Supplier Relationship Management towards Quality Management System of Indian automotive manufacturing industry - A Total Interpretive Structural Modeling approach

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Abstract. This research paper identifies Supplier Relationship Management (SRM) as a significant factor influencing quality development of products in automobile sector. SRM is a crucial methodology to achieve mutual gains by companies and their suppliers. The supplier may be having different business culture than the company. The business culture and environment differs from organization to organization. SRM provides a common platform for exchange of knowledge, ideas, goals, etc. for the company and its suppliers which enhance processes like material handling, procurement and goods management. SRM impacts product quality directly and in a positive way. Finally, through Interpretive Structural Modeling (ISM), different manufacturing and quality issues are identified at different levels & their contributions, which ultimately construct the direction towards Quality Management System (QMS) and then through Total Interpretive Structural Modeling(TISM) the developed model is logically modified.

1. Introduction
In the competitive market the product quality is acting as a key to success of companies and their strategies. In such cases SRM comes into picture for a better and efficient method of achieving product quality. Now, only marketing strategies are not enough to capture the lead in the market. The companies need to have knowledge about technologies also which may influence their hold in the market. Here, SRM plays a significant role for companies to interact with their suppliers to gain latest knowledge base helpful in shaping their future strategic moves. This fact is also supported by [1]. Our objective for this research paper is to evaluate measurable Supplier certification processes and effectiveness of SRM using various factors leading to QMS and product Quality which is further analysed by ISM and TISM.

2. Literature Review
Supplier Relationship Management is identified as the interacting tool between the suppliers and the company. For the growth of suppliers and company it is mutually important to develop a healthy relation with each other. [2] has considered this as an element of information exchange and flow in Supply Chain Management. The main significance of SRM is to bring the companies and their
suppliers with diverse business culture and atmosphere on a common base for mutually enhancing their organizational processes such as management of goods, procurement, material handling, inventory management, etc. Considering such facts by different researchers, the use of SRM is always considered as a path to mutual benefits as it creates situation with win-win scenarios for the suppliers as well as the company. Once a positive influence from the supplier is maintained by the company with mutual understandings, product quality experiences a positive impact.

The researchers have pointed out various incidents marking SRM as an efficient tool in business. One such fact is mentioned in the research of [3] which shows a significant reduction in development time of products with the SRM. [4] also points towards Honda culture where they start collaborating with their suppliers significantly prior to the launch of new product. [3] also show SRM as a risk Mitigation technique for companies. He says, supplier’s involvement can point out significant economic and marketing loopholes which might turn out to be a potential risk in future. This is supported by [5] who mentions SRM as a tool for better decision making on right time to get a superior product quality. The Automobile sector cannot neglect the contribution of various suppliers in the industry. Due to this we can easily find the automobile companies putting efforts towards improving their relations with suppliers. The companies are designing and planning different programs & activities to develop and maintain healthy relationship with their suppliers [6]. [7] presents SRM as a way to effectively implement just-in-time mechanism in the company leading to economic benefits to the company. [8] finds SRM as a factor for building trustworthy relation between company and the suppliers. As per his research such relationships are highly valued and useful. This finding is supported by [9] when he presents trust in business as an effective and affordable for saving specific investments of the companies. [10] also supports by his research which says, trust in business avoids any conflicts of interest, goals, and thinking.

3. Research Methodology:

From the Literature review and the survey result of 27 senior management personnel from Original Equipment Manufacturers (OEMs) belonging to Manufacturing, Shop Floor, Quality process, Material and Ancillary Development Department (ADD)/Supplier Quality Improvement Group (SQIG), and 34 Quality /Material Shop Floor /Supplier representatives personnel views we concluded 15 factors which will impact the manufacturing Quality of an automotive supplier. We arranged them in weightage wise after a brainstorming and consensus build up process.

1. Manufacturing Facilities and special equipments 2. Process Control Equipments 3 Control During Processing 4 Quality Planning and change control 5. Shop Lay out and House Keeping 6. Tools, Dies and Fixtures availability 7. Process capability and Statistical Process Control 8. Tool Room Facilities 9. Management of Quality 10. Condition of Machines, tooling and equipments
11. Technical infrastructure for product and process development 12. Control of Purchased Material 13. Inspection facilities 14. Finished product control through Product Part Approval Process (PPAP) and Measurement System Analysis (MSA) 15. QMS (Quality Management System)

3.1 ISM approach:

ISM offers a qualitative modelling language for structuring complexity and enables a group of users to map their thinking on an issue by building an agreed structural model through expert opinion. The ISM methodology consists of the following important steps.

a. development of structural self-interaction matrix
b. construction of reachability matrix
c. carrying out level partitions
d. obtaining classification of factors
e. formation of interpretive structural model.
Hence an ISM approach was attempted for Supplier Relationship Management towards Quality Management System Development taking these afore mentioned 15 factors of Manufacturing Quality in Automotive Manufacturing Industries.

