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Supply Chain Transformation- through DDMRP approach

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Abstract

Supply Chain Management of today is witnessing unprecedented challenges due to extremely high dual-variability on demand and supply side. There is a two-side experience of either availability of items not needed in short term, or shortage of those needed immediately. Planners of today are moving from the conventional deterministic environment, push-based MRP approach to a scientific pull-based demand driven materials requirement planning (DDMRP)working in an unpredictable and realistic business environment, while maintaining the consistency of flow in operations.

Established in 2011, the main objective of DDMRP approach is to focus flow of operations, which automatically leads to keeping a check on the inventory levels and associated costs. This approach suggests identifying specific items at a specific strategic position in the manufacturing process for planning maintenance of flow. This involves a consistent watch on inventory buffer levels at just the levels that help in maintaining the flow and avoiding any operational disruptions.

Incomplete understanding of DDMRP approach makes industry practitioners consider it as a process to reduce inventory rather than as a process to improve flow. This paper examines the flow management under DDMRP approach for a supply chain transformation.

Keywords: DDMRP, inventory, buffer, flow, variability

Introduction

Traditional planning approaches evolved around the middle of last century (1950s), with the conception of Material Requirements Planning (MRP) as a planning tool. As computing capabilities developed, the acceptance and usage of MRP as a planning engine increased exponentially. The three main inputs to MRP calculations are the bills of material, real-time inventory status, and a production schedule to make the end item. Using these input data on quantity and time, an MRP engine calculates the required quantity of raw materials and components that are needed to produce the demanded quantities of end items, in the stipulated planning period.

The Question in Sight

The aforesaid mentioned mathematical MRP logic works best with an environment of stable demand and supply, assuming of course, that there is enough time to accomplish all mandatory activities to produce and deliver the end product. Hence, for an effective planning and execution, a planner needs a certain amount of time where the environment is relatively stable, during which planning and execution can take place. However, in today's VUCA world experiences ever shrinking time lines. Today's business environment is particularly characterized by situations that can rarely stable at both, demand and supply sides. Additionally, a competitive industry setup forces the manufacturer-supplier to race for faster time to market, as customers are no longer dependent on a single source of supply. Instead of addressing this gap, technological advancements / advanced computational capabilities have only accelerated the generation of erroneous outcomes. One such direct impact is to compute material quantities for order generation. The evidence of this comes primarily from observations on bimodal behaviour of inventory in business operations. More often than not, there is shortage of required inventory of one item on one hand, and on the other, abundance of unwanted inventory of a different item.

Two major contributing factors that work interdependently to due to demand and supply side variabilities and uncertainties, and those that give rise to a situation of bimodal inventory disbalances, are:

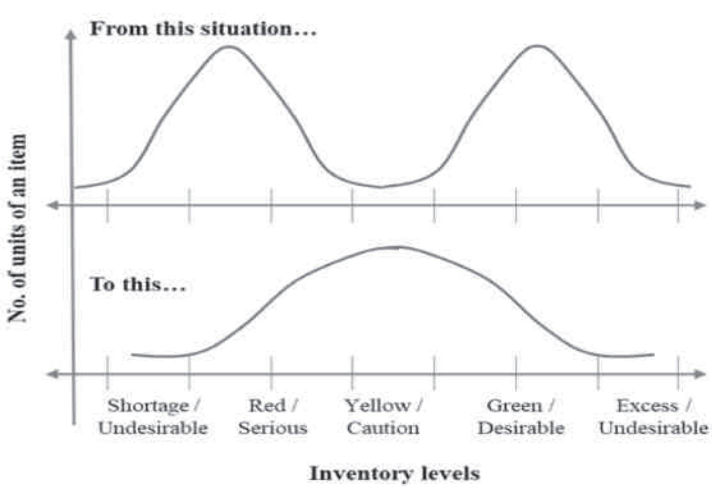
Estimating material requirement based on volatile demand estimations.

Meeting customer requirements, given the limited time to serve.

