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Analysing the possibility of dealing with uncertainty in ERP/MRP controlled environment with Demand Driven MRP

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Purpose: This paper proposes providing a research about the uncertainty that the companies managed through ERP (Enterprise Resource Planning)/ MRP (Material Requirements Planning) face nowadays and present and discuss the adoption of Demand Driven MRP (DDMRP) in SME to deal with this scenario in the context of Industry 4.0, digital transformation and in the necessity to be responsiveness in the global competition.

Design/methodology/approach: The methodology used is a literature review to conduct an explanatory research and a discussion comparing MRP and DDMRP in the SME environment.

Findings: The analysis and discussion found ERP/MRP difficulties in dealing with uncertainty and possibilities for improvements with DDMRP in this scenario.

Academic limitations/implications: Assuming that the purpose of this research is the possible adoption of DDMRP by a SME a suggestion for future work is dimension a DDMRP system in a SME that already uses the MRP logic and compare them.

Practical implications: The discussion of this research indicates a possibility for adoption of ERP/MRP systems in SME that is not very widespread in this business offering a new solution for their challenges.

Originality/value: This paper contributes to increase the analysis about the possibilities of DDMRP adoption to deal with uncertainty in SME manufacturing environment, especially considering the advances based on I4.0 technologies.

Keywords: DDMRP, Demand Driven, Uncertainty, ERP in SME.

1. Introduction

ERP (Enterprise Resource Planning) systems are commonly used in large companies; almost all of them have implemented some type of ERP system since it became well known in the 80s. Only recently, since the 21st century, ERP systems are being implemented and used by small and medium enterprises to give an advantage for this category of manufacturers in terms of improving the efficiency of operations [1].

The ERP systems have been gaining importance and popularity as a technological solution because of the complexity of processes and the big increase of global competition in the last decades [2]. In terms of operations management, that is the focus of this work, ERP systems are basically an evolution of the MRP (Material Requirement Planning) and the MRP II (Manufacturing Resource Planning) in more functions, such as, equipment, labor, financial capital, marketing, sales, etc. ERP integrates the management processes and the business processes providing a global vision of the organization.

Nowadays, organizations are under many pressures, e.g., global competition, fast changes in the behavior of the customers, technological innovations, among others, and these pressures create an uncertainty environment that affects the production planning. Koh and Saad [3] defined uncertainty for these cases

as an unpredictable event that disturbs the production process in a manufacturing system that is planned by MRP, MRP II or ERP.

In this context of global competition, necessity of increase the efficiency of supply chain management and uncertainty caused by many factors was created the Demand Driven Material Requirements Planning (DDMRP). This recent method focus on manufacturing and distribution flows and it is supposed to deal with uncertainties better than traditional MRP.

This paper has a literature review of the use of MRP and ERP systems under uncertainty, a review of the demand driven supply chains and a review of DDMRP, focusing on the possible adoption of this method for SMEs.

2. Literature Review

ERP and MRP in SMEs

The capacity of ERP systems to manage companies' resources efficiently and effectively by providing an integrated solution for its information processing needs has persuaded not only large organizations, but small and medium sized firms about the importance of these systems as well [4], [5]. One of the main boosters for the emerging trend of implementation of ERP systems by SMEs is the necessity to compete in Business-to-Business and Business-to-Consumer markets. To compete in these markets MRP/ ERP systems play an important role in production planning and scheduling [6].

The cost to implement these systems is high and difficult to justify by a SME. The most important criteria for the decision to implement or not an ERP system by a SME is the total cost, including implementation, purchasing and service & support [1]. Moreover, many advanced features, e.g. material allocation used in conjunction with production planning in ERP have not been explored and SMEs use ERP mainly for its finance and accounting functions [6], [7].

Most of SMEs never think to implement ERP due to high costs and the long time to implementation [7]. Just recently SMEs began adopting ERP systems in their daily operations. SMEs have an important role in economy and ERP systems can be a solution to improve their productivity and overall business performance [8].

