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Dashboard for the Management and Acceptance of Customer Orders

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Abstract

Background: This paper focuses on activities related to Customer Orders Management withing an auto components plant in the Automotive Industry. The main challenge was highlighted: customers don't always regard the flexibility rules agreed with the company. Hence, planners must decide if variation in ordered quantity can be accepted in the forecast period or if adjusting is necessary. **Objectives:** The purpose was not only to streamline the decision-making process in the planning team but also to provide essential tools for the execution of their daily tasks – a visual and interactive dashboard to assess whether variations in customer orders were within the limits agreed with the company. **Methods/Approach:** Following Lean information management and business intelligence principles, a thorough process analysis was carried out, centralized and standardized reports were created that served as databases, and the dashboard was developed. **Results:** The proposed tool allowed reductions from 3,5h per week, spent mainly on collecting data, calculating variations, and selecting and adjusting the flexibility limits, to 0,2h a day per planner. **Conclusions:** Besides streamlining planners' daily activities, main contributions regard the promotion of digital transformation, data-driven decision-making, and an automated record of customer order variations that could easily be adapted to suppliers.

Keywords: Order variation calculation, flexibility rules, customer order management, dashboard development, data analytics, digital transformation

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Introduction

Over the years, the manufacturing industry has witnessed a steady increase in complexity and requirements, with digital transformation (DT) revolutionizing the industrial environment to an unprecedented degree, establishing a variety of new business potentials and opportunities for industries worldwide. DT is focused on business transformation, mainly motivated by "organizational, customer and technology-driven initiatives" (Tomičić Furjan, Tomičić-Pupek, & Pihir, 2020). The success of an industry essentially depends on how consistently and actively the DT is shaped and how the use of new opportunities is made, making it possible for industries to improve quality, costs, and delivery performance and thus increase customer satisfaction (Bosch, 2020).

The Lean logistics paradigm appeared with a focus on non-value-added logistics activities, as logistics operations are characterized by a high level of manual control which ultimately impacts the cost of operations (Pejić, Lerher, Jereb & Lisec, 2016). In administrative areas, the processes that add value to a product or service depend immensely, amongst other factors, on the overall flow of information and employee knowledge (Monteiro, Alves & Carvalho, 2017). Although there is a lack of current research on the application of Lean paradigms in administrative areas, this paper aims to study Lean practices to reduce non-value-added activities through improvements in information flow, automation, and digitalization.

This paper focuses on optimizing customer order management tasks performed by the planning teams within the logistics department at an automotive electronics components company. With a focus on task effectiveness and efficiency through automation, its main goal is to achieve waste reduction, structure adjustment, and capacity re-allocation to where it is most beneficial for profitable growth.

After introducing the theme, the second chapter reviews the existing literature on the themes surrounding the subject, and the diagnosis of the analyzed processes and description of the identified problems are presented, formulating the research hypothesis. The fourth chapter describes the development and implementation of the proposed improvements, and the fifth chapter examines the improvements achieved. This paper is concluded with the sixth chapter, where a general balance of the project is made, and conclusions and possibilities to improve the work are developed continuously.

Theoretical Background

The application of Lean principles in administrative areas is denoted as Lean office and embraces "the improvement of administrative processes and information flows" (Freitas & Freitas, 2020). Monteiro, Pacheco, Dinis-Carvalho & Paiva (2015) improved lead times, process tasks, space organization, and work standardization by implementing Lean office in the public sector, eliminating non-value-adding activities and automating tasks that were performed manually to increase efficiency in data search and daily problem-solving requirements.

In modern days offices, it is vital to coordinate the development of information management capabilities and optimization of information flows, with emphasis on the advantages of electronic technologies and resources, guaranteeing information quality, reducing the use of paper with digitalization, and increasing the use of information systems (Freitas & Freitas, 2020). The focus on improving the flow of information and implementing a Lean approach to information management proves to be crucial to increase competitiveness, as it allows organizations to achieve improvements over a short period with low resource investment (Bevilacqua et al., 2015).

