

Factors involved in successful implementation of Vendor Managed Inventory and their structural model

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Abstract: Currently many industries are adopting collaborative planning techniques to achieve the desired results i.e. smooth functioning of supply chain .Continuous replenishment process (CRP) and Vendor Managed Inventory (VMI) are best examples of these mutually agreed processes. In the last 15 years , the research on optimized inventory and VMI in particular has increased on a fast pace. Many case studies and different type of models are proposed. The success rate of VMI process is still around 30-40%. To overcome the limitations of VMI ,we have applied the structural model on the factors involved in VMI and derived the order on which these factors should be focused by MICMAC analysis.

Keywords — Collaborative planning, Vendor Managed Inventory, Interpretive Structural Modelling; ISM; MICMAC.

I. INTRODUCTION

The importance of delivering products on right time can be well understood by the number of trucks we see while travelling on the highways. Any interruption in regular flow of products can result in disruption of business. E.g. Supply of fuel to the gas stations, supply of parts to the car makers. The whole process that lies behind this includes transportation, storage, coordination and much more.

Supply chain management is governed by the philosophy of collaboration with the external organizations to achieve common benefits for all stakeholders.

II. ROLE OF MANAGING INVENTORY

As the process of production and distribution involves a fairly good amount of time so the companies strive to make the products available within a reasonable time. Inventory decisions are vital decisions and are required to take in consideration multiple factors to achieve certain goals. Optimized inventory levels help organizations sustain or reduce the costs while maintaining a higher customer service level.

III. VENDOR MANAGED INVENTORY

Vendor Managed Inventory is another inventory control technique that allows companies to respond quickly to customer demands. As nowadays businesses are spread across many countries so management of supply chain becomes the main concern. Similar to JIT Inventory management between OEMs (Car makers) and Tier 1 (Component) suppliers, Retailers and suppliers are now

shifting to Vendor Managed Inventory. In VMI process, inventory at retailer is directly monitored and managed by supplier. Supplier send out a shipping notification to retailer as a communication to what products are dispatched. This concept is already adopted by big organizations like Walmart, Procter and Gamble. These are big fishes in the market and spend any amount of money to maintain a smooth functioning of supply chain, whereas for the middle level and smaller supply chains it is not easy to invest in any new process. . There are certain factors which we target to achieve through Vendor Managed inventory. The factors are very crucial in applying the VMI process.

The concept of VMI can be applied in any industry. In Automotive industry, 3PL (3 party logistics) in which third partner is responsible for maintaining the inventory at warehouse near to the customer which is mutual economic benefit to both customer and supplier.

IV. LITERATURE REVIEW

The Literature review done till date reveals that there are various factors that are achieved if VMI is applied. The studies done so far have revealed the factors. Some researchers have tried to bring up some benefits of VMI adoption, they have discussed ordering costs[3],inventory related costs[4],transportation costs in VMI[5],service levels targeted[6] etc.

Cachon insisted on a fixed payment transfer method in VMI, He says, “VMI alone cannot assure a supply chain solution, both supplier and retailer must agree on fixed payment transfer methods”. Dong and Xu analyzed the effect of VMI on costs involved in the entire chain, They

focused upon an integrated supply chain. Hines et.al. defined, “VMI is a collaborative strategy between customer and vendor”. The supplier is responsible for managing inventory at customer's end. The performance targets are mutually decided and are changed as per the requirement. All these studies focus on benefits of VMI but present a one-sided approach without taking care of the whole supply chain. Most of the studies on VMI focus upon one or two mutually agreed outcomes.

An early study shows that the order release policy in use with VMI influences the level of inventory required at the vendor which directly affects the supplier's inventory cost. [13,14], Another study found that value CRP is affected by the characteristics of consumer demand [16]. In another study on JIT (Just in Time) practices showed that the benefits of these inventory control methods flow to the buyer rather than supplier. [15]

Another study analyzed the various costs involved and showed that buyer benefits from inventory cost savings whereas supplier maintains higher level of inventory.

V. METHODOLOGY

In our present work, we tried to find out all the factors that result, after successful VMI implementation. We have explained various factors and applied ISM technique to give a hierarchy to each factor followed by application of Mic-Mac techniques to analyze driving and dependent factors. First section deals with these factors that we have listed after interviewing some experts in the field of supply chain management and some industry owners, managers etc., second section deals with these factors and a structural model is obtained after iterations, third section uses the MICMAC analysis, driving factors and dependent factors are identified, finally a conclusion is drawn. This research will give a proper direction to the VMI partners and they can focus on the factors obtained at end to obtain their desired results..

