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ANALYSIS OF KEY SUCCESS FACTORS FOR SUCCESSFUL IMPLEMENTATION OF VENDOR MANAGED INVENTORY

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Abstract

The purpose of this paper to study the key success factor of vendor managed inventory which help to identify the main driver of any supply chain for successful implementation of vendor managed inventory. The study of this paper is divided into four part first, the success factors are identified by extensive literature review and with help of expert, key success factors are identified; second for a particular supply chain, with the help of ISM methodology relationship between the key success factor are identified and with this relationship a model is obtained for the key success factor; third from the various industrial organization which use vendor managed inventory a questionnaire based survey is conducted and with the help of questionnaire data and SPSS software correlations between the various success factors is find.

***Keywords**: VMI, Key success factor, ISM, SPSS*

1. INTRODUCTION

Inventory is very crucial part for any product-based organization because it represents main asset of organization, from the last few year inventory management is attracted researcher and industrial organization. VMI concept in retail industry is first time used by Wal-Mart and P & G (Procter & Gamble) in 1980 and resulted in lower inventory cost and transportation cost as well as increase the customer service level. Based on ownership of the inventory there are two type of inventory management one is retailer management inventory which is traditional way of inventory management in which retailer is owner of inventory management and other is VMI in which vendor take the responsibility of inventory management on the basis of information which is provided by the retailer.

large inventory show that system is inefficient as well as increase the holding cost, on other side customer satisfaction level may decrease with small inventor so organization have to keep suitable level of inventory, for effective and efficient inventory management Vendor Managed Inventory (VMI) can be used and for the effective implementation of VMI, the management should focus on managerial aspects such as better inventory management, supply chain integration, production planning and control, vendor development, automation of processes, employee involvement, investment in information systems and infrastructure and effective marketing process (R Singh, 2013).

2. LITERATURE REVIEW

The concept of VMI was developed and popularized in the late 1980s by Wal-Mart and Proctor & Gamble and is presently one of the most thoroughly researched partnering initiatives used to improve multi-firm supply chain efficiency. VMI is inventory management technique in which supplier (vendor) is managing inventory of the retailer (customer). Industrial vending systems represent a specific form of vendor-managed inventory. VMI has been defined as a collaborative agreement between a buyer and a vendor to optimize the availability of products and minimize cost to the two entities.

Success of any supply chain mainly depends upon two factor one is inventory cost and customer service level. VMI not only reduce the inventory cost and other types of cost but also it mitigates the uncertainty of demand. VMI allowing the smaller buffers of capacity and inventory and at the supplier end no need for larger buffer stocks. VMI make more efficient route planning and reduce transportation cost.

Table -1 Findings from various research paper

S.No.	Author	Title	Contribution
1	Hooshang M. Beheshti, Iain J. Clelland & K. Vernard Harrington (2020)[4]	Competitive Advantage with Vendor Managed Inventory	VMI as a supply chain integration tool that can improve the interactions among buyers, manufacturers, suppliers and third- party logistics organizations.
2	Lan Tang (2019)[20]	Integrated Inventory-Transportation Problem in Vendor-Managed Inventory System	With the help of two-echelon model whole logistics system operate more effectively and efficiency compared to independent optimization of inventory and transportation

