Università
Ca' Foscari
Venezia

**Department
of Management**

Working Paper Series

Daniela Favaretto and Alessandro Marin

**An empirical comparison study
between DDMRP and MRP in
Material Management**

**Working Paper n. 15/2018
December 2018**

ISSN: 2239-2734

This Working Paper is published under the auspices of the Department of Management at Università Ca' Foscari Venezia. Opinions expressed herein are those of the authors and not those of the Department or the University. The Working Paper series is designed to divulge preliminary or incomplete work, circulated to favour discussion and comments. Citation of this paper should consider its provisional nature.

Working Paper: An empirical comparison study between DDMRP and MRP in Material Management

DANIELA FAVARETTO
<favaret@unive.it>
Dept. of Management
University Ca' Foscari Venice

ALESSANDRO MARIN
<alessandro.marin@unive.it>
Dept. of Management
University Ca' Foscari Venice
Qantica srl (PD)

December 2018

Abstract *The objective of the following paper is to clearly outline the types of Manufacturing Planning and Control systems (MPC) that have characterized the last hundred years, but which are affected, in terms of functionality, the characteristics of the contexts and the decades in which they were designed. This led to the need to devise a new planning and control approach called Demand Driven Material Requirements Planning (DDMRP) that does not create a clear detachment from previous methodologies but takes the characteristics of each that is more suited to the current volatile and complex context. In this paper, the fundamental characteristics of the approach will be reviewed and the methodology that will be followed in the future implementation will be presented.*

Keywords: DDMRP; MRP; TOC; PLANNING; CONTROL

JEL Classification Numbers: M11 Production Management

MathSci Classification Numbers: 90-00

Correspondence to:

Daniela Favaretto	Dept. of Management, University Ca' Foscari Venice Cannaregio 873 30121 Venezia, Italy
Phone:	[++39] (041)-234-6936
E-mail:	favaret@unive.it

Contents

1	Introduction	1
2	The Route towards the DDMRP	3
2.1	Where All started: Before the <i>MRP</i>	3
2.2	Material Requirements Planning (<i>MRP</i>)	4
2.3	Just in Time (<i>JIT</i>)	4
2.4	Theory of Constraints (<i>TOC</i>)	5
3	Demand-Driven Material Requirements Planning (<i>DDMRP</i>)	5
3.1	DDMRP: An introduction	5
3.2	DDMRP: The methodology	6
4	Objective of the empirical study	8
5	Conclusion	9

1 Introduction

The high degree of dynamism in the environments where companies operate and the ever-increasing dissemination and ease at approaching global sourcing mean that the management of supply chains is considered a critical and primary element on which to concentrate large efforts in order to manage them in an effective (in terms of service level) and efficient (in terms of cost) manner. For this reason, distinct typologies of Manufacturing Planning and Control systems (*MPC*) are used to support business decisions, systems that have not been able to evolve throughout the years, still maintaining a correct fit with the context that *MRP* may have had in the 1950/60s when it was conceived. Despite this, *MRP* is unquestionably the most common management system for requests and the one used by the vast majority of structured companies, even though we are beginning to hear more and more insistently about an innovative system called Demand Driven Material Requirement Planning (*DDMRP*). This methodology was created to solve problems that the traditional *MPC* systems encounter, incorporating the features characteristic to each one of these problems. Some assessments of its benefits were made mostly based on simulations and less on applications in the field, but still a lot of work will be necessary to understand how the system responds when confronting problems characteristic to each specific sector or context with specified criteria, as compared to the traditional approach, that in this case will be the *MRP* and is the one we will use in the scope of this work.

A strictly quantitative approach will be used to analyze the results, as a qualitative approach is not needed since we are directly involved in the implementation of the new system and can thus obtain all the necessary information about the context directly. The quantitative side will entail the comparison between the performance of the two systems. This may be on the same data by having both use the same software within the same

timeframe, or by comparing the performance of the previous year in a context where the request had features that correspond significantly to the current request.

