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DEMAND DRIVEN MRP: LITERATURE REVIEW AND RESEARCH ISSUES

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ABSTRACT: *The Demand-Driven Material Requirements Planning (DDMRP) is a recent approach focusing on planning, production and inventory management that is invented to manage uncertainties demand in the VUCA environment. Nevertheless, there is a lack of literature review in this field and only a few studies have scientifically proven the performance of DDMRP but not much has been academically validated yet.*

In this paper, we survey the state-of-the-art research of DDMRP. A literature review is used to identify DDMRP contributions that discuss in recent methods and focuse on production planning and flow distribution.

The final goal of our work research is to objectivize the reality of the DDMRP benefits, to discuss the contradictions and inconsistencies found in the literature, and to propose new opportunities and challenges that should be addressed by future research.

KEYWORDS: *Demand Driven MRP, Supply Chains, Operations Management, Production Management.*

1 INTRODUCTION

Efficient Operations and Supply Chain Management are important part of most businesses and applying the right strategy is essential for managers in competitive industries and markets. Different planning, management, and supply chain control systems are widely used in practice. However, these systems are difficult to optimize, especially in a VUCA “Volatility, Uncertainty, Complexity, Ambiguity” environment (Bennett, N. and G. James Lemoine, 2014).

In this context, this paper presents a preliminary analysis of the traditional methods of planning and execution of the production MRP (Material Requirement Planning), and Demand Driven MRP. So, this analysis will enrich the research environment and encourage Moroccan Industries to implement new methods in their manufacturing process.

This study was motivated by the opportunities that the DDMRP approach was not exploited to its full potential by researchers. Therefore, the main contribution of this paper is to provide a comprehensive literature review of DDMRP during the last 10 years, which shows a significant increase in research work published in this field. Also, this new classification aims to enhance our ability to discover important knowledge in this literature, to identify any new trends in this field, and to highlight any gaps that would benefit from future research efforts.

This work was mainly based on the book "Demand Driven Material Requirement Planning" by Carol Ptak and Chad Smith, inventors of this method, to develop this literature review (Ptak, C. and C. Smith, 2018).

The paper is organized as follows: In Section 2, we present the « Research methodology » used in this topic. Then in Section 3, we show the « Literature review » of the main Manufacturing Planning and Control (MPC) System in operations management. Section 4 « Critical Analysis and Discussion » presents an analysis and discussion about the most prevalent DDMRP aspects. Finally, the conclusion will be drawn in section 5.

2 RESEARCH METHODOLOGY

The literature review is a usual method to investigate thoroughly different approaches to the research subject. Literature review usually aims to identify and evaluate the current state of the art of research on the field and then, to classify the relevant articles so as to identify possible gaps, issues, and opportunities for further research. To do this, this work aims to explain the similarities and differences between conventional methods such as MRP and the new DDMRP approach. This work highlighted the lack of studies in the literature review on this approach. Starting from this lack of knowledge, we conducted a literature review to collect and critically analyze all relevant research in the field of DDMRP and provide directions for a possible model.

The results of this discussion will generate new knowledge in the field of industrial engineering, operations, and supply chain management.

The process of analysis contains the main steps: defining unit of analysis, period of analysis, classification context, material evaluation and collecting publications, and delimiting the field. Following this process guarantees a structured and effective literature review. A summary of the method used is shown in Table 1, it was inspired by the method used by (Cherrafi, A. et al., 2016) in their literature review.

To capture evolution, two variables were selected:

First, number of articles published about a DDMRP's: we considered only papers that contribute clearly to the development of a DDMRP by a conceptual, simulations, empirical study or comparison with other systems. Therefore, papers that only cite the system were not considered in the evolution analysis.

Second, type of paper published: we classified the papers published about each system into axiomatic or empirical, following the classification of operations management papers proposed by (Bertrand, J. W. M., and J. C.Fransoo, 2002). This variable was important to further analyze how close are literature and practice regarding the new systems identified.

