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ScienceDirect

Procedia Computer Science 263 (2025) 25–33

Procedia Computer Science

www.elsevier.com/locate/procedia

International Conference on Industry Sciences and Computer Science Innovation

A decision support system to define new inventory management policies in companies transitioning towards data-driven decision-making

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Abstract

Information and Digital Technologies (IDT) not only help connecting processes and making them more efficient, they also increase one's visibility over them, by the intensive data creation and collection associated to their use. This data, when properly treated, can be quite revealing of a company's performance status and what future direction it seems to be heading. Data transformed into information is a powerful tool that must be used to support decision-making. Unfortunately, many companies have not yet mastered this transformation and plenty of others have not even acknowledged its potential.

This article describes a case study carried out at a company responsible for the production of car seat covers, aiming to transition towards a data-driven decision making mindset. Revising their raw materials inventory management policies was their first step towards this goal, which led to the creation of a Decision Support System (DSS) that analyses the trade-offs between inventory-related costs and achieved service levels, considering the separate and joint use of safety stocks and safety time buffers. This paper presents the proposed DSS and illustrates its application to a small set of raw materials from the case study organisation.

Keywords: Demand and Supply Uncertainty; Business Analytics; Inventory Management; Safety Buffers

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10.1016/j.procs.2025.07.004

1. Introduction

Today's global market is not only particularly dynamic, but also highly and increasingly volatile. Whilst trying to run their supply chains as efficiently as possible, companies fight to maintain their competitiveness, meet customer requirements and be prepared to face disruptive events of any nature (at an internal or external level) [1], [2].

In Material Requirements Planning (MRP) systems, supply and demand uncertainty are tackled via buffering strategies, which, in practice, translates into the adoption of safety stock or safety time [3], [4]. Although safety stock remains the most popular buffering technique amongst researchers and practitioners, plenty of studies have tried to better understand under which circumstances each strategy should be used instead of the other, in order to minimise materials' holding costs and to maximise service levels. The dimensioning of safety buffers, however, relies heavily on the level of understanding decision makers have of the uncertainties they face, which ultimately relates to the strategies in place to signal and quantify such variations.

One could think that living in the information era would make this job much easier, but, surprisingly, the ever increasing amount of data generated and collected, is not always the most reliable, nor is it often structured in the best way, which presents new challenges to practitioners who want real-time data access to support their decision-making. Indeed, plenty of companies worldwide, have entered the new Industry 4.0 era by digitalizing their systems and investing in Information Technologies (IT) tools without taking full advantage of this new way of operating.

Even though current literature widely discusses the use of safety stock and safety time, as well as the potential of data to obtain information and drive organisations forward, these research topics still present clear literature gaps. In regard to the study of safety buffers, even though plenty of researchers tried, unsuccessfully, to ascertain under which circumstances each methodology should be used instead of the other, as [3], [4], [5] pointed out, most of these works not only disregard the joint consequences of supply and demand variability and the possible benefits of combining safety stocks and safety lead times, as they are also mainly theoretical and based on very restrictive scenarios, not tested in real production settings. On the other hand, when it comes to the IDT field, research related to its ground-breaking opportunities and main applications is often found. However, none of this research seems to detail how companies take this next technological step. Most discussed issues refer to practical difficulties that come with Industry 4.0 and big data itself, while few explore the big hurdles that organisations encounter when trying to evolve from more traditional industries, where information is often spread across departments, to new hyper-connected systems, where real-time information is available to all users.

To address these shortcomings, in this paper, we propose a DSS that keeps track of supply chain Key Performance Indicators (KPIs) concerning demand and supply uncertainty and that, based on information collected from companies' information systems as well as user input, is capable of simulating the performance of new inventory management policies and comparing its results to the policies currently in place. The contribution of this paper is threefold:

- We propose a DSS to define raw materials inventory management policies based on real demand and supply uncertainty, collected from companies' information systems;
- Inspired by [4], we intend to understand if the adoption of hybrid safety buffers, i.e., combining safety stock and safety time, can improve the system's current performance, in terms of the inventory-service trade-off.
- We also signal some system vulnerabilities that companies transitioning towards data-driven decision making might face, concerning information sharing, data storage and data treatment.