Although the implementation is just beginning to develop, we already have a clear idea of the results that may be produced during this research. The first result we expect to achieve is tied to the reduction of inventory costs at an expected range of 30-40%. This result should be read in conjunction with two other expected results in order to be considered as a positive result, that is in conjunction with a consumer service level expected at 97-100% and a compression of lead time ([22], 2017; [18], 2016); [19], 2018).

The *DDMRP* methodology requires further analysis of its performance in real contexts, after the positive results that we have obtained in simulations in predetermined contexts ([9], 2015; [10], 2018). Any analysis that will be done in the context of specific sectors can be useful in clarifying the performance of the *DDMRP*, but also to define its limits. A comparative study of the performance of the *DDMRP* and the *MRP* was made using data from a company operating in Indonesia in the automotive sector by M. J. Shofa and W. O. Widyarto in 2015. The analyzed data refer to an extremely short time frame, or 4 weeks, in the period March-April 2015. In order to draw robust conclusions regarding the performance, it would be optimal to analyze a longer period and understand how both the software behave as the characteristics of the environment ([22], 2015).

The paper is organized as follows:

In Section 2 we show chronologically the most used Manufacturing Planning and Control systems that characterized 1900, then in Section 3 introduce and then deepen a new approach to planning and control. This approach, being new, needs to be tested in several possible sectors to define its potential, its limits and to limit the application contexts and it is the object that will be clarified in detail in Section 4. Finally, conclusions will be drawn in Section 5 that briefly anticipate the expected results in future implementations.

2 The Route towards the DDMRP

The objective of this chapter is to retrace the fundamental steps from the first studies of Frederick W. Taylor on the standardization of processes, passing through the invention of the first planning and control systems between 1950 and 1960. Each methodology seeks or makes up for the deficiencies of the previous one, as in the case of the Just in Time philosophy, referring to the problem linked to an excessive quantity of stocks or trying to solve the same problem from another point of view, as for the Theory of Constraints ([24], 1914).

2.1 Where All started: Before the *MRP*

To understand how we have come to the proposal of a new planning system, it is first necessary to clarify the starting point and the initial evolution of the systems, for thereafter to explore the conventional planning system called *MRP* (Material Requirements Planning). During the twentieth century many, ever more advanced, contributions for the development of the planning and control systems followed each other, especially in the United States where the rate of development increased exponentially in the second half of twentieth century ([15], 1994). The first substantial attempt to improve the manufacturing processes and the productivity of factory workers is due to the creator of Scientific Management, Frederick W. Taylor. His main studies regarded the definition of standardized procedures in a manufacturing reality dominated by inefficient procedures tied in particular to the use of labour methodologies and instruments not agreed upon ([24], 1914). Furthermore, before Taylor's contribution, relevant and objective methods to determine how long an activity should take did not exist and the majority of entrepreneurs used past experiences as a point of reference ([7], 1980). Taylor's contribution was initially not understood or appreciated fully from his contemporary writers ([7], 1980). His concepts were later picked up and applied by Henry Gantt, Frank and Lilian Gilbreth, and Harrington Emerson ([3], 1919; [4], 1919; [5], 1911). In 1934, R. H. Wilson understood that the world had changed, noticing that demand had become volatile and difficult to predict, which is what is happening today ([18], 2016). In his contribution titled "A scientific routine for stock control" R. H. Wilson demonstrated how statistics could be used in the planning of requests and could represent an amortization thus reducing the impact of prediction errors with regards to demand, reducing the possibility of ending up in stockout and improving the level of service while also reducing the quantity of stock. Wilson's contribution provided the basis for literature regarding the management of stock, literature that was initially focused only on the management of materials independently of demand ([26], 1934).

