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Order picking and loading-dock arrival punctuality performance indicators for supply chain management: a case study

Micaela Marzialia Daniel Alejandro Rossit
Adrián Toncovicha

Daniel Alejandro Rossit

Engineering Department, Universidad Nacional del Sur (UNS), Argentina
INMABB, CONICET-UNS, Argentina
ORCID 0000-0002-2381-4352

Corresponding author:
e-mail: daniel.rossit@uns.edu.ar

Micaela Marziali

Engineering Department, Universidad Nacional del Sur (UNS), Argentina

Adrián Toncovich

Engineering Department, Universidad Nacional del Sur (UNS), Argentina
ORCID 0000-0002-1841-8726

ABSTRACT

Supply chain activity control is an essential part of Supply Chain Management (SCM), ensuring compliance with customer requirements. This paper presents a case study into the control of SCM activities. The study analysed two areas involving two different SC links associated with order picking, and outsourced truck freights, respectively. The studied company had problems with these links. An approach based on developing a KPI (Key Performance Indicator) was proposed to address the issues. Consequently, different affected processes were analysed and characterised, considering the relevant data for defining a KPI. Then, strategies and methods were devised for data collection and processing regarding the system's current state. Finally, tools were designed to facilitate the interpretation of the system's current state and thus, pave the way for the decision-making process on corrective measures.

KEY WORDS
supply chain management, key performance indicators, control, logistics, operations management

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Introduction

Supply Chain Management (SCM) is one of the key elements of a successfully operating business in today's world (Lambert & Cooper, 2000; Sangwan, 2017). It must be effective and efficient, accomplishing Supply Chain (SC) goals and reducing the usage of resources (Bieńkowska, 2020; Osadolor et al., 2021). The SCM function has gained preponderance within company systems, becoming an essential management activity in generating added value

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(Carter & Rogers, 2008; Bukowski, 2019; Komza, 2017). The main support activities provided by the SCM system must encompass the planning of inter-organisational and intra-organisational operations to meet customer demands (Ivanov et al., 2017; Shiri et al., 2020). Supply chain management is responsible for balanced supply and demand along the entire value-added chain (Christopher, 2011).

Even though plans for the Supply Chain (SC) consider the anticipated conditions, the real-world events may impact the behaviour of various agents (internal and/or external) differently than expected, affecting the efficiency of the plans (Ivanov, 2018). These effects should be minimised to maintain efficiency at expected levels (Makris et al., 2011). To achieve this, operations must be controlled by using the information on the system's state for taking corrective measures to avoid unwanted results (Broz et al., 2018). Managers and supply chain members must spend at least half of their working time handling uncertainties and risks. Consequently, as the natural feedback channel between planned and real processes, the control function has become increasingly more important (Ivanov et al., 2017).

Process control ensures that real and planned operations concur by evaluating the current process and necessary actions to be implemented to achieve the proposed objectives (Neely et al., 1997; Gunasekaran & Kobu, 2007; Nurakhova et al., 2020). Indicators are created to determine whether the proposed objectives are being met and to measure the degree of their achievement (Kucukaltan et al., 2016). Action plans can be designed to control the indicators and lead the organisation back to the initially established strategy by obtaining information about the real state of decision areas that affect the company's performance (Lohman et al., 2004).

These implemented indicators mainly aim to provide a quantifiable vision for senior management and a measure to identify business success, frequently assessing the evolution of the process and constantly developing ideas that contribute to increased performance (Rafele, 2004; Parmenter, 2015). Therefore, indicators must be formulated along with objectives to show their success or failure, progress or delay, and the causes allowing or preventing their achievement to identify maintaining or corrective actions (Neely, 2007; Sujová et al., 2019).

