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RESEARCH ARTICLE

DEVELOPMENT OF A DEMAND FORECAST SYSTEM IN VBA: CASE STUDY OF A PRODUCER OF PORK DERIVATIVES

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ABSTRACT

Due to the globalization in which companies are inserted today, competition is inevitable and a constant threat. In addition, customers are increasingly demanding and resources increasingly scarce. In this context, a competitive advantage is established when meeting the requirements of the clients: speed, punctuality and flexibility. Companies are increasingly attentive to customer needs and have begun investing in production management techniques to ensure the reliability of their products and services. The application of demand forecasting models has the possibility of maintaining a lean stock structure of raw materials of the organization, as well as the possibility to identify a better way to avoid wastes and deviations of the processes through some analytical models of the Operational Research. As most of the company's employees at the operational level do not have the necessary skills to handle these mathematical models, this paper aims to propose the development and implementation of a production management system through the Microsoft Visual Basic® (VBA) interface, in A company of products derived from pigs, with the purpose of reducing waste and assisting in decision making, reducing the levels of stock of raw material.

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INTRODUCTION

According to Instituto Brasileiro de Geografia e Estatística (IBGE), in the 4th quarter of 2015, 10.22 million pigs were slaughtered, representing an increase of 0.3% in relation to the immediately previous quarter and of 7.6% In comparison with the same period of 2014. It is understood that the loss of the competitiveness of small and micro national companies, due in large part to the obsolescence of the managerial and technological practices applied to their productive systems, having its origin triggered from five basic points: deficiency in the measures of performance; Negligence with technological considerations; Excessive specialization of production functions without adequate integration of these functions; Loss of business focus; Resistance and delay in taking on new productive positions (Corrêa and Gianesi, 1993).

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The use of spreadsheets is a useful tool when using intelligent macros that reduce errors and generate graphs that aid in decision making. As Rocha (2011) states, spreadsheets are commonly used and accessible to most employees of organizations, specifically Excel.

MATERIALS AND METHODS

Theoretical basis - The decision-making process

Santos et al. (2016) state that the use of Operational Research (OR) is justified by the fact that it is a science composed of innumerable techniques and models intrinsically related to the optimization of productive systems, that is, to produce more and better the starting from a certain amount of inputs. Therefore, OR is an optimization tool par excellence. Santos (2015) stares that OR makes use of mathematic and/or logical model in order to solve real problems, presenting a highly multidisciplinar. Thus, Santos (2013) says according to the type and complexity of the problem studied, we will look for the

best model that adhere to reality. The problem studied in this article is a typical demand forecasting application. Tubino (2000) defend that demand forecasting is the basis for strategic production planning. Applying demand forecasting techniques, managers will be able to adapt production in such a way as to meet market demand, plan stock, and hire labor. The model of demand forecast by the weighted moving average is a variation of the simple moving average, which should also be applied only to demands that are neither trend nor seasonal. The difference between this model and that of the simple moving average is that it is now considered a greater weight for the last period of demand, a slightly lower weight for the penultimate period and so on until the last period to be used for the estimate. In other words, the demand values of the nearer periods are considered more important in the definition of the estimate than the more distant periods. Usually the sum of weights equal to one is used, so that it is not necessary to divide the result by the sum of the weights. The following expression shows the calculation of the weighted moving average.

$$\overline{C} = \sum_{i=1}^{n} C_{t-i} \cdot p_{t-i}$$

Production planning is indispensable to optimize production and, consequently, to maximize the financial results of companies. However, Miglioli; Ostanel and Tachibana (2004) observe that there are small companies with great difficulty regarding the generation of knowledge, causing small Brazilian companies to lose spaces and market opportunities by improvising in the decision making and the formulation of strategies. In fact, as Cezarino; Filho and Ratto (2009), smaller companies coexist with smaller-scale problems, and sophisticated tools, of course, would not be of great value. In this case, then, the use of spreadsheets presents itself as a low-cost and low complexity alternative for solving managerial problems in small companies.

Problem

In the quest for opportunities to improve the financial performance of a pork industry, it was identified that the factory needed to improve its raw material yield by reworking the formula used to produce finished products, thus reducing its stocks, waste and production. From the analysis of the company's production processes, it was evident that there was a big problem in production management: the demand for finished products was not taken into account. This made the company produce more than needed, causing high inventory levels of a large number of raw material residues and finished products. Another factor to emphasize is that to program production, the formulas are used for batch production, and there is no way to produce them in small fractions.