3	Detcharat Sumrit (2019)[19]	Understanding critical success factors of vendor managed inventory in healthcare sector: A case study in Thailand	Most critical success factors of VMI in Thailand healthcare sector are Information Sharing, Institutional trust, Top Management Commitment, and Goal congruence
4	Lixin Shen, Kannan Govindan, Atul B. Borade, Ali Diabat4 and Devika Kannan (2018)[4]	An evaluation of vendor managed inventory practices from small and medium Indian enterprises	VMI adoption there are some similarities and differences in the manufacturing and service sector industries. It is found that VMI is in its early stages in India; hence, the basic form of VMI is applied
5	Alireza Hajia, Maryam Afzalabadia and Rasoul Hajia (2017)[2]	Pricing and inventory decisions in a vendor managed inventory system with revenue sharing contract	The optimal pricing and inventory policy of the supply chain can be obtained under a revenue sharing contract by which the equilibrium is the same as the centralized control
6	Shin-Yuan Hung (2016)[7]	Key Success Factors of Vendor Managed Inventory Implementation in Taiwan's Manufacturing Industry	The key success factors in implementing VMI belong to the dimension of IT governance
7	Rajesh K. Singh (2013)[19]	Analyzing the Factors for VMI Implementation: A Framework	Top management support is crucial for taking initiatives for implementing VMI and continuous improvements in the supply chain.
8	Atul B. Borade, Satish V. Bansod (2010)[5]	Study of vendor-managed inventory practices in Indian industries	while adopting VMI, objectives, strategic drivers, obstacles and affected operational areas are significantly different for SMEs and large enterprises
9	Claassen (2008)[9]	Performance outcomes and success factors of vendor managed inventory performance outcomes and success factors of vendor managed inventory (VMI)	Information quality does not have a significant impact on VMI success while information sharing does and the effect of VMI on cost benefits is the weakest.

3. METHODOLOGY

Key success factors of vendor managed inventory are identified by extensive literature review, with the help of academy and industrial expert new key success factor are identified which are main driver for the successful implementation of vendor managed inventory. With brainstorming technique and interview of industrial expert data for the relationship between the key success factor of VMI is obtained, this data is used in Interpretive Structural Modelling (ISM) to find dependent relationship between the factor is obtained. Based on dependent power and driving power MICMAC analysis is done to divided in factors into four cluster Autonomous, Driving, Dependent and linkage factors.

3.1. Questionnaire Framing

With the help of academy experts, a research questionnaire for key success factor of VMI is designed on Google Form. Questionnaire is designed on five points Likert Scale, 5-Strongly agree, 4-Agree, 3-Neutral, 2-Disagree, 1-Strongly disagree. A First copy of questionnaire is reviewed by academia expert, content validity is checked by previews articles and literature review. Questionnaire is sent through Email to various industry top management, middle management and bottom management. 50 responses are obtained from various industry. With the help of responses statistical is done to rank the variable and correlation between the key success factors is obtained by SPSS software.

Table - 2 Identified Factors based on Social Perspectives

S.No.	Key Success Factors	Reference
1	Employee involvement	Rajesh K Singh (2013)[19]
2	Information system	Claassen (2008)[9]
3.	Better Technical capability	Rajesh K. Singh (2013)[19], Hung (2016)[6], Claassen (2008)[9]

4.	Effective Inventory Management	Rajesh K Singh (2013)[19]
5.	Supply chain Integration	Hung (2016)[6]
6.	Top management Involvement	Rajesh K Singh (2013)[19]
7.	Supplier capacity	Hung (2016)[6]
8.	Trust among the Members	Hung (2016)[6], Claassen (2008)[9]
9.	Effective Inventory Management	Claassen (2008)[9], Rajesh K Singh (2013)[19]
10.	Potential of cost cutting	Afzalabadia M., Hajia A., Haji R., (2018)[2]
11.	Buyer-Supplier relationship	Hung (2016)[6]

3.2. Interpretive Structural Modelling (ISM)

ISM is a process that transforms unclear and poorly articulated mental model of system into visible, well-defined models used for many purposes. ISM is a computer assisted interactive learning process whereby structural model are produced and studies. ISM is a qualitive tool that was first proposed by J.N. Warfield, in 1976 to analyses the complex socioeconomics system. ISM transforms unclear, poorly articulated mental models of a system into visible well- defined, hierarchical. It is well- known methodology for identifying summarized relationships among specific elements, which define an issue or a problem, and provide a means by which order be imposed on the imposed on the complexity of such elements. ISM is a computer- assisted learning process that enables individuals or group of develop a map of the complex relationship between the many elements involved in a complex situation. Its basis idea is to use experts practical experience and knowledge to decompose a complicated system into several sub-system(elements) and construct a multilevel structural model.