This paper addresses two problems of a Supply Chain case study carried out in a German company and developed during an improvement project. The company manufactures and markets household vacuum cleaners. The studied company's problems affect two SC links: the logistics of the carriers (suppliers and customers) and the assembly of customer orders. Regarding the first problem, the main drawback is the failure to meet deadlines and lead times planned by carriers, exacerbating the activities that follow the loading or unloading of trucks. The second problem is related to the customer's order picking, where errors in quantity and product types are significant. This implies extra costs from the logistics of recovering wrongly shipped products and sending the right items.

These problems are addressed by developing Key Performance Indicators (KPIs). This approach allows gathering and processing all the data regarding the system's current state and presenting it in an easily interpretable manner. The information visualisation of using graphics was an important part of the project. The developed KPIs enable the company's managers to address the problems directly and achieve a significant improvement with planning at the Supply Chain Department.

The rest of the article is organised as follows. Section 2 introduces materials and methods used in this study. Section 3 describes the development of the KPIs and presents the results. Section 4 discusses the results obtained applying the KPIs. Finally, Section 5 provides conclusions.

1. Materials and methods

Regardless of the business characteristics, every management system is composed of a set of complex functions providing it with a structure and facilitating operations (Vollmann et al., 2005). A suitable management strategy is required to ensure coordinated operation of these functions to accomplish the system's objective (Steiner, 2010; Jabilles et al., 2019). Good management must comply with the plan; thus, the system's control constitutes a primary administrative stage allowing managers to verify the actual situation in the organisation by employing a mechanism for checking its alignment with set objectives (Maulina & Natakusumah, 2020; Marziali et al., 2021). Control systems evaluate performance against the existing plan (Colledani & Tolio, 2011).

Management control is a dynamic and important system for achieving the organisational goals set in the planning process. The control function should focus on assessing the behaviour of the critical factors that influence the fulfilment of the strategy. It should be flexible and continuously adjust to changing strategies of the organisation (Gunasekaran & Kobu, 2007). One way to manage and implement a control system is by developing indicators. The indicators will measure attributes of the business or industry processes and provide relevant information for making decisions against deviations from the plan (Parmenter 2015).

1.1. Key performance indicators

KPIs measure the level of process performance, focusing on the "how" and indicating its state. Key performance indicators are measurements used to quantify objectives that reflect the organisation's performance, generally included in the strategic plan (Neely et al., 1997; Lohman et al., 2004). They are necessary for improving operations 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 convey the company's mission and vision to the lower hierarchical levels and directly involve all employees in achieving the strategic objectives (Parmenter, 2015).

Although they vary from company to company, the most common KPIs aim to evaluate work productivity, product and service quality, business profitability, deadlines, process effectiveness, lead times, resources utilisation, growth, cost control, level of innovation and performance of technological infrastructure (Neely, 2007; Sangwan, 2017; Florek-Paszkowska et al., 2021; Mandal, 2016).

However, defining a sound set of KPIs has its complexities since the real challenge is to select the indicators that help meet budget goals and, more importantly, those in perfect tune with the company's strategic goals (Rafele, 2004).

Fig. 1 schematises the central idea: the KPI value is plotted on the Y-axis, and the X-axis shows the evolution of the controlled process. The maximum point is defined as the goal to be achieved in terms of the KPI value. Then, different states of the controlled process are identified, allowing different corrective actions to be implemented to reach the desired level of the KPI.

1.2. KPI system implementation

During the project for the creation and implementation of indicators, the logistics team of the studied company's Supply Chain Department considered it necessary to create systems of indicators with specific characteristics.

The system comprised the indicator, the baseline level, the current level, the goal, and the traffic light or the RAG rating system for performance evaluation. These elements facilitate the interpretation of the results obtained from the measurement of an indicator, allowing to know the initial situation of the indicator, its variations and the degree of progress towards the proposed goal.