Unit of analysis	Relevant books, articles and theses published on the links among DDMRP and MRP from both professional and scholarly publishers. Unpublished working papers, non-English papers, and Demand Driven Institute articles / presentations were excluded.
Type of analysis	Quantitative and Qualitative documents were considered for this research.
Period of Publication	Period of analysis was from 2011 (the year of the publication of the first book) to 2019
Search engines used to search relevant publications	The databases chosen for the research were : Elsevier, Emerald, Springer, Taylor & Francis, and the Google Scholar database, or library services (e.g.Wiley online library, Ebsco, Scopus, Metapress, Subito)
Keywords to carry out the literature review	For the search criteria, the authors used a combination of the following terms: 1. DDMRP 2. Demand Driven MRP , Demand Driven Material Requirement Planning 3. DDMRP Approach, DDMRP Process, DDMRP Method 4. Literature Review
Main journals in operations management	International Journal of Production Research, International Journal of Operations & Production Management, Journal of Industrial Engineering and Management, International Journal of Production Economics
Select the exclusion and inclusion criteria to focus on relevant papers	The criteria used to select and evaluate the articles included: (1) exclusive focus on the DDMRP methodology, (2) inclusion of no other methodology, (3) publication in an academic journal or conference, (4) not being written for a terminal degree or master's degree, (5) the chosen articles included some case studies, both simulated and real. Taking the stated delimitations into account, a total of 23 relevant papers/ books were selected

Table 1: Summary of research protocol

Descriptive analysis

Figure 1 presents, an analysis of the distribution of publications per year across the period studied, to show the quantitative trend of research topics evolved over time. Figure 1 presents the year wise distribution of all 23 papers from 2011 to 2019. Although the starting point was appeared in 2011 as part of the research effort conducted by Ptak, C. and C. Smith. This year is the year of the publication of the first book of these authors. It can be deduced that the DDMRP topic has received and continues to receive greater attention from researchers.

With regard to the present time, it can be seen that there has been a significant growth in the interest shown in the DDMRP topic since 2018. The graphical representation indicates the increasing number of research articles published over the two last years of the period: 52% of the articles were published between 2018 and 2019. The year 2019 has the highest number (7) of published articles and the year 2018 has the second highest (6). Therefore, we can deduce that it is a domain of recent research, which may explain the lack of abundance of studies covering the discipline.

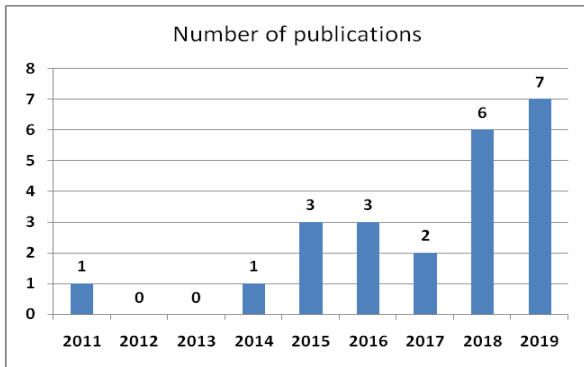


Figure1. Distribution of publications per year across the period studied.

3 LITERATURE REVIEWS OF MAIN MPC SYSTEMS

3.1 Material Requirements Planning: MRP

Material Requirements Planning (MRP) was the most widespread MPC system in the world as a push system. It has evolved into MRP II (Manufacturing Resource Planning) and ERP (Enterprise Resource Planning). It properly determines the components as well as the parts needed to satisfy the requirements of a product. APICS (2016: PP.110) define MRP as « a set of techniques that uses Bill Of Materials (BOM) data, inventory data, and the Master Production Schedule (MPS) to calculate requirements for materials. It makes recommendations to release replenishment orders for material.

However, many authors have analyzed MRP and identified some issues about this method. According to (Ihme, M. and R.Stratton, 2015), the MRP method had several problems, inaccuracy of the forecast/MPS, full BOM runs, manufacturing order release, limited early-warning functionality, lead-time ambiguity, unresponsive demand determination and lacking priority consideration. Likewise, Kortabarria (2018) have analyzed MRP and have concluded that it is not the best MPC system to deal with a volatile and variable world. Finally, MRP was designed for a typical 1970s manufacturing company: it has not changed since (Acosta, A.P.V. et al., 2019). Therefore, traditional MRP is not a suitable system in the agile environment.

3.2 Evolution of Supply Chain conditions:

The general market behavior has evolved in the last 20 years: more demand instabilities, more sensibility to crisis and economic events, more product diversity, increasing competition, reduced customer lead times and reduced time to market, etc (Miclo, M. 2015). These different parameters result in creating more variability in the MRPII production system and difficulties to establish accurate forecasts. Moreover, Material Requirement Planning is known to react nervously to demand changes being a source of the bullwhip effect (Ptak, C. and C. Smith, 2018) and causes a Bi-Modal stock level. Therefore, MRP re-

mains reliable in the absence of demand variables and peaks. MRP has limits with new market constraints. It is in this context that a new innovative approach appeared: the DDMRP.

