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Warehouse Management Problem and a KPI Approach: a Case Study

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Abstract
Warehouse and inventory management is a recurring issue in many of the different supply chains in diverse industries, where the constant changes in the markets have a direct impact on the management of warehouses and inventories, either generating over-stocks or shortages. This paper presents a case study on warehouse and inventory management control. The company under study was having problems in this area, where over-stocks were generated frequently, leading to various incidents, such as having to store finished and packaged product in unsuitable places, with the associated risk of deterioration. To deal with this problem, control tools based on the KPI (Key Performance Indicator) concept were developed. To this end, the corresponding problem and the information management process within the Supply Chain department had to be analyzed. In this case, it was observed that the databases were not synchronized, therefore strategies were proposed to systematize the collection and updating of data. In addition, to summarize the information, we proceeded to the implementation of an interactive form that facilitates the visualization and interpretation of the evolution of the process, and to be able to apply an efficient control on it, and thus to propose corrective actions supported by evidence.

Keywords
stock control, logistics, operations management, key performance indicators, warehouse management, control function.

Introduction

The inventory and warehouse management issue affects the vast majority of supply chains (Christopher, 2011; Mason et al., 2003; Toncovich et al., 2019). The mismanagement of the warehousing and inventory function can influence adversely the economic returns of companies, either by generating excessive inventories (immobilizing great amounts of capital), or by producing inventory breaks (lost sales and customers) (Lee, et al., 2018; Silver, et al., 1998). On the other hand, inventory management is one of the main strategies used to face and overcome unexpected market crises or uncertainties, as the Ripple Effect (Ivanov, et al., 2014) or the Bullwhip Effect (Chen et al., 2000). In other words, an organization will be able to better overcome these crises and uncertainties depending on whether its inventory and warehouse management is efficient (Chiang et al., 2011). In line with this conception, many of the great advances in production management include a new perspective on inventories, as shown by the emergence of the Just-in-Time philosophy and Lean manufacturing in the 1980s (Vollmann et al., 2005; Srisuk & Tippayawong, 2020).

In addition, inventory management must face scenarios and situations that change over time, so decision makers must be able to solve the associated problems in these varying situations and scenarios (Ivanov, 2018). It may happen that in some periods it is better to overstock, while in others, it is better to keep inventories at the lowest possible levels (Vollmann et al., 2005; Braglia et al., 2016). In this sense, it is essential to have tools and methodologies that allow analyzing whether the policy that is currently being executed is correct and aligned with the company's objectives, or not. In other words, inventory and warehouse management requires process control tools (Broz et al., 2018; Purba et al., 2019). The im-

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portance of the control function is such that managers and members of the supply chain dedicate at least half of their working time to managing uncertainties and risks (Ivanov et al., 2017). Therefore, in real life, control tools are the natural means of obtaining feedback on planned activities and their actual evolution (Vollmann et al., 2005).

The control tools analyze the actual operations against the plan, thus, they can generate information about the quality of operations planning (Neely, 2007; Gunasekaran & Kobu, 2007). This information is usually represented by means of indicators, which directly associate the state of operations with the planned or proposed objectives, and usually have the capacity to measure the degree of compliance of those objectives (Kucukaltan et al., 2016). Indicators allow improving the general control process, helping to generate action plans that enable to correct deviations between what is real and what is planned, ultimately improving the performance of the company (Lohman et al., 2004).

That is why in practice the use of indicators is one of the main decision-support tools, since they let senior management have a sound picture of the situation, and also, measurable data of the current state of the processes and activities. Then, indicators are indispensable inputs for developing new ideas to improve company performance (Parmenter, 2015; Villalba-Diez et al, 2018). That is why, for an indicator to be effective, it must be associated with the evaluation of some objective, allowing monitoring the success or failure of an objective during the evolution of the process, as well as showing, in failure cases, the potential causes of the failure reported by the indicator (Lohman et al., 2004).