According to Bittencourt, Alves & Leão (2019), the implementation of I4.0 is facilitated by Lean Thinking as "it simplifies processes and eliminates waste in a way that it is not repeated, reduces the possibility of compromising scarce resources, and increases the transparency of work processes/organization." The same authors highlighted the importance of controlling and optimizing a process before automating it, as "the automation of an inefficient process does not make it efficient." Hoellthaler et al. (2020) proposed a framework to classify and characterize digital technologies within ICT, identification technologies, and automation technologies, which allowed for more efficient information flows, declining trial and error rates, and improving overall process speed, thus increasing efficiency. In his study, they expected the proposed framework to offer "starting points and potential levers to improve information processes in the context of information logistics" and incentivize "to use digital technologies accordingly".

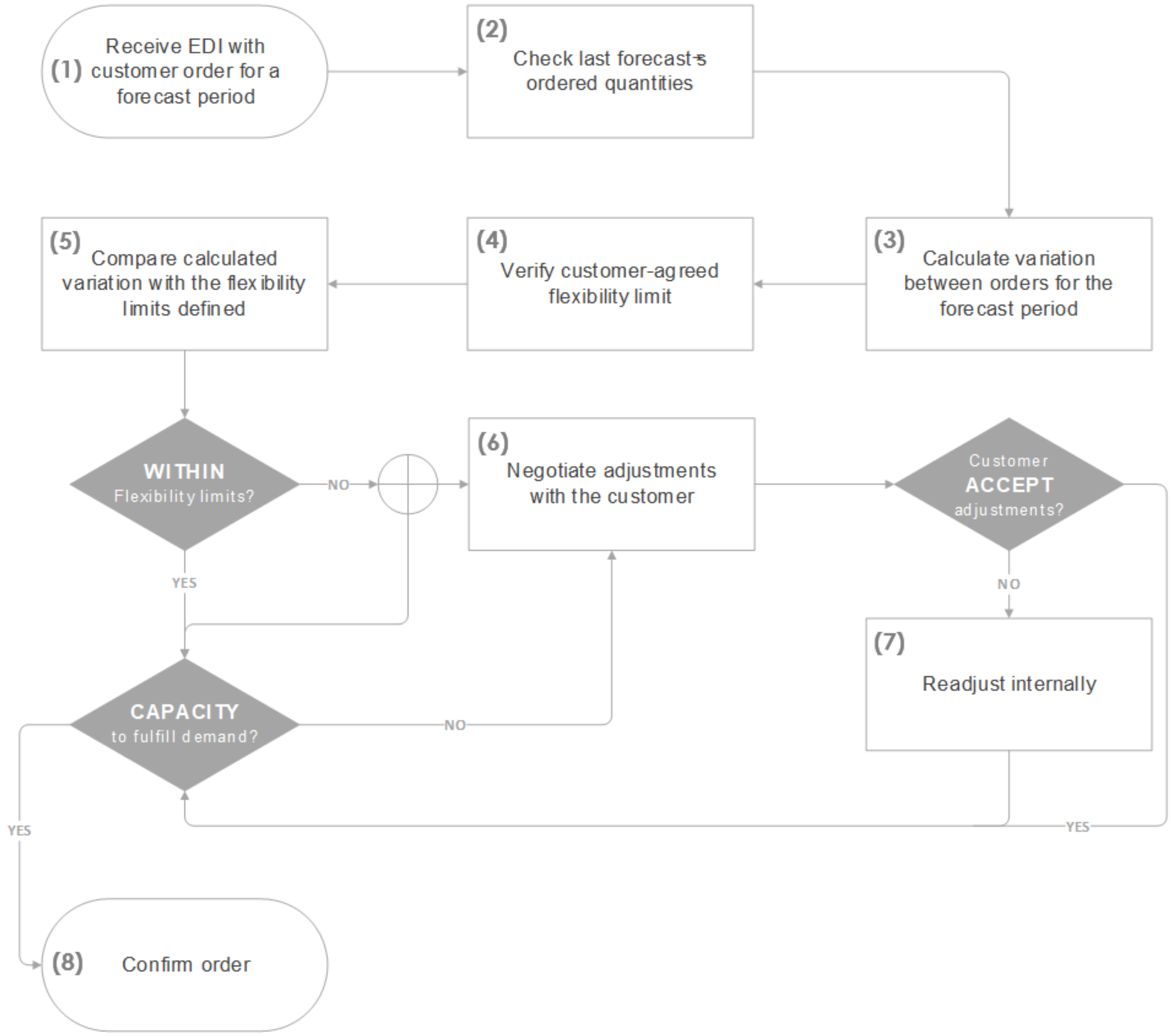
Good information management competencies to integrate, transform and access business data are fundamental to distinctive analytical capabilities. As Davenport & Harris (2007) noted, "it's better to know (…) than to believe or think or feel" as "most companies can benefit from more analytical decision making". Data quality is an essential characteristic that determines data reliability for organizational decision-making. Specifically, guaranteeing high-quality, reliable data is a competitive advantage for all industries (Salem & Abdo, 2016).