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

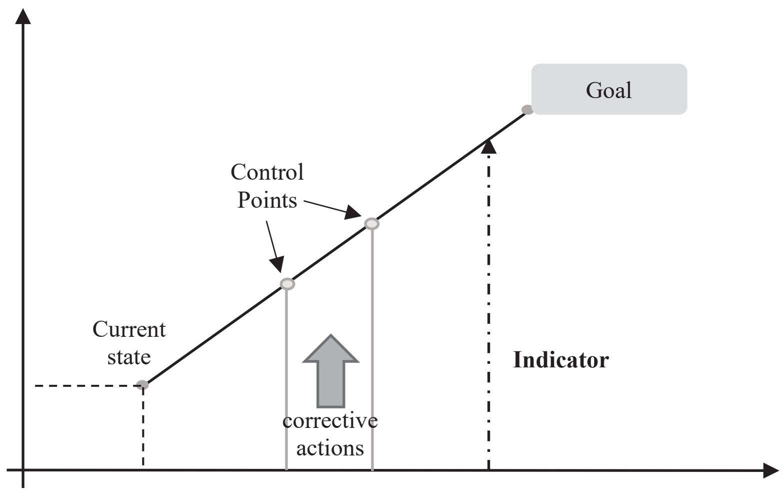

Fig. 1. Relationship between the business objective and the indicator

The current level represents the indicator measurements period by period as influenced by the effects of strategic initiatives.

The goal is the expected level of the indicator that the organisation wishes to achieve after successfully executing the improvement actions.

A traffic light rating system, traffic light or RAG (red, amber, green) is used to easily observe the indicator's performance level, where green represents expected performance, amber (yellow) — worrying performance, and red indicates unacceptable performance.

1.3. Problem description

This case study is based on a supply chain of vacuum cleaners with the manufacturer and the main parts of the chain located in Germany. The manufacturer distributes its finished products from its headquarters in Germany by freight train and trucks. The company owns the freight train, wagons and access railway tracks to the cargo sector of the warehouse facilities. The trucking services are outsourced; thus, the company does not own the vehicles used to distribute final products. However, the outsourced services do not include distribution logistics, remaining under the care of the SC Department's logistics team. The delivery service is outsourced to several transportation companies (thirteen in total). Orders placed by clients or retailers are handled at the Finished Product Warehouse. The whole supply chain is illustrated in Fig. 2. Grey stars in Fig. 2 indicate the problems considered in this study. These stars are placed on SC links that present logistic problems. "Problem 1" refers to the punctuality of trucks arriving at the loading dock, i.e., the company has problems with the outsourced logistic systems as trucks fail to provide services on time. However, no issues exist with delivery by trains. "Problem 2" refers to picking finished products, i.e., some orders have issues with the quantity, the product mix or the quality.

1.4. Related KPIs

As explained in the previous section, the problems addressed in this article occurred in different links of the Supply Chain; besides, each problem involves different responsibilities as the truck transport is outsourced and the order preparation is performed by the company's labour. This feature prevents the company from using usual supply chain indicators, such as OTIF (Order in Time, In Full) for Problem 1 and POR (Perfect Order) for Problem 2 (Chae, 2009; Maestrini et al., 2017), because they have a wider scope than required for the case study. If the OTIF indicator was used for Problem 1, then the part of the indicator related to "in full" would be constantly 1, which does not make much sense. And, if a wider KPI, such as OTIFEF (Order in Time, In Full, Error Free), was used for considering the two problems together, its value would mix the responsibilities.