This paper addresses a stock and warehouse management case study. The company is dedicated to the manufacture and marketing of household vacuum cleaners. Basically, the problem consists of a mismanagement of finished goods inventory, which means that the production area does not have updated and accurate information, generating excessive finished product stock, which must be stored in a precarious way that can cause product deterioration. This problem was tackled with the collaboration of the Supply Chain department of the company. The solution approach is based on the development of key performance indicators (KPI). This approach enables all data related to the current state of the system to be collected and processed and presented in an easily interpretable manner. KPIs allow company managers to work directly on the problem and achieve significant improvements in the execution of plans in the Supply Chain department (Parmenter, 2015). However, it is worth of mention that this work does not address a comprehensive policy in inventory management, such as studying the reorder point and demand cycles (Porras and Dekker, 2008). The time horizon considered here (one month) is not long enough to study these features of the problem.

Literature review

KPIs have been widely used in inventory management and supply chain logistics processes (Staudt et al., 2015). For example, Laosirihongthong et al. (2018) analyze how to synchronize production with inventory management, and the management of third party logistics service providers. This work highlights the main data to be collected to measure the overall performance of the system. In (Dev et al., 2019) the impact of having information in real time from architectures that support Big Data is analyzed, and KPIs are designed that allow keeping track of the current state of the system. A similar case is studied in (Tokat et al., 2021) where methods based on artificial intelligence are proposed to address data processing, for the calculation of KPIs. While in (Torbacki & Kijewska, 2019), the use of KPIs is extended to measure the logistics and production performance of supply chains in municipal management environments.

On the other hand, inventory management is also affected by the sustainable development objectives that have been generating structural changes in industries in recent years. In this regard, in (Torabizadeh et al., 2020) a literature review is carried out and 33 KPIs are identified, which are later analyzed in a particular way. In this sense, the results proposed by (Agyabeng-Mensah et al., 2020) are interesting, where, based on a survey carried out on industries from Ghana, they conclude that the incorporation of environmentally friendly criteria has a negative impact on the economic balance of the agent in charge of the warehouse, but achieves global benefits for the supply chain.

On the other hand, warehouse management is affected by the labor performance of the workforce, as described and modeled in (Popović et al., 2021). In this work, the authors addressed the possibility of integrating production scheduling, based on inventory levels and customer demand through mathematical programming models, and planning the use of labor. At the other end are fully automated environments. This is the case addressed by (Nantee & Sureeyatanapas, 2021), where they study warehouses with a complete transformation to Industry 4.0 systems. The main impact they found was a substantial improvement in the indicators associated with sustainable objectives, but a worsening performance in other types of indicators such as maintenance costs and job losses. On the contrary, a study on lean indicators in the management of warehouses was developed in (Pereira et al., 2020). In this work, the authors carried out a field study, and verified that, in many cases, the possibilities of improving the performance in the indicators could be achieved by implementing non-technological solutions, that is, without investing in sophisticated information technologies. Another case, where a lean approach allowed to significantly improve the performance of warehouse indicators is presented in (Sharma & Shah, 2016). In this work, they propose a method based on Real Time Delphi and Analytical Network Process, to make decisions that affect inventory management. This type of lean approach was deepened in (Buonamico et al., 2017) where they propose KPIs to analyze the performance of the warehouse system based on lean concepts, which allow a 6% reduction in waste.

In the reviewed works, it was found that KPIs are a more than effective method to improve the performance of warehouses, whether in terms of sustainability, use of resources or economic benefits. However, these studies started from the base where the information systems that fed the indicators were already implemented and functioning. On the other hand, in the work carried out here there is no such systematization of the information. This work contributes to outline and generate the data required to calculate the main indicator, the inventory level, that will then feed the rest of the indicators. In the particular case addressed in this work, it is vital to analyze all the channels that affect the inventory, as well as the periodicity of records to avoid duplicating data. Considering the taxonomy proposed by (Staudt et al., 2015), the indicator developed here is close to the percentage of use of warehouses.

Materials and methods

Every administration system, regardless of the characteristics of the business, is composed of a set of complex functions, which gives its structure, and facilitates operations (Vollmann et al., 2005). To ensure that these functions are coordinated in their operation and they help to accomplish the objective of the system, it is necessary to have a proper system management (Ivanov, 2018). To this aim, it is necessary to comply with the plan, and it is in this area that system control will constitute a primary stage, since the manager will not be able to verify the real situation of the organization if there is no mechanism to report whether or not the facts are aligned with the objectives (Neely, 2007). Control systems are those means that will be used to evaluate actual performance against the plan in place (Colledani & Tolio, 2011).