3.2.1 ISM Steps

Warfield (1974) developed a methodology that uses systematic application of some elementary notions of graph theory and Boolean algebra in such a way that when implemented in a man machine interactive mode, theoretical, conceptual and computational leverage is exploited to construct directed graph (a representation of the hierarchical structure of the system). This methodology has at least two desirable properties when compared to the similar approaches namely simplicity in the sense of not requiring from the user i.e., viewpoint of advance mathematical knowledge and efficiency in terms of economizing in computer time Variable affecting the system under consideration are listed, which can be objectives, action and individual etc.

Step 1: From the variable identified in step 1, a contextual relationship is established among

variable with respect to which pairs of variables would be examined.

Step 2: A structural Self-Interaction Matrix (SSIM) is developed for variable, which indicates pair wise relations among variable of the system under consideration.

Step 3: Reachability matrix is developed from the SSIM and the matrix is checked for transitivity. The transitivity of the contextual relation is a basic assumption made in ISM. It states that if a variable A is related to B and B is related to C, then A is necessary related to C.

Step 4: The reachability matrix obtained in Steps 4 is partitioned into different levels.

Step 5: Based on the relationships given above in reachability matrix, a directed graph is drawn and the transitive links are removed.

Step 6: The resultant digraph is converted into an ISM, by replacing variable nodes with statements

Step 7: The ISM model developed in Step 7 is reviewed to check for conceptual inconsistency and necessary modification are made.

3.2.2 MICMAC Analysis

The key factors are classified into four clusters, first Autonomous factors: These factors have weak drive power and weak dependence power. They are relatively disconnected from the system, with which they have few links, which may be very strong, second Linkage factors: These factors have strong drive power as well as strong dependence power. These factors are unstable in the fact that any action on these factors will have an effect on others and also a feedback effect on themselves, third Dependence factors: These factors have weak drive power but strong dependence power and fourth is Independent factors: These factors have strong drive power but weak dependence power. A factor with a very strong drive power, called the 'key factor' falls into the category of independent or linkage factors.

4. ANALYSIS AND RESULT

4.1 Questionnaire- based survey

With the help SPSS software, questionnaire data is analyses and value of mean, standard error of mean, standard deviation and variance is obtained. Ranking of the key success factors is done on the basis of mean. Supply chain integration, Top management Involvement, Automation and Information System have been ranked by responded as top four variable and Trust among the members is ranked as last variable

Table 3- Descriptive Analysis

Descriptive Statistics						
	N	Mean		Std. Deviation	Variance	Rank
Factors	Statistic	Statistic	Std. Error	Statistic	Statistic	
TM	50	3.6133	0.13846	0.97906	0.959	I
BSR	50	3.5667	0.13842	0.97880	0.958	II
IS	50	3.5667	0.12131	0.85780	0.736	III
AU	50	3.4067	0.06618	0.46798	0.219	IV
PCC	50	3.3400	0.07346	0.51942	0.270	V
BTC	50	3.2733	0.08555	0.60493	0.366	VI
TAM	50	3.0733	0.08480	0.59966	0.360	VII
EI	50	2.9867	0.11663	0.82468	0.680	VIII
SC	50	2.9800	0.08215	0.58091	0.337	IX
SCI	50	2.9200	0.08495	0.60068	0.361	X
EIM	50	2.9133	0.08561	0.60538	0.366	XI

Where AU- Automation, BSR- Buyer supplier relationship, BTC- Better technical capability, EI- Employee involvement, EIM- Effective inventory Management, PCC- Potential of cost cutting, TAM- Trust among members, TM- Top management involvement, SC- Supplier capacity, SCI- Supply chain integration.