To meet these needs of SMEs, lower cost and simpler functions, many midrange and less complex systems have been developed e.g. Alliance/ MFG - Exact Software, MFG/PRO - QAD, WinMan - TTW and All-in-One - SAP. Besides that, many companies combine the software with others production planning and controls techniques, such as Just-in-Time (JIT),Optimised Production Technology (OPT) and finite capacity scheduling to control the flow of materials and manage utilisation of resources. This combination suggests that MRP and ERP are good for planning but are not so good for control and they are susceptible by uncertainty [6].

Uncertainties in ERP controlled Environment

A study with a survey and interviews concluded that ERP systems can create a competitive advantage in delivery for SMEs by promoting more agility to change, but not to uncertainty. SMEs generally use their ERP system to create a plan for production and use it as a guideline. To deal with the uncertainty the small and medium enterprises use a range of buffering or dampening techniques for creating a competitive advantage in delivery [9].

In this study the authors identified seven causes of uncertainty in Make To Stock (MTS) strategy: insecure stores, customer changes delivery lead-times, internal design changes during/after planning, MRP plan overload (infinite scheduling of labour), planned maintenance/repair time exceeded, waiting for labour, and seeking concession. In Make To Order (MTO) strategy there are thirty causes of uncertainty such as, problems related to supplier delivery performance, customer or demand changes, resources (labour, machine and material) availability, design changes, schedule control rules, quality issues, and post-production. And in the Mixed Model (MM) there are five main causes: insecure stores, customer changes delivery lead-times, MRP plan overload (infinite scheduling of labour), waiting for labour, and seeking concession [9].

To tackle uncertainty caused by external demand and external supply was developed a framework to dampen the system nervousness caused by these factors. The framework proposes the use of safety stock, safety capacity, safety lead-times and rescheduling to tackle these problems in the ERP controlled environments [10].

Demand Driven Supply Chain

The Demand Driven Supply Chain can be defined as a network of systems, technologies and business processes that detect and respond to demand signals in real time, through a network of customers, suppliers and employees [11]. This type of supply chain needs to be agile with the ability to respond quickly to changes in demand for both volume and variability of products [12].

Owing to these characteristics, many companies are trying to shift to Demand Driven strategy, they do it by changing from a build-to-forecast to a build-to-order discipline. Demand Driven Supply Chains are the ones that derive information for production and inventory decisions from the real time demand, not the demand forecasted [13].

There are limits to each company reach the build-to-order strategy, but many companies don't access their potential to be demand driven. There is a systematic effort with three elements that can be used to raise the "demand driven" level [13]:

i. Shortening process lead time;
ii. Adopting flow model economics;
iii. Replace forecasts with demand.

DDMRP

"Demand Driven Material Requirements Planning (DDMRP) is a formal multi-echelon planning and execution method to protect and promote the flow of relevant information and materials through the establishment and management of strategically placed decoupling point stock buffers." [14]. DDMRP has six pillars based in conventional methods as shown in figure 1 [14].