Management control is a dynamic and important system for achieving the organizational goals set in the planning process. The control function should be focused on assessing the behavior of the critical factors that influence the fulfillment of the strategies, should be flexible and permanently adjusted to the changing strategies of the organization (Gunasekaran & Kobu, 2007). One way to manage and implement a control system is through the development of indicators. The indicators will allow to measure attributes of the business or industry processes and provide relevant information to make decisions against deviations from the plan (Parmenter, 2015).

Key performance indicators

KPIs, or key performance indicators, measure the level of performance of a process, focusing on the "how" and indicating how good the processes are. The key performance indicators are metrics used to quantify objectives that reflect the performance of an organization, and which are generally included in its strategic plan (Lohman et al., 2004). They are necessary to improve, since what is not measured cannot be controlled, and what is not controlled cannot be managed (Kucukaltan et al., 2016). KPIs are "vehicles of communication", in the sense that they allow top-level executives to communicate the mission and vision of the company at the lower hierarchical levels, directly involving all employees in achieving the strategic goals of the company (Parmenter, 2015).

Although they vary from company to company, the most common KPIs aim at improve performance objectives related to work productivity, product and ser-

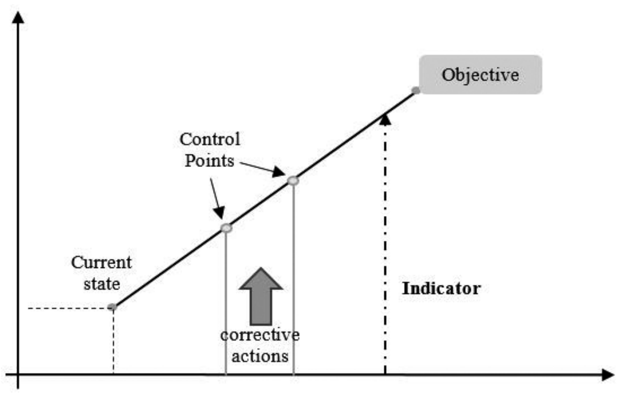

Fig. 1. Relationship between the business objective and the indicator

vice quality, business profitability, deadlines, process effectiveness, lead times, resources utilization, growth, cost control, level of innovation and productivity of the technological infrastructure (Sangwan, 2017). But defining a correct set of KPIs has its complexities, since the real challenge is to select indicators that not only help meeting budgeting goals, but also, and more importantly, that are in perfect tune with the company's strategic goals (Rafele, 2004).

KPI characteristics

For defining a KPI, Parmenter (2015) follows the "SMART" criteria of Peter Drucker (Drucker, 2012), used to define goals, and clarifies that these criteria are also useful for the design of successful indicators. These SMART criteria, refer to Specific (it should be clear what you want measure), Measurable (must be quantifiable, and in the most direct way possible), Achievable (feasible to achieve from the initial situation), Realistic (the desired level of change should be possible to obtain), Timely (sensitive as time goes by).

Since the systems that can be controlled depend largely on the item and the activity subject to control, there are many types of KPIs. Next, we present the classification applied according to the quality policies of the company in question, which allows us to evaluate the different processes that will be developed under a single referential framework. This classification depends on two variables: the scope of control and the managerial dimension. Figure 2 depicts the classification scheme. Regarding the Scope of Control of the KPIs, each one of the areas that can be controlled is detailed below:

Inputs: They are the available resources that the organization has to achieve a product or result. Examples: workforce, material resources.

Processes: Activities, tasks and operations necessary to obtain the product / result. Examples: administrative processes, purchasing procedures.

Products: They represent the products or services generated by a given system or process. It measures the volume of production that has been achieved during a given period. Examples: units produced, personnel hired.

Results: Final outcome that is reached, when the products or services fulfill their purpose. Examples: customer satisfaction, increased sales.

For the Dimensions of the KPIs, we have the following:

Efficacy: They measure the degree of compliance with the objectives of the organization, without reference to cost.

Efficiency: They are used to evaluate the costs per unit of service or good produced.

Quality: They measure the technical characteristics of the product or service delivered, as well as the degree of compliance, by the service or product, with the requirements and expectations of the customer.

Economy: They measure the company's ability to mobilize adequately its financial resources.

Ecology: They measure the degree of pollution released to the environment at each stage of the production process.

