to enter the access information, such as username and password. The CommandButtons allow to enter the information typed in the TextBox, or to exit the generated interface of the program. Figure 13 shows the basic form of the interface with the elements already mentioned.

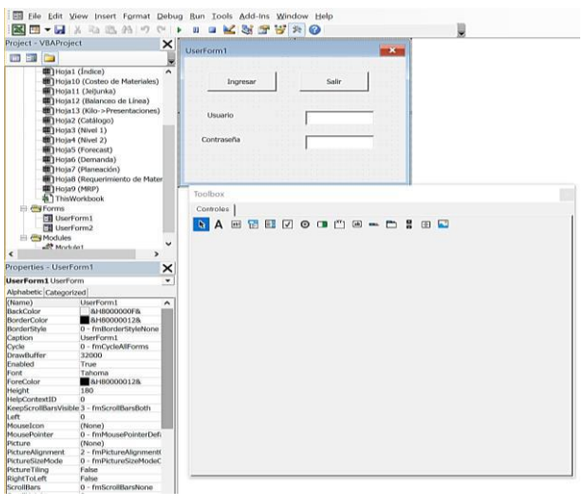


Figure 13 Use Form (basic interface elements) Oct. 2018

After adding the elements to the UserForm, each of the elements was programmed, in the Visual Basic Code tab, as shown in Figure 14, the code only seeks to give instructions to the elements that were attached to the UserForm.

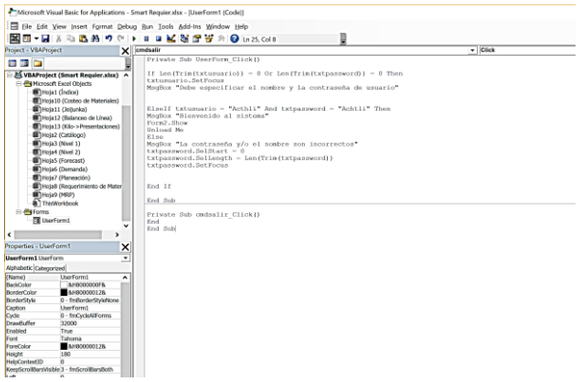


Figure 14 Use Form with of basic interface elements. 2018

Training of Production Area personnel to use the MRP application

In order to introduce the personnel in the use of the program, training was carried out in the Production Area of the company, where each of the components of the MRP system was explained, but not before introducing the analysis tools used to assess the situation of the company. Their recommendations were taken, thus raising countermeasures to avoid recurrence in the Production Area of the shortcomings found. Subsequently, he trained on the use and handling of the application.

Results

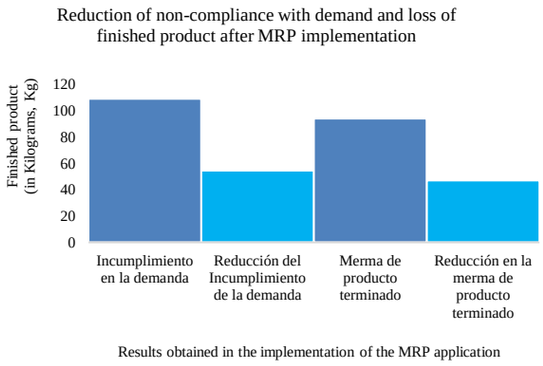
The system that was developed consists of multiple spreadsheets, which, aim to gather information from the different departments, so that production control is kept.

As can be seen in Figure 10, the proposed system has the inter-catalog sections (total products and components), product levels (components), forecast and demand, material requirements, MRP, line balancing, production leveling and cost of materials. In addition, the application can run without an internet connection.

Catalog	Product levels	Forecast and Demand	Materials requirement	MRP	Line Balancing	Production leveling	Materials Costing

Figure 15 Component of MRP production Nov. 2018

Graphic 5 shows the results in which a 50%-compliance with demand and the product was obtained. Fulfillment of its demand is expected and implementation of the system in full these results



Graph 5 Expected reduction in non-compliance with demand and decrease in November 2018

Smart Requirer application in Visual Basic

The executable application created as a result of the process carried out in the microenterprise has the name of Smart Requirer. This application allows users to obtain the data provided by the spreadsheet based on Excel, but prevents them from seeing the formulas used or modifying them, thus protecting the functionality of the system.

Another feature of Smart Requirerer is that the application has a user control to restrict the access of unauthorized personnel to the application, as shown in Figure 13:

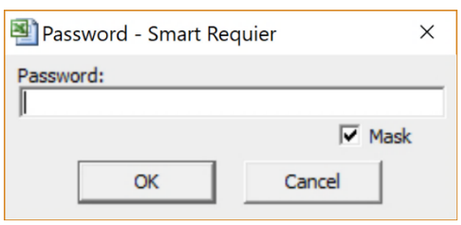


Figure 6 Password requested from Smart Requirer. Nov. 2018

Conclusions

The production planning system with the MRP methodology carried out is expected to reduce 50% of the production default. Although the implementation is in process, it is estimated that in a period of three months it will be achieved one hundred percent, currently the staff is trained and the approval was issued by the company verifying the advantages and achievements of the system.

It is worth mentioning that a possible obstacle to implementation would depend on the times of the company in relation to the fulfillment of the above, it The conversion into an executable file of the system successfully connected different areas of the company, creating a database that will support its functionality. As well as, support in the planning and fulfillment of the demand of the product.

With the present work, it is intended to make available to small businesses tools in the area of industrial engineering and information technologies, as well as make a scientific contribution from them.

Suggestions

It is suggested to complete the implementation of the system one hundred percent, as well as to replicate in other areas.

For future work, it is suggested to expand research on the use and implementation of industrial engineering methodologies and tools that foster the development and competitiveness of small businesses, innovating processes and technologies.

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