MATERIAL MANAGEMENT WITHOUT FORECASTING IN FLEXIBLE MANUFACTURING SYSTEMS

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Abstract:

Purpose: **Efficient Operations and Supply Chain Management is key to building sustainable competitive edge for companies. However, the achievement of this goal is becoming challenging in the present dynamic production environment, as traditional Manufacturing Planning and Control systems were not developed to work in this context. The Demand-Driven Material Requirement Planning (DDMRP) methodology was developed with the aim of addressing this need and deal efficiently with material management. The present work therefore, analyzes the implemented changes and the subsequent qualitative and quantitative results of a company after converting from MRP to DDMRP.**

Design/methodology/approach: **To achieve an in depth understanding of the case study a qualitative approach was taken. Data was collected from semi-structured interviews, documents and archival records enabling triangulation. The results from before and after the implementation of DDMRP were compared, and the evolution of the performance of the company was evaluated.**

Findings: **The results clearly show that using DDMRP the company increased visibility in the supply chain. In addition, the inventory level was reduced by 52.53% while material consumption was increased by 8.7%. These results were achieved while maintaining the high service level.**

Originality/value: **DDMRP is a relatively new methodology and for this reason there is little published data in this field. In addition the few studies found in the literature analyze the performance of DDMRP in simulated environments. The present work aims to go one step further and analyzes the implementation of DDMRP in a real company.**

Keywords: **DDMRP, inventory level, visibility, MRP, forecast, uncertainty**

1. Introduction

In the 1960s, the primary competitive thrust for companies was cost, therefore manufacturing strategy was based on high-volume production, cost minimization, and stable economic conditions. However, the market changed between 1960 and 1980, with quality becoming a primary element of competitivity . What mattered in the 1980s was the ability of suppliers to create or adapt new products and services on a timely basis to meet specific customer needs.

This new reality required a dynamic production environment where products, processes and production schedule could change frequently. Thus, companies were under pressure to lower total costs in the entire supply chain, shorten throughput times, drastically reduce inventories, expand product choice, provide more reliable delivery dates and better customer service and improve quality to achieve competitive advantage.

Barney and Clark (2007) defined competitive advantage as economic net value gained; either greater profits were obtained at the same cost in comparison to competitors, or profits were the same as those of the competitors but produced at lower cost. Many authors have analyzed competitive advantage: Jones and Riley (1985) asserted that to reduce the inventory level keeping or improving customer service level led a positive differentiation against competitors. Inventory and operating expense as operational measures that directly are related to the Return on Investment performance measure of a company.

2. Overview of Main MPC Systems

2.1. MRP

APICS (2016: pp. 110) defines MRP as "a set of techniques that uses BOM data, inventory data, and the Master Production Schedule (MPS) to calculate requirements for materials. It makes recommendations to release replenishment orders for material".

2.2. JIT

At first glance, the JIT system appears to be an efficient MPC. Nevertheless, according to many authors, a JIT production system is sensitive and susceptible to variation in demand because it operates without buffers.

2.3. TOC

TOC is a holistic management philosophy based on the principle that complex systems exhibit inherent simplicity. Every system has at least one constraint that limits the ability to generate more of the goal of the system.

2.4. DDMRP

Considering the present highly volatile and variable manufacturing environment where planning scenarios are more complex than ever, a demand-driven manufacturing strategy is necessary. The goal of this strategy is to compress LT and align efforts to market demands. This includes careful synchronization of planning, scheduling and execution with material consumption. Such a strategy encourages companies to centralize the demand instead of the inventory. Thus they are able to sense and adapt to market changes, becoming more agile

DDMRP is composed of five phases (Figure 2). The first three phases define the initial and evolving configuration of the DDMRP model. The fourth and fifth define the operational aspects of the DDMRP system, which are planning and execution.