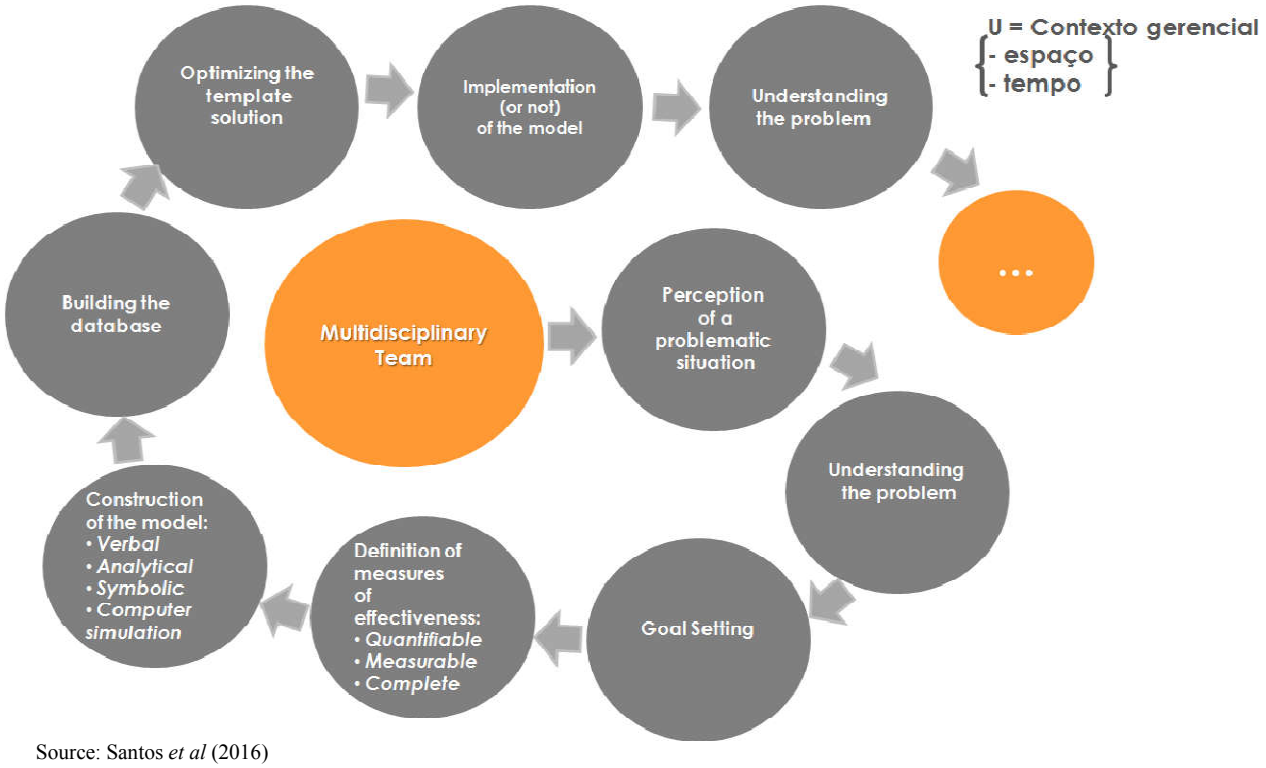
Methodology

Every OR problem begins with a problematic situation, that is, with a mismatch between what one wants and what one has, whether for a person, a group of people or an organization. Thus, the first step in solving a problem is the perfect understanding of the problem and its boundary conditions. From there, a goal can be determined. Having set the objective, it is necessary to define the operational effectiveness measure (OEM), that is, a measure that allows measuring how much a measure contributes to the achievement of the objective function. In order to fulfill this function, the OEM must have three indispensable characteristics: it must be quantifiable, measurable and complete. Quantifiable refers to being able to represent it by means of a number. Measurable, it is about being possible to measure it, directly or indirectly. And, last but not least, an OEM must be complete, ie, contain all the information necessary to measure the effectiveness of a system. From this, a model is constructed, and it can be analytical or not. However, for a model to be used, especially the mathematician, it must be fed by data, which must be as reliable as possible. The structuring and formation of a consistent, coherent and reliable database is of fundamental importance for the model to present results adhering to the context that one wishes to intervene. In the possession of the model and the database, one starts for the optimization of the model, that is, under what circumstances that system will produce the maximum possible, if the function is of maximization. And, closing the "first round" of the decision making process comes the implementation or not of the model. It is worth mentioning that this decision rests solely with the decision maker. Most of the time, this domain dominates other relevant information, which for some reason were not transmitted to who did the mathematical modeling of the problem. Figure 1 presents the spiral of the decision-making process, conceived as a mental abstraction, since the decision-making process about a problem unfolds in the first eight stages, starting from a problematic situation, 1st stage, until the implementation or not model, 8th stage, when then, the perception of the problematic situation takes on a new dimension, incorporating new facts of the underlying reality that had not previously been taken into account. This will lead to a new understanding of the problem, and, perhaps, will lead to a new goal, making the whole process repeat itself. Therefore, the decision-making process is iterative and growing.

It is known that every model is a simplification of reality, in order to manipulate only the decision variables that actually exert some significant influence on the studied phenomenon. Although the OR uses a number of tools to support the decision, pointing to the pessimistic, optimistic and most likely scenario, it will never replace the decision maker. This is a key part of the decision-making process, because it involves risks and uncertainties that will be evaluated within the managerial context of the organization. Among the range of analytical models of the OR, this article will use a relatively simple demand prediction model, but that could bring a significant gain to the studied company, as it does not apply any type of methodology for this purpose. Regarding the objective of the study, the research is classified as descriptive and explanatory, since it seeks to produce knowledge for practical application directed to the solution of specific problems. As to the means, this article can be classified as documentary research, field research and case study, since data from documents of the company studied were used, and such data have not yet received analytical treatment of any kind. In addition, the research is also classified as bibliographical based on research in books, articles, theses and published materials.