In that period, the contributions that fuelled the relevant literature were focused on two macro terms: the identification of the amount of stock to purchase or produce and the identification of the Re Order Point (*ROP*), that is the level of stock beyond which an order for the purchase or production of a specific material is issued ([8], 2007). Until that moment though, the techniques that were presented suffered from a strong imperfection due to the necessary approximation present in the models and the lack of advanced technological support, based often on hypothesis far away from operative reality and concepts

forced to allow for the applicability of theory ([16], 2011). From 1950 and on everything changed. Computers, both with regards to hardware and software, were commercialized and entered into manufacturing companies. This innovation rendered some of the methods and systems described above obsolete, updated others and promised the creation of new ones. The manufacturing companies identified as pioneers in the use of applications tied to the management of requests had to make a strategic choice: either to renovate the existing procedures (the statistical approach) adapting them to new applications, or create new ones. This latter option was the riskier one because it foresaw the relinquishment of previous techniques to welcome a radically different approach that the advent of the computer had made possible. In this field the innovation that met with great success was that of Joe Orlicky, an innovation that we now know under the name of *MRP* (Material Requirements Planning) ([12], 1975).

2.2 Material Requirements Planning (*MRP*)

An *MRP* system is defined by *APICS* (American Production and Inventory Control Society) as “a set of techniques that uses bill of material data, inventory data, and the master production schedule to calculate requirements for materials. *MRP* makes recommendations to release replenishment orders for material” ([14], 2016). Since *MRP* is an instrument that takes into consideration temporal horizons, it advises the rescheduling of orders that are already ready open if the delivery date results beyond the predetermined temporal horizon. The Master Production Schedule (*MPS*) represents what the company wants to produce and purchase, expressed in a precise configuration, date and quantity. It is important to highlight that the *MPS* does not make predictions, but they represent an important input in the planning process. It takes into consideration capacity constraints, production cost, as well as sale and production plans only in terms of volume defined at a superior level, also called *S&OP* ([6], 2011).

In summary, the *ROP* system is oriented towards the management of individual parts, while material requirements planning is oriented towards the product. The first uses historical data relative to the performance of demand, isolating the behaviour of a certain component from that of other components, even if they are part of the same product. The *MRP* uses a radically different approach as it is oriented toward the future thanks to the support of *MPS*, and furthermore works with specific data put in relation among each other, thanks to a distinct base that defines the relationship between the components ([12], 1975).

2.3 Just in Time (*JIT*)

Between 1980 and 1990, in parallel to what is presented above, an ulterior approach to the management of needs was defined and developed by Toyota called Just-in-Time (*JIT*). *JIT* refers the tendency to produce the smallest number of separate units, at their smallest quantities possible, as close as possible to the moment the order is made while trying to conduct your own activity without the use of a warehouse, from where the concept of zero inventory ([1], 2010). This practice, that later became a proper philosophy, was born of the

necessity to take on an ever-more pressing time to market caused by the reduction of client tolerance time. The level of service expected, that is the ability of the company to satisfy requests within the timeline and with the products desired, is not the same as it used to be years ago. The old model of operation did not allow for the fulfillment of needs of an increasingly more dynamic and impatient market. For this reason, companies have begun to adopt the philosophy of Just-in-Time and create partnerships with suppliers to remain competitive ([23], 2007). This entails also a change in mentality in the everyday of companies, as they can no longer focus only on what happens within the walls of the company, but have to collaborate with other companies with the aim of creating a collaborative supply chain ([11], 2002; [13], 2013; [21], 2001).

2.4 Theory of Constraints (*TOC*)

The *TOC* is part of that branch of studies called Continuous Improvements (*CI*) that developed in the early 90s, the result of an evolution of OPT (Optimized Production Timetables). As for the Lean methodology, this can also be defined as a cross-functional approach that involves not only the functions closely related to Operations ([20], 1998). Systems are defined as a series of interdependent processes and the *TOC* focuses on improving these. Thinking at the supply chain in terms of systems and a set of interconnected processes, the *TOC* focuses on identifying those processes that slow down or prevent the system from flowing towards the common goal ([25], 2007). This is because the main assumption that is made is that these steps, part of an interconnected path, being slower should dictate the times for all the others. They define this station and the buffer are positioning upstream this station with the purpose to feed it every time ([2], 2010).

3 Demand-Driven Material Requirements Planning (*DDMRP*)

The objective of this chapter is to describe the “Demand-Driven Material Requirements Planning” (*DDMRP*): an introduction and the methodology.