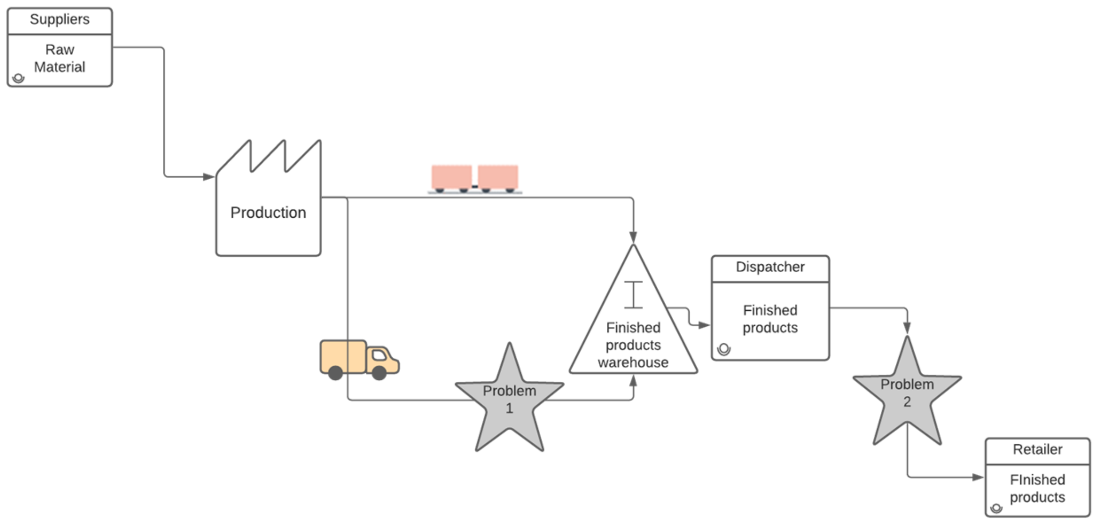

Fig. 2. Supply chain illustration: grey stars indicate links with addressed problems

Consequently, if the trucks were punctual but the dispatching centre was wrong, OTIFEF would flag this situation but would not indicate the problem directly. Besides, since both problems represent different supply chain partners and consequently, different contracts, it would be much easier to execute penalisation by having a clear indicator for each partner or responsible group. Thus, newly tailored indicators are proposed, enabling to include the poor performance causes.

2. Results: KPI development and outcomes

This section presents the system of indicators for different KPIs, specifying the reasons that led to its proposal, explaining how they are measured, where the information is obtained and providing the results.

It is worth mentioning that at the time of starting this control project using KPIs, the company had already begun with primary developments required for its implementation. Consequently, the standard control project phases aimed at institutional diagnosis and the identification of key processes had already been completed. The participation of researchers in the project consisted mainly of developing the indicator systems for key processes aiming to measure their attributes and set the basis to perform corrective measures.

2.1. KPI-I: punctuality of trucks

The company distributes its finished products from its headquarters in Germany by freight train and trucks. The company owns the freight train, wagons and access railway tracks to the cargo sector of the warehouse facilities.

The trucking services are outsourced; thus, the company does not own the vehicles used to distribute final products. However, the outsourced services do not include distribution logistics, remaining under the care of the SC Department's logistics team. The delivery service is outsourced to several transportation companies (thirteen in total).

The recurrent problems with the punctuality of arriving trucks at the depot necessitated the control of this variable. The first step consisted of digitising the forms used to record the arrival of the trucks, including information on arrival time (planned and actual), destination, outsourced owner of the truck, numbers of loaded products and loading time, etc. This information is used to monitor different outsourced companies, keep track of the number of trucks that are loaded and dispatched as planned and take corrective actions for product lines that frequently experience punctuality problems. Also, the obtained data is used to generate a new table to measure the performance of the parameter month by month, recording the percentage of trucks that are on time, regardless of the expedition or the transportation company.

Several meetings were held with the managers and leaders of the Supply Chain Department to develop the indicator system. Therefore, the values were set for baseline, current and desired levels and intervals required to apply the traffic light rating system. These values were set based on historical records provided by the same department. Table 1 shows the main attributes of this system.

2.1.1. KPI-I: indicator development procedure

At this point, the procedure will be detailed, from the initial moment of data collection to obtaining the results and graphs showing the performance of the indicator.