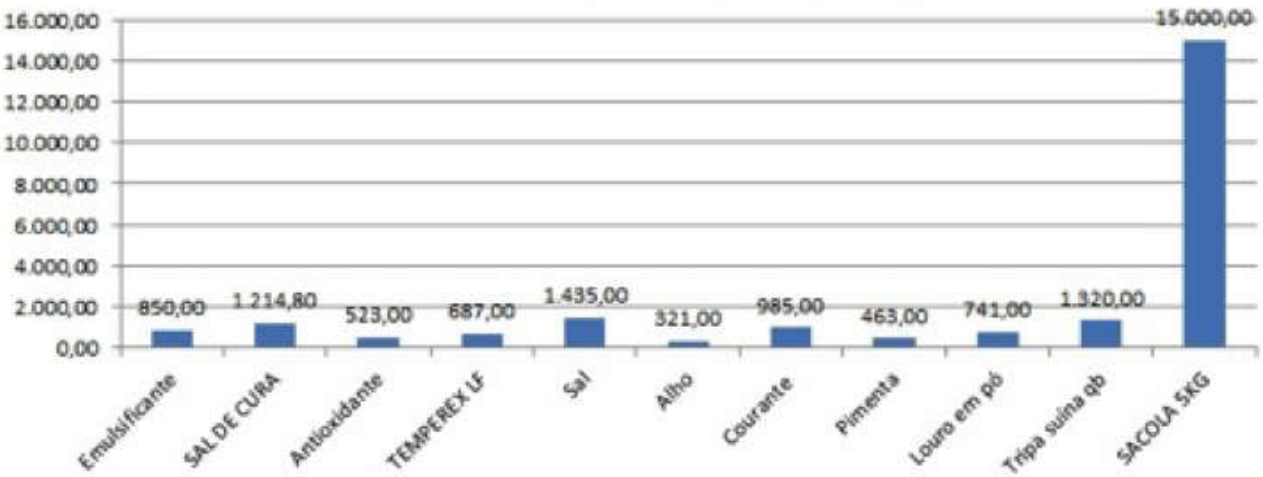
Data Collet

In OR, the data collection phase plays a critical role. This is because the availability, quantity and quality of the data available will in some way influence the choice of the model to



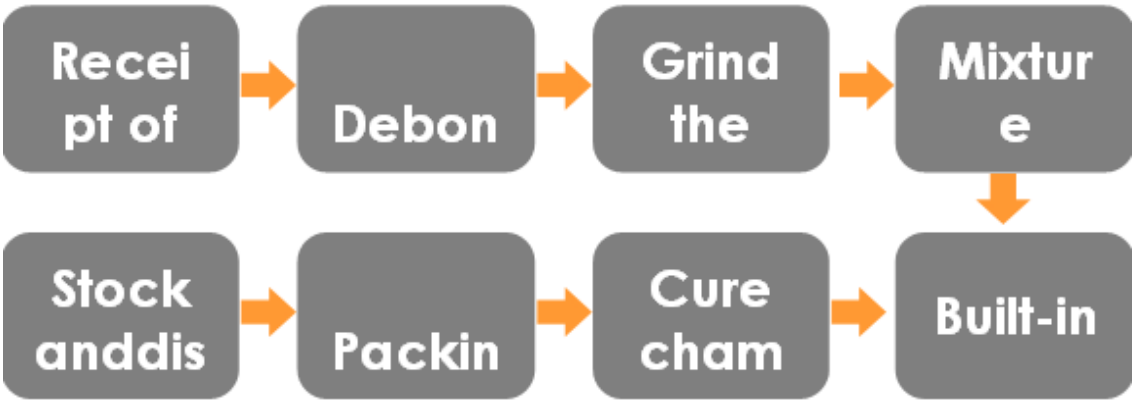
Source: Santos *et al* (2016)