This paper presents the architecture of the proposed DSS and illustrates the system's practical relevance in a company responsible for the production of luxury car seat covers for different OEMs and Tier I suppliers.

We start this paper by presenting, in Section 2, an overview of related literature, regarding the adoption of safety stock and safety time buffers as means of protection against uncertainty, whereas Section 3 clearly states the problem addressed by this study. Section 4 details the architecture of the proposed DSS, while Section 5 encompasses the results of the practical tests conducted for a small group of raw materials. Lastly, Section 6 summarises the main findings of our work and outlines the direction of future research.

2. Related Work

MRP production systems appear to be rather vulnerable to demand and/or supply risks, as a consequence of timing and/or quantity uncertainties [3]. On the one hand, customer demand is typically forecasted as it is not known in advance [6], which implies that there is always a degree of uncertainty [3], [6] in the volume, product type or timing of incoming orders [5] that can be intensified by insufficient or distorted demand information about orders or demand quantities [2]. This "demand amplification" (Bullwhip Effect, BWE) [7], can decrease supply chain performance [8] since it leads to several operational problems, such as excessive inventory levels and higher supply chain costs [7].

On the other hand, supply chains also face supply risks related to time, quality and quantity deviations, as well as other product or information disturbances that involve upstream partners [2].

In such a setting, buffering is regarded as the primary means of protection against demand and supply uncertainty, which, in practice, translates into the adoption of safety stocks and safety lead times [3], [4]. Over time, despite safety stock's popularity amongst researchers and practitioners, many studies tried, unsuccessfully, to ascertain under which circumstances one methodology should be used instead of the other, while simultaneously minimising inventory holding costs and maximising service levels. In [9], the authors conducted the first systematic study on buffering decisions in MRP systems, using a simulation experiment in single-stage production systems that faced demand and supply risks, caused by quantity and timing uncertainties [3], [4], [10], [11]. They concluded that, when facing timing uncertainty, safety time should always be adopted, regardless of the level of uncertainty involved [3], [4], [10], [11]. On the contrary, after using a simulation approach to better understand lead time uncertainty of purchased parts in multi-stage systems, [12] suggested the adoption of safety stock over safety time [3], [4], [10], [11]. After considering all types of demand and supply uncertainties, the results of the study conducted by [13] supported that, in MRP production systems operating under quantity variability, safety time should be disregarded as the primary buffering technique, whereas in products with sparse delivery schedules, also affected by timing variability, safety time proved to be the better choice. Furthermore, it is carefully underlined that no buffering method can assure the superior performance in every single scenario [3], [4]. A few years later, [11] chose to simultaneously optimize the safety buffers and the constant order quantity within an hypothetical MRP system, having concluded that, when demand variability increased, safety stock was the best option. However, before high levels of both demand and lead time variability, safety time should be adopted instead. By analysing a real multiproduct industrial setting via a simulation study, [5] supported these conclusions – to cope with high demand variability, safety stock is the advisable alternative; if uncertainty is mainly in supply, safety lead time allowed for better results and, lastly, when the system faces both demand and supply uncertainty, safety time should be adopted. A completely different perspective on the matter was presented by [4] who, instead of, once again, analysing the separate performance of safety stocks and safety lead times, chose to optimise them jointly and understand their impact on materials' holding costs and the achieved service levels. It is noteworthy that this study was conducted in a real and complex industrial setting – a company in the automotive electronics business, with multi-component and multi-supplier considerations, a single-stage system and both demand and supply uncertainties. The results of this study allowed the researchers to suggest the combination of both buffering strategies in two different instances – on materials with low delivery frequencies (sparse delivery schedules) or when demand variation increased in the system.

Stimulated by the research conducted by [4], we use uncertainty information to determine safety buffers, including the joint and separate use of safety stock and safety time. This way, we intend to estimate the practical benefits of implementing these buffering strategies in a dynamic, real industrial setting.