On the other hand, beyond the classification of Figure 2, it is also important to identify the desired direction of the KPI evolution, in order to correctly interpret measured values. In this sense, the indicators can be positive or negative:

Positive indicators: An increase in their value or trend would be indicating an advance towards the desired situation.

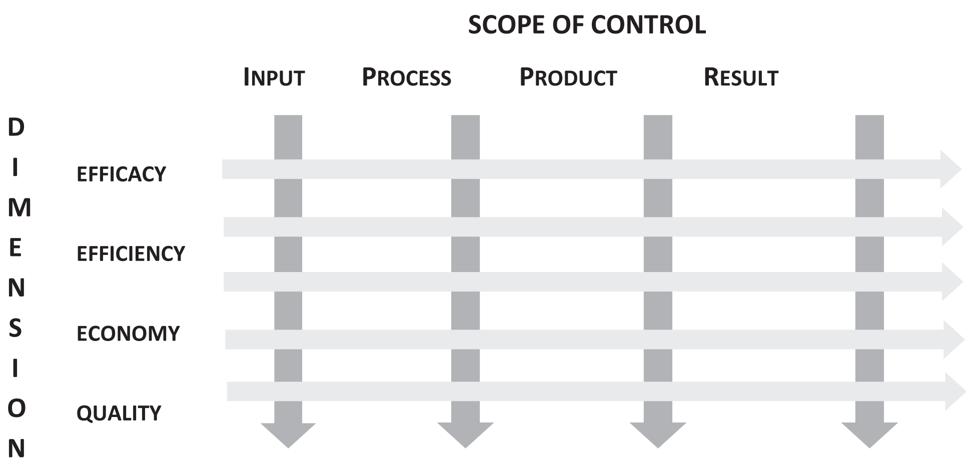

Fig. 2. KPI classification scheme

Negative indicators: A decrease in their value or trend, would be indicating an improvement with respect to the desired situation.

KPI Implementation

During its involvement in the project of creation and implementation of the indicators, the logistics team of the Supply Chain Department of the company considered it necessary to create systems of indicators with specific characteristics. For this purpose, it was determined that the system of an indicator would be made up of the definition of indicator, the *baseline level*, the *current value*, the *goal*, and the traffic light or RAG (red, amber- yellow, green) rating system for performance evaluation. These elements facilitate the interpretation of the results obtained from the measurement of an indicator, allowing to ascertain the initial situation of the indicator, its evolution and the degree of progress towards the proposed goal.

Baseline Level: Refers to the initial measurement or standard level taken for the indicator, and represents the performance achieved before the effect of strategic improvement initiatives.

Current Value: Represents the period-by-period measurements of the indicator, which are influenced by the effects of strategic initiatives.

Goal: It is the expected level of the indicator that the organization wishes to achieve after successfully executing the improvement actions.

Traffic light rating system: To be able to easily observe the level of performance of the indicators, traffic light or RAG rating system is used, where green represents an expected performance, amber (yellow) a worrying performance, and red indicates an unacceptable performance.

Warehouse problem

This section presents the inventory and warehouse management problem addressed in this work. It is worth of mention that at the time of starting this control project through the KPI method, the company had already initiated the primary developments required to implement it. Thus, the standard control project phases of institutional diagnosis and identification of key processes had already been completed. Our participation in the project consisted mainly in developing the indicator systems for the key processes, in order to measure their attributes and set the basis to perform corrective measures.

The main goal of this study was to provide means to better control the quantity of finished product stored in the warehouse. It was decided to monitor this aspect since the maximum capacity of the warehouse had been reached (and sometimes even exceeded), forcing the company to use areas of the warehouse that were not conceived to store finished product. The problem of overstocking in the warehouse was due to a decrease in sales of vacuum cleaners in Europe.

In the first half of the year 2018, a decrease in the company's sales of approximately 5% was experienced, generating the accumulation of units in the warehouse. Therefore, it was decided to keep track of the stock in the warehouse through this indicator, to assess in what way the decrease in sales really affected the inventory of finished product.

Controlling this parameter has a deep relationship with the Production and Sales Departments, and with the Purchasing area of the Supply Chain Department, since, based on the results and conclusions obtained using this indicator, it was intended to modify the production plans for the last four months of 2018, and for the following year.