3.2.1 Variability:

The four main DDMRP variability sources are identified by (Ptak, C. and C. Smith, 2011) as supply variability, demand variability, operational variability and operation time variations, and quality issues management variability shown on figure 2. These latter generate bullwhip effect and bi-modale distribution of inventory in the supply chain system.



Figure 2: Main variability sources (Miclo, R., 2016)

3.2.2 Bullwhip effect:

The bullwhip effect is the phenomenon of variability magnification as the view moves from the customer to the producer in the supply chain. For example, where orders to the supplier tend to have larger variance than sales to the buyer (i.e., demand distortion), and the distortion propagates upstream in an amplified form (i.e., variance amplification). The effect indicates a lack of synchronization among supply chain members.

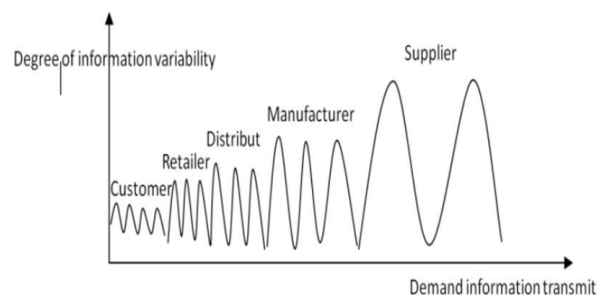


Figure 3: Schematic diagram of bullwhip effect (Jianhua, D., 2017)

3.2.3 Typical Bi-Modal Distribution of inventory:

Using a traditional MPC system, the stock level of a company presents a Bi-Modal distribution that switches between too much and too little stock resulting in high cost and a low level of service (Figure 4) (Ptak, C. and C. Smith, 2018).

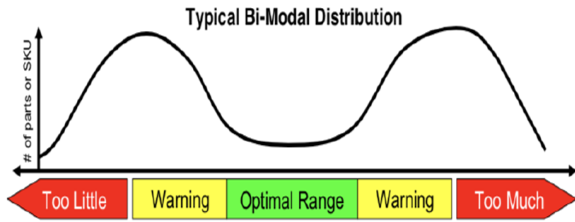


Figure 4: Typical Bi-Modal Distribution (Ptak & Smith, 2018)

3.3 Demand Driven MRP:

Given the current VUCA highly volatile and variable manufacturing environment where planning scenarios are more complex than ever, a demand-driven manufacturing strategy is required. This strategy aims to compress the deadline and align efforts with market demands. This includes careful planning, planning and execution synchronization with material consumption. Such a strategy encourages companies to centralize demand instead of storing. Thus, they can detect and adapt to market changes, to become more agile (Ptak, C. and C. Smith, 2011).

Taking into account this dilemma and the need for an MPC responding to a demand-driven manufacturing strategy, the DDMRP methodology was developed. DDMRP is the engine that generates and manages the supply orders for a demand-driven operating model (Ptak, C. and C. Smith, 2018).

DDMRP was created by Carol Ptak and Chad Smith at the start of the 21st century and was featured in the 3rd edition of Orlicky's Material Requirements Planning in 2011 (Ptak, C. and C. Smith, 2011) and the book DDMRP Demand Driven Material Requirements Planning (Ptak, C. and C. Smith, 2018). To face the current market problems, DDMRP brings together the advantages of well-known concepts drawn from MRP (Material Requirements Planning), DRP (Distribution Requirements Planning), Lean, Six Sigma and TOC (Theory Of Constraints) with some specific innovations (Figure 5).

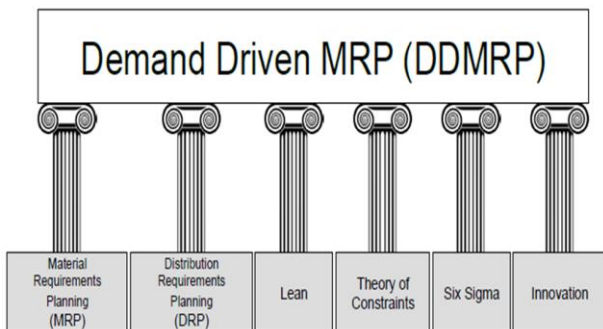


Figure 5: The six DDMRP pillars (Ptak & Smith, 2018)

DDMRP can be applied in three key areas: purchase (critical/long-term purchase), production (critical item manufactured, sub-assemblies, finished product, and

some critical items not stored), and distribution (finished product stocks). The DDMRP is composed of five phases (Figure 6). The first three phases define the initial and evolutionary modeling of the DDMRP model. The fourth and fifth phases define the operational aspects of the DDMRP system, which are planning and execution.