3. Empirical Context

Over the years, the primary goal of supply chain management has remained the same – to efficiently link and integrate manufacturers, warehouses and stores, so that the final product is produced and distributed at the right quantities, to the right locations, at the right time, while satisfying service levels requirements and minimising total system-wide costs, from transportation and distribution to inventories of raw materials [14].

Traditionally, IT plays an important role in increasing supply chain effectiveness, since it helps creating an information trail parallel to the one physically made by the product [14]. Furthermore, IDT not only help connecting processes and making them more efficient, they also increase one's visibility over them, by the intensive data creation and collection associated to their use. This data, when properly treated, can be quite revealing of a company's current status and what future direction it seems to be heading. Data transformed into information is a powerful tool that must be used to support decision-making. Unfortunately, many companies have not yet mastered this transformation and plenty of others have not even acknowledged its potential.

Being responsible for the production of luxury car seat covers for different OEMs and Tier I suppliers, the company where this study was conducted can be described as an upstream member in their customers' very complex supply chains, which makes them particularly vulnerable to the BWE. Working with a multitude of suppliers and clients, spread across several geographical locations, while keeping its manufacturing process as flexible as possible proves to be quite a challenge, especially in a market as volatile and competitive as the one typically surrounding the automotive industry. Additionally, the fact that the company works simultaneously with various car makes and models means they must comply with different requirements and its production needs to use a wide range of raw materials, from leather and luxury textiles to thread, airbag materials, foam and vinyl.

As a result, the company under study is currently finding it ever more difficult to balance raw materials inventory costs and their service levels. They are aware that end-item volatility is one of their major issues, but they do not have any strategies put in place to quantify its impact on raw materials service levels or to assess how raw materials needs evolve overtime. In short, the company aims to change their *modus operandi* and to start supporting their strategic decisions on real data, retrieved from their information systems. Revising their raw materials inventory management policies was their first step towards this goal.

4. Model Development

4.1. Conceptual Model

In order to define new raw materials' inventory management policies that take into account demand and supply uncertainty, we designed a DSS that analyses the trade-offs between inventory-related costs and achieved service levels, considering the separate and joint use of safety stocks and safety time buffers, and tested its practical relevance with a small group of materials.

The proposed DSS follows the system architecture found in the work of [15], meaning that it was conceived on a three-layer architecture comprised by a database, the simulator of new inventory management policies and a graphical user interface (GUI), as shown in Figure 1. The database layer combines supply and MRP-related data collected from the company's information systems about the raw materials under study. This data feeds the entire process layer, since, after being properly treated and cleansed, it is used as the main input for the determination of parameters associated with the desired simulation model. Lastly, the GUI layer not only enables the user to keep track of demand, supply and production KPIs, but also allows him to interact with the system itself and to contribute positively to the simulation of new inventory management policies.

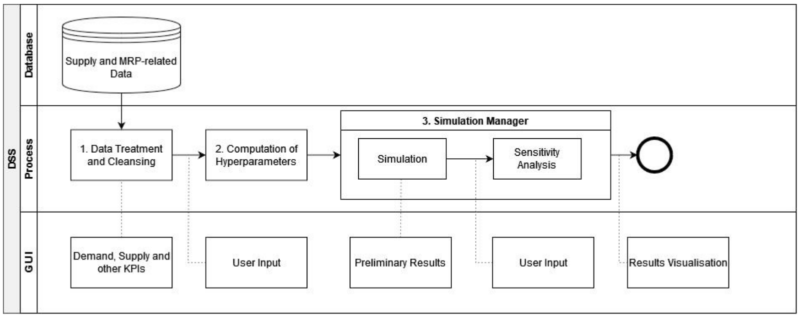


Fig. 1. Architecture of the proposed DSS.

As detailed in Figure 1, this DSS starts by treating supply and MRP-related data collected from the company's information systems and turning it into useful information regarding the evolution of demand and supply KPIs, as well as other indicators related to the manufacturing process itself. The reports resulting from this process display information regarding, for instance, (i) the unmet demand ratio, (ii) the average variation rates of materials' needs, (iii) the amount of missing material, in comparison with the total amount of ordered material, (iv) the risk of supply delay and (v) the average number of extra days it takes to close a production order.