Fig. 1. Decision process spiral



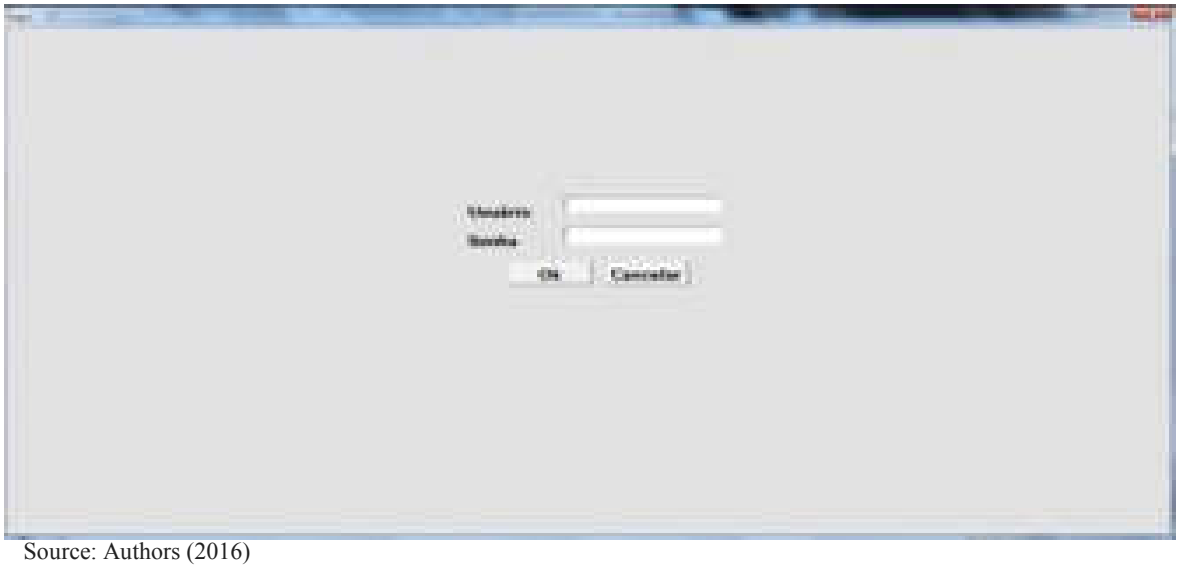
Source: Authors (2016)

Fig. 2. Amount of raw materials in stock



Source: Authors (2016)

Fig. 3. Process for the production of fresh sausage

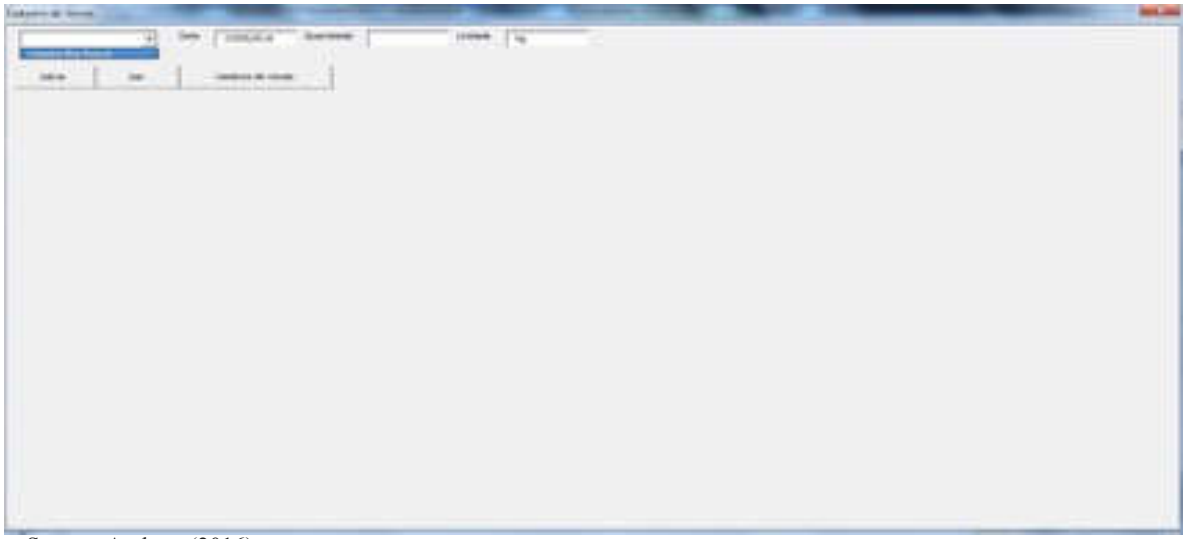


Source: Authors (2016)

Fig. 4. Login screen

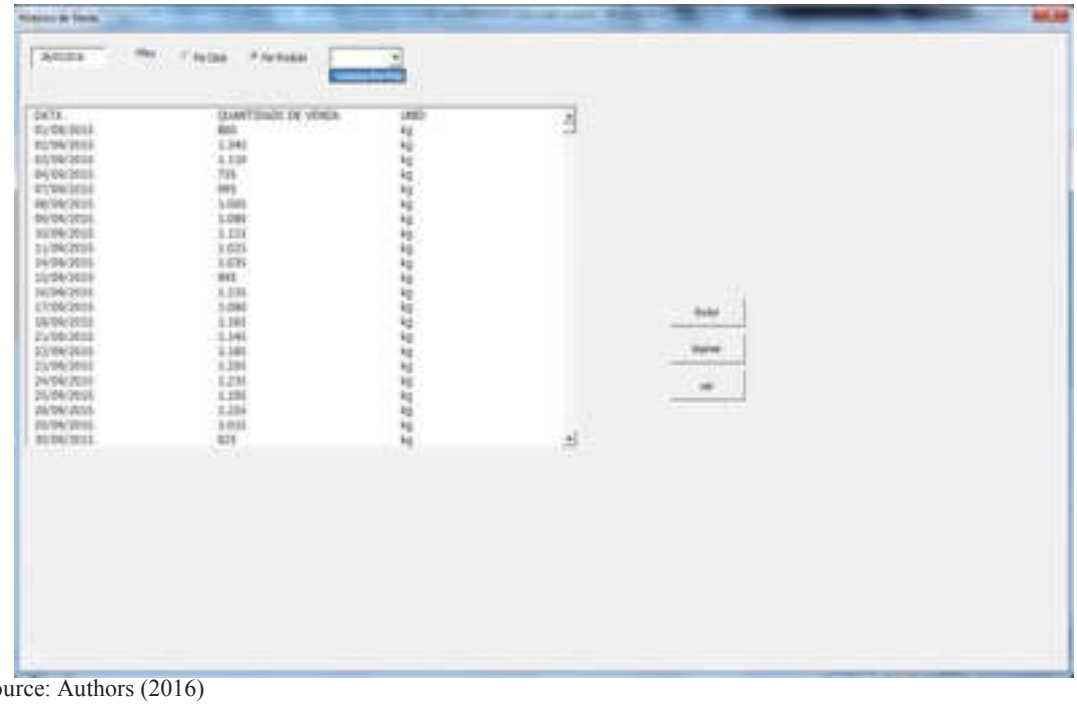
Source: Authors (2016)