The first step is to digitalise forms containing information on truck arrival, including data, such as

Tab. 1. KPI-I system: truck punctuality

Truck punctuality KPI: indicator system	
Baseline level	The first measurement of the indicator taken in June of 2018 is considered the baseline level
Current level	The value obtained from the monthly measurement of the indicator is considered the current level
Goal	The proposed goal for this indicator is 90 % of punctual trucks obtained during a year
Traffic light rating system	The indicator limits are set using the traffic light rating system. The upper limit is 100 % (the maximum value of the indicator). The lower limit is 80 % of trucks on time, below which the situation is considered critical and requires corrective actions

arrival time (planned and actual), destination, owner of the truck, the quantity of product loaded (in the number of pallets) and loading time. A spreadsheet was used to prepare Table 2.

The information to complete Table 2 is obtained from the registration forms available in the loading area, which are completed manually by the personnel assigned to truck loading. The information in the table is updated weekly, on the last business day of the week.

The "Expedition" column holds information on the load destination and the loaded vehicle owner. For example, the destination is Berlin, and the vehicle owner is ABC Transport (fictitious name), the column "Expedition" should say "Berlin — ABC Transport". The "Status" column must indicate either "Punctual" or "Unpunctual", depending on the difference between the actual and planned arrival times. This column has a drop-down list with the two available options.

A two-hour margin in the difference between actual and planned arrival times is used as a tolerance range for determining the expedition status. Thus, if the truck arrives within two hours after or before the scheduled time, it is considered on time. Other parameter values of the indicator and the range for punctuality were determined by the leader of the logistics team, based on his knowledge regarding the delays in the arrival of trucks and the accuracy required by the rest of the process.

Table 3 shows the complete truck arrival record for the first half of June 2018. This month's values were taken as the indicator's baseline level since it was the first control. The information obtained during June and recorded in forms similar to the one shown in Table 3 was used to create two new tables with information relevant to the truck punctuality indicator. The first form records the number of trips that have complied with the arrival time for each expedition (Table 4); and the second form shows the KPI performance throughout the investigated period (Table 5). Each of the mentioned tables corresponds to a graph that helps visualise the data.

Table 4 presents the status (punctuality or unpunctuality) of the trips made for each expedition during a specific month. It helps to analyse the problems of truck punctuality in relation to each expedition, thus allowing to apply corrective actions to problematic expeditions.

The automatically completed Table 5 uses data from Table 4. Both tables are linked by spreadsheet formulas, reducing the user workload by not having to manually input the data.

Table 6 is the last table with information related to this KPI. It shows how the information related to the truck punctuality indicator is recorded and pro-

Tab. 2. Truck arrival and loading information form

Date	Expedition	Arrival time		Status	Loading time	Quantity of loaded pallets
		Planned	Actual			

Tab. 3. Example of Table 2 filled out in June 2018

Date	Expedition	Arrival time		Status	Loading time	Quantity of loaded pallets
		Planned	Actual			
6 Jun	A	7:00	8:00	Punctual	1:15	34
	B	9:00	8:45	Punctual	1:15	33
	C	7:00	7:30	Punctual	1:00	32
7 Jun	A	7:00	8:30	Punctual	1:45	53
	D	7:00	9:15	Unpunctual	1:00	33
8 Jun	A	7:00	8:00	Punctual	1:30	34
11 Jun	A	7:00	9:00	Punctual	1:15	34
	E	13:00	10:15	Punctual	0:45	33
	D	7:00	7:15	Punctual	1:00	33
12 Jun	A	7:00	7:30	Punctual	1:30	34

Tab. 4. Punctuality of trucks by expedition for all expeditions of June 2018

Expedition	Total	Status	
		Punctual	Unpunctual
A	15	14	1
B	8	7	1
C	2	2	0
D	2	1	1
E	3	2	1
F	2	1	1
G	3	2	1
H	1	1	0
I	1	1	0
J	1	0	1

Tab. 5. Percentage of punctuality per expedition in June 2018

Expedition	Punctuality %
A	93.33 %
B	87.50 %
C	100.00 %
D	50.00 %
E	66.67 %
F	50.00 %
G	66.67 %
H	100.00 %
I	100.00 %
J	0.00 %