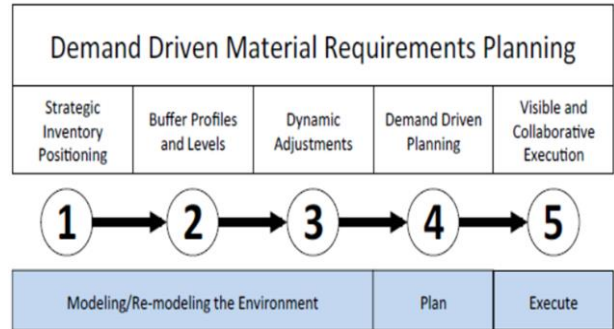


Figure 6: the 3 steps and 5 components to implement DDMRP (Ptak & Smith, 2018)

The following table 2 explains their characteristics (Ihme, M., 2015).

Component	Characteristics
Strategic Inventory Positioning	Ptak and Smith (2008) found that the question of how much inventory one should hold needs to change to asking where inventory should be positioned. It is necessary to protect the supply chain from fluctuating customer demand and supply variability. Inventory of raw and intermediate items can also help to compress cumulative lead-times and improve overall stability.
Buffer Profiles and Levels	Buffers are calculated for manufactured, purchased and distributed items. The calculation is based on the average daily usage (ADU), variability and lead-time. Furthermore, minimum order quantities are considered if needed. Ptak and Smith (2011) define three distinct buffer zones (green, yellow and red). Green stands for nothing to do; yellow indicates the rebuild or replenishment zone and red means special attention required.
Dynamic Adjustments	DDMRP considers recalculated adjustments, planned adjustments and manual adjustments within the model triggered by external events changing ADUs.
Demand Driven Planning	DDMRP separates parts into five distinct categories (replenished, replenished override, min-max, non-buffered and lead-time managed) and parts are allocated to one of the five categories according to their needs.
Visible and Collaborative Execution	DDMRP contains a sophisticated alerting system that circumvents the priority by due-date issue of classic MRP by establishing alerts based on buffer states while still considering due dates as a second source of information. Alerts are created based on the buffer state of the part in focus. Collaboration is needed to establish clear rules for decision-making based on these buffer states.

Table 2: five components of DDMRP

4 CRITICAL ANALYSIS AND DISCUSSION

Since the publication of this method, the research work done on the subject has been quite small. This section presents the review of 23 scholarly articles during 2011-2019. We identify titles, authors, years,

research methodologies, and the research contributions as shown in Table 3 to draw conclusions and identify some gaps and lines of research.

Table 3 presents the different research methodologies used by various researchers are divided into four types: conceptual, empirical, comparative, and exploratory (Dangayach, G.S. and S. G. Deshmukh, 2001).