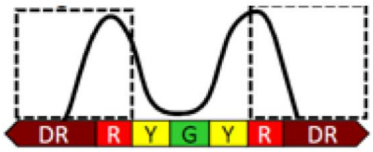

Figure 1. BI-MODAL distribution of inventory

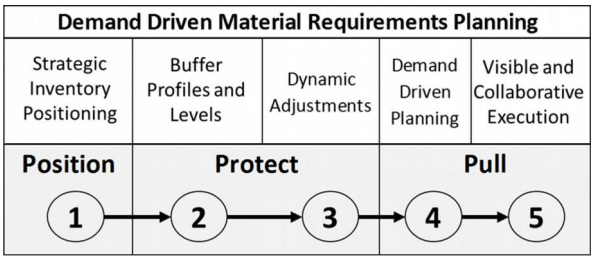

Figure 2. The five phases of DDMRP

DDMRP defined color-coded buffers composed of 3 zones where each zone has a specific function as set out in Figure 3. To size each zone factors such as DLT, Average Daily Use (ADU) and Minimum Order Quantity (MOQ) are considered.

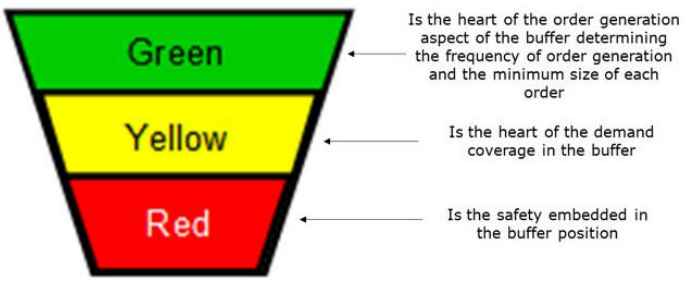

Figure 3. Zones of the buffer

- Dynamic Adjustments: Supply chains must be ready to adapt to volatile markets and provide the best service to the customer. This requires the use of dynamic buffers to be able to adjust to new requirements. For this purpose, DDMRP provides dynamic adjustments that define buffer level fluctuations based on operating parameters, market changes, and planned or known future events

3. Objective of this Research Study

A number of studies have been found in the literature which indicate that DDMRP manages material efficiently (Lee & Jang, 2013, 2014; Rim et al., 2014; Ihme, 2015; Ihme & Stratton, 2015; Miclo et al., 2015; Miclo, 2016; Shofa & Widyarto, 2017; Miclo et al., 2018). However Ihme (2015) and Shofa and Widyarto (2017) stated that few studies have scientifically proven the performance of DDMRP. Miclo et al. (2018) also pointed out the need for further research to uncover more aspects of DDMRP in terms of its value to manufacturing organizations.

4. Methodology

The approach chosen for this case study was exploratory and descriptive, and followed a qualitative research strategy (Robson, 2002). The unit of analysis was a single case study, analyzing the implementation of DDMRP in a real company (Yin, 2009).

5. Case Study

In this section the company where DDMRP was implemented is introduced, and the reasons for implementation are explained. Then, critical points that prevented material and information flow are set out. After that, the DDMRP implementation is summarized and finally the qualitative and quantitative results are presented.

5.1. Introduction

This case study is based on a company that was established in 1948. They started business as a padlock manufacturer and the growing reputation of the brand, encouraged the company to widen its product range. Today, this company is leader in the Spanish locksmith market and provides sales coverage throughout Spain and more than 50 countries worldwide. Approximately 85% of total sales are national customers while the rest are international.

5.2. Critical Points that Reduced the Flow of Materials and Information in the Supply Chain

When consultants in collaboration with Mondragon Unibertsitatea began analyzing data to implement DDMRP in the company they found operational situations that were directly affecting the flow of materials and information. These situations are set out below.

5.2.1. High On-hand Inventory Level

The suppliers of CS1 were from China. Due to the weight and final price of the end products, CS1 transported the goods in containers by boat. Moreover, to optimize the transport cost, the company purchased in large batches. A final important point to note is that CS1 purchased material before the required date to deal with supply variability.

To plan purchase orders, the Purchasing and Planning Manager (PPM) used demand forecast. However, this forecast was seldom met. To manage this uncertainty CS1 required high SS level so as not to suffer from a stock-out and to maintain a high service level.

5.2.2. Planning Purchase Orders Once per Month

Prior to DDMRP, CS1 planned material purchases once a month for a period of one month. Thus, with an average purchasing LT of 3.5 months, the PPM planned the material requirements of a month, 3.5 months in advance.