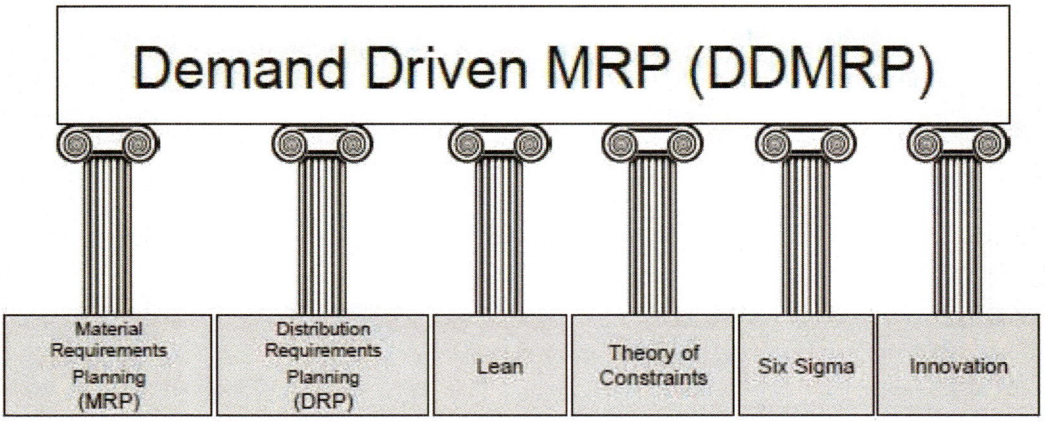

Figure 4: The methodological foundation of DDMRP [14]

DDMRP has five sequential components to be implemented [14]. Figure 2 shows this sequence of components.

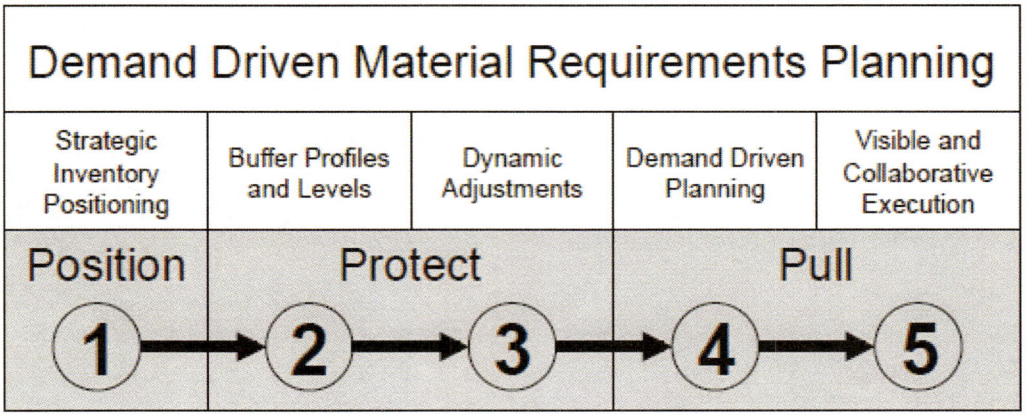

Figure 5 - The five components of DDMRP [14]

The first step is the positioning of strategic inventory, it evaluates if there are benefits to position or not a buffer of articles of the Bill of Materials. The functions of these buffers are launch replenishments and control the dispersion of variability (supply, operational, demand and management). After the buffers are positioned the next step is "Buffer Profiles and Level". A buffer is replenished according to the "Available Stock Equation" (ASE) that is the inventory position minus qualified spikes. Qualified spikes are large demand orders that need to anticipate production lead time, therefore, made on demand. The ASE is compared to three buffer levels alert: red (safety stock), yellow (average quantity of in process replenishment) and green (replenishment size). When ASE enters in yellow zone a replenishment order is done to reach the green level [15].

The next step is the "Dynamic Adjustments", it refers to the buffers' level and it is made according to the formulas (1), (2), (3), (4), (5), (6).

$$\text{Green Zone} = \text{Max (Yellow Zone x Lead Time Factor; Lot Size)} \quad (1)$$

$$\text{Yellow Zone} = \text{ADU x ASRLT x PAF} \quad (2)$$

$$\text{Red Zone} = \text{Yellow Zone x Lead Time Factor x (1 + Variability Factor)} \quad (3)$$

$$\text{Top of Red} = \text{Red Zone} \quad (4)$$

$$\text{Top of Yellow} = \text{Top of Red + Yellow Zone} \quad (5)$$

$$\text{Top of Green} = \text{Top of Yellow + Green Zone} \quad (6)$$

Average Daily Usage (ADU) is the result of demand forecasting. ASRLT is the longest unprotected sequence (considering a sum of lead times) in the bill of material of a buffered article. As previously stated, buffers control variability, the unprotected sequences are considered between articles with buffers [15].