Factors targeted in implementation of VMI

Factors that are the desired outcomes of applying Vendor Managed Inventory. These factors are developed after thorough search and discussions with professionals in supply chain.

1. Better customer service/satisfaction.
2. Better management of goods.
3. Planned production
4. Decreased Inventory holding costs.
5. Decreased storage area.
6. Increased reliability on supplier.
7. Timely delivery of goods/production.
8. Better documentation.
9. Decreased cost of products.

10. Better prediction of sales.
11. Better coordination /communication between supplier and retailer.
12. Improved trust among supplier and retailer.
13. Efficiently managed supply chain .

Better customer service/ satisfaction:

A goods manufacturing company cannot survive in today's competitive environment if the end customer is not satisfied. So this factor is one of the biggest determinant of success of VMI.

Better management of goods:

One of the major factors that encourages adoption of VMI process is the improved management of goods manufactured. As supplier gets hold of inventory management, it helps supplier align his production process in line with customer's requirements and also to overcome the inconsistent demand patterns from customers. This gives supplier better control on manufacturing processes and planning. Hence products are delivered in efficient manner and always on time.

Planned Production:

A quick and easy access to Retailer's inventory levels always help manufacturer in laying a good plan for production of goods. At the same time, it help suppliers schedule optimal lot size and plan manpower and other resources. Planning is always the first step for achievement of results in any of the inventory models and in VMI too.

Reduced inventory holding costs:

In traditional set-up, inventory is stored in large batch sizes in big stores. Storage for long periods always cost companies lot of money and in addition to that loss due to damage or expired shelf life period. Use of VMI leads to reduced inventory holding costs and optimised inventory levels at storage area.

Reduced storage area

Inventory is maintained in big stores which consumes lot of space. Hence additional costs. Use of VMI leads to optimized inventory levels further reducing the costs related to space for storage as big warehouses.

Increased reliability on suppliers

VMI model works on collaboration between manufacturers and retailers wherein manufacturers have complete access to inventory levels and have authority to deal with inventory levels to avoid any stock-out situations. This leads to more reliable relation between the two parties.

Timely delivery of goods/products:

Better management at vendor's end will ensure quick and efficient delivery of products. As soon as the inventory is

about to reach the lowest mark, vendor makes sure that the product reaches the retailer's end

Improved Documentation:

More managed production and product delivery can be ensured if proper documentation is done at all levels. So post VMI, this will definitely be an additional benefit.

Reduced product costs:

VMI leads to effective inventory management which helps in reducing inventory carrying cost. Hence cost of goods/products is reduced as well.

Better prediction of sales numbers:

Since the supplier is owner of inventory management process, the demand patterns can be analysed in a better manner over a period of time. This helps in prediction of sales in a better way.

Improved communication:

Coordination amongst supplier and retailer is prerequisite for successful implementation of VMI process. It helps in achieving common goals

Improved trust among vendor/retailer:

Lack of trust in supply chain leads to failure of any collaboration approach. VMI process brings in more trust and visibility leading to effective management of inventory.

After understanding all these factors, the discussions with managers also suggested a thorough analysis of factors. The firms generally have profit goals and they don't move in a planned way i.e. giving more importance to crucial factors that later on help in achieving higher profits. We have tried to use ISM technique so that the factors are analysed and assigned a priority level.

Understanding ISM :

ISM is a systematic approach for formation of processes. It clears up the path and forms a linkage towards achievement of company's strategy, goals. Sometimes in the implementation of any new process, the focus on models, processes takes away the attention on linkages between various factors. Concentrating on the right process can bring the desired result.