Demand Variability is the uncertainty of demand patterns from the customer/ market side. Supply Variability is the uncertainty at the supply side, which could be due to many-fold reasons like delay in material delivery, or part / full rejection of material at incoming quality inspection stage, or due to operational and delivery disturbances at the supplier side, or such other situations. Whatever be the underlying causes, such variabilities present a distorted and erroneous picture of demand-supply statuses, thereby impregnating the system with nervousness. Due to supply variability (in time and quantity), operations may initially experience scarcity of material; provoking the decision makers to expedite material delivery. Further, in the VUCA environment, customers have other options available to fulfil their requirement for the same product-service package. The uncertainty of the environment arises due to customers not willing to wait beyond a time, oftentimes influenced by the competition. Such situations give rise to the need to market faster, which translates to expedite the availability of raw material to quickly convert into the product-service offering for the customer, before the customer gets turned away.

A common scenario poses a great threat when even if one item from the product structure faces shortages, the entire production schedule gets impacted, adversely affecting the supply and delivery capabilities. Such distorted inputs of even one material item availability, and the consequent need to expedite the same, are considered by the MRP systems to calculate material requirement, offsetting the time by the lead times in question, magnified by the supplier agreed minimum order quantities. Upon receipt of this item's ordered quantity, inventory managers experience a sudden upsurge of the item's quantity levels, quickly swinging from a situation of scarce resources to one of an excess stock. This need to move from bimodal inventory behaviour to a near-to-normal distribution curve is depicted in Graph-1.

Graph-1. Bi-modal behaviour



The other question faced is that businesses today are unaware of the actual problem at hand. Hence, every operational manager who faces inventory management issues, is rarely able to devise the right solution. Inaccurate understanding the real underlying problem leads to arriving at incorrect solutions.

The Answer to the Questions

Around the year 2011, Carol Ptak and Chad Smith of Demand Driven Institute, Inc., USA, innovated and popularized the Demand Driven approach to plan material requirement to serve as a solution to the problem in hand. This Demand Driven Material Requirements Planning (DDMRP) approach focuses on how to maintain a consistency in operations by taking care of any hinderances due to shortage of excess stocks of an item needed in production. In the simplest terms, this involves identifying which specific items need consistent attention and how. Such identified items that may pose a potential threat of either stockout or overstock, are then 'buffered' in the right quantity, keeping a regular watch on their inventory levels and placing replenishment orders are the right time. The effectiveness of implementing this approach is in strategically identifying specific items for planning and to be able to decouple them from the rest of the system, so that interdependency does not result in creating nervousness to the entire system.

This paper looks at the need for such solutions approach to the age-old challenge faced by the Indian industry.

Discussion on the Demand Driven Approach

The essence of being demand driven is moving from the traditional forecasting-based planning to planning based on actual demand signals, and to be able to effectively adapt to changing circumstances. Any forecasting technique is inherently flawed, as no estimations can be considered 100% accurate. This, with its acceptable limitation, continues to be used for planning purposes, thus generating plan that vary suddenly from one planning period to the other, inculcating huge amounts of system nervousness. On the other hand, the actual demand numbers do not behave as a guess work. Demand based on actual numbers are closer to reality and hence serve as a better candidate for planning and execution purposes. Since the actual demand is expected to vary with each planning period, dynamic adjustments to production and supply order quantities needs to be incorporated in practice.

In order to achieve this, there is a need to identify those specificitems that potentially create a disruption in the manufacturing flow due to variabilities in demand and/or supply or due to customer's willingness to wait for deliveries. Such items need to decoupled from the preceding / subsequent process steps, so that the impact of variability can be curtailed at this level, by creating sufficient amounts of buffer that absorb variability.

The first step in demand driven planning is hence, to select a strategic inventory position of a chosen item. Various factors like the extent of demand/supply variability, time to which a customer (/segment) can tolerate (to wait to be serviced), critical item and/or a critical operation within the process, are considered to identify the strategic inventory position needed to be buffered. A critical item can be identified by looking whether the item is a shared component for different end items or the sub-assembly item is directly demanded by the customer (for example, as a spare part). Similarly, a critical operation in the process can be identified by looking the complexity of operation; like, need for highly skilled resource, load exceeding the capacity at a resource level, or such resource that tends to add variability to the process.