Tab. 6. KPI-I performance: truck punctuality, an example of June 2018

Date	6 Jun	7 Jun	8 Jun	11 Jun	12 Jun
Number of trucks	3	2	1	3	1
Punctual	3	1	1	3	1
Percentage	100%	50%	100%	100%	100%
Goal	90	90	90	90	90
Lower limit	80	80	80	80	80
Upper limit	100	100	100	100	100

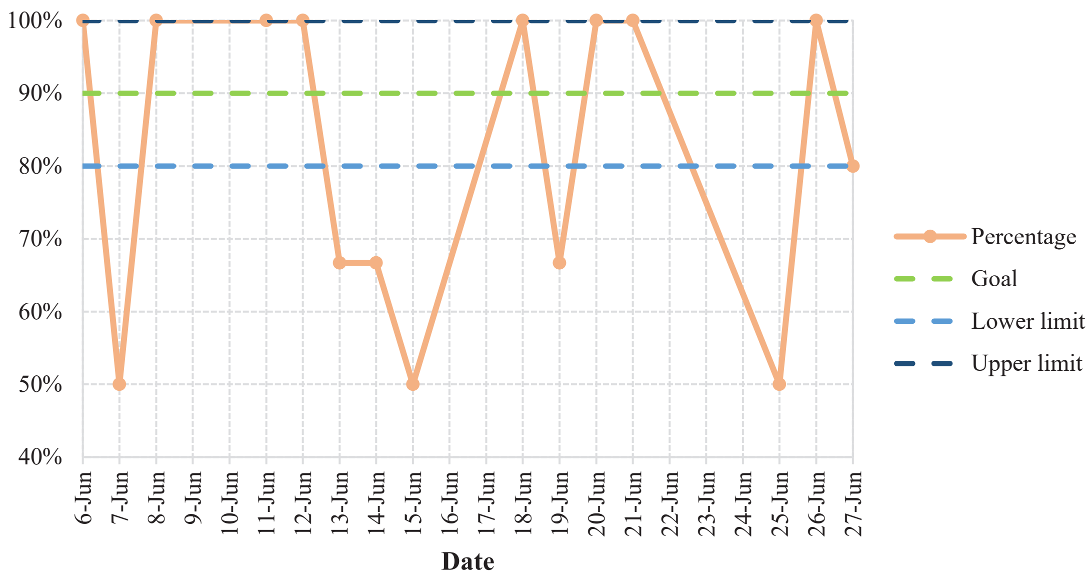

Fig. 3. KPI performance: truck punctuality (June 2018)

vides detailed information for some days of June 2018 as an example. The table lists the number of trucks that made deliveries and arrived at the company's warehouse on time for each working day of the month.

Also, it calculates the percentage of punctual over the total number of trucks for each day. However, Table 6 does not account for expedition codes since it shows the overall performance of the indicator, for which the goal for trucks arriving on time was established at 90 %, with lower and upper limits of 80 % and 100 %, respectively. Finally, for the first indicator, Fig. 3 is obtained from Table 6.

The information from Table 6 is clearly and simply shown in Fig. 3, where the percentage of trucks on time is indicated for each day of the month. It simultaneously displays the level established as a goal for the indicator and the lower and upper limits.

2.2. KPI-II: order picking errors

The logistics team of the Supply Chain Department is responsible for the delivery of finished products from the company's warehouse to different destinations.

The trip logistics include planning and decision-making on delivery frequencies, the quantity and variety of sent products, the outsourced carrier etc. Thus, as this team is responsible for sending the finished products, it receives and must process all documentation related to the dispatched merchandise, including delivery receipts.

In cases where the shipped products do not match (in terms of the quantity, product type or quality) the documents, the products are returned to the company along with the corresponding freight claim.

This indicator was initiated due to repeated problems and complaints regarding rejected deliveries or disagreements. It aims to determine the most frequent errors when preparing shipments made by trucks to apply corrective actions and avoid extra costs generated in the process.