The second stage of the DSS encompasses the determination of parameters that are crucial to the simulation of new inventory management policies, including the estimate of safety stock and safety time buffers. During this phase, the system can base its calculations on each material's historical demand and supply behavior (available due to the data treatment and cleansing stage) or it can use inputs provided by the user themselves.

Afterwards, the DSS is meant to study a series of new approaches to raw materials inventory management and compare their performance to inventory-related costs and service levels achieved by the policies currently in place (Simulation stage). Yet, before definitively choosing new inventory management policies, these preliminary results must be subject to a sensitivity analysis to assess their consistency. Consequently, the user has the power to adjust parameters that directly influence the performance of the inventory management policies under study, since, this way, they can evaluate the impact of small variations to the original test conditions on the preferable policies.

4.2. Test Version

To assess how such a DSS would work, a test version was developed. The aim here is to use the proposed DSS as a support system to evaluate new inventory management policies for four different materials that are relevant to the organisation under study. In order to achieve this, we modeled uncertainty in supply and demand for the different materials using historical data. We determined the expected weekly average demand and its deviation for each material based on two different methods, both only including information available prior to the simulation start date – the use of theoretical normal distributions that best fitted each material's total demand, and the estimate of a seasonal variation rate that affected the expected demand values**.** These two main approaches were assessed in parallel, meaning that all scenarios evaluated under one method were also assessed using the other, and the performance of all inventory management policies derived from them were compared to the performance of the policies currently in place.

The calculation of safety time buffers relied on each supplier's historical delay risk and the average number of extra days they needed to deliver the material, so that a probability function returning the most adequate safety time value to a certain and customisable significance level was built. To achieve this, it was first necessary to combine information regarding scheduled deliveries and receiving reports from different sources, as they were not directly available on any of the company's information systems.

Since all the materials subject to this analysis were categorised as A-type items in the company's ABC analysis and periodic-review systems *(R, s, S)* are known to more efficiently reduce replenishment and shortage costs, while ensuring material availability, the undertaken simulations implemented this inventory management policy. This means that for every *R* units of time, the inventory position is checked and, if it is below the reorder point s, material is ordered up to level *S. R, s* and *S* parameters were estimated based on inventory management costs C1, C2 and C3 – holding, stock out and ordering costs, respectively –, as well as on the expected average demand per period and its deviation. However, the theoretical expressions used in these calculations rely on the assumption that demand is normality distributed over time, which required that, first and foremost, normality had to be ensured. In both theoretical normal distribution and seasonal variation rate approaches, the hypothesis of keeping the company's current review period of one week was assessed in contrast to the adoption of a new review period *R*, all the while considering the possibility of suppliers not complying with the ordered quantity.

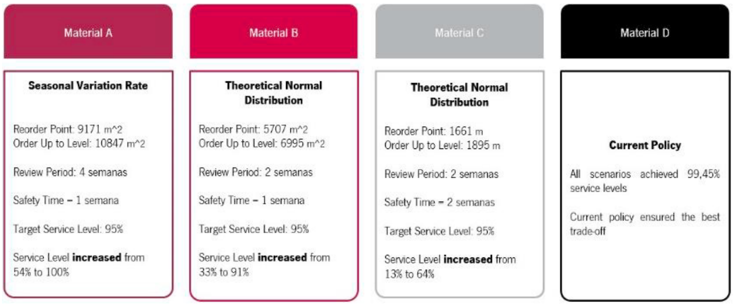
All simulation scenarios were tested for the separate and joint adoptions of safety stock and safety time buffers, considering target service levels of 95% and 99%. This translated into the simulation and assessment of 28 different scenarios, 26 of which regarding new inventory management policies.

Nonetheless, testing different scenarios and comparing their results is only possible if they relate to the same data. Consequently, all possibilities were tested for the same period of time – from the first week of November 2022 until mid-March 2023. This means that, for each material, its simulations reproduced the system's performance over the course of 20 weeks, a reasonable timeframe, considering that it allowed for all of them to virtually place and receive orders to and from their suppliers multiple times.