Fig. 5. Initial menu screen



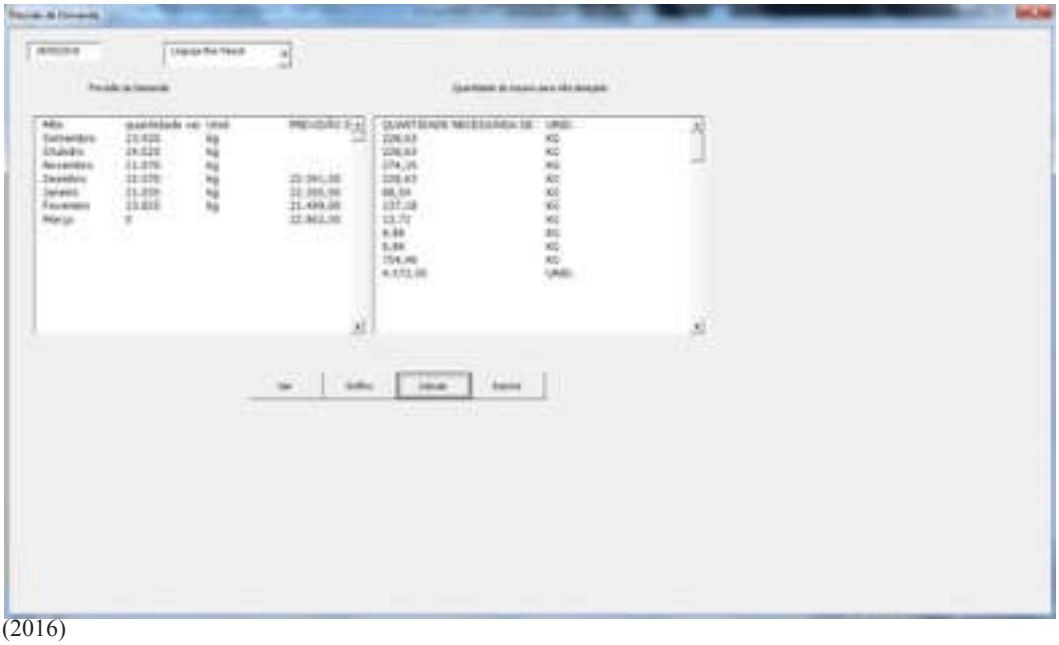
Source: Authors (2016)

Fig. 6. Sale register screen



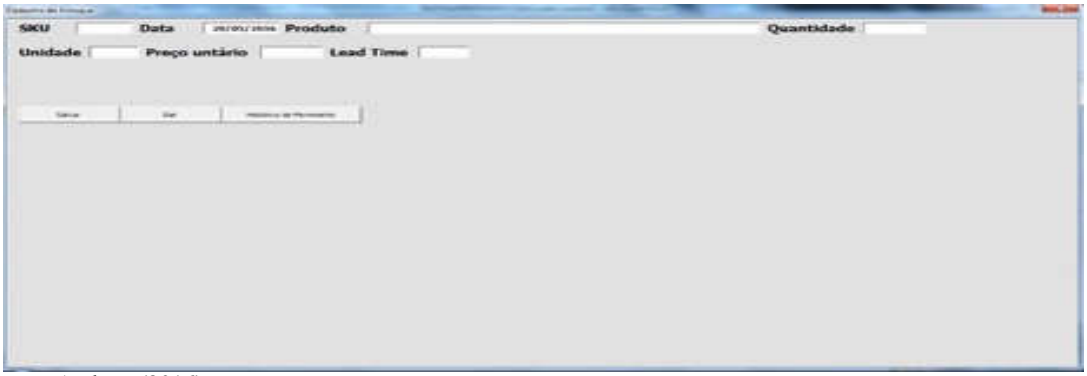
Source: Authors (2016)

