Parameters for Delivery Improvement of Indian Automotive Sector in Make to Order Environments: An ISM Analysis

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Abstract— In the world of technology & development, delivery performance plays a critical role in reputation of Indian manufacturing sector. Generally, in make-to-order environments, which act only in response to the orders made by the customers, manufacturers should offer the best price and delivery time for an order considering the existing capacity and the customer's satisfaction to maximize the profits. The present study states that Production rate can play an important role in on-time deliverance of finished goods in Indian Automotive sector. The study identifies ten parameters affecting on-time delivery in the Indian Automotive sector. Based on the rigorous literature review, ten major parameters are obtained. The Delphi technique is applied as a potentially valuable tool for the grouping these parameters. The study analyse the impact of these parameters to enhance the delivery performance of manufactured goods. The research theme has been categorised into three segments, i.e. identifying the parameters from the literature, conduct interviews with key persons of different departments in Academia and Industries and analysis of the Indian automotive industries. Interpretive Structural Modeling (ISM) has been used to analyse the relationships among these parameters. This analysis serves to identify which parameter is performing as the leading one to raise the delivery improvement bar of manufacturing industries. This study plays a vital role to enhance the delivery improvement of manufacturing industries in India. The efficiency of the proposed ISM model is confirmed by comparing it to both the existing literature and the current practice.

Keywords: Delivery time, delivery performance, Indian automotive sector, ISM analysis, make to order, on-time delivery, profit maximization

1 INTRODUCTION

The market structure changes frequently and advancements in technology have created new competitive environments. In these modern markets, continuous changes in the customers' expectations, demands, and reduced product lifecycle create a wide range of customer orders, which should constantly be delivered in the given timeframe. Accordingly, make-to-stock (MTS) systems have become as inefficient and unreliable solutions to fulfil the demands raised by the customers especially when the production capacity is limited. Hence, more weightage has been paid to make-to-order (MTO) systems; currently, manufacturing and service industries are shifting towards make to order strategy.

This paper is prepared as follows: A literature review focused on the concepts of make to order manufacturing environments (in general contexts) and identifies the parameters for improving on-time delivery in the Indian manufacturing sector. In next section, problem description, methodology for the study, is presented. In next section, the findings of the study are summarized. The most important factors, different methods, and analysis that relates to delivery improvement are summarized. In the concluding section, the most relevant issues are discussed, including suggestions for future scope.

2 METHODS AND MATERIALS

In this research, study factors are the delivery affecting parameters in a make to order environment. Author has identified eight significant factors from various literature review, other existing studies, and opinion of the experts. This work can be characterized as first theoretical concept, specifically for review of literature on delivery improvement and reduction in unwanted delays. The approach of the research is mainly exploratory in nature, which constitutes a secondary source for the progress.

First, the relevant literature is reviewed and marked. The author focused on literature from 2000 to 2017. The Literature Review chiefly includes implementation of ISM technique in manufacturing environments and other service sectors as well. The literature survey was supplemented by use of online database such as Taylor and Francis Science Direct, Google Scholar, Bing etc. using primary keywords such as delivery, on time delivery and make to order, ISM technique, etc. and secondary key words like improvement, modelling, framework, etc. Majorly, the research is based on the collected secondary data, which includes compilation of various research articles and different industrial survey reports, etc., after scanning the reference sections of the selected papers. The endmost list of articles reviewed for this research paper covers articles, which are published in reputed referred scholarly journals on delivery improvement and ISM.

In the present study, Interpretive Structural Modeling (ISM) is used to achieve the objective of the work. Interpretive Structural Modeling (ISM) developed for complex situations and problems. It acts as a communication tool between the selected elements, variables, parameters, etc. The main objectives of this paper are:

a) To identify and rank the delivery parameters for implementation of on time delivery practices in a make to order environment.

b) To develop and analyze the interaction between identified affecting delivery parameters using ISM

c) To prepare a framework for on time delivery system implementation.

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2.1 Criteria used for final selection

After reviewing various research papers, the criteria for selecting the research papers finally were established. The papers appearing in reputed journals were included in the review of literature and few articles in periodicals, conference proceedings, etc. are also considered, represented a higher level of research. For a better exploration of the field, the references of the remaining papers were also taken into consideration according to the year of their publication. Afterwards, the abstracts of the selected papers were studied. Finally, after reading the abstracts of these papers, 40 papers associated with the area, which were published in different journals, conferences, book sections, articles, etc. were considered in the review of literature.