A low-hanging identification can be done for those items that are currently being safety-stocked, as the item would have demonstrated bimodal behaviour by exposing operations to situations of item abundance and scarcity at different times. More often than not, this is usually at the raw material and finished good stages, and less at any intermediate stage. This identification of item is more strategic a choice, than operational, because the location needs to be decoupled from the rest of the operation and aimed to perform independently in its sphere of influence. Such positions of decoupling are buffered with the right quantities so that the rest of the operations can proceed at an uninterrupted rate of flow. Thus, the demand driven approach enables continuity of flow of overall system by identifying, decoupling, and buffering specific item locations. This continues with a consistent watch for adjustments that may be required.

Decoupling Point and Buffers

Items can be buffered at raw material, finished goods or intermediate stages, or a combination of these. The decision to decouple an item position influenced by some factors that help to maintain the consistency of operational flow.

Decoupling is the process of separation, aka firewall that enables cutting off the dependency to absorb / cut off propagation of variability from both sides. A decoupling point thus acts as a variability collection point, considered as a position of independence to create independence between the supply and use of material, by putting in a buffer to act as a cushion at that decoupling point. A buffer helps decouple by absorbing from variability upstream to downstream to minimize bullwhip effect. This was not possible by using the traditional safety stocks, as it absorbed variability only either from the supply or from the demand side. That further explains why safety stock is typically put either at raw material stage or finished goods stage, and never anywhere in between operations. Buffer decouples the bull whip effect as they are placed either (1) between supplier and production, or (2) between two machines, or (3) at finished goods before distribution points. In that sense, instead of adding inventory all across, buffers add only the right kind of inventory at strategic points to ensure availability of inventory by controlling variability. The final impact is lowered aggregate inventory levels, immediate compression of lead time, and more reliable response time, resulting in improved ROI. The resulting lead time, called decoupled lead time (DLT), is the sum of all lead times of the longest chain on the unbuffered sequence in the product structure (BOM), between decoupled item locations.

Table-1. Inventory Decoupling Points

Where	**Why**
Buffering Materials (incoming from suppliers)	Suppliers represent the longest lead time, which can be reduced Supply variability is more, which can be better managed
Buffering Intermediates (in between operations)	Gives shorter lead times Gives better ROI
Buffering Distributed Items (at distribution level)	Absorbs more market side variability Shorter response time to market place

Thus, DDMRP helps (a) identify positions of independence, (b) protect the positions of independence, using appropriate buffer levels (and their adjustments), and (c) pull through generate and manage supply order. The identified locations create buffers in terms of item stock, time, or capacity. Buffers do not mean creating extra inventory throughout the manufacturing process; rather these create support production positions that enable a smoother flow of operations, eliminating (or at least, minimizing) chances of disruptions. How much buffer needs to be created is governed by the specific item's buffer profile.

There are three types of buffers to protect control points:

Stock Buffer – typically at product structure (BOM) level.

Time Buffer – with respect to an amount of time that allows to absorb variability in a string of resources.

Capacity Buffer – at the preceding resources that allows to make up for the variabilities.

These three types of buffers are interchangeable and interdependent regarding sizing and flow. Having a buffer capacity would require less time at operations, and vice versa. With more capacity and time availability, there is effectively less need of carrying inventory. Buffers of all types and at all locations, thus support each other, resulting in overall inventory reduction.

Buffer Zones and Profiles

As the first level of protection required to be built in for an item, its buffer profile helps define the amount of protection at the identified decoupling points. The next step is to define how the item consumption (or replenishment need) would vary with the varying demand signals, and adjusting the buffer levels dynamically. The buffer level depends mainly on factors like, per unit standard quantity consumed (also influenced by operational performance), minimum order quantity agreed with the supplying source, and the variabilities associated with demand and supply positions. Accordingly, the average periodic usage (usually, daily) of the item is determined to know how much quantity will be needed and in what time period.