3.1 DDMRP: An introduction

In order to manage the flow of materials moving within the company, nearly all companies adopt either a push policy, where *MRPII* is the most common method, or a pull policy, where the Lean approach is one of the most commonly used. Depending on the type of demand that must be satisfied, the type/quantity of materials that are treated and especially the philosophy that is decided to embrace, one of the many methods is used to meet one’s needs. The premises on which the *MRP* was designed and built are no longer relevant, because the characteristics of the supply chain have changed significantly since the 1960s. In those years, the dynamics were governed by a stability that is no longer existing today. The current context is characterized by high complexity and volatility, which has led to an increasing gap between the circumstances under which the *MRP* was designed and those under which it is being used now. The transition from a deterministic to a stochastic environment has led to an increase in lead times, a reduction in the customer tolerance zone to

a minimum and a compression of the product life cycle that makes long-term forecasts even more ineffective. The attempt to better manage capabilities and resources has led to the loss of confidence in the results obtained from the processing of *MRP* software; therefore, the manual intervention is carried out by exporting data and making own considerations in this regard, causing problems of transparency and scalability, but above all an increase in the margin of error. If we consider a warehouse made up of a large number of components managed with a traditional MRP system, it is very common to find oneself in the situation represented in Figure 1.

Source: [18], 2016

Figure 1: Typical Bi-Modal Distribution

The Figure 1 clearly shows where this oscillation occurs, which is a physiological characteristic of MRP systems. This happens when planning systems based on traditional demand forecasts, where safety stocks are used and a run on a weekly basis of the MRP is planned. Whenever the MRP is executed the planner will find himself in a situation where some parts will belong to the “right” bell other than the left one and will have to spend a lot of time to make up for this problem, even with the use of alternative shortcuts like highlighted previously. This oscillation is also called “system nervousness” and is characteristic of every MRP system; furthermore, if we think of a supply chain where every actor contributes from upstream to downstream and vice versa. This oscillation create what is called “the bullwhip effect” or “Forrester effect” that we will explain in the following paragraphs ([18], 2016).

To face the new challenges that the context raises, we must equip ourselves with new tools that allow us to face them in the best possible way and that are able to adapt to the need of companies to be as resilient as possible. To meet these requirements Carol Ptak and Chad Smith have designed a tool that acts as a hybrid form between the two aforementioned trends, called *DDMRP* “Demand-Driven Material Requirements Planning” ([18], 2016).

3.2 DDMRP: The methodology

DDMRP is a method through which we can model, plan and manage the supply chain by protecting and promoting the flow of relevant materials and information through the positioning and management of stock buffers positioned at strategic decoupling points. The *DDMRP* combines typical aspects of Material Requirements Planning (*MRP*) and Distribution Requirements Planning (*DRP*), also incorporating key aspects of Lean and

TOC (Theory of Constraints) approaches such as visibility and pull logic. Position, protect and pull these are the three words that best summarize the whole methodology, without forgetting the flow, the mainstay and ultimate goal of all operations. The *DDMRP* consists of 5 sequential elements:

- **Strategic Decoupling:** as a first operation, decoupling points are positioned in strategic points considering both the internal structure of each product and the entire supply chain. This allows to stop the proliferation of variability both downstream and upstream, to compress the lead time, to render the planning horizon independent and shorter. This is not allowed in *MRP* logics because there is a dependency logic that, forcing long-term planning horizons, creates and feeds a phenomenon of system nervousness ([18], 2016).
- **Buffer Profile and Levels:** this step creates levels to absorb shock at the decoupling points and reduces variability. Buffer levels are determined using a unique mix of information that includes forecasts, historical data and data derived from the *DDMRP* methodology. Each buffer is composed of three distinctive zones, each zone has different objectives and is calculated in a specific way as represented in Figure 2. This provides immediacy and transparency in the vision of stock positions that cannot be achieved with *MRP* (*MRP* is designed to be a tool that only indicates the perfect quantity to be ordered at a precise time). Moreover, we need to clarify the enormous differences between a *DDMRP* buffered item and the Safety Stocked item used in the *MRP* method ([18], 2016).