Table 4 show the coefficient of correlation between the key success factors of VMI

Factors	SCI	AU	PCC	EI	IS	EIM	SC	TM	BSR	BTC	TAM
SCI	1										
AU	0.328*	1									
PCC	0.380*	0.558**	1								
EI	0.167	0.208	0.392*	1							
IS	-0.038	-0.230	0.169	0.610**	1						
EIM	0.997**	0.327*	0.384*	0.166	-0.048	1					
SC	0.138	0.514**	0.406**	0.170	-0.059	0.124	1				
TM	0.112	-0.080	0.117	0.609**	0.660**	0.103	-0.046	1			
BSR	0.164	-0.008	0.001	0.532**	0.498**	0.153	-0.095	0.789	1		
BTC	0.055	0.168	-0.013	0.003	0.045	0.054	0.164	-0.055	-0.029	1	
TAM	-0.997	-0.327	-0.373	-0.168	0.028	-0.988	-0.152	-0.121	-0.173	-0.056	1

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4.2 Structural Self- Iteration Matrix (SSIM)

For analyzing the criteria, a contextual relationship of "lead to" is chosen here. For developing contextual relationships among variables, expert opinions based on management technique such as brainstorming was considered. For expressing the relationships between different factors for coordination and responsiveness in supply chain, four symbols have been used to denote the direction of relationship between the parameters i and j (here i<j).

A: parameter j will lead to parameter i

X: parameter i and j will lead to each other

V: parameter i will lead to parameter j.

O: parameter i and j are unrelated

Table 5 Structural Self- Iteration Matrix (SSIM)

S. No.	Factor	S11	S10	S9	S8	S7	S6	S5	S4	S3	S2	S1
S1	Top Management involvement	V	V	V	V	V	V	V	V	V	V	X
S2	Buyer supplier relationship	V	V	V	V	V	V	A	V	V	X	
S3	Information System	V	V	O	V	V	V	A	A	X		
S4	Automation	V	V	V	V	V	V	V	X			
S5	Potential of cost cutting	V	V	V	V	O	V	X				
S6	Better technical capability	V	V	V	V	V	X					
S7	Trust among members	V	V	V	V	X						
S8	Employee Involvement	V	O	O	X							
S9	Supplier Capacity	V	V	X								
S10	Supply chain integration	V	X									
S11	Effective inventory Management	X										

Reachability Matrix

The SSIM has been converted into a binary matrix, called the initial reachability matrix by substituting V, A, X and O by 1 and 0 as per the case. The substitution of 1s and 0s are as per following rules.

If the (i,j) entry in the SSIM is V, then (i,j) entry in the reachability matrix become 1 and the (j,i) entry become 0.

If the (i,j) entry in the SSIM is A, then (i,j) entry in the reachability matrix become 0 and the (j,i) entry become 1.

If the (i,j) entry in the SSIM is X, then (i,j) entry in the reachability matrix become 1 and the (j,i) entry become 1.

If the (i,j) entry in the SSIM is V, then (i,j) entry in the reachability matrix become 0 and the (j,i) entry become 0.

Table-6 Initial Reachability Matrix

S.No.	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
S1	1	1	1	1	1	1	1	1	1	1	1
S2	0	1	1	1	0	1	1	1	1	1	1
S3	0	0	1	0	0	1	1	1	0	1	1
S4	0	0	1	1	1	1	1	1	1	1	1
S5	0	1	1	0	1	1	0	1	1	1	1
S6	0	0	0	0	0	1	1	1	1	1	1
S7	0	0	0	0	0	0	1	1	1	1	1
S8	0	0	0	0	0	0	0	1	0	0	1
S9	0	0	0	0	0	0	0	0	1	1	1
S10	0	0	0	0	0	0	0	0	0	1	1
S11	0	0	0	0	0	0	0	0	0	0	1

4.4 Final Reachability Matrix

The final reachability matrix is obtained by incorporating the transitivity among the variables. The driving power of a particular factor is the total number of factor (including itself), which it may help achieve while the dependence is the total number of factors, which may help achieving it. On the basis of driving power and dependence, these factors will be classified into four groups of autonomous, dependence, linkage and independent (driver) factors.