Through business intelligence (BI), it is possible to improve business analysis and support decision-making. Teixeira, Oliveira & Varajão (2019) demonstrated the importance of an area dedicated to BI within organizations as a way of increasing agility and quality in data processing since its deficiency made it "difficult to have access to data because there were no tools or software that allowed to have the information and the data on time". BI is characterized as the technologies and processes that take advantage of the extensive use of data to comprehend and analyze the performance of organizations. In contrast, business analytics (BA) makes statistical and quantitative analysis with explanatory and predictive models possible to achieve greater efficiency and drive smarter decision-making and better business actions (Davenport & Harris, 2007). Analytical applications range from a variety of tools and systems, including simple data analytics, manipulation, and visualization tools such as Excel and Power BI, to complex deep learning algorithms and predictive analysis, applicable in a wide range of techniques to assist organizations in forecasting, simulation, and optimization to streamline and improve decision making (Krishnamoorthi & Mathew, 2018). Silva, Cortez, Pereira & Pilastri (2021) added that, although BA has proven useful in optimizing resources and detecting customer needs, there are still few research application studies within this topic.

Problem Identification

Several types of waste arise from inadequate information management principles and the deficiency of digital and automated data analysis tools (Nascimento, Frazão, Teixeira & Ribeiro, 2021). These problems were identified in receiving and analyzing customer orders, mainly to verify if there were variations in the ordered quantities and if they are allowed in the customer's contracts (Figure 1).

Figure 1
Customer Order Variation Analysis



Source: Author's work

Customer orders are transferred via Electronic Data Interchange (EDI), and planners need to receive and analyze them to plan production according to customer needs (1). When examining new orders, the planners also check for any alteration in the demand quantity (2 and 3) and whether it is within the variation limits fixed with the customer (4 and 5). The order is accepted if the variation is within the flexibility rules (8); if not, adjustments need to be made with the customer (6), as long as it is within the reaction time or in the production plans for the forecast period (7). This analysis is crucial to determine whether the plant can fulfil the order or needs to renegotiate order quantity or reallocate production for the next forecast period.

The main issue identified is that planners waste too much time and manual effort on data searching, collection, and reporting tasks. To manage customer orders, it is necessary to generate several reports whose data sources have different origins. There is no common repository for all customers where flexibility rules are available, as well as a tool that consolidates the results for later analysis and action by planners. As a consequence of not fulfilling this task on time, planners have to accept the order leading to capacity problems in fulfilling the orders. This can result in negative impacts on service level and stock levels, from unfulfilled orders to customers, delays in delivering the orders, shortage of raw materials in orders with large increases in variations, or wasteful accumulation of stocks with large decreases in ordered quantity. The main purpose of this paper is to assess whether the application of lean information management principles with digitalization reduces the planning team's time and manual effort.

Methodology

To define what procedures should be structured to accomplish the automation objective, the most important aspect was to ascertain what tool would best support the planners in their analysis, what data should be taken into consideration, and how that data should be displayed. The purpose of the tool would be to compare the current week's releases with snapshots of previous releases for a specific forecast period, clearly and visually indicating whether there is variation between the current release and the forecast release and whether this variation is permitted or restricted by the flexibility limits contractually defined with the customer. Furthermore, the tool should also be able to quantify the variation, as this information is necessary to report to the customer. The team of planners was already acquainted with dashboards, using them daily to support planning activities, examine stock levels, coordinate production backlogs, and occupation production lines. Therefore, it was decided to develop a new dashboard sheet for managing customers' orders and integrate it into the team's existing dashboard. This dashboard would be powered by reports that could also be consulted if planners needed a more detailed analysis. It would also report information regarding releases, forecasts, variations in quantities, and flexibility rules associated with each customer.