Fig. 7. Sale history screen



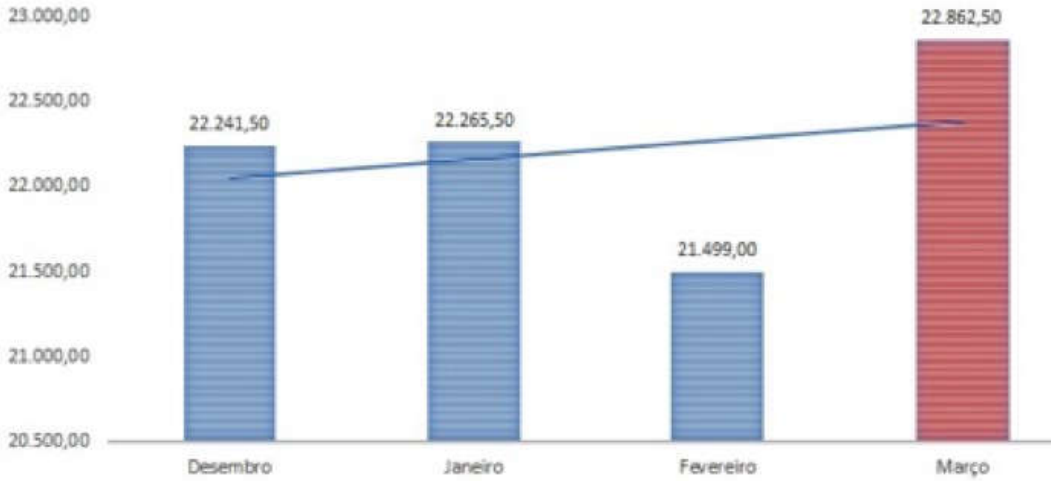
Source: Authors (2016)

Fig. 8. Demand forecast screen



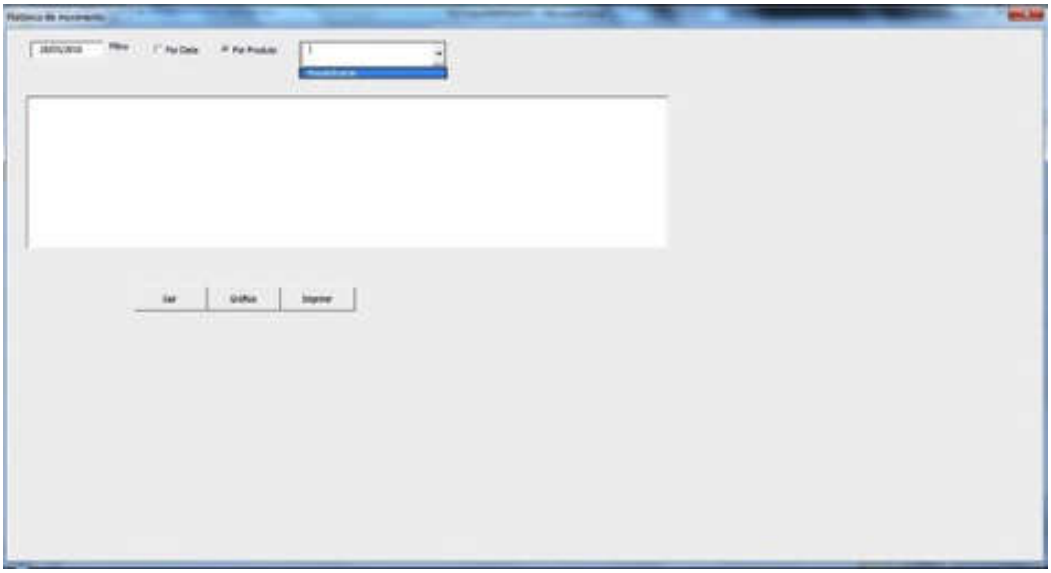
Source: Authors (2016)