Table-7 Final Reachability Matrix

S.No.	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	Driving Power
S1	1	1	1	1	1	1	1	1	1	1	1	**11**
S2	0	1	1	1	1*	1	1	1	1	1	1	**10**
S3	0	0	1	0	0	1	1	1	1*	1	1	**7**
S4	0	1*	1	1	1	1	1	1	1	1	1	**10**
S5	0	1	1	1*	1	1	1*	1	1	1	1	**10**
S6	0	0	0	0	0	1	1	1	1	1	1	**6**
S7	0	0	0	0	0	0	1	1	1	1	1	**5**
S8	0	0	0	0	0	0	0	1	0	0	1	**2**
S9	0	0	0	0	0	0	0	0	1	1	1	**3**
S10	0	0	0	0	0	0	0	0	0	1	1	**2**
S11	0	0	0	0	0	0	0	0	0	0	1	**1**
Dependence Power	**1**	**4**	**5**	**4**	**4**	**6**	**7**	**8**	**8**	**9**	**11**	**67**

1*- Transitive links between the factors

4.5 Level Partitions

From the final reachability matrix, the reachability and antecedent set for each factor and found. The reachability set element itself and other elements to which it may help achieve, whereas the antecedent set consist of the element itself and other elements which may help achieving it. Then the intersection of these sets is derived for all elements.

The elements for which the reachability and intersection sets are same is the top-level elements in the ISM hierarchy. The top-level element of the hierarchy would not help in achieving any other elements above their own. Once the top-level elements are identified, it is separated out from the other elements. Then by the same process, the next level of elements if found. These identified level helps in building the diagraph and final model. The identified levels aid in building the final model of ISM

Table- 8 Iteration 1

Criteria	Reachability Set	Antecedent Set	Intersection	Level
S1	1,2,3,4,5,6,7,8,9,10,11	1	1	
S2	2,3,4,5,6,7,8,9,10,11	1,2,4,5	2,4,5	
S3	3,6,7,8,9,10,11	1,2,3,4,5	3,5	
S4	2,3,4,5,6,7,8,9,10,11	1,2,4,5	2,4,5	
S5	2,3,4,5,6,7,8,9,10,11	1,2,4,5	2,4,5	
S6	6,7,8,9,10,11	1,2,3,4,5,6	6	
S7	7,8,9,10,11	1,2,3,4,5,6,7	7	
S8	8,11	1,2,3,4,5,6,7,8	8	
S9	9,10,11	1,2,3,4,5,6,7,9	9	
S10	10,11	1,2,3,4,5,6,7,9,10	10	
S11	11	1,2,3,4,5,6,7,8,9,10,11	11	**Level I**

Table- 9 Iteration 2

Criteria	Reachability Set	Antecedent Set	Intersection	Level
S1	1,2,3,4,5,6,7,8,9,10	1	1	
S2	2,3,4,5,6,7,8,9,10	1,2,4,5	2,4,5	
S3	3,6,7,8,9,10	1,2,3,4,5	3	
S4	2,3,4,5,6,7,8,9,10	1,2,4,5	2,4,5	
S5	2,3,4,5,6,7,8,9,10	1,2,4,5	2,4,5	
S6	6,7,8,9,10	1,2,3,4,5,6	6	
S7	7,8,9,10	1,2,3,4,5,6,7	7	
S8	8	1,2,3,4,5,6,7,8	8	
S9	9,10	1,2,3,4,5,6,7,9	9	
S10	10	1,2,3,4,5,6,7,9,10	10	**Level II**

Table- 10 Iteration 3

Criteria	Reachability Set	Antecedent Set	Intersection	Level
S1	1,2,3,4,5,6,7,8,9	1	1	
S2	2,3,4,5,6,7,8,9	1,2,4,5	2,4,5	
S3	3,6,7,8,9	1,2,3,4,5	3	
S4	2,3,4,5,6,7,8,9	1,2,4,5	2,4,5	
S5	2,3,4,5,6,7,8,9	1,2,4,5	2,4,5	
S6	6,7,8,9	1,2,3,4,5,6	6	
S7	7,8,9	1,2,3,4,5,6,7	7	
S8	8	1,2,3,4,5,6,7,8	8	**Level III**
S9	9	1,2,3,4,5,6,7,9	9	**Level III**