N°	Title	Author(s)	Year	Methodology	Contribution to research
1	Orlicky's Material Requirements Planning	Ptak, C. and C. Smith	2011	Conceptual	The authors explain the DDMRP as an innovative multi-echelon pull methodology to plan and control inventories and materials
2	Strategic Inventory Positioning for MTO Manufacturing Using ASR Lead Time	Rim, S et al.	2014	Conceptual	Development of a Genetic Algorithm to optimize strategic inventory position for MTO manufacturing using ASR Lead Time
3	MRP vs. Demand-Driven MRP: Towards an Objective Comparison	Miclo, R et al.	2015	Comparative	A Case study was adopted to compare MRP and DDMRP using a Discrete-Event Simulation (DES) approach
4	Interpreting and applying Demand Driven MRP : A case study	Ihme, M.	2015	Empirical Study	Comparison between MRP and DDMRP using a simulation on a case study
5	Evaluating Demand Driven MRP: a case based simulated study	Ihme, M. and R. Stratton	2015	Empirical Study	A case analysis was used to determine the underlying reasons for the current performance and a simulation study designed to compare the impact of adopting DDMRP and MRP
6	Strategic Inventory Positioning in BOM with Multiple Parents Using ASR Lead Time	Jiang, J and S. Rim	2016	Conceptual	Development of a Genetic Algorithm to optimize strategic inventory position in BOM with multiple parents using ASR Lead Time
7	An empirical study of Demand-Driven MRP	Miclo, R. et al.	2016	Empirical Study	A Discrete-Event Simulation approach used to conduct an objective and quantitative comparison between DDMRP and MRP
8	Challenging the "Demand Driven MRP" Promises : a Discrete Event Simulation Approach	Miclo, R	2016	Empirical Study Comparative	Quantitative study challenging the promises of DDMRP following several simulations on two case studies
9	Effective production control in an automotive industry: MRP vs. demand-driven MRP	Shofa, M. J and W. O. Widyarto	2017	Comparative	Evaluation was conducted through a simulation using data from an automotive company in Indonesia
10	Strategic WIP Inventory Positioning for Make-to-Order Production with Stochastic Processing Times	Jiang, J and S. Rim	2017	Conceptual	Development of a Genetic Algorithm to optimize strategic inventory position make-to-order production with stochastic processing times
11	Effective production planning for purchased part under long lead time and uncertain demand: MRP Vs demand-driven MRP	Shofa, M. J et al.	2018	Comparative	The evaluation of MRP and DDMRP was conducted through a Discrete Event Simulation with the long lead time and uncertain demand scenarios
12	An empirical comparison study between DDMRP and MRP in Material Management	Favaretto, D and A. Marin	2018	Comparative	The fundamental characteristics of the DDMRP reviewed and the methodology of implementation presented
13	Modélisation UML des processus de planification MRP II et DDMRP : Analyse critique.	Laraje, N and S. L. Elhaq	2018	Conceptual	Development of the two methods MRPII and DDMRP using of a simulation model which is based on the UML language
14	Vers une cartographie de processus explicite pour le modèle Demand Driven Adaptive Enterprise	Martin, G et al.	2018	Conceptual	Development of a process model mapping model applied to the Demand Driven Adaptive Enterprise methodology
15	Material Management without Forecasting: From MRP to Demand Driven MRP	Kortabarria, A. et al.	2018	Empirical study	Analysis of the implemented changes of a case study and the subsequent qualitative and quantitative results of a company after converting from MRP to DDMRP.
16	Enjeux financiers de DDMRP : Une approche simulateur.	Bayard, S., and F. Grimaud	2018	Empirical Study	Analysis of the impact of DDMRP on the Working Capital Requirement using discrete event simulation
17	Inventory Management using Demand Driven Material Requirement Planning for Analysis Food Industry	Mukhlis, D. H. F et al.	2019	Comparative	Development of the DDMRP methodology and comparing before and after of the sauce industry material.
18	Demand Driven MRP: assessment of a new approach to materials management	Miclo, R et al.	2019	Comparative	Presented a comparative between DDMRP, Kanban/Lean and MRP II and evaluated it in a test environment

19	A Mathematical Safety Stock Model for DDMRP Inventory Replenishment	Lee, C. and S. Rim	2019	Conceptual	Development of a new mathematical formula for calculating safety stock and make a simulation to compare the new safety stock with the traditional method and the DDMRP method
20	Demand Driven Material Requirements Planning : some methodical and practical comments	Pekarciková, M et al.	2019	Empirical Study	Extend the knowledge base in the area of demand driven supply logistics in the context of Industry 4.0 and verify the processed theoretical knowledge in a case study
21	Compréhension du DDMRP et de son adoption : premiers éléments empiriques	Bahu, B. et al.	2019	Exploratory	Presents the practical functioning of the DDMRP method and to propose proposals concerning the reasons which seem to push companies to be interested in it
22	Decoupled Lead Time in finite capacity flowshop: A feedback loop approach	Dessevre, G. et al.	2019	Empirical Study	Defines a dynamic adjustment of the decoupled lead time, taking into account lead time variability. The results show that the dynamic adjustment of buffer sizes reduces stock while ensuring a good quality of service
23	Applicability of Demand-Driven MRP in a complex manufacturing environment	Acosta, A.P.V. et al.	2019	Exploratory longitudinal	Evaluated the applicability of DDMRP in a complex manufacturing environment (four level of nemonclature) in terms of customer satisfaction and the level of stock by simulation

Table 3: DDMRP literature review

The meaning of these research methodologies is given below:

- Comparative: comparison between two or more practices or solutions and the evaluation of the best practice or a solution (30%).
- Conceptual: basic or fundamental concepts of DDMRP (30%).
- Empirical: data for the study has been taken from an existing database, review, case study, taxonomy, or typological approaches (30%).
- Exploratory (cross-sectional or longitudinal) : the objective of the study is to become more familiar through survey, in which information is collected at one point of time (cross-sectional) or more points over time in the same organization (longitudinal) (10%) .