Source: [18], 2016

Figure 2: Different composition of buffer levels

The Safety stock is defined by the *APICS* Dictionary 15th as: a quantity of stock planned to be in inventory, to protect against fluctuations in demand or supply. In the context of master production scheduling, the additional inventory and capacity planned as protection against forecast errors and short-term changes in the backlog. Over-planning can be used to create safety stock ([14], 2016). The definition clarifies immediately what is the purpose of the safety stock in the *MRP*, i.e. to be an

additional part, to find a solution to the mismatches that may exist between current demand, planned orders and supply orders. A different speech must be made regarding the items buffered with the *DDMRP* method, since they are no longer considered as a tool for managing the mismatches, but as a strategic element designed to reduce the variability between the demand and the supply, and to compress the lead time. We can consider it a strategic element, because it prevents the creation and the propagation of the bullwhip effect, and acts as a tool for prevention.

- **Dynamic buffer adjustment:** after setting the initial levels of strategic buffers, the *DDMRP* approach allows you to protect the buffer levels by adapting them to internal and external changes. Therefore, there will be levels of strategic buffers that will be dynamic and no longer static. These adjustments also allow to avoid the risk of having a strategic stock out buffer when needed ([18], 2016).
- **Demand driven planning:** in the *DDMRP* methodology, planning is the ability to generate supply orders, in order to do this the methodology uses its own simple but effective algorithm. Thanks to the structure created in the previous points, the algorithm allows to carry out supply orders using only sales orders linked to a short time horizon. The use of sales orders does not foresee a complete provisioning of long-term forecasts, but these are reclassified in terms of decisions ([18], 2016).
- **Visible and collaborative execution:** when the *DDMRP* methodology refers to execution, this means the management of supply orders that are open or that will have to be executed. Thanks to clear and precise signals, it is possible to identify which priorities require attention. The lower the strategic buffer level, the higher the priority assigned. This implies a radical change from *MRP* logic as it moves from prioritizing delivery dates to prioritizing dates driven by buffer levels. The underlying logic is always that of flow maintenance ([18], 2016). The use of *DDMRP* enables the companies that use it to have an optimal stock level, at the selected decoupling points, without the worrying of having too much or too little material at the time when it is needed. The case studies related to the application of this methodology are several and the average benefits observed are of great interest. The main thing missing is an detailed academical study regarding the different performance between the *MRP* and the *DDMRP* approach.

4 Objective of the empirical study

Our purpose will be to investigate in order to measure and assess how perform the different approaches, *MRP* and *DDMRP*, in an Italian *SME* (Small and Medium Enterprise). A strictly quantitative approach will be used to analyze the data collected on the field, as a qualitative approach is not needed since we are directly involved in the implementation of the new system and can thus obtain all the necessary information about the context directly. The quantitative side will entail the analysis of the behavior of the *DDMRP* approach and the comparison with the performance of the previous system used. This may

be on the same data by having both use the same software within the same timeframe, or by comparing the performance of the previous year in a context where the request had features that correspond significantly to the current request.

5 Conclusion

The purpose of this paper is to lay the foundations of the most quantitative work we are going to do in the following months. First of all, it was necessary to provide a clear reconstruction of the approaches that have been created to solve the problem of managing needs to understand why the need to use a new methodology has emerged to date. The reconstruction was necessary also because this new methodology is a daughter of all the previous ones. The following sections presented the key aspects of the methodology that we will follow faithfully during the implementation, highlighting the problem of the bimodal distribution of stocks that occurs with most of the previous approaches. Not only that, but we also wanted to highlight the change of paradigm in the structure of the stocks that are used as a remedy by a safety stock as a strategic element to be positioned with careful evaluation. The analysis of the following months will focus on verifying the performance of the new approach in terms of inventory reduction, compression of lead times and an increase in the level of customer service ([18], 2016; [19], 2018).