Table- 11 Iteration 4

Criteria	Reachability Set	Antecedent Set	Intersection	Level
S1	1,2,3,4,5,6,7	1	1	
S2	2,3,4,5,6,7	1,2,4,5	2,4,5	
S3	3,6,7	1,2,3,4,5	3	
S4	2,3,4,5,6,7	1,2,4,5	2,4,5	
S5	2,3,4,5,6,7	1,2,4,5	2,4,5	
S6	6,7	1,2,3,4,5,6	6	
S7	7	1,2,3,4,5,6,7	7	**Level IV**

Table- 12 Iteration 5

Criteria	Reachability Set	Antecedent Set	Intersection	Level
S1	1,2,3,4,5,6	1	1	
S2	2,3,4,5,6	1,2,4,5	2,4,5	
S3	3,6	1,2,3,4,5	3	
S4	2,3,4,5,6	1,2,4,5	2,4,5	
S5	2,3,4,5,6	1,2,4,5	2,4,5	
S6	6	1,2,3,4,5,6	6	**Level V**

Table- 13 Iteration 6

Criteria	Reachability Set	Antecedent Set	Intersection	Level
S1	1,2,3,4,5	1	1	
S2	2,3,4,5	1,2,4,5	2,4,5	
S3	3	1,2,3,4,5	3	**Level VI**
S4	2,3,4,5	1,2,4,5	2,4,5	
S5	2,3,4,5	1,2,4,5	2,4,5	