"ISM gives a structured approach to any complex system. ISM is a comprehensive systematic model to portray the structure of a problem in a carefully designed pattern"(Singh et. al 2003)

"ISM is a result of years of practical and theoretical development. It analysis the various needs very quickly and efficiently and leads to structural improvement in service delivery"(from eBook, "The ISM Method", ISBN 9789401801997)

The ISM approach:

Once we have enlisted the variegated factors from our sources. The steps involved in applying ISM are as follows:

Step I: Finding the distinctive relationships between factors :

In the wake of the list of factors that are finalised after discussions with professionals and the input received from various experts in supply chain. The correlation between the various factors and their corresponding direction is decided. Symbols are used for denoting the relationship between two factors (a and b).The matrix that is formed is called the Structural Self Interaction Matrix. The symbol is decided according to the given relationship between a and b

- i) If the factor a is directly related to b, then V can be used to denote the relationship.
- ii) If factor b influences a, then A is used to denote the relationship.
- iii) If both a and b are related to each other i.e. increase in a will ensure increase in b and vice versa. The relationship will be denoted by X.
- iv) If both the factors a and b are not related to each other, then O is used to denote the relationship.

Step II: Setting up the reachability matrix (RM):

In this reachability concept, the distinctive factors that are identified by the experts/researchers are correlated to each other and a relationship is represented in the form of a matrix. If a influences b, then the entry in the matrix is 1, if a doesn't influences b, then the entry is 0. This binary matrix will be called the IRM i.e. the initial reachability matrix.

Step III: Setting up FRM (Final Reachability Matrix):

The next level of RM will use the concept of transitivity. Transitivity will mean ,if a influences b, b influences c ,then a also influences c i.e. (a, b)=1, (b, c)=1 implies that (a, c)=1. These transitive relationships are denoted by 1* in the subsequent iterations. So the final matrix is achieved.

Step IV: The RM so obtained is subdivided into different levels.

Step V : The RM is then converted into canonical form i.e. with most zeros in upper half of the matrix and unitary elements in lower half.

Step VI: Now according to the levels achieved, we can give a hierarchy to the various factors and a digraph is drawn.

Step VII: The final ISM model is presented with the relationship between them .

The SSIM that we get for the variegated factors is

	13	12	11	10	9	8	7	6	5	4	3	2
1	A	A	X	A	A	O	A	A	O	O	A	A
2	X	A	A	A	V	V	V	A	V	V	A	
3	X	A	A	A	V	V	A	A	V	V		
4	A	O	A	A	V	O	A	A	A			
5	A	A	O	A	V	O	A	A				
6	V	A	A	O	O	A	A					

7	V	V	A	A	O	A						
8	X	V	A	V	O							
9	A	O	A	O								
10	A	V	A									
11	V	X										
12	V											

IRM: Initial Reachability Matrix is formed based on the SSIM , the values are assigned as discussed in step II

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1	0	0	0	0	0	0	0	0	0	1	0	0
2	1	1	0	1	1	0	1	1	1	0	0	0	1
3	1	1	1	1	1	0	0	1	1	0	0	0	1
4	0	0	0	1	0	0	0	0	1	0	0	0	1
5	0	0	0	1	1	0	0	0	1	0	0	0	0
6	1	1	1	1	1	1	0	0	0	0	0	0	1
7	1	0	1	1	1	1	1	0	0	0	0	1	1
8	0	0	0	0	0	1	1	1	0	1	0	1	1
9	1	0	0	0	0	0	0	0	1	0	0	0	0
10	1	1	1	1	1	0	1	0	0	1	0	1	0
11	1	1	1	1	0	1	1	1	1	1	1	1	1
12	1	1	1	0	1	1	0	0	0	0	1	1	1
13	1	1	1	1	1	0	0	1	1	1	0	0	1

The final reachability matrix is formed by applying transitivity

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1	1*	1*	1*	0	1*	1*	1	1*	1*	1*	1*	1*
2	1	1	0	1	1	1*	1	1	1	1*	0	1*	1
3	1	1	1	1	1	1*	1*	1	1	1*	0	1*	1
4	1*	0	0	1	0	0	0	0	1	0	0	0	0
5	1*	0	0	1	1	0	0	0	1	0	0	0	0
6	1	1	1	1	1	1	0	1*	1*	0	0	0	1
7	1	1*	1	1	1	1	1	1*	1*	1*	1*	1*	1
8	1	0	1*	1*	1*	1	1	1	1*	1	1*	1	1
9	1	0	0	0	0	0	0	1*	1	0	0	0	0
10	1	1	1	1	1*	1*	1	1*	1*	1	1	1	1*
11	1	1	1	1	1	1	1	1	1	1	1	1	1
12	1	1	1	1*	1	1	0	1*	1*	1*	1*	1*	1
13	1	1	1	0	1	1	1*	1*	1	1	1	1	1