Since DDMRP is a new topic, so few researches related have been given. In previous works, many authors have worked with different methodologies and on different areas like reducing the lead time, optimizing the inventory level and satisfying the customer. It shows that a maximum number of publications (Ihme, M., 2015; Miclo, R. et al., 2016; Shofa, M.J et al., 2018; Kortabarria, A. et al., 2018; Miclo, R et al., 2019) have adopted the comparative and empirical study to compare and test the DDMRP with other methods like MRP, KANBAN and TOC using the simulation system.

Consequently, they seek to confirm the new concepts innovated by this approach to assess the benefits of DDMRP over other systems. While some studies developed a new model for the concepts of strategic inventory positioning to optimize it using a genetic algorithm (Rim, S. C et al., 2014; Jiang, J., and S. Rim, 2016; Jiang, J., and S. Rim, 2017). Lee, C. and S. Rim, 2019 have developed the mathematical model to propose a new safety stock model for DDMRP inventory replenishment.

As a conclusion, they recognize that their results do not show the unconditional dominance of DDMRP over MRP, Kanban or TOC, as the study is only made on a

limited number of environment conditions and only one case study. Nonetheless, on the tested perimeters, DDMRP shows interesting results because it gives superior results both in low and high variability conditions. However, some studies found that the DDMRP implementation strategy did not drive a significant improvement in manufacturing performance. Therefore, none of the available frameworks/models on DDMRP concepts of strategic inventory positioning provide a step-wise guideline or process to implement DDMRP in this first step.

Unfortunately, the interpretation is made on these steps and gives the choice to practitioners to decide where to position strategic buffers based on their experience.

Consequently, many of these decisions will have a large number of scenarios to each framework. This is perhaps the most undesirable effect of an empirical exploratory study in DDMRP. There is a strong need to converge these divergent views to some standard framework.

4.1 Steps of implementing DDMRP:

In this section, we will present the relevant components in DDMRP philosophy, Strategic Inventory Planning, Buffer Profiles and Levels, and Dynamic Adjustment, which are the main steps in DDMRP. These steps are modeling, planning, and managing the supply chains to protect and to promote the information flow of through the positioning and management of stock buffers positioned at strategic decoupling points.

4.1.1 Strategic Inventory positioning:

Strategic inventory positioning is the first step in DDMRP that considers where the inventory should be positioned to identify breakpoints, to reflect the four main of variability and to compresses lead time. Putting inventory everywhere is a huge waste of corporate resources. However, eliminating inventory everywhere puts the business and the supply chain at risk. Since the variability of supply and demand is the enemy of the flow.

DDMRP offers six positioning factors for positioning the inventory. At this step, we define a new concept of DDMRP, Actively Synchronized Replenishment Lead Time (ASRLT), also called decoupling points (Ptak, C. and C. Smith, 2018). Acosta (2019) highlights the importance of strategic buffer positioning and its effect on manufacturing performance within DDMRP. Related to the implementation process, Dessevre et al., (2019) proposes a dynamic adjustment of the decoupled lead time, taking into account lead time variability.

Nevertheless, many aspects of DDMRP are subjective and depend on the planner's judgment and consultant experience to decide where to position strategic buffers, to choose the LT percentage, variability percentage, buffer profiles, and the frequency of dynamic buffer re-adjustment (Acosta, A. P. V. et al., 2019; Miclo, R. et al., 2016). Consequently, The DDMRP appears not stabilized on these aspects (Bahu, B. et al., 2019).

Although, this issue namely, the Strategic Inventory Positioning (SIP) problem on the replenishment model introduced in DDMRP, has been studied by many researchers. Rim, S. et al., (2014) presents a model to determine the optimal position and quantity of WIP inventory for a given bill of material (S-BOM), in which any part in the BOM has only one immediate parent node. The authors use the actively synchronized replenishment (ASR) lead time and propose a genetic algorithm solution to solve this problem. According to the authors, this approach is suitable for a make-to-order manufacturing in which a large number of references can exist.