As a first approach to the problem, the classification scheme of Figure 2 is applied to then develop the measurement and interpretation system associated with the indicator. Applying this classification is required by internal regulations from the company. Table 1 shows the classification of the KPI and Table 2 defines the attributes of the indicator system.

Table 1
KPI Classification: Finished Product Stock

Finished Product Stock KPI: Classification	
Indicator type	The present indicator is of the negative type, since a decrease in its value implies an advance towards the objective (the current problem in the depot is the excess stock of finished units, so it is sought that the stored amount of these products decreases).
Scope of Control	This indicator falls within the scope of "Products", since the stock of finished product stored in the warehouse is measured.
Dimension	The dimension of the indicator is "Efficacy", since the stock of finished product in the warehouse is being monitored, taking into account the available capacity, regardless of storage costs.

Table 2
KPI System: Finished Product Stock

Finished Products Stock KPI: Indicator System	
Baseline Level	The baseline level is given by the first measurement of the indicator, taken in the month of June of the year 2018.
Current Level	The value obtained from the monthly measurement of the indicator is considered as the current level.
Goal	The proposed goal for this indicator is to ensure that the quantity of finished product in inventory is less than 33 000 units. This value was adopted based on the available storage capacity. The finished product warehouse has a maximum established capacity of 33 000 units. Therefore, if this value is exceeded, it means that space not intended for this purpose is being used to store finished product.
Traffic light rating system	The following limits are established to set the traffic light rating system: less than 33 000 units of finished product in stock as expected performance (green color); between 33 000 and 36 000 units as a worrying performance (yellow color); more than 36 000 units as unacceptable performance (red color). This last value was determined taking into account the availability of storage space in the sector destined for raw material and other supplies. It was established that in this sector there was free space to store approximately 3 000 units of finished product. However, using this space to store finished product was a temporary measure, and it was expected for each storage sector to be used in its intended purpose.

KPI development and results

To begin with the development of this indicator, the record shown in Table 3 was created on a spreadsheet in order to collect information on the quantity of finished product stored in the warehouse, which is updated daily.

Table 3 is completed at the beginning of each day. The required steps are the following:

1. The first column "Date" is filled out with the date of the day.
2. The second column "Planned" is completed with the value of units of finished product that should be stored at the beginning of the day, as planned. This value is calculated for the day i as:

$$\text{Planned}_i = \text{Total}\,U_{i-1} - \text{Truck}\,U_{i-1} - \text{Train}\,U_{i-1}\,. \tag{1}$$

   - It should be noted that the "TotalU" column represents all the amount of finished product that is available in the warehouse before being loaded to the transport vehicles for shipment to the different destinations.

$$\text{Actual}_i = \text{Total}\,U_{i-1} - \text{Truck}\,U_{i-1} - \text{Train}\,U_{i-1}\,. \tag{2}$$

   - The information of the actual quantity dispatched is obtained from the registration forms available in the shipment area of the warehouse, corresponding to the previous day.
3. The "Finished units" column indicates the quantity of finished products that were produced the previous day and that are sent to the warehouse for storage. This information is obtained from documents processed by the Production Department staff, and it is shared with the Supply Chain Department.
4. The "Total Units" column shows the quantity of finished product stored in the warehouse on a business day, without taking into account those products that have been or will be dispatched during that day. Therefore, its calculation is performed as follows:

$$\text{Total}\,U_{i-1} = \text{Actual}_i - \text{Finished}\,U_i\,. \tag{3}$$

   - In the colored column, the different colors indicate the status of the KPI for each day. The cell is automatically colored using a conditional

Table 3
Stock control of finished product warehouse

Date	Planned	Actual	Finished units	Total units	**< 33 000** **33 000–36 000** **> 36 000**	Truck units	Train units

format based on the value of "Total units", according with the following conditions:

If: Total Units $< 33\,000$,
then, **green cell**
else,
if: $33\,000 \leq$ Total Units $< 36\,000$,
then, **yellow cell**
else (Total Units $\geq 36\,000$),
then, **red cell**

5. The "Truck units" and "Train Units" columns are completed with the quantities of finished product units that are expected to be dispatched during the day according to the plan. A distinction is made between what is sent by trucks (column "Truck units") and what is dispatched on the train (column "Train Units"). The necessary information is btained from the dispatch plans established by the Logistics Department staff.