5. Results

5.1. Preliminary Results

Figure 2 shows the simulation results for each material under study. A preliminary analysis to these data allows to verify that for all materials but one the service levels achieved by any of the new approaches scenarios were considerably superior to the theoretical ones estimated by current status algorithms.



Material A

Seasonal Variation Rate

Reorder Point: 9171 m^2
Order Up to Level: 10847 m^2

Review Period: 4 semanas

Safety Time – 1 semana

Target Service Level: 95%

Service Level **increased** from 54% to 100%

Material B

Theoretical Normal Distribution

Reorder Point: 5707 m^2
Order Up to Level: 6995 m^2

Review Period: 2 semanas

Safety Time – 1 semana

Target Service Level: 95%

Service Level **increased** from 33% to 91%

Material C

Theoretical Normal Distribution

Reorder Point: 1661 m
Order Up to Level: 1895 m

Review Period: 2 semanas

Safety Time – 2 semanas

Target Service Level: 95%

Service Level **increased** from 13% to 64%

Material D

Current Policy

All scenarios achieved 99,45% service levels

Current policy ensured the best trade-off

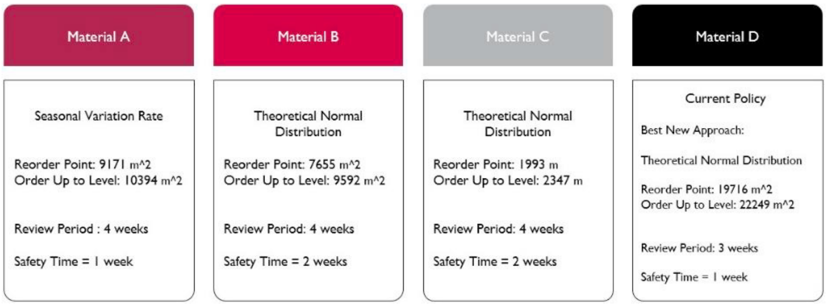
Fig. 2. Simulation Study - Preliminary Results.

Taking a closer look to these results individually, for material A, all new scenarios were capable of ensuring a service level of 100%, which translated into going from an average stock out of 339,98 square metres per week (55% service level), in the current status scenario, to fulfilling total material demand every week, during the simulation period. This, of course, happened at the expense of an increase in the amount of material kept in stock and, consequently, in the amount of material ordered from the supplier. In fact, the new approaches scenarios with less average stock of material on hand ensured an average inventory level of 7.257,91 square metres per week, almost ten times more than the values obtained in the current policies scenarios. In the case of materials B, C and D, the maximum service levels achieved were not of 100%, since these materials' stock outs occurred within the transition period between the old and the new inventory management policies, during which the effects of the latter would still not be visible. As a result, when it comes to material B, all new approaches guaranteed a service level of 91,33% for the twenty weeks of the simulation, which represents an increase of 58% when in comparison to current status scenarios. The approach using the theoretical normal distribution, a new inventory review period of two weeks and the safety time buffer for a target service level equal to 95% was the one that ensured this increase while requiring less amount of material in stock. On the other hand, the results achieved for material C were quite similar to the ones found for material B, since the same new approach scenario reached the best trade-off between service level and investment in raw material. In the case of material C, this approach implies the review of inventory levels every two weeks and that a safety time of another two weeks is also put in place, allowing to improve the service level from around 13% to 64%, by increasing the average inventory level from 3,79 to 2.981,13 metres.

In sharp contrast to all results described so far, in the case of material D, current status scenarios performed at the same level as the new approaches, ensuring an equal service level of 99%. However, because they achieved this with a fifth of the average inventory level attained by the highest ranking new approach scenario (the same baseline scenario as materials B and C), current inventory management policies guaranteed the best service level/raw material investment trade-off, at least during this simulation period.

5.2. Sensitivity Analysis Results

Following our reasearch methodoly the presented preliminay results were subject to a sensitivity analysis that allowed to obtained the final results shown in Figure 3.