Buffer management involves continuously determining the levels of buffer to be managed; maintaining only those levels that suffice to keep consistency in flow of operations. For instance, it is a matter of experience to decide on the variability factor for an item with respect to its demand and supply variabilities. Buffer levels are dynamically controlled by dividing each buffer level into three logical zones, determined by a way of scientific calculation. For an easy visual identification, Carol Ptak&Chad Smith defines these as red, yellow, and green zones. The levels of inventory preferably need to lie in the green zone to avoid disruptions in manufacturing operations by ensuring sufficient supplies at buffer positions for the purpose of maintaining a consistency of flow. These are arrived at by looking at following factors:

(a) Daily quantity required for consumption, calculated as an average over a period of time

(b) Decoupled lead time for the item being buffered

(c) Lead time variability factor to account for variability in lead time of supplies

(d) Minimum order quantity (MOQ) as agreed with the item's supplier

Based on these major factors, the size of each zone is calculated. The green zone determines the order frequency and the size of each order. It is the greater of the values of MOQ or the average daily usage over the lead time factor. Sometimes, other than the MOQ value, the item may warrant an average quantity needed over the order cycle agreed with the item's supplier. The yellow zone determines the quantity demanded during the time till the order is available for use (lead time). It is simply calculated as the quantity required for consumption per day times the decoupled lead time for the buffered item. The red zone (logically divided into two sub-zones), realistically desired, determines the safety in the buffer quantity. The two sub-zones are known as red zone buffer and the red zone safety.

All these zone levels have a direct impact on operational functioning. When the batch size changes, that results in increase of green zone and it takes more time for the inventory levels to touch the yellow zone level. However, changing yellow zone only changes the timing of ordering and not the frequency of ordering or the batch size of ordering. Similarly, increase in red zone safety increases the inventory and accelerate the ordering. As long as the item quantity remains within the green or yellow zones, there is no immediate need to release a supply order for replenishment. To calculate the amount of inventory to be ordered, DDMRP follows a typical, simple, and innovative calculation using a net flow equation; conceptualized, theorised, and advocated by Ptak, C, et.al, (2011).

Net Flow Equation = On-hand + On-order – Qualified Demand

The net flow equation gives a summary of in and out flow in operations on a daily basis. Since the individual components of the equation change dynamically during the day, it is calculated daily and dynamically, usually supported by DDMRP-complaint business solution systems rather than being controlled manually. The individual components of the simple equation are explained further as:

(a) On-hand inventory is the physical inventory in stock, and available for use.

(b) On-order is the ordered item quantity (in production or in purchase), but not yet received.

(c) Qualified demand is the sum of all sales order due as on date, past due, and any qualified spike.

(d) A qualified spike is the quantity of a single or group of orders, that goes over the threshold level identified within the decoupled lead time. It goes by logic that the spike threshold value lies within the total red zone value; because the green and yellow zones of the buffer are created for the purpose of being consumed, unlike a safety stock level, which is not supposed to be utilized in a flow-based system.

The goal is to keep net flow position in green zone to ensure consistency in flow of operations and for the purpose of identifying the order release point. Two rules emerge:

No order release is required as long as the Net Flow quantity remains within the Green Zone (indicating sufficient quantity to continue a disruption-free operational flow).

Supply order release takes place only if the Net Flow quantity falls below the Green Zone, that is, it is less than or equal to the Yellow plus Red Zone quantities (called, Top of Yellow or TOY position), indicating possible disruption in future, based on actual demand and supply situations.

In order to identify the order quantity, planners and purchaser need to look at the terms agreed with the item-supplier, and/or associated inventory policy. The criteria could be the agreed MOQ quantity or calculate the average daily usage of the item (based on past trend or future needs as per actual demand numbers). In case of lot-for-lot ordering, the order quantity needs to be the balance required to make inventory levels reach the top of green zone levels. This ensures maintaining the consistency of material availability, thus avoiding any operational disruptions, despite any level of variations on demand and supply side. Whenever the inventory levels drop down the defined threshold level, the approach incorporates alert mechanism to pre-caution the planners on the need to release supply orders.