TABLE: 1 Structural self-interaction matrix (SSIM)

| SL No | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 |
|-------|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|
| 1     | V  | V  | V  | O  | V  | V  | V  | O  | O  | V  | O  | O  | X  | A  |
| 2     | A  | V  | A  | O  | O  | O  | X  | O  | O  | X  | O  | V  |
| 3     | X  | O  | O  | A  | O  | A  | V  | O  | O  | X  | O  | O  |
| 4     | O  | A  | V  | A  | O  | A  | O  | A  | O  | A  | A  |
| 5     | O  | O  | V  | V  | O  | A  | V  | O  | O  | V  |
| 6     | V  | V  | V  | X  | A  | A  | V  | O  | O  |
| 7     | O  | O  | O  | O  | V  | A  | O  | V  |
| 8     | O  | V  | O  | O  | A  | A  | V  |
| 9     | V  | A  | V  | A  | V  |
| 10    | V  | V  | V  | V  |
| 11    | V  | V  | O  | A  |
| 12    | O  | V  | V  |
| 13    | V  | A  |
| 14    | V  |
| 15    | V  |

V: Parameter I will influence Parameter j;
A: Parameter j will influence parameter I;
X: Parameter I and j will help influence each other; and
O: Parameter I and j are unrelated.
The following will explain the use of Symbols V, A, X and O in SSIM (Table 1). Based on similar contextual relationships, the SSIM is developed for all the 15 Parameters identified for the QMS (Table 1). The SSIM is transformed into a binary matrix, called the initial reachability matrix by substituting V, A, X, O by 1 and 0 as per the case.

Reachability matrix for the Parameters is shown in Table 2.

From the final reachability matrix, the reachability set, the antecedent set and the intersection set can be found. The factor for which the reachability and intersection set are the same is the top level factor. Once this is identified, it should be separated from the other factor and hence next level factor and the diagraph and final model.
TISM is interpretive in nature as the opinions of the experts’ group determine how the different elements are connected and why these are supposed to connect in that way;

1. It is a modeling technique, as the contextual relationships, entire structure and interpretation for direct as well as significant transitive linkages are depicted by a digraph model;
2. It assists in portraying a complicated system in a simple manner;
3. It is developed to overcome the key drawback of ISM, i.e. poor interpretation of the links, by employing interpretive matrix;
4. It is exploited to transform imprecise and feebly articulated rational models of different systems into unambiguous and straightforward models and hence facilitates in answering “what,” “why” and “how” in theory building; and
5. It provides interpretation for both the links and nodes in the structural model.

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Further, the second objective of this study is accomplished by reviewing the existing literature and acquiring the experts’ opinions. The last objective is achieved by applying TISM to develop a hierarchy-based model for inhibitors of improving SRM towards improving product quality. The methodology of ISM is reassessed and advanced to TISM approach by integrating the interpretation for all the nodes and links in the structural model. In the present study, we highlight the significance of TISM approach over ISM approach to exemplify its ability to provide absolute interpretation. Further, the novelty of this research lies in the identification of inhibitors, which restrain the development.

In our study, it is found from experts suggestion that process controls of equipments and control during the process are the same factors that is explained by process capability and statistical process
control. So, further analysis is done by TISM by logically excluding these two factors and reachability matrix developed. So lastly a TISM Model is developed in Figure.2.

![TISM Model](image)

**Figure 1: Interpretive Structural Modelling**

**Results and Discussions:**
Table 1 and 2 identifies the hierarchy of actions and pin points the relative importance and interdependencies among the critical factors.
Identified factors at the bottom of the model are driving power which will help the industry to attain the desired goal and are also named as independent drivers. Factors i.e QMS, product control through PPAP and MSA are dependent factors most cherished by the top management of any manufacturing industry. Manufacturing facilities, Technical infrastructure, Conditions of machines, tooling and equipment coupled with layout and Housekeeping are the basic pillars and have a great impact on other significant factors having a bearing with long term objective.

In order to meet the stiff competition, it is of paramount importance that all components are of consistent Quality which is the chief focus of QMS.

Above identified parameters pave the way for a self assessment and a gap analysis thereof to attain the World Class Quality by bridging the anomaly if any.

Figure 2: Total Interpretive Structural Modelling (TISM)
Conclusion:

Fifteen factors were identified from the literature and the opinion survey of industry experts and we have developed a structure of interrelationships among the identified factors using an ISM and finally a TISM. The study will help the budding managers in Supply chain management to prioritise the actions needed to establish QMS and achieve the key Manufacturing Quality parameters. Manufacturing Quality score can be deduced attaching suitable weightages to the QMS parameters and OEMs can approve and certify the suppliers as Preferred category of capable suppliers based on their satisfactory findings on above parameters. This also can be used as a preliminary diagnostic checklist to evaluate the preparedness of journey for QMS and figuring out the Opportunities For Improvement towards becoming a World Class supplier with a view to remain competitive in the automotive manufacturing arena. In a nutshell, objective of QMS i.e. Quality consistency and Product Reliability can be brought about through Manufacturing capability up-gradation, Manufacturing Process improvement and Technological enhancement as evident from above analysis.

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