Three types of errors were detected when preparing the orders:

- Picking incorrect products, i.e., others than indicated in the order. Although the company only produces vacuum cleaners, more than 300 different product variants are available.
- Picking correct products in wrong quantities, i.e., orders are delivered in greater or lesser quantities than ordered.
- Picking correct products and quantities but with defective quality, i.e., products that do not meet the corresponding quality requirements.

In addition to the mentioned errors, the possibility is considered that several different errors can be made in one order, i.e., all possible combinations of the basic errors are considered.

The information necessary to obtain the KPI-II indicator comes from the documentation that accompanies the delivery receipts signed in disagreement and freight claims. Due to the time required to receive and process these documents, it was decided to update the indicator monthly.

Tab. 7. KPI-II system: order picking errors

Order picking errors KPI: indicator system	
Baseline level	The first measurement of the indicator for May 2018 is taken as the baseline level. The measurement was taken during June since the required information was obtained over the past month
Current level	The value obtained from the monthly measurement of the indicator is considered as the current level
Goal	To be aligned with the "zero defects" policy adopted by the company, the goal for this indicator was proposed to ensure no errors in the order picking process for the shipments of finished products made by trucks
Traffic light rating system	Although the delivery receipts signed in disagreement indicated errors in order preparation, the information was not digitised. Therefore, no previous knowledge of the amount and types of errors made in preparing orders for shipment was available prior to the development and implementation of this indicator. Consequently, the results of the first indicator measurements are necessary to establish the parameter values for the traffic light rating system

2.2.1. KPI-II: indicator development procedure

Different possible errors in preparing orders are provided in Table 8 to clarify the indicator development. Errors and their combinations were coded to make the indicator record completion easier. Error E02 "Defective quality" is used when products to be reprocessed get dispatched as ready products. A clear example is packaging damaged during the process.

Table 9 presents a record in which the data about erroneously picked orders is entered on a monthly basis from the documentation that accompanies the order delivery receipts of the previous month.

The first step is to complete the "Date" column with the business days of the month. Then, the copies

Tab. 8. Types of order picking errors and their codification

Code	Type of error
E01	Wrong product
E02	Defective quality
E03	Wrong quantity
E04	Wrong product and quantity
E05	Wrong product and defective quality
E06	Defective quality and wrong quantity
E07	Wrong product, wrong quantity and defective quality

Tab. 9. Order picking errors for deliveries made by truck

Date	Code	Type of error	Quantity
Total			

Tab. 10. Order picking errors made in deliveries by truck for May 2018

Date	Code	Type of error	Quantity
2 May			
3 May			
4 May			
7 May			
8 May			
9 May			
14 May	E04	Wrong product and quantity	60
15 May			
16 May	E01	Wrong product	72
17 May			
18 May			
22 May			
23 May			
24 May	E02	Defective quality	24
25 May			
28 May			
29 May			
Total			**156**

Tab. 11. Truck order picking errors expressed in percentage and ppm for May 2018

Total amount of delivered units	Type of error	Quantity	%	ppm (1 % = 10 000 ppm)
39622	E01: Wrong product	72	0.18 %	1817.17
	E02: Defective quality	24	0.06 %	605.72
	E03: Wrong quantity	0	0.00 %	0.00
	E04: Wrong product and quantity	60	0.15 %	1514.31
	E05: Wrong product and defective quality	0	0.00 %	0.00
	E06: Defective quality and wrong quantity	0	0.00 %	0.00
	E07: Wrong product, wrong quantity and defective quality	0	0.00 %	0.00

of the delivery receipts of the same month are selected, and those with order picking errors are set apart. For each erroneously picked order, the information in the row corresponding to the date is completed as follows:

- In the "Code" column, the corresponding error code is entered from Table 8. This column has a drop-down list with seven error options.
- The "Type of Error" column is automatically completed based on the code selected in the "Code" column.
- The column "Wrong quantity" must indicate the quantity of finished product units that was wrongly picked in the order.