FOR LEVEL I

In this first level of selection , the factors that have same R.S. and I.S. are placed at the top level in digraph. In this first table the factor number 1, 9 are marked as the factors at Level I

R.S.	A.S.	I.S.
1	1,2,3,4,6,7,8,9,10,11,12,13	1,2,3,4,6,7,8,9,10,11,12,13
2	1,2,4,5,6,7,8,9,10,12,13	1,2,6,7,10,12,13

3	1,2,3,4,5,6,7,8,9,10,12,13	1,3,6,7,8,10,11,12,13	1,3,6,7,8,10,12,13
4	1,4,9	1,2,3,4,5,6,7,8,10,11,12,13	1,4
5	1,4,5,9	2,3,5,6,7,8,10,11,12,13	5
6	1,2,3,4,5,6,8,9	1,2,3,6,7,8,10,11,12,13	1,2,3,6,8
7	1,2,3,4,5,6,7,8,9,10,11,12,13	1,2,3,7,8,10,11,13	1,2,3,7,8,10,11,13
8	1,3,4,5,6,7,8,9,10,11,12,13	1,2,3,6,7,8,9,10,11,12,13	1,3,4,5,6,7,8,9,10,11,12,13
9	1,8,9	1,2,3,4,5,6,7,8,9,10,11,12,13	1,8,9
10	1,2,3,4,5,6,7,8,9,10,11,12,13	1,2,3,7,8,11,13	1,2,3,7,8,11,13
11	1,2,3,4,5,6,7,8,9,10,12,13	1,7,8,10,12	1,7,8,10,12
12	1,2,3,4,5,6,8,9,10,11,12,13	1,2,3,7,8,10,11,12,13	1,2,3,8,10,11,12,13
13	1,2,3,4,5,6,7,8,9,10,12,13	1,2,3,6,7,8,10,11,12,13	1,2,3,6,7,8,10,12,13

OR LEVEL II

In the second round of levels ,Factor at number 4 qualifies for level II in digraph

	R.S	A.S.	I.S.
2	2,4,5,6,7,8,10,12,13	2,3,6,7,10,11,12,13	2,6,7,10,12,13
3	2,3,4,5,6,7,8,10,12,13	3,6,7,8,10,11,12,13	3,7,8,10,12,13
4	4	2,3,4,5,6,7,8,10,11,12,13	4
5	4,5	2,3,5,6,7,8,10,11,12,13	5
6	2,3,4,5,6,8	2,3,6,7,8,10,11,12,13	2,3,6,8
7	2,3,4,5,6,7,8,10,11,12,13	2,3,7,8,10,11,13	2,3,7,8,10,11,13
8	3,4,5,6,7,8,10,11,12,13	2,3,6,7,8,10,11,12,13	3,6,7,8,10,11,12,13
10	2,3,4,5,6,7,8,10,11,12,13	2,3,7,8,11,13	2,3,7,8,11,13
11	2,3,4,5,6,7,8,10,12,13	7,8,10,12	7,8,10,12
12	2,3,4,5,6,8,10,11,12,13	2,3,7,8,10,11,12,13	2,3,8,10,11,12,13
13	2,3,4,5,6,7,8,10,12,13	2,3,6,7,8,10,11,12,13	2,3,6,7,8,10,12,13

LEVEL III

In the third round , factor 5 comes at the third level

	R.S.	A.S.	I.S.
2	2,5,6,7,8,10,12,13	2,3,6,7,10,11,12,13	2,6,7,10,12,13
3	2,3,5,6,7,8,10,12,13	3,6,7,8,10,11,12,13	3,6,7,8,10,12,13
5	5	2,3,5,6,7,8,10,11,12,13	5
6	2,3,5,6,8	2,3,6,7,8,10,11,12,13	2,3,6,8
7	2,3,5,6,7,8,10,11,12,13	2,3,7,8,10,11,13	2,3,7,8,11,13
8	3,5,6,7,8,10,11,12,13	2,3,6,7,8,10,11,12,13	3,6,7,8,10,11,12,13
10	2,3,5,6,7,8,10,11,12,13	2,3,7,8,11,13	2,3,7,8,11,13
11	2,3,5,6,7,8,10,12,13	7,8,10,12	7,8,10,12
12	2,3,5,6,8,10,11,12,13	2,3,7,8,10,11,12,13	2,3,8,10,11,12,13
13	2,3,5,6,7,8,10,12,13	2,3,6,7,8,10,11,12,13	2,3,6,7,8,10,12,13