Material A

Seasonal Variation Rate

Reorder Point: 9171 m^2
Order Up to Level: 10394 m^2

Review Period : 4 weeks

Safety Time = 1 week

Material B

Theoretical Normal Distribution

Reorder Point: 7655 m^2
Order Up to Level: 9592 m^2

Review Period: 4 weeks

Safety Time = 2 weeks

Material C

Theoretical Normal Distribution

Reorder Point: 1993 m
Order Up to Level: 2347 m

Review Period: 4 weeks

Safety Time = 2 weeks

Material D

Current Policy

Best New Approach:

Theoretical Normal Distribution

Reorder Point: 19716 m^2
Order Up to Level: 22249 m^2

Review Period: 3 weeks

Safety Time = 1 week

Fig. 3. Simulation Study – Sensitivity Analysis Results.

When it comes to material A, regardless of the values of C1 and C3 costs, the best trade-off between service level and material investment was ensured by the same baseline scenario. Nevertheless, the lower order up to level point, obtained after increasing the internal interest rate for keeping material in stock to 20%, guaranteed the same service level as the approach presented in the preliminary results (100%), though requiring less material to do so – the weekly average stock on hand was estimated to decrease 418,33 square metres.

In the case of material B, although for most scenarios the preliminary results approach remained the best option, when the C1 internal interest rate dropped to 10% and C3 cost doubled its value, a new approach became an interesting alternative. In its essence it is exactly the same as the one obtained in the preliminary results, the only difference between them relates to the significance level used to determine the safety time buffer - 99%, instead of 95%. This means that, for material B, increasing its reorder and order up to level points, as well as its review period and safety time buffer, as a consequence of the new simulation scenario, ensured a service level only 0,04% inferior to the one achieved in the preliminary analysis, while decreasing the weekly average stock on hand by 543,51 square metres.

Regarding the material C, the same baseline approach outperformed all others for all scenarios, as it did in the original analysis. Moreover, it was once again proved that the adoption of different parameters could deliver a more efficient result – the same service level could be guaranteed by having, on average, less 1.579,99 metres in inventory per week, if reorder and order up to level points increased enough to compensate the longer review period of 4 weeks.

Lastly, it came as no surprise that, regardless of the scenario under assessment, none of the new approaches outperformed the current policy in place for material D. Nonetheless, it was possible to improve the best new approach scenario – the best trade-off between service level and the amount of required inventory was still ensured by the same baseline scenario, though, when dropping the C1 internal interest rate to 10% and doubling the C3 cost, the increase in its review period, as well as in the reorder and order up to level points led to a remarkable decrease of the weekly average stock on hand by 4.215,90 square metres, dropping it to 26.604,21 square metres per week (still very far from the 5.734,99 square metres achieved by the company's current policy).

This sensitivity analysis led to some very interesting results, since it not only allowed to increase the efficiency of the policies suggested during the preliminary analysis, as it also proved that the main choices behind them remain the same regardless of the new C1 and C3 costs. By not changing the choice of adopting theoretical normal distributions or the estimated seasonal variation rate; by maintaining the safety time as the buffer of choice against uncertainty; and by opting for new inventory review periods superior to one week, the presented policies proved to be stable solutions for this problem. Furthermore, the results of this sensitivity analysis suggested the adoption of long inventory review periods for all materials, in particular a review period of four weeks was recommended to the three materials whose service levels were estimated to increase by the adoption of new inventory management policies.

6. Discussion and Conclusion

This paper presents a DSS that helps defining new raw materials inventory management policies based in real demand and supply uncertainty in companies transitioning towards data-driven decision making. As a result, we also used this study to signal the main vulnerabilities found in our company's information systems, concerning information sharing, data storage and data treatment, since other companies in this situation also face issues like these.

Additionally, we studied the joint and separate adoption of safety stock and safety time buffers as means of protection against supply and demand uncertainty.

In regard to the study of inventory management policies, assessing raw materials' historical service levels and supply quality was of top priority. In fact the unstructured way data is currently stored in the company's information systems led to an intensive data gathering and treatment stages, before information about the performance of current inventory management policies and supply quality could be obtained.

It was only after this comprehensive system diagnosis that a DSS was conceived to, in the future, report back the evolution of such KPIs and to analyse the trade-offs between inventory-related costs and achieved service levels.