The first step in the project development was to analyze the planners' daily activities and how the tasks were currently performed, then automate these as possible tasks. Three main actions were established:

- Automate order variation calculation
- Analyze flexibility rules by the customer from the orders variation report
- Develop order variation dashboard

The first two actions identified consisted of creating the reports that would serve as the database for the dashboard, and the third act was the development of the dashboard itself.

Automation of Order Variation Calculation

To retrieve data relating to customer order volume analysis, traditional data sources and centralized manual data inputs were used. The report from the company's internal system contains the parameters of each customer order and quantities ordered by Calendar Week (W) – when the order is due – taking place in each Snapshot Week (SW) – when the customer places the order. Each order release is retrieved from the company's management software and characterized with predetermined parameters. Customers place an order for a final product associated with a project that can contain more than one final product. This means that each project can comprehend multiple products, but a product can only be associated with one project.

To automate the calculation of the variation of order releases, the first stage was to define which forecast period would be considered. The requirements for the forecast period selected and the time horizons to be compared were defined:

- The variation in releases would be calculated weekly, as there are no significant daily variations

- Relative order variation in releases is used in comparison with the flexibility rules, while absolute variation in quantity ordered is displayed as information for the planner
- To allow records comparison, the report would comprise information on releases from the snapshot of the current week (SW_n) up to snapshots of six weeks prior (SW_{n-6})
- Would only be considered variations in percentage in releases between the snapshot of the current week's releases (SW_n) and the two previous weeks' snapshots (SW_{n-2}) in a 60-week calendar horizon (W_{n-8} to W_{n+52})

For each calendar week, the variations of the ordered quantities (Q) are calculated as follows:

$$\Delta Q_{SW_{n,n-x}} = Q_{SW_n} - Q_{SW_{n-x}}, for\ x = \{1, 2, 3, 4, 5, 6\} \quad (1)$$

$$\Delta_{SW_{n,n-1}}(\%) = \left(\left(Q_{SW_n}/Q_{SW_{n-1}}\right) - 1\right) * 100 \quad (2)$$

$$\Delta_{SW_{n,n-2}}(\%) = \left(\left(Q_{SW_n}/Q_{SW_{n-2}}\right) - 1\right) * 100 \quad (3)$$

Table 1
Description of the notations used in the equations

Symbol	Description
Δ	Variation
Q	Ordered quantities
SW	Snapshot date of customer order releases
n, x	Week

Source: Author's work

After identifying the parameters characterizing each release and the fields needed for the calculation, the order variation report was created (Table 2).

Table 2
Order Variation Calculation Report

Calendar Week	Order Release Parameters	SW_{n-6}	…	SW_n	$\Delta Q_{SW_{n,n-1}}$	…	$\Delta Q_{SW_{n,n-6}}$	$\Delta_{SW_{n,n-1}}$	$\Delta_{SW_{n,n-2}}$
W_{n-8}		PC	…	PC	PC	…	PC	%	%
…		…	…	…	…	…	…	…	…
W_{n+52}		PC	…	PC	PC	…	PC	%	%

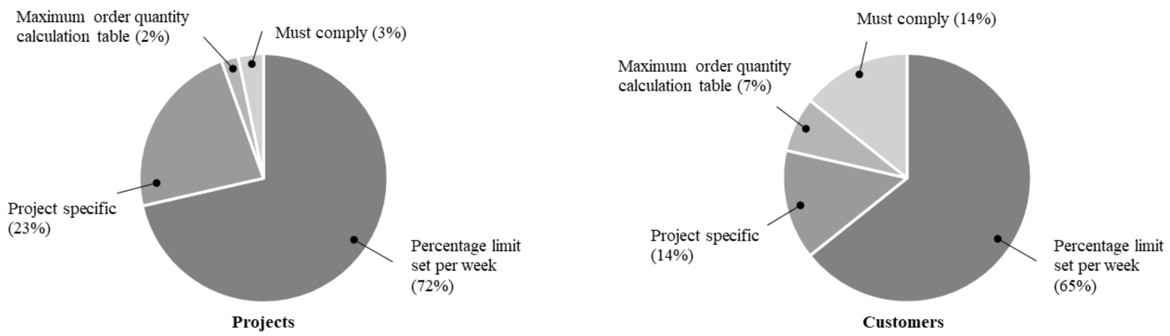
Source: Author's work

The report comprises information on order variations quantity, in pieces (PC) and percentage (%) per customer material, ship-to, plant, and total volume with data retrieved from various integrated systems.

