Manufacturing Strategy: Evidences from Indian Automotive Industry

Abstract - Increasing competition is compelling firms continuously to search for new and better methods to reduce the costs and enhance quality. Indian manufacturing companies have quite often followed an opportunistic approach to growth as opposed to a capability driven approach, and paid very little strategic attention to their shop floors in the last few decades. In view of the emerging competitive scenario, it is envisaged that manufacturing strategy is needed for Indian companies. The paper presents findings of a study conducted in Indian automotive industry. In this research a structured questionnaire methodology is used to assess various manufacturing strategy issues through exploratory survey followed by three case studies. Final version of questionnaire is administered in 150 automotive manufacturing companies in all parts of India and 66 filled responses (with 44 % response rate) were analyzed. Competitive priorities and advanced manufacturing technologies (AMT) are identified and presented. It is observed that Indian companies are investing more in ‘administrative AMT’ to simplify the system; ‘indirect AMT’ is their second preferred choice to integrate the various systems, and finally to automate the manufacturing systems the companies are investing in ‘direct AMT’. It seems Indian automotive manufacturing companies follow SIA (Simplify - Integrate - Automate) model. The survey findings are validated in three automotive companies through case study methodology.

Keywords - Manufacturing strategy, Automotive industry, Competitive priority, Advanced manufacturing technologies.
Manufacturing industry is made up of many different sectors, each of which is influenced by the overall-manufacturing climate. From the Indian perspective, the major manufacturing sectors are automotive, electronics, machinery, and process industries. Table 1 gives the comparative statistics of all four sectors (Statistical outline of India 1999-2000).

### TABLE 1

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Auto</th>
<th>Elec</th>
<th>Mach</th>
<th>Proc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exports (billion US $)</td>
<td>55</td>
<td>65</td>
<td>6</td>
<td>60</td>
</tr>
<tr>
<td>Percentage of National Export</td>
<td>16.5</td>
<td>18.3</td>
<td>1.6</td>
<td>17.0</td>
</tr>
<tr>
<td>Percentage Market share of primary product</td>
<td>33.6</td>
<td>18.8</td>
<td>28.6</td>
<td>13.8</td>
</tr>
<tr>
<td>Capacity utilization (%)</td>
<td>80.0</td>
<td>69.6</td>
<td>64.2</td>
<td>91.7</td>
</tr>
<tr>
<td>Average manufacturing lead time (days)</td>
<td>19.2</td>
<td>13.3</td>
<td>74.7</td>
<td>30.0</td>
</tr>
<tr>
<td>Foreign Direct Investment (billion US $)</td>
<td>54</td>
<td>60</td>
<td>N/A</td>
<td>3.5</td>
</tr>
</tbody>
</table>

*Auto - Automotive, Elec - Electronics, Mach - Machinery, Proc - Process*

### Indian Manufacturing Industry

Manufacturing industry is made up of many different sectors, each of which is influenced by the overall-manufacturing climate. From the Indian perspective, the major manufacturing sectors are automotive, electronics, machinery, and process industries. Table 1 gives the comparative statistics of all four sectors (Statistical outline of India 1999-2000).

**The Indian Automotive Sector**

The global automotive industry is an important component of industrial and economic progress and its development has characterized global competitiveness of leading industrialized economies. This industry is fairly developed one, and involves huge investments in research and development, and technology. It is also seen as an indicator of the economic progress of the country. An understanding of the automotive industry in some of the developed countries enables one to study the emerging trends in the developing countries.

Since introduction of economic reforms in 1991, Indian companies are facing a very different competitive scenario compared to the past. The abolition of license regime meant end of protection and control measures. Manufacturing in India is at a critical juncture. Generally in Indian perspective manufacturing is a support activity for marketing and finance, and therefore have got little top management attention. Most of companies are still very far from world-class practices. Meanwhile interna-
tional competitors are continuously working on improving manufacturing, bringing in new products and making manufacturing more proactive and responsive (Chandra and Sastry 1998). Indian industry is facing competition both from imports and multinational companies in the domestic markets. The new competition is in terms of reduced cost; improved quality, products with higher performance, a wider range of products and better service, all delivered simultaneously. The automotive industry is no exception to this. Here the term “automotive industry” is used to include two wheeler, four wheeler (passenger cars) and auto component manufacturers. Table 1 shows various phases undergone in Indian auto industry.

In addition, Indian automotive industry has witnessed entry of global players such as Ford, General Motors, Suzuki, Honda, Mercedes, Daewoo, Santro etc. in four wheeler segment, whereas Piaggio, Suzuki, Honda, Yamaha, Kawasaki etc. in two wheeler segment. The Indian market for two wheelers is the second largest in the world after China. Scooters represented 45% of these unit sales, motorbikes 37%, and mopeds 18%. The two wheeler industry today has a significant role in the Indian economy. With an annual turnover of 155 billion US $ and a compounded average growth rate of 10% in recent years, it is one of the few industrial sectors in the growth phase today (Kumar 1998).

In this study, following research questions relating to Indian automotive manufacturing companies were explored through survey and case studies:

- What are competitive priorities of Indian automotive manufacturing companies?
- Which advanced manufacturing technologies (AMT) are important for this sector?
- What are the trends in adopting of advanced manufacturing technologies?
- How AMT are implemented?