Fig. 9. Inventory register screen



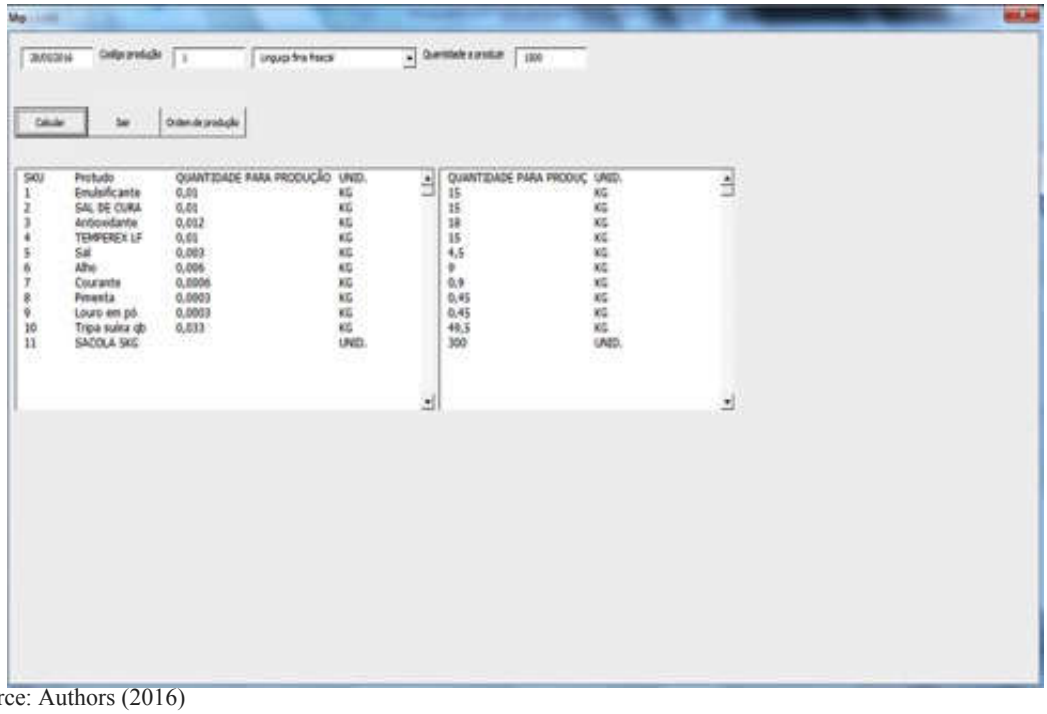
Source: Authors (2016)

Fig. 10. Demand forecast



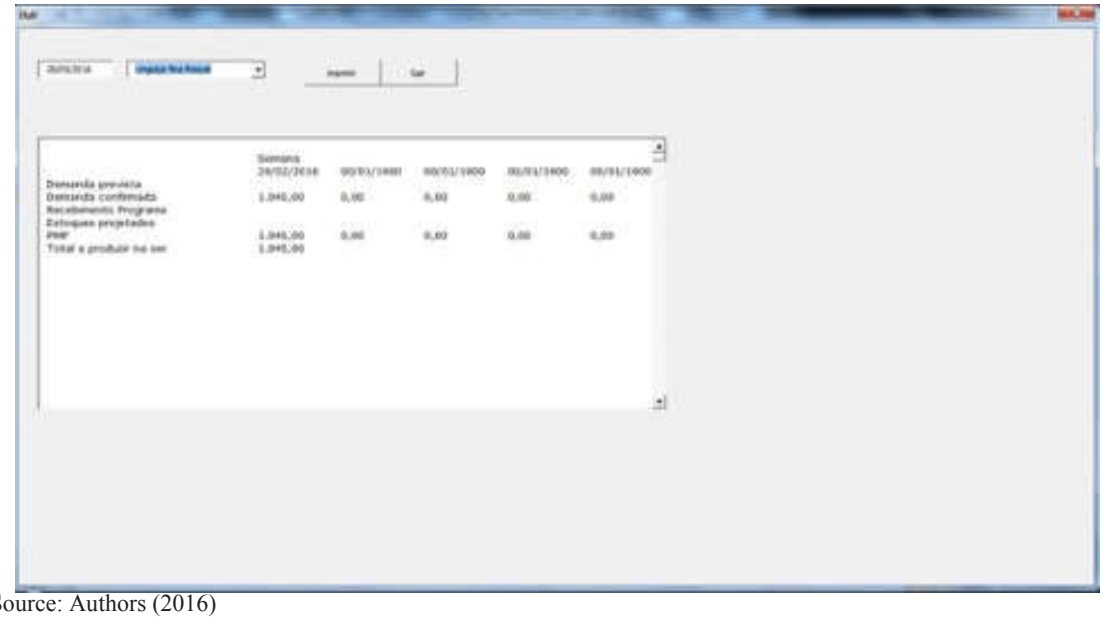
Source: Authors (2016)

Fig.11. Motion history screen



Source: Authors (2016)

Fig. 12. MRP screen



Source: Authors (2016)

Fig. 13. PMP screen

be applied, whether analytical or not. Moreover, regardless of the model being used, hardly any poor quality data will generate results that deserve great consideration. There is a maxim in engineering called GIGO, which means "garbage in, garbage out", ie "if garbage enters, garbage leaves". So, however sophisticated an analytical model may seem, it will hardly generate good results, and ultimately support the decision to the satisfaction. In this context, it must be considered that on some occasions it is preferable to take a decision blindly, than to take it with incorrect subsidies. The company's data on demand behavior, surplus stock evolution and production levels between September 2015 and February 2016 were used.

Case Study

Company

The company has been operating in the processed meats business for more than 25 years and is located in the Mountain Region of the State of Rio de Janeiro. The products manufactured by the company are: fresh sausage, smoked sausage, smoked pork loin, pork loin pan, and others. The differences in the quantities indicated in Figure 2, cause a series of harm to the company, such as: excess inventory of raw material and finished products, cost of maintenance of facilities, opportunity cost, among others. In many cases, the raw material is lost due to the expiration date, due to not observing FIFO (first in first out) discipline.