Flexibility Rules Analysis

Following the completion of the orders, the variation report was the development of the flexibility rules report. It consisted of gathering the logistics analysis reports from the different customers, standardize the flexibility rules defined within the agreements, and grouping customers and projects by the standard. Each customer group has agreed on flexibility rules applied to all orders commissioned by that customer, consequently applied to the projects with which the products are associated. However, there are projects associated with multiple customers with different rule sets. Four standard rules were identified (Figure 2): Increase/decrease *percentage limit set per week*; *Project* *specific* rules; *Maximum order quantity calculation tables*; *Must comply* with ordering quantity.

Figure 2
Project and Customer Distribution by Standard



Source: Author's work

The development of the report and dashboard mostly includes the most significant standard, the *percentage limit set per week* (72% of projects and 65% of customers), since there is no standard guideline for active projects with *specific rules* (23% of projects and 14% of customers) and customers with *must comply* rules (3% of projects and 14% of customers) are outside the scope of this analysis. For the *calculation tables* standard (2% of projects and 7% of customers), an adapted calculator (Figure 3) was developed and accessible through the dashboard. Entering specific parameters returns the maximum daily, weekly, and monthly quantities allowed to order. The calculator is based on data tables and calculation instructions provided by customers. Based on the periodic forecast, the average daily consumption of each product is compared with the flexibility tables provided by the customers to identify the maximum consumption quantities, which, multiplied by the consumption coefficient provided, allows the calculation of the maximum order quantities for each period (daily, weekly or monthly).

Figure 3
Example of Calculator Developed for *Calculation Tables* Standard

CALCULATOR - *CALCULATION TABLES* STANDARD

INPUT FIELDS	
Last Periodic Forecast	17600
Number of Worked Days	20,5
Consumption Coefficient	1
Packaging Unit	100
Volume Constraint	1000
Average Daily Consumption (ADC)	**858,54**

Maximum Quantity in Flexibility Tables	**1070**
w/ consumption coefficient	**1070**
Maximum DAILY Consumption	**1000**
Maximum Quantity in Flexibility Tables	**4625**
w/ consumption coefficient	**4625**
Maximum WEEKLY Consumption	**4700**
Maximum Quantity in Flexibility Tables	**17958**
w/ consumption coefficient	**17958**
Maximum MONTHLY Consumption	**18500**

Source: Author's work

The standard increase/decrease *percentage limit set per week* characterizes the limit as a percentage change defined in a predetermined time horizon in weeks (Table 3). This standard is known in 9 customers and more than 60 projects of the plant

Table 3
Flexibility Rule Standard General Example - *Percentage Limit Set per Week*

W	**x%**		**y%**				**z%**		
	0	+1	+2	+3	+4	+5	+6	+7	+8
	-x%		-y%				-z%		

Source: Author's work

This example characterizes a flexibility rule defined on a 9-week horizon. W_0 is considered the week the order is released, and the rule is applied over the next eight weeks. In this example, the first two weeks following the posting of the purchase order, W_0, and W_{+1}, have allowable quantity changes of ±x%. The next four weeks, W_{+2}, W_{+3}, W_{+4}, and W_{+5}, allow quantity changes of ±y%, and the last three weeks of the horizon, W_{+6}, W_{+7}, and W_{+8}, ±z% variation.

After identifying the fields characterizing the first flexibility rule standard, the flexibility rules report was created (Table 4). The report aims to centralize the manual data inputs and serve as a database for the dashboard.