The company planned once a month due to the work involved. To identify material requirements, the PPM had to feed a manually programmed spreadsheet through the ERP.

5.2.3. Lack of Visibility to Manage the References of the Same Family

CS1 purchased goods from many suppliers with certain providers supplying more than one type of good. These suppliers defined a common MOQ that had to be filled by the total amount of references belonging to the same family. In other words, the purchased quantity of different references of the same family needed to be greater than the common MOQ.

5.2.4. Fully Dependent Purchasing Process

Only one person was dedicated to the task of planning material requirements, the PPM, and only this person had required information to carry out this task. The rest of the staff of the company had no knowledge of the process, the criteria to plan orders or the status of the on-order materials, since this information was not easily available in the ERP.

5.3. DDMRP Implementation in CS1

The implementation of the 5 steps of DDMRP in CS1 is set out below.

5.3.1. Strategic Inventory Positioning

Considering the supply chain of CS1, the strategic position of the inventory that enabled decoupling the company from supply and customer demand variability was identified as the inventory of Goods (Figure 6). The company already had inventory in this position and thus no further action was required in this step.

5.3.2. Buffer Profiles and Level Determination

To define buffer size the DLT, the ADU and the MOQ of the references to be stored were identified, analyzed and validated. After that, the buffers were sized. To this end, new fields were developed in the ERP of the company to record the new attributes such as ADU, red, yellow and green levels of the buffers of each reference.

In this step the family code to which each reference belonged was also defined. In this way, references belonging to the same family could be filtered out and thus made visible when a joint purchase was carried out.

5.3.3. Dynamic Buffers

In this step the recalculated adjustment was scheduled, so that the buffers were adjusted based on changes to individual part attributes.

5.3.4. Demand Driven Planning

After configuring the supply chain in a DDMRP environment, CS1 began planning using new methodology. The information required to plan supply orders such as the demand of each reference within a LT, the ADU, the LT, the MOQ, the on-hand inventory, open supply orders, and the red, yellow and green zones of each references was exported daily from the ERP into software that managed DDMRP (R+).

5.3.5. Highly Visible and Collaborative Execution

This step manages the tracking of the orders launched in the previous step to ensure supply within the expected dates and avoid stock-outs due to unexpected delays.

When a launched order was delayed and did not meet the due date an execution alert was triggered. Hence, the PPM could contact the supplier of that particular reference and take the necessary measures to avoid a future possible stock-out.

5.4. Results Achieved after DDMRP Implementation

The implementation of DDMRP in CS1 involved a change in material management. These changes delivered qualitative and quantitative results that are explained below.

5.4.1. Qualitative Results

Prior to DDMRP implementation, CS1 relied on forecasts to launch purchase orders. However, forecast demand and real demand did not match and the company used SS to cover this mismatch, and thus maintain a high service level.

Using DDMRP criteria to manage inventory and plan material requirements brought about changes.
compromising service level.

5.4.2. Quantitative Results

In this Section, a global analysis of 579 references belonging to the Goods cluster was carried out. This involved studying the evolution of the total consumption, total on-hand inventory and total coverage stock. Considering the long LT of the references, the analysis was conducted over a period of 11 months, which allowed us to see several inventory turnover performances.

With the aim of doing a more in-depth study, the most consumed family was independently analyzed. This family was composed of 23 references. First a general analysis of the whole family was done, where the total ADU, total on-hand inventory and total coverage stock was studied. Then, to see the evolution of the references in detail, the most consumed three references were individually examined. The amount of three references was considered enough to carry out this analysis, as it allowed us to see if the global pattern was repeated in the references with the highest consumption.