From, the rigorous literature review eight key parameters for delivery improvement in the Indian manufacturing sector have been identified.

2.2 The Delphi technique

The Delphi technique is a group process used to survey and collect the opinions of experts on a particular subject. The main components of Delphi techniques include the communication process, a group of experts, and essential feedback" (Yousuf, 2007). Following steps of the Delphi technique as identified by Brooks (1979) were conducted in the present study:

i. Identifying the panel of experts
ii. Determining the willingness of individuals to serve on the panel
iii. Gathering individual input on the specific issue and then compiling it into basic statements
iv. Analyzing data from the panel
v. Compiling information on a new questionnaire and sending to each panel member for review
vi. Analyzing the new input and returning to the panel members the distribution of the responses
vii. Asking each panel member to study the data and evaluate their own position based on the responses from the group. When individual responses vary significantly from that of the group norm, the individual is asked to provide a rationale for their differing viewpoint while limitations are placed on the length of the remarks in order to keep responses brief
viii. Analyzing the input, and sharing the minority supporting statements with the panel. Panel members are again asked to review their position and if not within a specified range, to justify the position with a brief statement

3 Literature Review

Parameters for delivery improvement in MTO environments for Indian manufacturing sector are selected from the following list of sources:

S. No.	VARIABLE/ PARAMETER	TITLE OF THE PAPER/ ARTICLE/ THESIS	RESEARCHERS	YEAR OF PUB.
1	Outsourcing	The Analysis of the Use of Outsourcing Services in Logistics by Czech Manufacturing Companies	Hrušecká Denisa, Macurová Lucie, Juřičková Eva, Kozáková Leona	2015
2	Non-Value-Added Activities	Managing non-value adding activities in a supply chain by a product design	Sataporn Amornsawadwatana	2007
3	Administrative & Logistical Bottlenecks	Supply chain information risk management model in MTO	Prima Denny Sentia, Muriati Mukhtar, Syaimak Abdul Shukor	2013
4	Transportation Activities	Supply chain information risk management model in MTO	Prima Denny Sentia, Muriati Mukhtar, Syaimak Abdul Shukor	2013
5	Demand	Supply chain information risk management model in MTO	Prima Denny Sentia, Muriati Mukhtar, Syaimak Abdul Shukor	2013
6	Material & HR	a. Supply chain information risk management model in MTO b. Improving supply chain performance through improved visibility	a. Prima Denny Sentia, Muriati Mukhtar, Syaimak Abdul Shukor b. Bartlett, Paul A, Julien, Denyse M and Baines, Tim S	2013