Case of production improvement Project

As presented, it is necessary for the PCP department to implement a forecast of the demand in order to improve the planning of the raw material requirement. In addition, it is also necessary to adjust and / or elaborate the formula of the quantity of inputs required for the production of fresh thin sausage. Due to the absence of these actions, the company has presented high levels of stock of raw material, as indicated in The following expression establishes the necessary quantity of each raw material for the production of 100 kg of fresh thin sausage.

$1kg$ emulsifier $+$ $1kg$ dry salt $+$ $1.2kg$ antioxyd $+$ $1kg$ temperex LF $+$ *0.3kg*salt + *0.6kg* garlic + *0.06kg* courante + *0.03kg* pepper + *0.03kg* blonde powder =*100kg thin sausage*

The process of production of fresh thin sausage is composed of eight processing steps, as shown in figure 3.

Mathematical model adjustment

After the data collected, it was observed that one of the causes of wastage was due to the formula used to calculate the necessary quantity of inputs for the production of fresh sausage, generating lots of 100 kg. The formula was adjusted for the production of 1kg of sausage, facilitating the calculation of fractional production, thus avoiding wastage. The expression below shows the adjustment for the production of one kilo of fresh thin sausage.

$$\begin{aligned} &0{,}01\ kg\text{emulsifier} + 0{,}01kg\text{curing salt} \\ &\quad + 0{,}012kg\text{antioxidant} \\ &\quad + 0{,}01kg\text{temperex LF} + 0{,}003kg\text{salt} \\ &\quad + 0{,}006kg\text{garlic} + 0{,}0006kg\text{courante} \\ &\quad + 0{,}0003kg\text{bay leafpowder} + 1kg\text{pork} = \\ &\quad 1kg\ \text{fresh thin sausage} \end{aligned}$$

System Development in VBA

In view of that company employees not expected to be familiar with demand forecasting models, a system has been developed where only quantities sold are to be released month by month and the demand for the following month is already calculated automatically By means of a weighted moving average of the last three months, with weighting factors 0.6; 0.3 and 0.1; being 0.6 the factor corresponding to the most recent month and 0.1 the weighting factor of the oldest month. For the creation of the interfaces, was taken into account, the logical structure of Excel for the construction of the general model. Next, the interfaces functionality architecture and macro routines were elaborated in a way to facilitate the operation of the system. Visual Basic for Applications (VBA) was used for the development of the interfaces, for the control and the

personalization of the environment. The initial interface, figure 4, is the login where the responsible user enters his username and password. After the login is done, it is moved to the start menu, as shown in figure 5. This menu was created to allow the user access to the work routines. Command buttons have been created to facilitate the user interface, such as: sales registration, demand forecasting, raw material entry, MRP (Material Requirement Planing) and PMP (Production Master Plan). This window presents to the user the graphs of the demand forecast and the quantity of raw material in stock. The button "sales register" records the quantities sold in kilos per day, making programming the PMP easier. By clicking on it, a sales order form opens, Figure 6, and automatically the date is filled with the current day and the unit in kilos. The user chooses the desired product, in the case of the study is fresh thin sausage, inserts the quantity sold and saves the operation.

The "sales history" button opens a form, figure 7, in which the user chooses which filter to use, by date or by product, selects and prints the desired report. The demand forecast screen, figure 8, lists the last three months of the sale due to the demand forecast being calculated using the weighted moving average. Automatically, from the current date, by choosing the desired product, the system generates the demand forecast. By pressing the "calculate" button, the amount of raw material required to produce the desired month is displayed, thus facilitating decision making. The "exit" button returns to the initial menu and the "print" button generates a report with all demand forecast data. The "raw material entry" button opens the form in figure 9, where the date is filled automatically with the current day. The user fills in the SKU of the desired raw material and the fields "product", "unit" and "lead time" with their respective values. To update some data like "lead time", for example, just change the respective field and save. The "exit" button returns to the main menu. The "chart" button opens the demand forecast graph, figure 10, and updates the initial menu graph. The "motion history" button opens the form in Figure 11. The date of the current day is automatically filled in and the user chooses the type of filter to be applied. The "Chart" button generates a chart with the quantities of stock in stock at that time. The "MRP" button, Figure 12, has been programmed to generate a production code as soon as you open the form. The usurer selects the desired product and its quantity, from then a list with the necessary inputs for the production of that product is opened. With the "PMP" button, figure 13, the user chooses a product from the list and then the weekly schedule appears.

Final considerations

This work achieved three important results: it proposed a new formula for the production of fresh sausage, with the necessary quantities of each raw material for the production of 1kg of the product; proposed a model of demand forecast adequate to the needs of the company, which could provide a considerable reduction in the waste of raw material; and has created an easy-to-use VBA system where monthly consumption data is entered, thus generating demand forecast for the following months. As an opportunity to deepen this research, two main surveys are considered - the first one consists of, after the implementation and maturation of the new methods, to verify if there was an effective reduction of the waste - the second is to research in the literature of Operational Research, particularly In Demand Forecasting Methods, in order to verify if there are more suitable models for this type of demand. It is worth emphasizing that the accuracy of each model will be determined by calculating the error of each model in relation to the demand observed in a given period.

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