Table 4
Flexibility Rule Standard General Example - *Percentage Limit Set per Week*

Calendar Week	**Customer**	**Rule Description**	$\Delta_{SW_{n,n-2}}$ **Upper Limit**	$\Delta_{SW_{n,n-2}}$ **Lower Limit**	$\Delta_{SW_{n,n-1}}$ **Upper Limit**	$\Delta_{SW_{n,n-1}}$ **Lower Limit**
W_{n-2}			%	%	-	-
W_{n-1}			%	%	%	%
…			…	…	…	…
W…			-	-	%	%

Source: Author's work

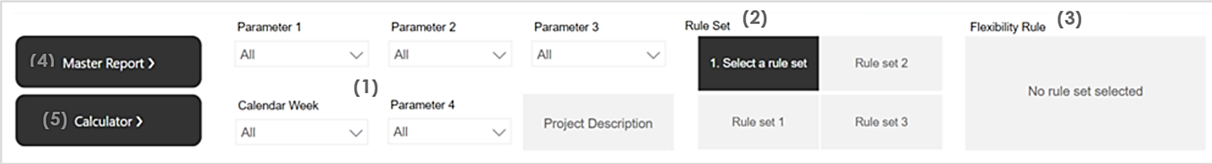
The report comprises information on percentage limits (%) per customer group with data retrieved from the requirements matrixes of customers.

Dashboard Development

After completing the reports that would serve as the database for the dashboard, the final action was to design an easy, visual, and interactive dashboard, with a graph comparison between order variation percentage and flexibility limits defined. Since planners have access to all the information detailed in the reports, it would be unnecessary to repeat data in the dashboard, displaying only the information that would be relevant in the comparison between order variation and flexibility rules in the dashboard.

The developed dashboard contains two charts representing variations in orders between snapshot weeks for the different calendar weeks and compares these variations with the limits set by the rules. The planner selects the parameters (Figure 4) concerning the order to be analyzed in the filters area (1) and selects the rule set corresponding to the customer for whom the order is placed (2). Descriptive information about each selected rule set is also provided (3). The centralized master report (4) is accessible through the dashboard, where the data is refreshed weekly, adding, modifying, or eliminating flexibility rules. The two reports created in the previous sections are also available in the master report. It is also through the dashboard that planners access the calculator for orders analyzed by the *calculation tables* standard (5).

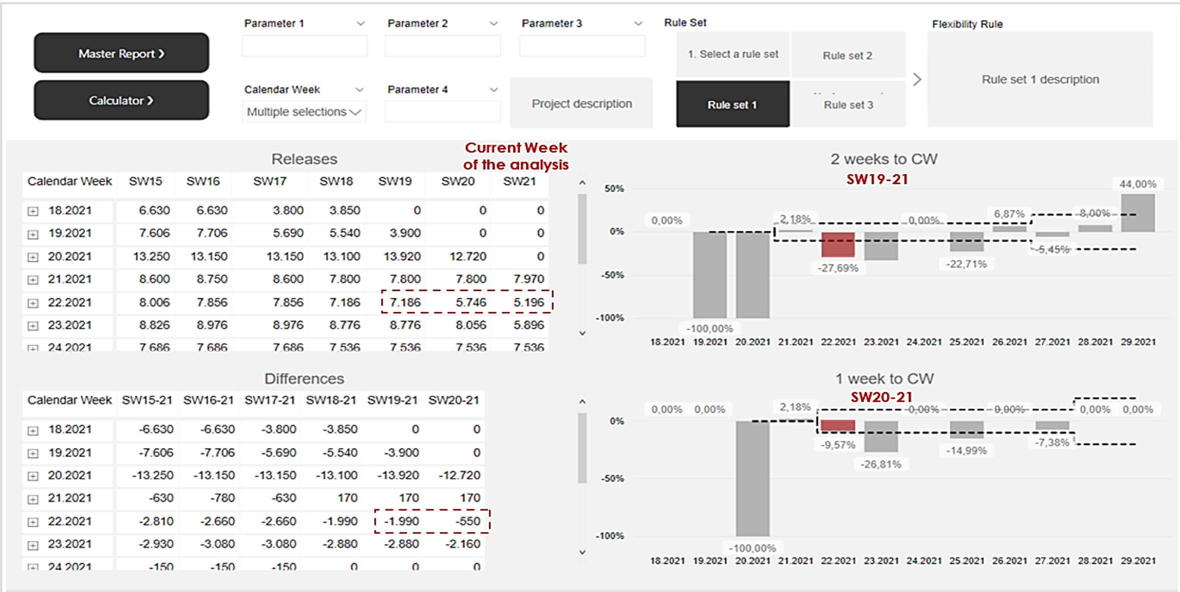
Figure 4
Order Variation Dashboard – Filter and Information Area