Likewise, Jingjing Jiang (2016) extended the previous study to the general BOM (G-BOM) in which parts in the BOM can have more than one immediate parent and propose a new solution method using a genetic algorithm. Furthermore, Jingjing Jiang (2017) addressed the problem with a stochastic SIP problem where processing times at the nodes follow a certain probability distribution. The authors presented a solution procedure for a simple BOM case using a genetic algorithm. However, DDMRP is a new approach, so few researches related DDMRP have been given to validate these studies on the other manufacturing environments.

4.1.2 Buffer Profiles and Levels:

This step of DDMRP is to determine the amount of protection at the buffers. Buffer inventory is composed of 3 zones: Red Zone (the safety stock), Yellow Zone (the mean in-process replenishment quantity), and Green Zone (the replenishment size).

Green Zone = Max(Yellow Zone.Lead Time Factor; Lot Size)

Yellow Zone = ADU. ASRLT .PAF

Red Zone = Yellow Zone. Lead Time Factor. (1+Variability Factor)

Top Of Red = Red Zone

Top Of Yellow = Top Of Red + Yellow Zone

Top Of Green= Top Of Yellow + Green Zone.

ADU (Average Daily Usage)

Lead time	Lead-time factor range
Long	20-40% of ADU over ASRLT
Medium	41-60% of ADU over ASRLT
Short	61-100% of ADU over ASRLT

Table 4: Guideline for lead time factor

Variability	Variability factor range
High	61-100% of Red-Base
Medium	41-60% of Red-Base
Low	0-40% of Red-Base

Table 5 : Guideline for variability factor

Although the buffers must be able to absorb different sources of variability (demand, supply, management, and operations) and guarantee profitability economically (Ptak, C. and C.Smith, 2018), they do not include the supply variability factor in their dimension calculation. Safety stock (RZ) of DDMRP replenishment is a function of the lead time factor and variability factor as determined by the guideline (Table 4 and 5) (Ptak, C. and C.Smith, 2018). However, state that there is an excessively large deviation that can be obtained by the subjective choice of the factors, so that the performance will be naturally inconsistent (Lee, C, and S. Rim, 2019).

4.1.3 Dynamic Adjustment:

Dynamic adjustment is to adjust the buffer profile to adapt company production planning to a dynamic environment. There are three types of adjustment: recalculated adjustment, planned adjustment, and manual 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 avoiding the risk of having a strategic stock out buffer when needed (Ptak, C. and C. Smith, 2018).

Plan Adjustment Factor (PAF) is percentage used to raise or lower the DDMRP strategic buffer size. They enable modeling and smoothing big seasonal variabilities, promotions. There are three plans adjustment factors: DAF (Demand Adjustment Factor), ZAF (Zone Adjustment Factor) and LAF (Lead time Adjustment Factor). Hence, there is a non-scientific method to calculate this factor of dynamic adjustment that must take into account operating parameters, market changes, and planned or known future events.

4.2 Promises benefits and improvements of DDMRP:

According to the Demand Driven Institute (DDI) that was founded in 2011 by Carol Ptak and Chad Smith, the DDMRP model promises benefits and improvements in the company that implement it. The DDI has shown that the companies choosing DDMRP had the following results in Table 6:

Benefit	Typical Improvements
Improved Customer Service	Users consistently achieve 97-100% on time fill rate performance
Lead Time Compression	Lead time reductions in excess of 80% have been achieved in several industry segments
Right-sizes Inventory	Typical inventory reductions of 30-45% are achieved while improving customer service

Table 6: Typical Improvements by DDMRP (Demand Driven Institute)

Those results will be compared with the different papers that will be analyzed in the state of the art of this work: table7