References

- [1] Chiarini, A. (2010), “Lean organisation for excellence. Hoshin Kanri, Value Stream Accounting, Lean Metrics e Toyota Production System nel mondo manifatturiero e dei servizi: Hoshin Kanri, Value Stream Accounting, Lean Metrics e Toyota Production System nel mondo manifatturiero e dei servizi”, Franco Angeli, Milano.
- [2] Cox III, J., Schleier, J. (2010), “Theory of Constraints”, Handbook, McGraw-Hill.
- [3] Emerson, H. (1919), “Efficiency as a Basis for Operation and Wages.” Engineering Magazine Co, New York.
- [4] Gantt, H. L. (1919), “Organizing for work”, Harcourt, Brace and Howe.
- [5] Gilbreth, F. B., Kent, R. T. (1911), “Motion study”, Constable, London.
- [6] Jacobs, F. R., Berry W. L., Whybark, D. C., Vollmann, T. E. (2011), “Manufacturing planning and control for supply chain management”, McGraw-Hill.
- [7] Locke, E. A. (1980), “Locke, E. A. (1980). The Ideas of Frederick W. Taylor: An Evaluation”, University of Maryland.
- [8] Mabert, V. A. (2007), “The early road to material requirements planning”, *Journal of Operations Management*, **25**, **2**, 346–356.

- [9] Miclo, R., Fontanili, F., Luras, M., Lamothe, J., Milian, B. (2015, October), “MRP vs. demand-driven MRP: Towards an objective comparison. In Industrial Engineering and Systems Management (IESM)”, 2015, International Conference on Industrial Engineering and Systems Management (pp. 1072–1080), IEEE.
- [10] Miclo, R., Luras, M., Fontanili, F., Lamothe, J., Melnyk, S. A. (2018), “Demand Driven MRP: assessment of a new approach to materials management”, *International Journal of Production Research*, 1-16.
- [11] Nave, D. (2002), “How to compare six sigma, lean and the theory of constraints. Quality progress”, American Society for Quality, Quality Progress **35**, **3**, 73.
- [12] Orlicky, J. (1975), “Material requirements planning”, McGraw-Hill, New York.
- [13] Packowski, J. (2013), “LEAN Supply Chain Planning: The New Supply Chain Management Paradigm for Process Industries to Master Today’s VUCA World”, CRC Press.
- [14] Paul H. Pittman, J. Brian Atwater (2016), “APICS Dictionary Fifteenth Edition”, APICS.
- [15] Plossl, G. W., Orlicky, J. (1994), “Orlicky’s material requirements planning”, McGraw-Hill.
- [16] Ptak, C., Smith, C. (2011), “Orlicky’s Material Requirements Planning 3/E”, McGraw-Hill.
- [17] Ptak, C. A., Schragenheim, E. (2016), “ERP: tools, techniques, and applications for integrating the supply chain”, CRC Press.
- [18] Ptak, C. A., Smith, C. (2016), “Demand Driven Material Requirements Planning (DDMRP)”, Industrial Press, Incorporated.
- [19] Ptak, C., Smith, C. (2018), “Precisely Wrong: Why Conventional Planning Systems Fail”, Industrial Press, Incorporated.
- [20] Rahman, S. U. (1998). “Theory of constraints: a review of the philosophy and its applications”, *International Journal of Operations and Production Management*, **18**(4), 336-355.
- [21] Rother, M., Harris, R. (2001), “Creating continuous flow”, Lean Enterprise Institute, Brookline.
- [22] Shofa, M. J., Widyarto, W. O. (2017, June), “Effective production control in an automotive industry: MRP vs. demand-driven MRP”, AIP Conference Proceedings **Vol. 1855**, **No. 1**, p. 020004. AIP Publishing.
- [23] Sugimori, Y., et al., (1977), “Toyota production system and kanban system materialization of just-in-time and respect-for-human system”, *The International Journal of Production Research* **15.6**, 553–564.

- [24] Taylor, F. W. (1914), “The principles of scientific management”, Harper.
- [25] Watson, K. J., Blackstone, J. H., Gardiner, S. C. (2007), “The evolution of a management philosophy: The theory of constraints”, *Journal of operations Management*, **25**(2), 387-402.
- [26] Wilson, R. H. (1934), “A scientific routine for stock control”, Harvard University.