Table 4 illustrates the information for the month of June of the year 2018. The values of that month were considered as the baseline level of the indicator. Table 4 shows the result of completing the control record of finished products in the depot for a particular month. To facilitate the visibility of the information, Figure 3 is presented.

Figure 3 is a line chart that shows, day by day during the month of June, the quantity of finished product stored in the warehouse (blue line). In addition, a horizontal purple line marks the average value of finished product stored during the month of June 2018. Finally, the green and red horizontal dotted lines mark the values established to analyze the performance of the indicator: if the blue line is below the green line then the indicator shows a good performance; if it is between the green and the red line, a worrying performance; and if it is above the red line, an unacceptable performance.

Furthermore, based on the information contained in Table 4, Table 5 presents the deviation between the planned value of stock of finished product and the actual value. This information is expressed in the "Deviation" column of Table 5. This discrepancy lies in the difference between the actual quantity of finished products shipped (by both train and truck) and the quantity contained in the dispatch plans. The causes

Table 4
Stock control in the finished product warehouse: June 2018

Date	Planned	Actual	Finished units	Total units	**$<$ 33 000** **33 000–36 000** **$>$ 36 000**	Truck units	Train units
6–Jun	27 650	28 350	8 750	37 100		2 183	7 750
7–Jun	27 168	27 698	8 753	36 451		2 070	7 750
8–Jun	26 631	27 009	8 559	35 568		2 295	7 550
11–Jun	25 723	25 916	9 226	35 142		2 048	7 750
12–Jun	25 345	25 473	8 659	34 132		2 250	7 750
13–Jun	24 132	28 632	9 258	37 890		2 318	7 750
14–Jun	27 823	28 240	8 545	36 785		2 115	7 750
15–Jun	26 920	26 840	9 354	36 194		2 318	7 750
18–Jun	26 127	27 193	9 112	36 305		2 160	7 750
19–Jun	26 395	27 179	9 224	36 403		2 228	7 750
20–Jun	26 426	26 673	8 604	35 277		2 340	7 750
21–Jun	25 187	25 818	8 824	34 642		2 070	7 600
25–Jun	24 972	25 005	8 681	33 686		2 093	7 750
26–Jun	23 844	24 700	9 236	33 936		2 070	7 870
27–Jun	23 996	24 280	8 535	32 815		2 205	7 750