PAF (Plan Adjustment Factors) are percentages used to raise or lower ADU. It enables to model and smooth large seasonal variabilities and promotions. Variability Factor is used to protect from uncertainties, it is a part of the Red Zone and represents the safety stock. Lead Time Factor is different for long or short lead time products, when ASRLT is long the Lead time Factor is small. When all DDMRP zones are defined, planners and operators can decide on quantity to replenish (in plan view) and orders to prioritize (in execution view) [15].

Figure 3 shows the buffer zones and purposes.

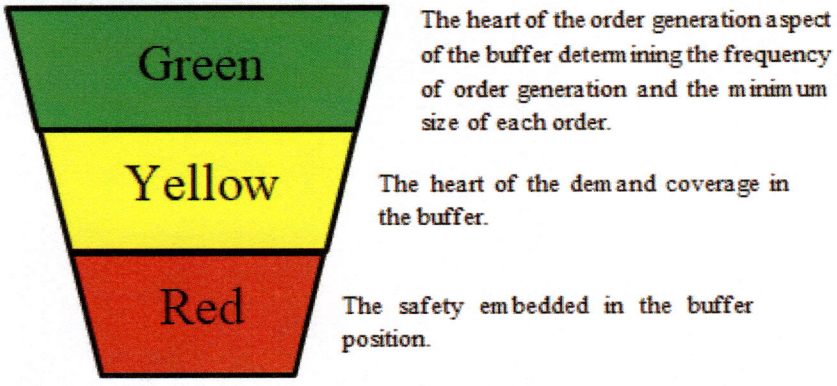

Figure 6 - Buffer zones and purposes [14]

3. Discussion

As shown in the literature review, DDMRP is a recent method created to deal better with uncertainties than the traditional MRP that is a method highly used in companies to manage the production. Over time, with the advancements of Industry 4.0, Internet of things, Big Data and Cloud Computing the possibilities of implementing an ERP system in SME are increasing.

Currently, many ERP providers are offering the possibility to implement the system with servers based outside of company by the use of cloud computing. As discussed before, the main reason of SMEs don't consider implement ERP is the high cost of the system, but with these advances there is a tendency of dropping the prices of these software. Besides that, with simpler options of the system, companies can choose just functions that they need.

Big Data's possibilities increase the potential of sharing information throughout supply chain and this can be used by companies to meet the demand in real time or reach higher levels of responsiveness. Besides that, enterprises can use this information to update the data for DDMRP. Industry 4.0 creates more responsive processes with technological advances, such as, automatizations and 3D Print. This can be used by companies to become more "demand driven" and work together with DDMRP.

Many ERP providers are seeing the potential of this new method and have embedded DDMRP's features and functionalities in their systems, such as: SAP, SabeSoft, LillyWorks, Agilis, IFS, SPX and Efficent.io. Other ones are in process of adaptation.

Some studies were made to test DDMRP comparing to MRP, they used simulation to assess the benefits of DDMRP over MRP. One of them submitted DDMRP to many uncertainty causes and concluded that this method reach the same level of on time deliveries with less working capital and less nervousness [15]. Another study, by simulation, confirmed that DDMRP deals better with variation in demand than MRP and it provides a better inventory management [16]. The last study consulted demonstrated that the lack of buffering control in traditional MRP causes instability and DDMRP manage better this situation than MRP [17].

So, based on the literature review and the simulation cases studied, it is possible to affirm that DDMRP is a potential method to be used by SMEs. As it is known, this kind of company has more difficult to deal with losses caused by instability or uncertainties, commons in Demand Driven Supply Chains, and DDMRP emerged as a possible solution to manage the operations of companies in this supply chain.

4. Conclusion

This study contributes to increase the knowledge of DDMRP and discuss its adoption by SMEs in the context of Industry 4.0. One limitation and suggestion for future works is to do a real case study to evaluate DDMRP in a real company that faces these challenges and compare with traditional MRP, as only simulations were found in the literature a case study would be a great contribution.

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