The results of the simulation study revealed that, for some materials, there is room to improve current inventory management policies, whereas, for others, current policies may be worth keeping.

For materials with highly unpredictable demand (materials A, B and C), the service levels estimated during the simulation period were considerably improved by the adoption of new policies that increased the amount of inventory kept on hand, showing that the company's current strategy to deal with this kind of materials may not be the most adequate, since it is leading to inventory levels too low to account for sudden demand fluctuation. For the material whose inventory management policies were not successfully improved, we could relate this result to the fact that it is used in one of the company's biggest projects, which makes its production lines run at full capacity all the time. This means that even though end-item demand may fluctuate considerably over time, the company must always maintain the highest production throughput possible, in order to meet customer demand, therefore, leading to more predictable raw materials' needs. However, since production capacity is not available in the company's information systems we were not able to optimise the new policies to this value, only to real demand estimates, which required more material to be kept in stock and that, consequently, were far less competitive than the one currently in place.

Other conclusions can be drawn from this study, especially concerning new policies' estimated review periods and safety buffer choice. When it comes to the review period results, both preliminary and sensitivity analyses show a clear preference for the adoption of longer review periods, in contrast with the company's current review period of one week. In fact, for materials A, B and C, their estimated review period ultimately converged to four weeks after conducting the sensitivity analysis. This tendency seems to indicate that if the company starts following inventory management policies similar to these, it may be able to increase service level performance and simultaneously reduce their raw materials' collaborators workload, as well as possibly diversify the scope of their tasks, since they would not have to keep track of every material's weekly inventory levels.

Regarding the preferable safety buffer, safety time was the unequivocal choice, since it was the safety buffer adopted in every material's best performing policy, in both the preliminary and sensitivity analyses. This predominance may be slightly influenced by the fact that the simulation was conducted following a weekly basis, meaning that safety buffers of only a few days were not tested and the results were rounded up to their corresponding weekly value. A daily simulation could have led to situations in which the combination of safety stock and safety time would be the most efficient approach, guaranteeing the same service levels with a lower inventory for some items at least. Nevertheless, it is clear that, considering the way simulations were conducted, the safety time buffer allowed to fulfil customers' demand, while requiring much lower inventory levels than the safety stock buffer itself.

Focusing, now, on the system's vulnerabilities, several issues were highlighted concerning information storage:

- Key information not being available in the system – whether it refers to updated information about end-item demand or information about production itself (for instance, production capacity), collaborators rely heavily on local files to access sensitive information;
- Lack of standardisation in files format – to overcome this issue, the collected data underwent an intensive treatment stage, before datasets could be linked to one another and knowledge could be drawn from them.

This kind of problem allows to conclude that, throughout the years, the technological solutions developed by our company have been designed to accommodate each departments' needs without taking into account the full integration of the information available in the system. However, now that the company intends to take as much advantage as possible out of all available data, these glitches become big hurdles that must be addressed on the company's way towards data-driven decision making.

Considering the documented findings, it seems that, moving forward, companies facing the same challenges as ours must extend their commitment towards data-driven decision making to their information systems. It is of the utmost importance to rethink the way information is shared within themselves and how systems communicate between one another. By addressing these issues, companies such as ours will be able to open a series of possibilities, not just concerning decision making associated with raw materials inventory management policies, but also with any other topic, involving internal and, perhaps, external parties.

Additionally, the next stage of this work should focus on materials with medium to low prodution volumes and high demand volatility, as materials A, B and C. These present themselves as the best contenders to be the first real-life test subjects of new data-driven inventory management policies, since they obtained the most promising results.

All in all, we encourage more companies transitioning towards Industry 4.0 to adapt and test this DSS as a first step on their way to a fully integrated system. It will certainly signal them many vulnerabilities and information sharing concerns that must be properly dealt with in order to achieve company goals, while it also lays the groundwork for making informed decisions based on real information retrieved from their information systems.

Acknowledgements

This work has been supported by FCT–Fundação para a Ciência e Tecnologia within the R&D Units Project Scope: UIDB/00319/2020.

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