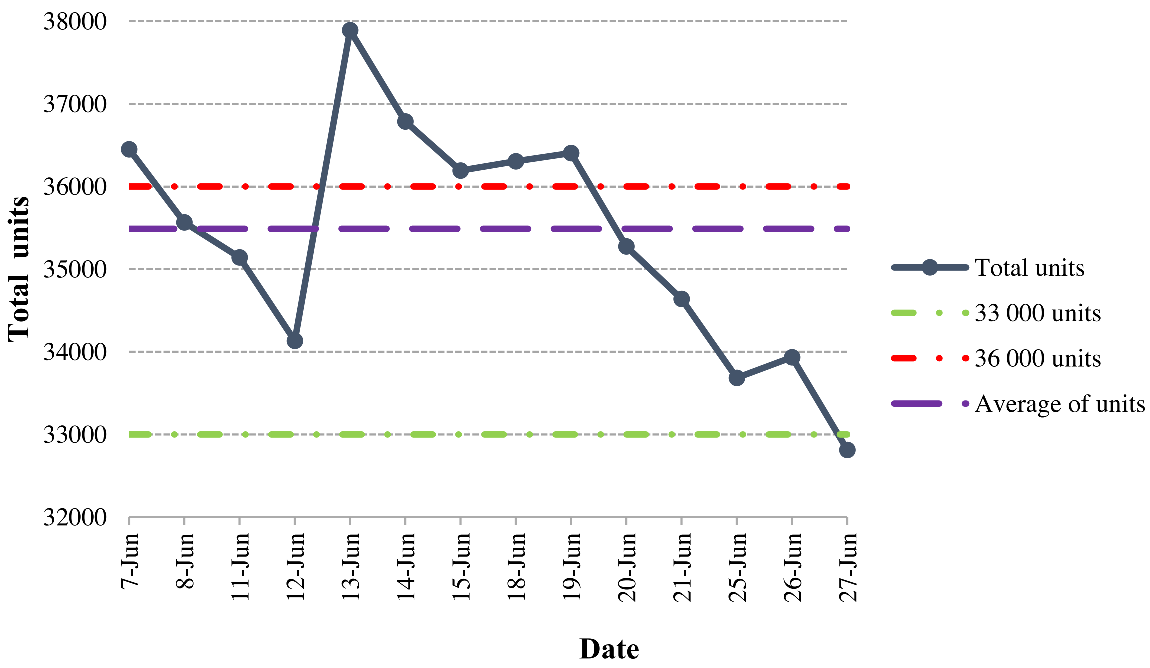

Fig. 3. Quantity of finished product stored in the warehouse: June 2018

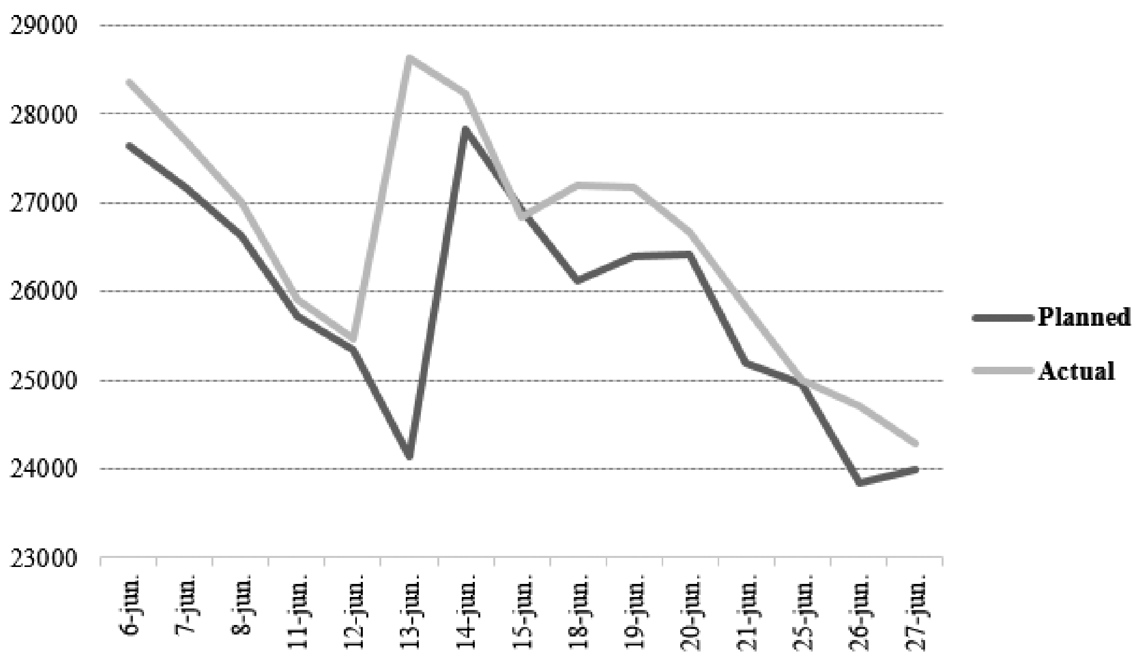

Fig. 4. Planned and actual values of finished product inventory: June 2018

that generate this deviation are diverse and present some difficulty in their identification. For example, it may be due to product loading errors, insufficient capacity on the train and trucks or due to the delays of trucks, among others causes.

Figure 4 allows to visualize more clearly the deviation information presented in Table 5. In Figure 4, the light grey line represents the actual number of units of finished product in the depot and the dark grey line depicts the planned value of finished product stock.

Table 5
Deviation between planned and actual value of finished product in sock: June 2018

Date	Units of finished product in stock at the beginning of the day		Deviation
	Planned	Actual	
6–Jun	27 650	28 350	700
7–Jun	27 168	27 698	531
8–Jun	26 631	27 009	378
11–Jun	25 723	25 916	193
12–Jun	25 345	25 473	129
13–Jun	24 132	28 632	4 500
14–Jun	27 823	28 240	418
15–Jun	26 920	26 840	–80
18–Jun	26 127	27 193	1 067
19–Jun	26 395	27 179	784
20–Jun	26 426	26 673	248
21–Jun	25 187	25 818	631
25–Jun	24 972	25 005	33
26–Jun	23 844	24 700	857
27–Jun	23 996	24 280	284

Analysis and discussion of results

To begin with, Figure 3 shows, by means of a blue line, the quantity of finished product in stock for each day of the month in review. Two dotted lines can also be appreciated, which represent values of importance for the KPI: the green horizontal line, at the level of 33 000 units, represents the value that was set as the target for the indicator; the red horizontal line, at the level of 36 000 units, represents the value that, when exceeded, implies an unacceptable performance of the indicator. The graph also shows a purple horizontal line, which indicates the average units of finished products in storage, during the month under evaluation.