Source: Author's work

The dashboard represented in Figure 5 contains fictitious data reporting order releases for a product from weeks 13.2021 to 21.2022. In the current week of the analysis, 22.2021, the releases in the week's snapshot, SW_{21}, are compared with the releases of the previous two weeks, SW_{19} and SW_{20}. The values of the columns in both charts represent this variation. Line values represent the maximum percentage variations allowed.

Figure 5
Order Variation Dashboard – Analysis Example



Source: Author's work

In this example, when analyzing calendar week 22.2021, it is observed that:

- In the snapshot for the week two weeks before the current week, SW_{19}, the ordered quantity for week 22.2021 was 7 186 PC, while in the current week's snapshot, SW_{21}, the ordered quantity is 5 196 PC (equation 1). This decrease of 1 990 PC represents a variation of -27.69% (equation 3) in the ordered quantity that is outside the permitted limit of ±10% for that week
- In the previous week's snapshot, SW20, the order for week 22.2021 was 5 746 PC, and in the current week's snapshot, SW21, 5 196 PC. This decrease of 550 PC (equation 1) represents a -9.57% (equation 2) variation within the permitted limit of ±10%.

Based on the information synthesized in the dashboard, the final decision always depends on the planner. In the example, for week 22.2021, it is observed that the reduction compared to the amount ordered two weeks before is greater than the one allowed by the flexibility limits. Still, the reduction compared to the previous week is allowed. This means that, according to the flexibility rules, the planner must inform the customer of the excess quantity and can reject the reduction that exceeds the allowed limits. However, depending on the plant's circumstances, the planner may not reject the order. Reliant on the quantity of product in stock, it may be in the planner's interest to reject the reduction and deliver the originally ordered quantity to the customer, avoiding keeping large accumulations of inventory. On the contrary, considering the crisis in electronic components affecting the industry, reducing the quantities ordered is beneficial for the planner, as it allows the relocation of critical raw materials to other orders and maintains the satisfaction of customer needs.

This design made it possible to achieve the main objective of this dashboard, understandable and easily interpreted by planners, providing an overview of customer orders and helping planners' decision-making. Ideally, the planner stops manually checking the comparison between order variation and customer flexibility rules, automatically obtaining the information to report to the customer.

Results and Discussion

By this time, the order variation dashboard is available and tested by the planners, whose response on its accuracy and suitability further improves customer order management and production planning. The customer order variation dashboard covers 72% of customers and 74% of projects within the plant, with over 18 000 customer orders being automatically evaluated weekly. To cover the entire range of projects and customers, guidelines for projects with the *specific rules* standard or *must comply* standard could be aligned with one of the two standards covered by the dashboard.

A study was carried out within the planning team, estimating that the planner took 2.5 hours per week on tasks like data searching, collection, and calculation of variations in orders and another 1 hour to prepare information to report to the customer. Automating this task with the proposed tool allows for potential savings of up to 1 337 hours per year in the department, reducing the time spent analyzing customer order variation and comparing flexibility rules to 1h per week per planner. More than 95% of the time spent would be saved with the automatic weekly refresh of the dashboard data, which loads the latest information from the internal system. In comparison, 7% is reflected by the data organization and added additional information displayed in the dashboard (Table 5).