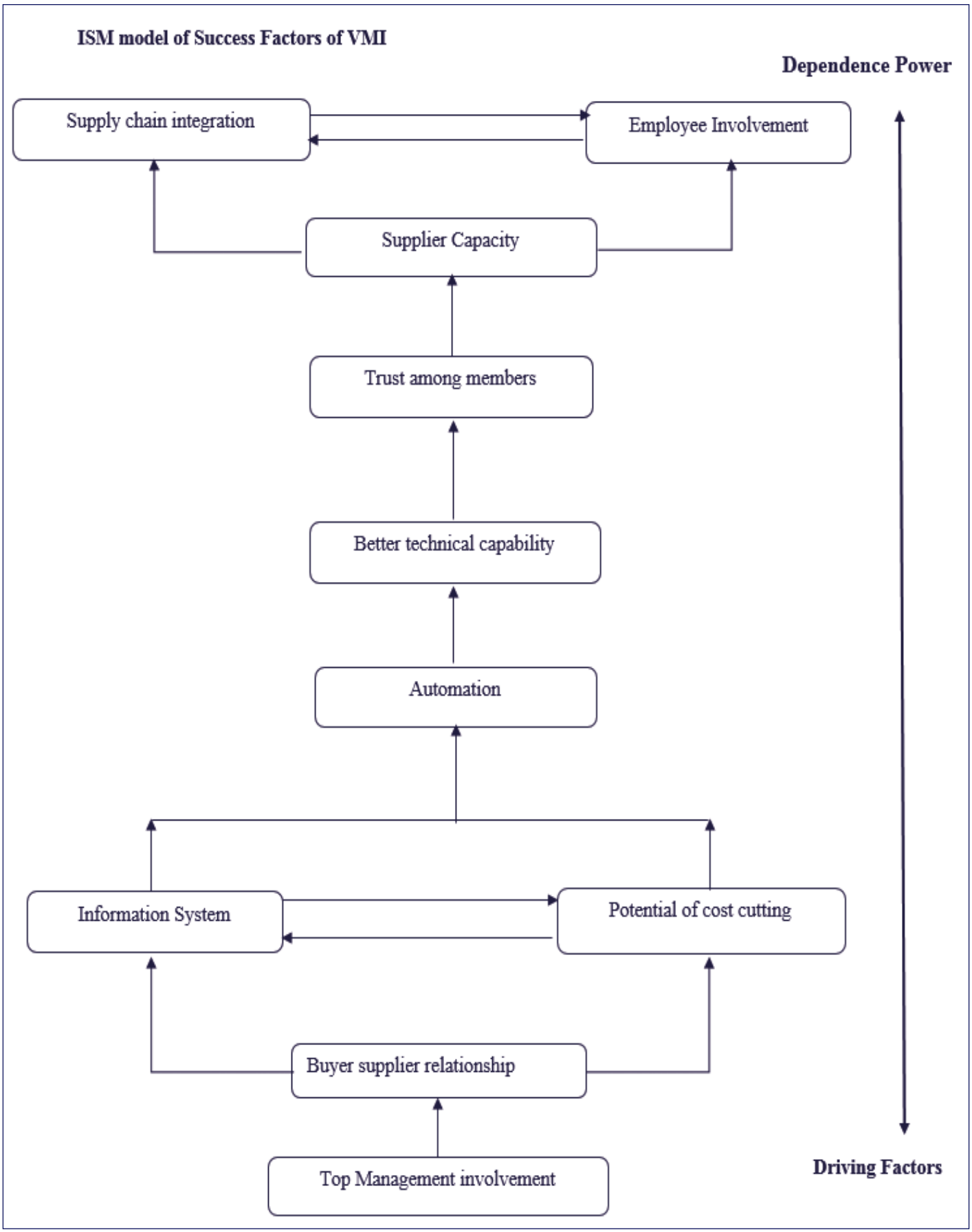
Table- 14 Iteration 7

Criteria	Reachability Set	Antecedent Set	Intersection	Level
S1	1,2,4,5	1	1	
S2	2,4,5	1,2,4,5	2,4,5	**Level VII**
S4	2,4,5	1,2,4,5	2,4,5	**Level VII**
S5	2,4,5	1,2,4,5	2,4,5	**Level VII**

Table- 15 Partitioning of variables

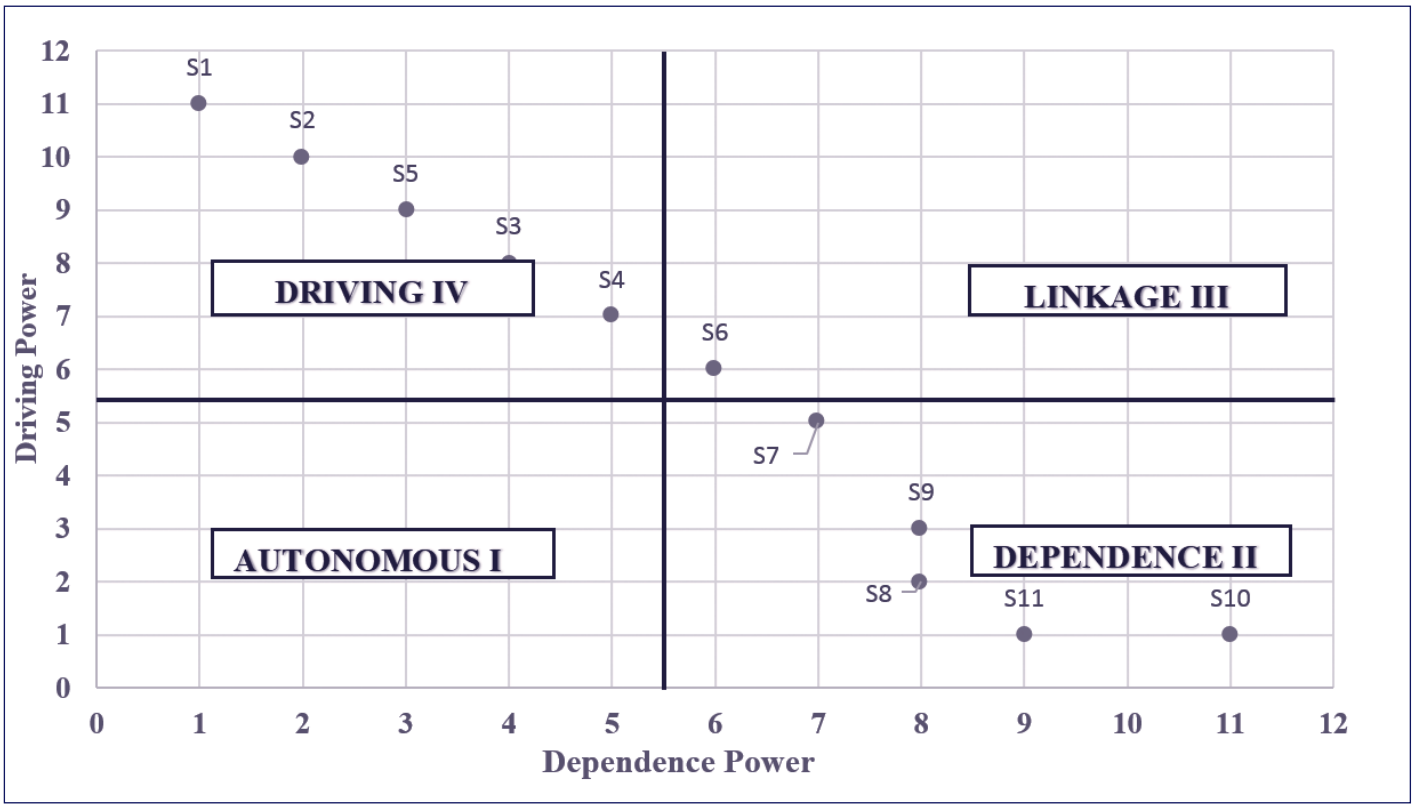
Criteria	Reachability Set	Antecedent Set	Intersection	Level
S1	1	1	1	Level VIII
S11	11	1,2,3,4,5,6,7,8,9,10,11	11	Level I
S10	10	1,2,3,4,5,6,7,9,10	10	Level II
S8	8	1,2,3,4,5,6,7,8	8	Level III
S9	9	1,2,3,4,5,6,7,9	9	Level III
S7	7	1,2,3,4,5,6,7	7	Level IV
S6	6	1,2,3,4,5,6	6	Level V
S3	3	1,2,3,4,5	3	Level VI
S2	2,4,5	1,2,4,5	2,4,5	Level VII
S4	2,4,5	1,2,4,5	2,4,5	Level VII
S5	2,4,5	1,2,4,5	2,4,5	Level VII
S1	1	1	1	Level VIII