Current state of DDMRP in Indian industry

Mogre's (2016) study of bullwhip effect on performance of manufacturing companies in Indore region lists major reasons of, and strategies to reduce bullwhip effect. These can effectively be translated into an industry-specific workable model that focuses on variability management, rather than elimination. Supply chain transformation can be achieved by following the operating model proposed by Ptak, Carol & Smith, Chad (2017) in their book on DDMRP, by focusing on actual demand-based planning approach instead of traditional forecast-based planning approach, which indicates more effective way to minimize bullwhip effect.

While the DDMRP concept is applicable across industry, an Indian industry-specific study can further help transform the way supply chains work, by narrowing down to an item's strategic positioning, protection of those positions by buffers, and an eventual execution of flow-based system. The current state in Indian manufacturing segment, especially as witnessed during pandemic times, is dominated by periodic MRP run based systems resulting in bimodal inventory behaviour as explained earlier in this paper. With respect to supply orders and timely material fulfilment needs, Indian businesses are marred with traits such as:

- reactive, inconsistent, and erratic buying behaviour, due to changes in demand signals
- inability to commit to spiked potential customer orders, or lack of confidence to do so
- dependency on unreliable computational capabilities with an expectation to lower inventory levels, using mrp-run systems as the sole calculation mechanism
- dependency on manually targeted inventory levels, driven by erroneous forecasted numbers
- infrequent and irregular payment of premium freight for supply orders
- carrying large quantities of irrelevant inventory, while facing shortage of a relevant inventory
- need to carry huge safety stock levels, as a means to meet material shortage situation, as a face-saving mechanism with the customer
- perceiving buffers as safety stocks, and vice versa; both resulting in higher levels of inventory
- spot buying to meet emergent situations by exploiting personal relationship with buyer for expedition
- supplier's inability to meet the spiked / irregular requirements
- unawareness of better ways of inventory management, especially to manage bimodal behaviour
- situational leadership skills to reactively tackle adverse situations

Conclusion and way forward

All such factors are a result of lack of (1) awareness and (2) adaptability of DDMRP approach. With awareness, adaptability can be visualized. Then once the buffer profile is applied at each buffered item, it can be dynamically updated based on net flow position, influenced by demand variability for the purchased and/or manufactured parts. Today's VUCA business environment also necessitates software systems to be upgraded to incorporate this approach, so that a real-time (daily) monitoring of buffer levels can be automated without an erroneous manual human intervention. Different industries in India experience different set of underlying variabilities in their demand and supply situations. But the overall desire is to ensure consistency of flow of undisrupted operations, despite controllable and/or uncontrollable reasons that give rise to disruptions. The full benefit of demand driven approach evolves over a period of time; the start point being educating the supply chain planners and executors on the innovative approach applicable specific to their business environment.

This paper provides an opportunity to look at specific Indian industries, their challenges, and the willingness to adapt the aforesaid described approach. Post industry's willingness, implementing DDMRP approach would warrant education to create awareness, enablement through right technological support, developing a simulation-oriented proof of concept, and management of associated risks.

Supply Chain goals are met by achieving a balance between customer value and financial value. For the customer to value the products and services that a business provides, and for the organization to itself remain profitable, the logical way is to develop organizational strengths and capabilities w.r.t its design, structure, processes, technology, and people.

The demand driven approach is adaptive, focused, and real time. This involves sensing changes in demand or supply levels, and then adapting the planning and production while pulling required quantities from the suppliers. The result is pacing of operations to the actual demand through strategic placement of decoupling points for lead time compressions, synchronizing the schedules by providing protection at the control points with material, time, or capacity buffers. Instead of sweating to eliminate variabilities, the new demand driven operating model (DDOM) acknowledges the existence of variabilities and aims to maintain and control an effective system flow supported by the right model design in concurrence with the concepts of MRP, Lean, or Theory of Constraints.

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