The procedure is repeated for all incorrect orders of the month. If one business day has picking errors in more than one order, a row is added for each wrong order, with the corresponding information (including the date).

Finally, the spreadsheet automatically calculates the monthly total of the "Wrong quantity" column, i.e., the sum of all incorrectly picked quantities.

Table 10 shows the complete record with the information for May 2018. The values obtained for that month were taken as the baseline level of the indicator.

Table 11 is derived from the information in Table 10, it calculates the proportion of truck order picking errors in percentage and in parts per million (ppm). Table 11 is automatically generated using formulas of the conditional sum type (for the "Quantity" column); while the percentage and ppm columns are automatically completed using multiplication and division formulas. These two columns calculate the percentage and parts per million of units that have been erroneously picked over the total units dispatched. The user must only enter the value of the first column, which indicates the total number of units delivered by truck during the month. The value is obtained by adding up the quantities of each shipment of the month.

3. Discussion

This section discusses the results obtained for each KPI. First, KPIs are presented, explaining their development and the results obtained during the evaluation period and then, their efficacy and relevance are analysed.

3.1. KPI-I (punctuality of trucks): analysis and discussion of results

The analysis of results requires considering Tables 4–6 and Fig. 3. Tables 4 and 5 show the results according to the expeditions, and Table 6 and Fig. 3 show the overall performance of the indicator throughout the studied month.

Based on Tables 4 and 5, expeditions A, B, C, H and I present a percentage of punctuality that is within the acceptable range (80–100 %). However, expeditions E and G with 66.67 % and D and F with 50 % are well below the lower limit. Finally, expedition J presents a 0 % punctuality (because the only delivery they made in June 2018 was behind schedule). Therefore, in the following months of evaluation, special attention should be paid to expeditions E, G, D, F and J, and their performance should be closely assessed in terms of punctuality. If the unpunctuality problem persists, it will be necessary to take action and improve the situation.

On the other hand, Fig. 3 shows the overall performance of the indicator without considering the expedition variable. Of the 15 business days of the studied month, six days had the percentage of on-time trucks outside the expected limits. Of the remaining evaluated days (those that fall within the established range), eight of them have a 100 % punctuality, exceeding the target set of 90 %, while only one is below the goal, with a percentage of 80 % (the value equal to the lower limit).

As these values were obtained from the first evaluation of the indicator, they are considered the baseline levels. In the following measurements, the performance of the indicator will be re-evaluated to establish whether it maintains stable values, shows improvements or performs worse.

3.2. KPI-II (order picking errors): analysis and discussion of results

This subsection analyses the results obtained from the first measurement of the KPI-II associated with errors in the order picking process. The values from this first evaluation will be considered the baseline level for the indicator, proceeding in the same way as for the previous indicator.

Table 11 is required to analyse the indicator during the studied month (May 2018) as it shows the picking order errors in parts per million (ppm). Of the seven types of errors that may occur, only three were observed during the month: "Incorrect product" with 1817 ppm; "Wrong product and incorrect quantity" with 1514 ppm; and "Defective quality" with 605 ppm.

For a deeper analysis of the indicator's performance, the measurements of the following months are required. Once obtained, it will be possible to determine the types of errors that are repeated more frequently, and in greater quantities, and in turn, it will allow proposing and applying corrective measures to reduce their impact.

Conclusions

The indicators proposed in this article will allow offering and implementing improvements based on the analysis and monitoring of processes, identifying irregularities that hinder the normal development of operations. Also, the systematisation in the data collection process allows having reliable and real-time information, identifying those processes that are not being carried out correctly and implementing actions that contribute to their improvement. Therefore, this case study serves the purpose of showing the substantial potential of KPIs to address Supply Chain Management problems.

The implementation of more sophisticated technologies for data capture is considered as a future line of research, as well as the development of a decision support system that integrates the KPIs in the hierarchical decision process.

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