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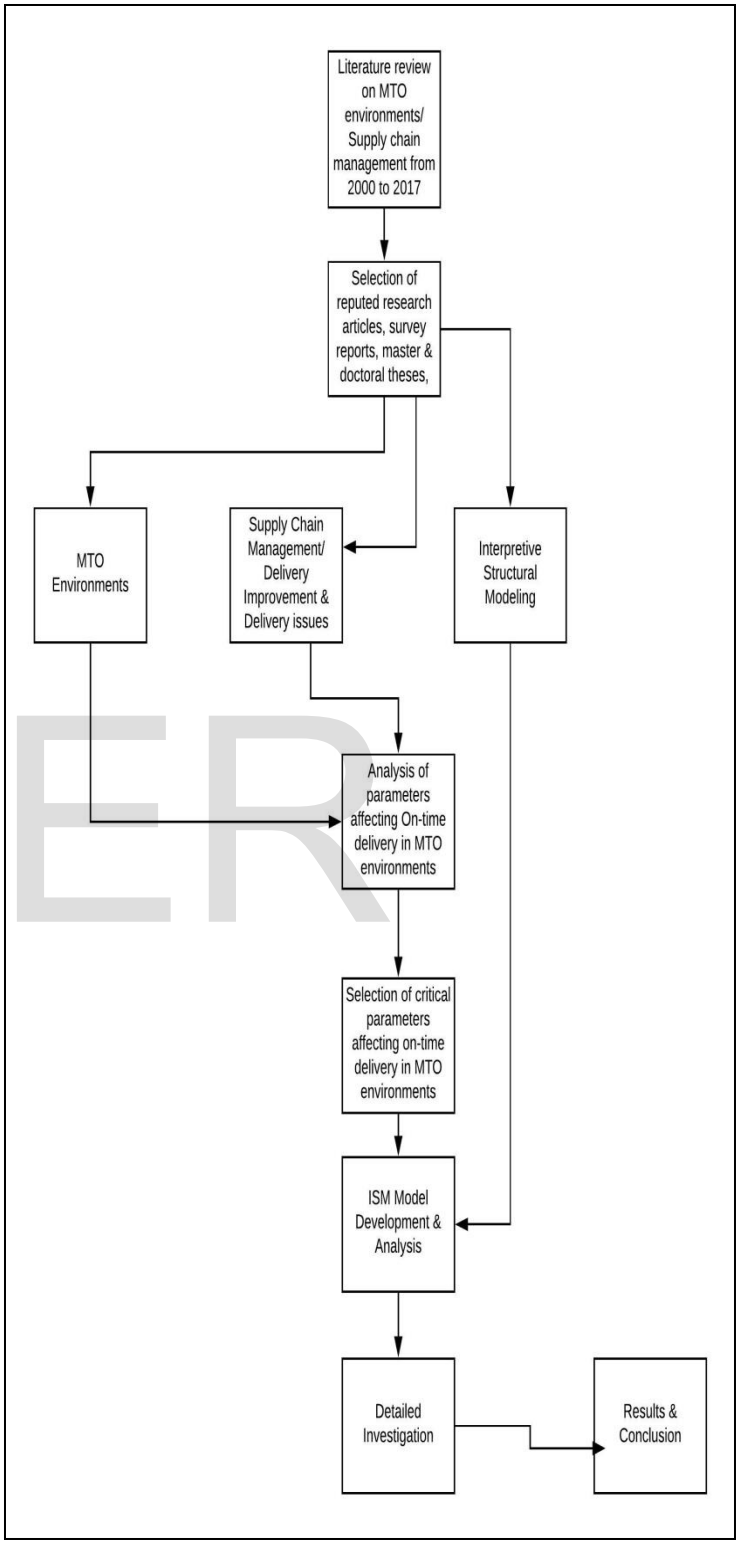
7	Lead Time	a. Price and Lead time competition, and coordination for make-to-order supply chains	a. Tiaojun Xiao, Jing Shi, Guohua Chen	2014
		b. Responding to customer enquiries in Make-to-Order companies: problems and solutions	b. Brian Kingsman, Linda Hendry, Alan Mercer, Antonio de Souza	1996
		c. Reduction of work in process inventory and production lead time in a bearing industry using value stream mapping tool	c.Praveen Saraswat, Deepak Kumar, Manoj Kumar Sain	2015
		d. Price and lead-time competition, and coordination for make-to-order supply chains	d.Tiaojun Xiao, Jing Shi, Guohua Chen	2014
8	Cycle Time	Cycle time reduction in context to the make to order (MTO) environment	Sanjay Sharma	2013
9	Procurement	a.Delivery Performance Improvement	a. Joseph H. Berk, J.H. Berk & Associates	2013
		b.Procurement outsourcing and supply chain performance of manufacturing firms in nairobi, kenya	b. Beatrice Mukuhi Kinyanjui	2013
10	Production Rate	Pricing, Production, Scheduling, & delivery-time Competition	Phillip J. Lederer & Lode Li	1995

5 RESEARCH METHODOLOGY



6.1 INTERPRETIVE STRUCTURAL MODELING (ISM)

The Interpretive Structural Modeling (ISM) was first proposed by J. N. Warfield (1973a) to analyze the complex socioeconom-

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ic systems. ISM is an interactive computer-assisted learning process into a set of heterogeneous directly related elements are structured into a comprehensive systematic model. ISM also gives the basic ideas to develop a map of the compound associations between the numerous elements concerned in multifaceted circumstances. The most important idea of ISM is to use of practical experience of experts and knowledge to decompose a complicated taxonomy into numerous sub-systems as well as assemble a multi-tiered structural form. ISM may be used for identifying and summarizing relationships among specific variables, which define a problem or an issue (Warfield, 1974; Sage, 1977). It provides us a means by which order may be imposed on the complexity of such variables (Mandal & Deshmukh, 1994; Jharkharia & Shankar, 2005; Luthra, Kumar, Kumar & Haleem, 2011). Raj et al. (2008) focused on an ISM approach to identify the mutual interaction of the manufacturing competitive enablers that help in the achievement manufacturing sector as well as it also helps to identify the driving and the dependent enablers. Raj et al. (2008) presented the following characteristics of ISM are as follows:

(i) This methodology is interpretive as the judgment of the group decides whether and how the different elements are related.
(ii) It is structural, too, based on relationship; an overall structure is extracted from the complex set of variables.
(iii) It is a modeling technique, as the specific relationships and overall structure are portrayed in a digraph model.
(iv) It helps to impose order and direction on the complexity of relationships among various elements of a system.
(v) It is primarily intended as a group learning process, but individuals can also use it.