LEVEL IV

At the fourth level of selection factors 6,8,13 are selected as R.S. and I.S. is the same

	R.S.	A.S.	I.S.
2	2,6,7,8,10,12,13	2,3,6,7,10,11,12,13	2,6,7,10,12,13
3	2,3,6,7,8,10,12,13	3,6,7,8,10,11,12,13	3,6,7,8,10,12,13
6	2,3,6,8	2,3,6,7,8,10,11,12,13	2,3,6,8
7	2,3,6,7,8,10,11,12,13	2,3,7,8,10,11,12,13	2,3,7,8,10,11,12,13
8	3,6,7,8,10,11,12,13	2,3,6,7,8,10,11,12,13	3,6,7,8,10,11,12,13
10	2,3,6,7,8,10,11,12,13	2,3,7,8,11,13	2,3,7,8,11,13
11	2,3,6,7,8,10,12,13	7,8,10,12	7,8,10,12

12	2,3,6,8,10,11,12,13	2,3,7,8,10,11,12,13	2,3,8,10,11,12,13
13	2,3,6,7,8,10,12,13	2,3,6,7,8,10,11,12,13	2,3,6,7,8,10,12,13

LEVEL V

At the fifth level factor number 2,12 are selected

	R.S.	A.S.	I.S.
2	2,7,10,12	2,3,7,10,11,12	2,7,10,12
3	2,3,7,10,12	3,7,10,11,12	3,7,10,12
7	2,3,7,10,11,12	2,3,7,10,11	2,3,7,10,11
10	2,3,7,10,11,12	2,3,7,11	2,3,7,11
11	2,3,7,10,12	7,10,12	7,10,12
12	2,3,10,11,12	2,3,7,10,11,12	2,3,10,11,12

LEVEL VI

The factors 3,7 are selected at level VI

	R.S.	A.S.	I.S.
3	3,7,10	3,7,10,11	3,7,10
7	3,7,10,11	3,7,10,11	3,7,10,11
10	3,7,10,11	3,7,11	3,7,11
11	3,7,10	7,10	7,10

LEVEL VII

At the seventh level , factor number 3 is selected .