Global analysis:

The total ADU of the 579 references analyzed during the 11 months after implementing DDMRP increased on average by 8.7% (Figure 8). This means that in general, the consumption of goods increased in the analyzed period of term. In a striking contrast, the on-hand inventory of this sample showed the opposite trend line, as it on average decreased by 52.53% (Figure 4)

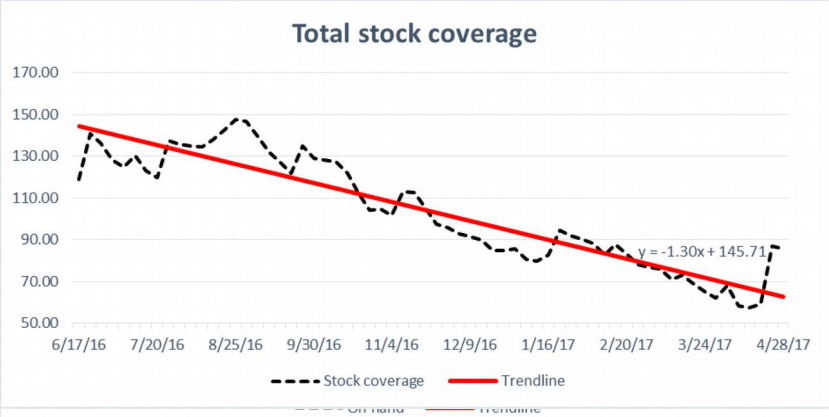

Figure 4. Evolution of the total stock coverage of 579 references belonging to the Goods cluster

The evolution of the total stock coverage of these references also decreased by 56.71% as set out in Figure 10. Therefore, after DDMRP implementation the inventory turnover of these references increased. The coverage stock was calculated dividing the total on-hand inventory by the total ADU.

6. Discussion

The main conclusion of this study is that as a result of the implementation of DDMRP, CS1 improved its operational measures resulting in competitive edge improvement.

DDMRP reduced the uncertainty and increased material and information flow through the supply chain enhancing the visibility of CS1. The following points show how the company increased its visibility.

- Following DDMRP criteria to manage material decoupled CS1 from supply and demand variability. Uncertainty was therefore considerably reduced and CS1 was able to adjust its inventory to the real demand without the need for high levels of SS. CS1 had inventory placed in the Goods cluster before DDMRP implementation, however it was managed according to MRP criteria making it unfeasible to adjust inventory level to real consumption while maintaining the service level.
- CS1 increased planning frequency from monthly to weekly. Thus, the status of the references were controlled more frequently and the company noticed earlier when a reference required an action. Weekly planning prior to DDMRP was unattainable due to the considerable investment of resources required.
- Grouping and visualizing references in families allowed CS1 to carry out strategic purchase orders filling the common MOQ established by the suppliers. This resulted in purchase optimization, preventing the purchase of large amounts of inventory that were not required.
- The planned adjustments allowed CS1 to continue serving customer orders during the downtime of the suppliers. These adjustments resized the buffers preventing the purchase of excess material as well as stock-outs. In addition, once the suppliers resumed normal working hours, the buffers were again resized to that situation.

After DDMRP implementation, CS1 adjusted its inventory to the real demand of the customer. This adjustment translated into a significant reduction in the average on-hand inventory, while the average ADU grew in the analyzed time period, resulting in substantial reduction of the coverage stock. A similar pattern in coverage stock

7. Conclusions

Efficient Operations and supply chain management is key to achieving a sustainable competitive edge, and over the years many systems have been developed to manage this process. One such system is MRP which predicts and guesses consumption to plan material requirements. The present dynamic production environment however poses significant challenges to this approach as it was not designed to work in this context. Therefore, a new alternative approach is required.

In 2011 DDMRP was developed to improve on the shortcomings of the existing MPC systems by protecting the supply chain from variability and dealing efficiently with the material management issue. This study analyzes a real implementation of DDMRP in a company that previously was using MRP. It contributes to the gap in the literature identified by a number of authors who cite the necessity for real world case studies.

The outcomes of the case study clearly show that using DDMRP the company changed material management, resulting in higher visibility in the supply chain. Furthermore, the inventory level saw a significant reduction while material consumption increased. This was achieved without any reduction in the high service level of the company. Miclo et al. (2018) concluded that "there is something noticeable and worthwhile in DDMRP". The results achieved in this work support this statement and are in line with the theoretical studies about DDMRP cited in the present paper.

More work will be needed to increase awareness of DDMRP. To this end it would be interesting to analyze more implementations in different sectors, as it would verify to what extent DDMRP improves logistical factors of companies while providing a competitive advantage.

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