The following steps are concerned with the ISM methodology are:
1. Variables considered for the system under consideration are listed.
2. From the variables identified in step 1, a contextual relationship is established among the variables in order to identify as to which pairs of variables should be examined.
3. A structural self-interaction matrix (SSIM) is developed for variables, which indicates pairwise relationships among the variables of the system under consideration.
4. 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 necessarily related to C.
5. The reachability matrix obtained in step 4 is partitioned into different levels.
6. Based on the relationships given above in the reachability matrix, a directed graph is drawn and the transitive links are removed.
8. The ISM model developed in step 7 is reviewed to check for conceptual inconsistency and necessary modifications are made.

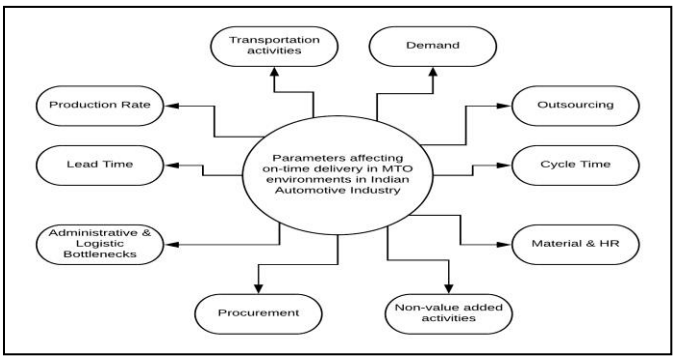

Fig.2 Selected parameters after using Delphi Technique

6.3 SSIM (SELF STRUCTURAL INTERACTION MATRIX)

Table 2: Self Structural Interaction Matrix

S. N.	Selected Parameters	10	9	8	7	6	5	4	3	2	1
1	Outsourcing	V	V	O	V	V	V	A	A		
2	Non-value-added activities	V	V	O	V	V	V	O	V		
3	Administrative & logistical bottlenecks	V	V	O	V	V	V	A			
4	Transportation activities	O	V	O	V	O	O				
5	Demand	V	V	O	V	X					
6	Material & hr	V	V	O	V						
7	Lead time	V	O	O							
8	Cycle time	V	O								
9	Procurement	V									
10	Production rate										

Table 3: Initial Reachability Matrix

S. N.	Selected Parameters	10	9	8	7	6	5	4	3	2	1
1	Outsourcing	1	1	0	1	1	1	0	0	0	1
2	Non-value-added activities	1	1	0	1	1	1	0	1	1	1
3	Administrative & logistical bottlenecks	1	1	0	1	1	1	0	1	0	1
4	Transportation activities	0	1	0	1	0	0	1	1	0	1
5	Demand	1	1	0	1	1	1	0	0	0	0
6	Material & hr	1	1	0	1	1	1	0	0	0	0
7	Lead time	1	0	0	1	0	0	0	0	0	0
8	Cycle time	1	0	1	0	0	0	0	0	0	0
9	Procurement	1	1	0	0	0	0	0	0	0	0
10	Production rate	1	0	0	0	0	0	0	0	0	0

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Table 4: Final Reachability Matrix

S.N.	Selected Parameters	10	9	8	7	6	5	4	3	2	1	Driver Power
1	Outsourcing	1	1	0	1	1	1	0	0	0	1	6
2	Non-value-added activities	1	1	0	1	1	1	0	1	1	1	8
3	Administrative & logistical bottlenecks	1	1	0	1	1	1	0	1	0	1	7
4	Transportation activities	1*	1	0	1	0	0	1	1	0	1	6
5	Demand	1	1	0	1	1	1	0	0	0	0	5
6	Material & HR	1	1	0	1	1	1	0	0	0	0	5
7	Lead time	1	0	0	1	0	0	0	0	0	0	2
8	Cycle time	1	0	1	0	0	0	0	0	0	0	2
9	Procurement	1	1	0	0	0	0	0	0	0	0	2
10	Production rate	1	0	0	0	0	0	0	0	0	0	1
	DEPENDENCE	10	7	1	7	5	5	1	3	1	4	