Table 5
Implementation Results

	Initial Process		After Implementation		Variation
	weekly	daily	weekly	daily	weekly
Data Collection Variation Calculations Select & Adjust Limits	2.5 h	0.5 h	0.07 h	0.01 h	- 1.5 h **- 97.2 %**
Report variation to the customer	1 h	0.2 h	0.93 h	0.19 h	- 0.07 h **- 7 %**
Total	**3.5 h**	**0.7 h**	**1 h**	**0.2 h**	- 2.5 h **- 71.43 %**

Source: Author's work

Main Contributions & Limitations

Implementing a lean approach to information management can increase a company's competitiveness (Bevilacqua et al., 2015). Overall, it is possible to observe great improvements both in expended time and necessary manual effort in the collection, cleaning, and use of information, allowing not only to streamlining the decision-making process of the planning team but also to provide essential tools for the execution of their daily tasks. Validating similar results obtained by Bevilacqua et al. (2015), "the specific focus on lean information management has enabled the company to increase the benefits already obtained by applying lean production principles", achieving substantial advantages in process lead times, task efforts, and reduction of waste in the form of non-value-added activities, in line with the results obtained in Monteiro, Pacheco, Dinis-Carvalho & Paiva (2015). Furthermore, the paper provides insights into the actual applicability of lean information management, from waste detection on manually performed tasks and data analytics to the flexibility and low cost of dashboard implementations. This paper also aims to give a reference for improving digitalization and information management practices within multiple industries.

In addition to saving 2.5 hours per week in the assessment of variations in customer orders, the developed dashboard could benefit the Planning and Fulfilment department and other areas within Logistics. Each customer group has stipulated flexibility rules applied to all projects associated with that customer, although there are projects associated with several customers with different rule sets. Selecting the flexibility rule and the project as two independent parameters presents the planner with the ability to evaluate one project by different rules and allows for better assessment in the analysis and decision support in reviewing the flexibility rules with the customer. Another contribution made possible by this dashboard concerns the response to demand fluctuations. Having an automated record of variations in customer orders allows the planning department to predict production plans better and the purchasing department to align this variation in orders with the variation in raw material purchases. In the future, based on the data provided by the dashboard, flexibility rules adapted to the plant's needs can be agreed upon with suppliers, and a new dashboard to inspect these variations can be created since the standard is already developed.

The integration of lean information management concepts allowed not only to take full advantage of the information that is continuously generated but also to transform and integrate it to satisfy the information needs of planners, providing them with the necessary information when required and guaranteeing its quality. Despite being available, the current circumstances of the crisis of electrical components make it impossible to use the order variation dashboard as intended. As there are shortages of various materials and insufficient quantities to satisfy all customer requests, the planners do not accept any changes to the ordered quantities. At the moment, planning is made according to the availability of raw materials and not according to customer requests. However, it is expected that active work will continue to improve this tool and allow greater agility and flexibility in the tasks performed by planners.

Enhancements can be developed in future work, such as the flexibility of reports and dashboards and a more detailed and real-time analysis of customer order launches. It was stated that the release variation would be calculated weekly as there were no significant daily variations. However, a variation to an already planned quantity would be registered once a week. Orders received the next days would only be considered the following week, substantial or not. A potential solution would be reducing the time between updates and replacing weekly snapshots with daily snapshots.

Furthermore, the calculation of variations always considers the current week of the analysis. To increase the flexibility of the analysis, another proposal for improvement would be to allow the choice of weeks to be compared, regardless of the current week. Implementing these proposals will generate new opportunities for progress and trigger other challenges following an endless cycle of continuous improvement.

Conclusion

The development of the dashboard described in this paper allowed for accomplishing the proposed objectives, saving time, and streamlining the tasks of the planning and fulfillment department planners. Simultaneously, the project permitted additional contributions associated with the planners' responsibilities in the decision-making. In addition, to improve the effectiveness and productivity of the Planning and Fulfilment department, the contributions of this article aim mainly to help to fill a gap in the literature with the study of the implementation of Lean practices in digitalization and information management supported not only by similar results obtained within the industry but other administrative areas as well.

The contributions of this paper employ not only the improvements in the effectiveness and productivity of the planning team but also help to fill a gap in the literature with the study of the implementation of Lean practices in the context of lean office and information management. The results are in line with studies consulted that obtained similar and significant improvements, both in the automotive industry and in other areas focused on information management and administrative processes. It highlights issues of lacking usage of business analytics tools and managing information, vital to the continuous improvement of organizations. Continuous work needs to be followed within the subject to generate new opportunities for growth and continuous improvement, both in studying information-related processes and their applicability within the wide range of an organization's divisions.

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