From what is observed in Figure 3, it is necessary to mention that, of the 15 working days of the month in review, only on June 27 the indicator presented a value lower than the 33 000 units in storage (expected performance and established goal). Of the remaining 14 days, 7 days it had values greater than 36 000 units (unacceptable performance) and 7 days the values were between 33 000 and 36 000 units (alarming performance). It should be noted that, throughout the month under review, the average number of units in storage yields the value of 35 488 units, representing an overall alarming performance. It means that, regularly during the month, finished product was stored in areas of the warehouse, which are not intended for this purpose. This situation can negatively interfere with the work of the warehouse staff, causing difficulties in handling material in these areas.

Therefore, it can be concluded that the indicator is, in general terms, very far from the expected performance and that it will be necessary to take actions to improve this situation. It should be mentioned that the values obtained in this first measurement will be considered as the baseline level for the indicator. Consequently, in order to make decisions and initiate improvement actions, it will be necessary to assess the status of the indicator in the following months.

Finally, in Figure 4 there is a light grey line (actual), which represents the actual number of units of finished product in the depot and a dark grey line (planned), which represents the planned value of finished product inventory. It can be seen that, throughout the whole month in review, the line that represents the actual amount of finished product stored was above the line that represents the planned value. The difference between the two lines, that is, the deviation between planned and actual values, is caused by the discrepancy between the units actually dispatched and the units specified in the shipping plans. This indicates that the plans are not being followed and that actions must be carried out so that both lines tend to superimpose one over another and thus allowing to achieve a decrease in the volume of finished product in storage. One way to reduce this difference would be through changes in the quantity of products manufactured per day. Then, reducing this value, the quantity of finished product in the warehouse would also decrease, minimizing the difference between planned and real quantities. However, this measure must only be applied temporarily, since the company should follow its production plans or, if necessary, modify them accordingly in light of new information and developments.

As a final discussion, we just add that the methods developed so far are not definitive solutions to the problem of achieving production that enables meeting demand in a perfectly efficient manner. To accomplish definitive solutions to the problem of overstock, more integrative tools are required than the indicator methods developed here. In other words, the production planning system is required to be able to capture the information generated by the indicators, and take advantage of it to improve future planning. A possible way of deepening the improvement of future planning is to try to reduce the level of inventories that the system requires to operate. To achieve this, it could be required to reduce the inventory values that define the different levels of the traffic light, that is, to tighten the inventories. However, this requires more integrative studies than the one proposed here, such as those based on the Theory of Constraints (Drucker, 2012), where the process is analyzed in order to reduce lead and cycle times, which reduces the need of having large inventories, since the production system is more responsive (Chou et al., 2012; Ikeziri et al., 2019). However, to accomplish these reductions in lead times, it is necessary to study and analyze time horizons greater than the one studied here. It would not be reasonable to try to minimize the inventory levels of the traffic light, considering only the records of the single month analyzed here.

Conclusions

This paper addressed a case study on an inventory and warehouse management problem solved effectively through the application of the KPI concept. The main advantage of this approach is to systematize data collection and orient its processing towards the desired objective: to keep inventory levels in the desired range. At the same time, given the design of the KPI developed for this work, the indicator allows to quickly interpret the flow of materials in the warehouse, the level of inventory and detect potential causes of deviations. This means that managers, who have to make decisions about how to modify the process to meet the objective, have at their disposal useful and accurate information on which they can base those decisions.

This work demonstrates that control strategies are in practice very necessary in the processes and activities of supply chains, and in this sense, the development of indicators is an efficient and very useful approach. Finally, it is proposed, as future step of improvement for the company, to incorporate more sophisticated technologies in data collection, in order to add more flexibility to the process.

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