	R.S.	A.S.	I.S.
3	3,10	3,10,11	3,10
10	3,10,11	3,11	3,11
11	3,10	10	10

LEVEL VIII

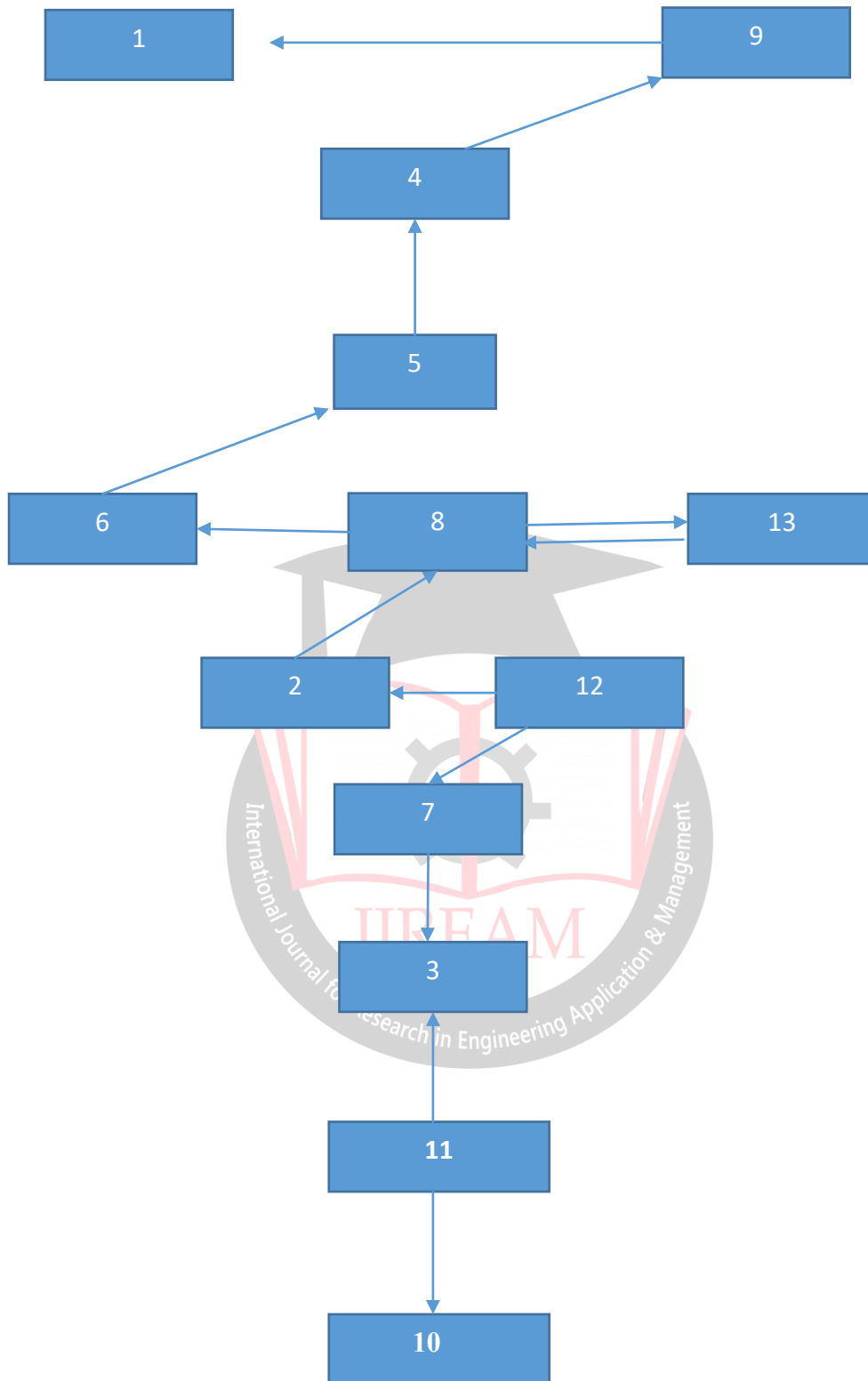
This final level is achieved by factor 11 and the factor ten attains the ninth level . This gives us the hierarchy of factors which are basically the best possible outcomes of VMI application.