Fig.1 ISM model of Success Factors of VMI



MICMAC Analysis

Figure 3 - Clusters of Key Success Factors of VMI



S1- Top management involvement, S2- Buyer supplier relationship, S3- Information system, S4- Automation, S5- Potential of cost cutting, S6- Better technical capability, S7- Trust among members, S8- Employee involvement, S9- Supplier capacity, S10- Supply chain integration, S11- Effective inventory management.

5. SUMMARY

5.1 Conclusion

VMI is mainly driven by the information shared by buyer so it necessary that the quality information is shared by the buyer on right time so it is easy for supplier to take necessary action to fulfill the customer demand on right time. From extensive literature review, success factors of VMI are obtained and with the help of academia and industrial expert the 11 key success factor is find which help in successful implementation of VMI. With the help of SPSS software various statistical parameter like Mean, standard deviation, variance, standard error is finding and based on the mean, ranking of the success factors is done also Pearson's coefficient of correlation is find between the various factors. ISM methodology is used to find the relationship between the key success factors also dependence power and driving power of the factors is determined by ISM. Top management involvement, Buyer supplier's relationship, Potential of cost cutting, Information system and Automation emerged as drivers of VMI. Trust among members, Supplier's capacity, Employee's involvement, Supply chain integration and Effective inventory management obtained as dependent variable because of the high dependence power and Better technical capability emerged as linkage variable. In these factors there is no autonomous factor is obtained. This study helps other to understand the dependence relationship of various factors and also help in understanding the framework of key success factors for any VMI based supply chain.

5.2 Limitation and future scope

- This study is based only on a particular supply chain
- No comparative study
- Questionnaire's responses are limited.
- Relationship between the factors is obtained by the expert opinion so it can be biased.
- This study can be applied on different organization or supply chain in different conditions.
- Relationship between the various success factors can be further validated by empirical data and structural equation modelling (SEM) approach.
- Different brain storming techniques can be used for expert's opinion for future study.

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