Author(s)	Paper	Year	Service Level	Lead Time	Inventory level	Others benefits
Miclo, R et al.	MRP vs. Demand-Driven MRP: Towards an Objective Comparison	2015	Unknown	Unknown	Reduced between 21% and 26%	Less Working Capital and less satisfying OTD
Ihme, M.	Interpreting and applying Demand Driven MRP : A case study	2015	Unknown	Unknown	Reduced high and low inventory alerts by 45%	Reduced stock outs by 95%
Ihme, M. and R. Stratton	Evaluating Demand Driven MRP: a case based simulated study	2015	Unknown	Unknown	Reduced high and low inventory alerts by 45%	Reduced stock outs by 95%
Miclo, R. et al.	An empirical study of Demand Driven MRP	2016	Unknown	Unknown	Unknown	Unsuccessful in satisfying the objective OTD less working capital (10%)
Shofa, M. J et al.	Effective production control in an automotive industry: MRP vs. Demand Driven MRP	2017	Unknown	Reduced by 94%	Unknown	No stock-out condition and improvement of the inventory level
Shofa, M. J et al.	Effective production planning for purchased part under long lead time and uncertain demand: MRP Vs Demand Driven MRP	2018	Unknown	Unknown	Reduced by 11%	
Kortabarria,A et al.	Material Management without Forecasting: From MRP to Demand Driven MRP	2018	Maintain the high service level	Unknown	Reduced by 52.53%	Material consumption increased by 8.7%
Dimas Mukhlis H. F et al.	Inventory Management using Demand Driven Material Requirement Planning for Analysis Food Industry	2019	Unknown	Unknown	Reduced by 53.5%	Material consumption increased to 10%
Miclo, M et al.	Demand Driven MRP: assessment of a new approach to materials management	2019	Unknown	Unknown	Unknown	Higher OTD Lower Average WIP
Lee, C. and S. Rim,	A Mathematical Safety Stock Model for DDMRP Inventory Replenishment	2019	Unknown	Unknown	lower inventory level	No Inventory shortage
Bahu, B. et al.	Compréhension du DDMRP et de son adoption : premiers éléments empiriques	2019	Increased between 14% to 99%	Unknown	Reduced between 30% and 60%	
Acosta, A. P.V. et al.	Applicability of Demand-Driven MRP in a complex manufacturing environment	2019	Unknown	Reduced by 41%	Reduced by 18%	

Table 7 : DDMRP performances

At the first glance, these results are shown by DDI, from many companies across a wide array of industries, encouraging other companies to adopt this approach. However, to gain objectivity, these results should be checked with a larger sample of companies. Furthermore, Bahu (2019) are trying to understand what DDMRP is and pinpoint why companies choose to implement DDMRP through 30 business cases. They confirm the same results promised by concepts of DDMRP in terms of customer service level and inventory reduction.

Likewise, it can be noticed that during recent years, the application of DDMRP in different types of industries is growing rapidly. Some of the organizations have reported huge benefits (Ihme, M. 2015; Ihme, M. and R. Stratton, 2015; Miclo, R et al., 2015; Jihan, M., 2017; Kortabarria, A. et al., 2018; Mukhlis, D. H. F et al., 2019; Acosta, A. P. V. et al., 2019), while many industries have not obtained the desired results (Miclo, R. et al., 2016; Miclo, R 2016; Miclo, R et al., 2019; Lee, C. and S. Rim, 2019).

Some of the literature recommended other studies, such a measurement of effectiveness in the aspect of the benefit-cost of inventory (Shofa1, M.J and W.O.Widyarto, 2017). Other authors (Kortabarria, A. et al., 2018) recommended analyzing more implementations in different sectors to improve logistical factors of companies while providing a competitive advantage. Miclo (2018) also pointed out the need for further research to uncover more aspects of DDMRP in terms of its value to manufacturing organizations.

As a conclusion, we recognize that these results do not show the unconditional dominance of DDMRP over others Manufacturing Planning and Control (MPC) System like MRPII, Kanban or TOC because these are limited numbers of academic studies and limited manufacturing and sector's environment. Nonetheless, on the tested perimeters, DDMRP shows interesting results because it gives superior results both in low and high variability conditions.

5 CONCLUSION

The Operations and Supply Chain Management fields are becoming more volatile and dynamic. Therefore, there is a need to adopt the new methods that manage efficiently the firms, protect and promote their materials and information flow to better deal with the new challenging environment demands.

DDMRP is an approach that includes a planning system managed by actual demand and a visible execution system that allows planners to react in real-time (Acosta, A. P. V. et al., 2019). The literature review on DDMRP is rare. However, the few studies have published the benefits of DDMRP philosophy promise outstanding results. The main objective of this study was to conduct a literature review to identify, classify, and analyze the DDMRP concepts and performance proposed by several academic researchers.

Based on the finding of this work, more studies will be needed to develop this literature review and to confirm objectively the benefits and disadvantages of this new approach. The outcomes of this work will give some direction of academic research and will encourage more industries to discover this new alternative manufacturing planning control system.

This study is the first to review the existing literature review on Demand Driven MRP during the period 2011 to 2019. It is also the first to extract theoretical elements to develop an integrated model. Also, this work aims to encourage research in the field of DDMRP performance and to stop researchers and practitioners from going off in unnecessary directions. Here, we highlight gaps in the existing literature as a basis for developing a research agenda.

One important limitation was the availability of papers published on this field and objectivity of some results.

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