Table 5: Level Partition – Iteration 1

S.N.	Reachability Set	Antecedent Set	Intersection Set	Level
1	1, 5,6,7,9,10	1, 2, 3, 4	1	
2	1, 2, 3, 5,6,7, 9,10	2	2	
3	1, 3, 5,6,7, 9,10	2, 3, 4	3	
4	1, 3, 4, 7, 9, 10	4	4	
5	5, 6, 7, 9, 10	1, 2, 3, 5, 6	5,6	
6	5, 6, 7, 9, 10	1, 2, 3, 5, 6	5,6	
7	7, 10	1, 2, 3, 4, 5, 6, 7	7	
8	8, 10	8	8	
9	9, 10	1, 2, 3, 4, 5, 6, 9	9	
10	10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	10	I

Table 6: Level Partition – Iteration 2

S.N.	Reachability Set	Antecedent Set	Intersection Set	Level
1	1, 5,6,7,9	1, 2, 3, 4	1	
2	1, 2, 3, 5,6,7, 9	2	2	
3	1, 3, 5,6,7, 9	2, 3, 4	3	
4	1, 3, 4, 7, 9	4	4	
5	5, 6, 7, 9	1, 2, 3, 5, 6	5,6	
6	5, 6, 7, 9	1, 2, 3, 5, 6	5,6	
7	7	1, 2, 3, 4, 5, 6, 7	7	II
8	8	8	8	II
9	9	1, 2, 3, 4, 5, 6, 9	9	II

Table 7: Level Partition – Iteration 3

S.N.	Reachability Set	Antecedent Set	Intersection Set	Level
1	1, 5,6	1, 2, 3, 4	1	
2	1, 2, 3, 5,6	2	2	
3	1, 3, 5,6	2, 3, 4	3	
4	1, 3, 4	4	4	
5	5, 6	1, 2, 3, 5, 6	5,6	III
6	5, 6	1, 2, 3, 5, 6	5,6	III

After repeating the iterations in the similar manner, we will get the final list of level partitions as follows:

Table 8: Final list of Level Partitions

Level	S.N.	Parameter
I	10	Production rate
II	7	Lead time
II	8	Cycle time
II	9	Procurement
III	5	Demand
III	6	Material & hr
IV	1	Outsourcing
V	3	Administrative & logistical bottlenecks
VI	2	Non-value added activities
VI	4	Transportation activities

7 RESULTS AND DISCUSSION

As per the ISM techniques implementation, production rate is the most affecting parameter in on time delivery under MTO environment in Indian Automotive sector. On the other hand, transportation activities and non-value-added activities are least affecting parameters. The result is entirely based upon the relative work of study, e.g. research articles, journals, conference proceedings, etc.

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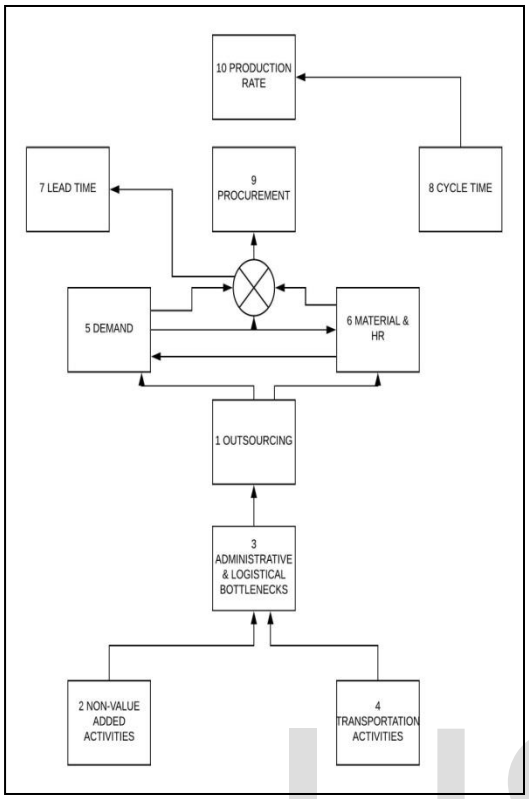
FIG.3: THE OBTAINED ISM MODEL



8 CONCLUSIONS

The critical parameters have been identified and are listed. They can be worked upon accordingly for better delivery scenarios in MTO environments in Indian Automotive Industries.

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