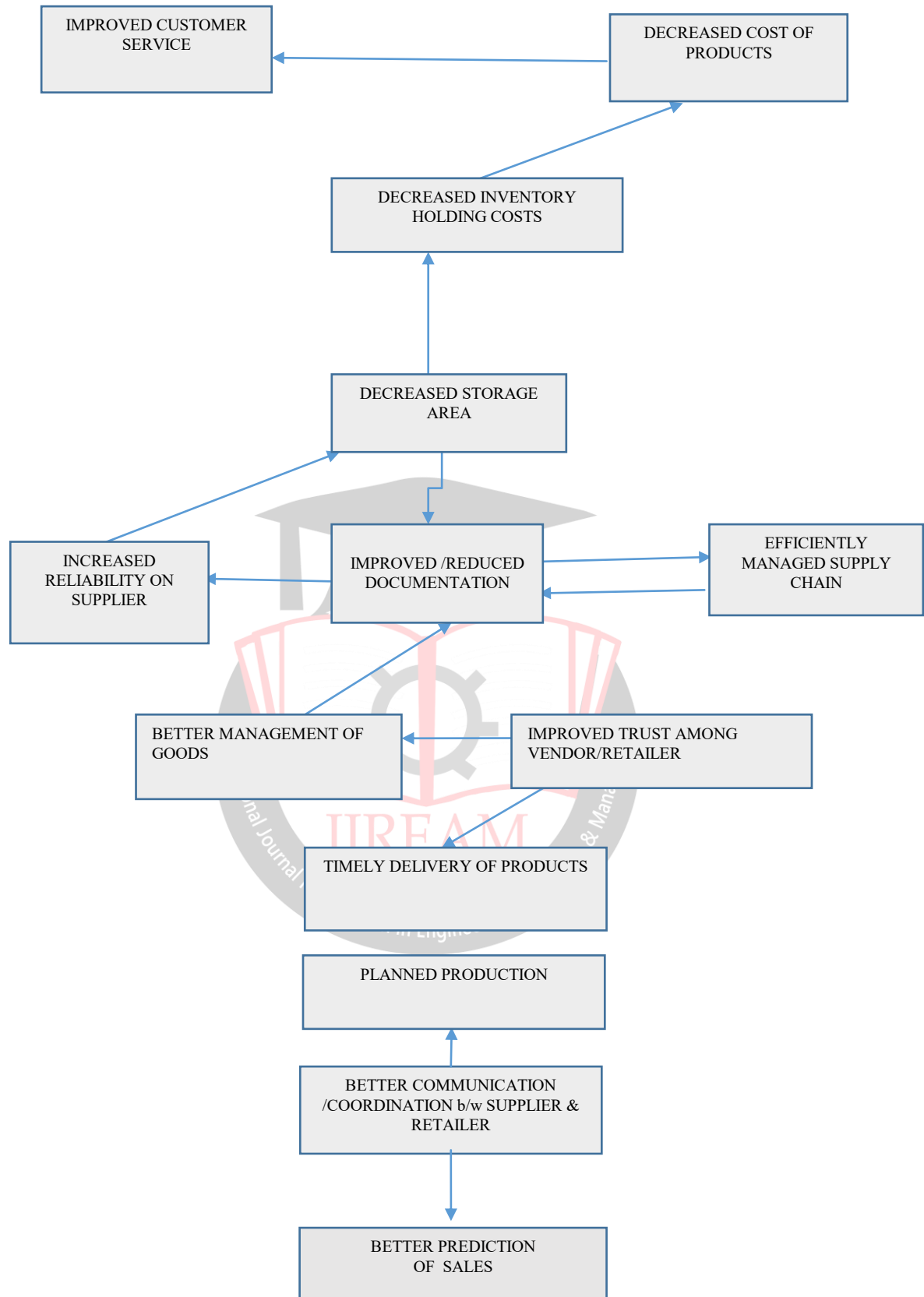
	R.S.	A.S.	I.S.
10	10,11	11	11
11	10	10	10

Finally the iterations resulted in

ITERATION NUMBER	FACTORS/ OUTCOMES THAT ARE SELECTED	LEVEL ASSIGNED FOR DIGRAPH
1	1,9	I
2	4	II
3	5	III
4	6,8,13	IV
5	2,12	V
6	7	VI
7	3	VII
8	11	VIII
9	10	IX

Digraph obtained by ISM





The MICMAC Analysis:

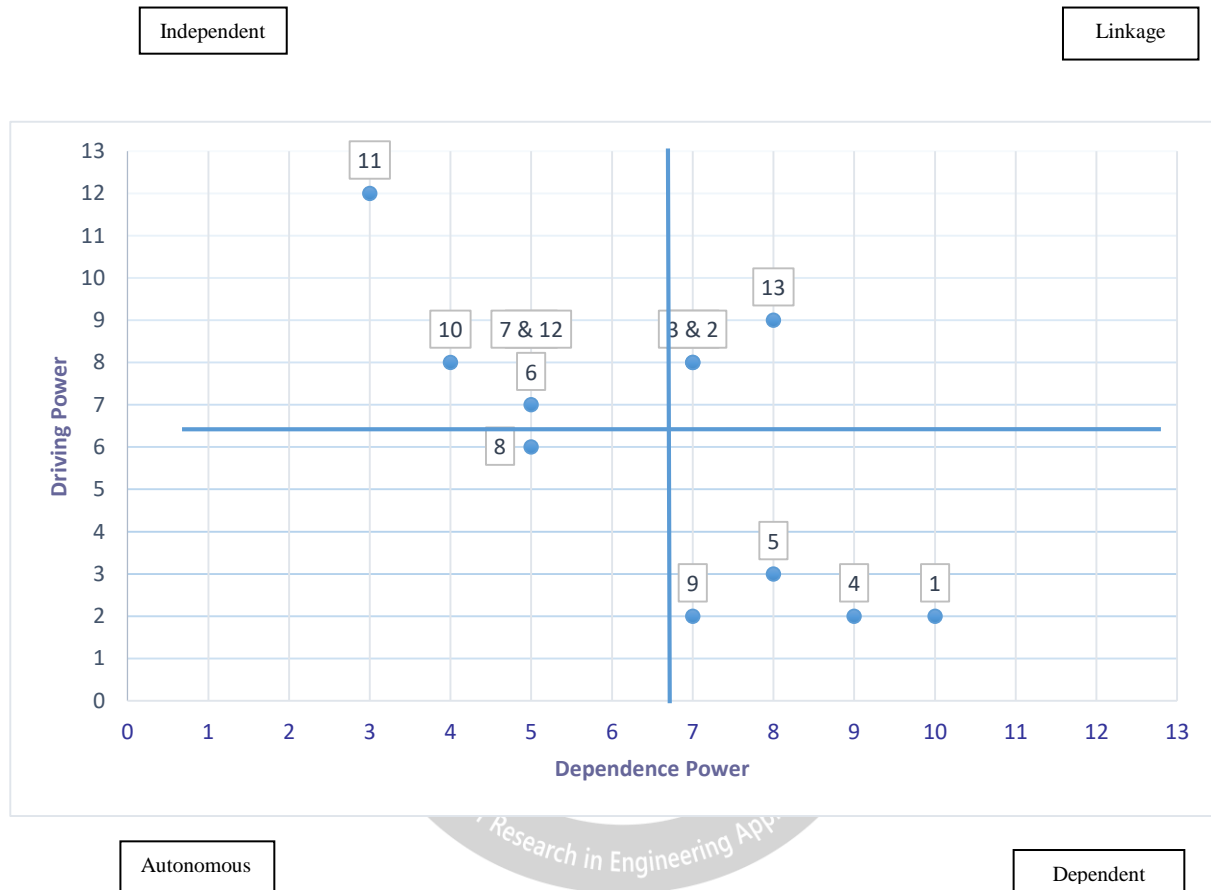
MICMAC analysis is done to calculate the driving power and dependence power of the various factors that are listed as the desired outcomes of VMI process. It is a cross-impact matrix multiplication applied to classification also called

Matrice d'Impact croises-multiplication applique an classment. Through MICMAC we can classify the factors that actually drive/impact other factors.

The factors are classified as

1. Autonomous factors: These factors have a weak driving power and weak dependence power are listed in this category. It occupies first quadrant. The factors listed in this quadrant are the least important factors.
2. Linkage factors: These factors have strong drive power and strong dependence power .They lie in the third quadrant of the figure .These are strong factors and can't be missed out.
3. Dependent factors: These factors have a weak drive power and strong dependence. These factors lie in the second quadrant . They are dependent upon some other factors but are not able to drive the process.
4. Independent factors: These are the factors which have strong drive power and weak dependence power .It is very influential factor in the process analysed by ISM.

The factors that fall in the independent or linkage factors are the key factors.



The MICMAC analysis: Through the MICMAC analysis we can categorize the various factors as

1. The autonomous factor is improved documentation, which means it doesn't play any significant role in VMI implementation as outcomes are not driven by this.
2. The dependent factors are decreased inventory holding costs, decreased storage area, decreased costs of products and better customer satisfaction.
3. The linkage factors are better management of goods, planned production and efficient management of supply chain .
4. The Independent factors are, reliability on supplier, better communication /coordination among vendor and retailer, Improved trust relation between supplier/ vendor and retailer, better prediction of sales and timely delivery of products.

VI. CONCLUSION

In this work, we have shortlisted the various factors/outcomes of applying VMI in any industry. Generally the researchers have discussed the various models or they have done empirical study of this inventory management process. As a researcher we have tried to do a complete analysis of all these factors by very successful ISM technique followed by MICMAC analysis. The results obtained are quite convincing , it shows that the driving force behind the whole VMI process is reliability on supplier, better communication /coordination among vendor and retailer, Improved trust relation between supplier/ vendor and retailer ,better prediction of sales and timely delivery of products. These are the strongest factors which will help any industry to apply VMI. The industry should keep its focus on these factors and the results will follow via

the linkage factors i.e. better management of goods, planned production and efficient management of supply chain. The results achieved will be decreased inventory holding costs, decreased storage area, decreased costs of products and better customer satisfaction. Moreover VMI is not adopted in small scale industries or middle level firms with small supply chain, where funds are limited. This analysis can be very beneficial for small supply chains that are planning to adopt VMI.

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