**Scale Development and Research Propositions**

Skinner (1969) gave the concept of manufacturing strategy. According to him “manufacturing strategy” refers to exploiting certain properties of the manufacturing function as a competitive weapon. After Skinner’s (1969) landmark article, manufacturing strategy has received lot of attention from various researchers. Various researchers (Skinner 1969; Hill 1989; Gerwin 1993) elaborated on customer expectations on attributes such as cost, quality, delivery, and flexibility, which are popularly termed as competitive priorities or manufacturing performance objectives. Competitive priorities have been established as a major building block in manufacturing strategy research (Hayes and Wheelwright 1984; Gerwin 1993; Upton 1994).

Hill (1989) introduced the concept of order winners and order qualifiers and differentiated between them. Order winners are those things, which directly and significantly contribute to winning business. Customers regard them as the key reasons for purchasing the product or service. Order

<table>
<thead>
<tr>
<th>Year</th>
<th>Phase</th>
<th>Characteristics Two Wheelers</th>
<th>Passenger Cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1950-1980</td>
<td>Phase of limited supply</td>
<td>- Long waiting list</td>
<td>- Limited buying capacity of consumers</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Huge pent up demand</td>
<td>- Limited number of companies</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Limited companies</td>
<td></td>
</tr>
<tr>
<td>1981-1990</td>
<td>Phase of take off</td>
<td>Entry of new global players such as Suzuki, Kawasaki, Honda, Piaggio etc</td>
<td>Entry of new global players such as Hyundai, Daewoo, Toyota, Ford, Mercedes Benz etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Rapid acceptance in urban &amp; rural markets</td>
<td>- Increase in buying capacity of consumer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Average growth rate 20% p.a.</td>
<td>- Easy finance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- More variety</td>
</tr>
</tbody>
</table>
qualifiers are those criteria that a company must meet for a customer even to consider it as a competitor. In addition, Hill (1989) suggested structural and infrastructural issues as two pillars of manufacturing strategy. Structural issues sets the process and technology for operations whereas infrastructure provide it long term competitive edge by continuously improving upon human resource policies, quality management systems, organization culture, and information technology.

Advanced manufacturing technologies (AMT) are action plans in which a company invests to improve upon its structure and infrastructure. AMT are often regarded as “ready-to-wear” sets of structural and infrastructural issues. A company selects the AMT in order to build the manufacturing capabilities required by the market (Kim and Arnold 1996). Advanced manufacturing technologies are used for operationalising the manufacturing strategy.

Many researchers conducted surveys in developed and developing countries to assess manufacturing strategy issues. In Indian context reported studies (Chandra and Sastry 1998; Nagabhushana and Shah 1999; Korgaonker 2000; Dangayach and Deshmukh 2001; Dangayach and Deshmukh 2006) were general. There is still lack of in-depth sector specific study especially for automotive sector in developing country like India. This research aimed to fill this gap. Key manufacturing strategy issues are given below.

**Competitive Priorities**

Manufacturing capabilities represent a holistic set of tasks, which should be performed by the manufacturing function in order to support the business strategy; and the degree of relative emphasis given to each of them represents manufacturing’s competitive priorities. Various researchers (Hayes and Wheelwright 1984; Hill 1989; Gerwin 1993; Kim and Arnold 1996) described four distinct competitive priorities—cost, quality, flexibility, and delivery.

**Proposition 1:** Quality, delivery, flexibility, and cost form the basic dimensions of manufacturing priorities for Indian automotive companies.

**Competitive Progression Theory**

According to this theory, competitive capabilities (quality (Q), delivery (D), flexibility (F), and cost (C)) accumulate in a sequential progression forward-from quality to delivery to flexibility to cost-over an innovation cycle (Roth 1996). Competitive progression theory posits that quality is a prerequisite for the long-term capability development. The pursuit of quality affords effective and efficient approaches to process variance reduction and organizational learning (continuous improvement). Changing one capability will automatically impact the others e.g. if a company is working toward six sigma product quality, a portion of this effort transfer into better delivery, since there is less rework, better process predictability, and more residual organizational energy to devote to delivery. Therefore, \( a_i = \text{capability specific process properties,} \ i = 1 \text{ to } 4 \text{ for } Q, D, F, \text{ and } C \text{ respectively. For consistent, on-time deliveries, more extensive process predictability is required. Quality and delivery pave the way for flexibility. Therefore, } (a_i, a_j) \text{ for } Q, D, F, \text{ and } C \text{ respectively.} \)

Based on the literature (Clark 1996; Udo and Ehie 1996), and discussions with practitioners a set of 16-items is identi-
fied to measure investment in advanced manufacturing technologies, relevant for Indian companies to address issues in manufacturing strategy (Appendix A). These advanced manufacturing technologies (AMT) were classified into direct AMT (DAMT), indirect AMT (IAMT), and administrative AMT (AAMT). It must be mentioned that this set is by no means an exhaustive set of activities. However, it captures the essence of advanced manufacturing technologies as practiced by Indian automotive companies.

Hardware base technologies termed as direct AMT. Software based technologies used for product design and scheduling are termed as indirect AMT, however administrative AMT are used for integration and simplification of business processes.

- Direct AMT: Technology used on the factory floor to cut, join, reshape, transport, store or modify materials e.g. CNC, DNC, robotics, FMS, AS/RS, AMHS, AGV, RP etc.
- Indirect AMT: Technology used to design products and schedule production e.g. CAD, MRP, SPC, BC, MRP II etc.
- Administrative AMT: Technology used to give administrative support to the factory and integrate its operations with the rest of the organization e.g. ERP, ABC, OA etc.

Based on the above discussion, the following proposition is formulated

**Proposition 3: Indian automotive companies are investing more in administrative AMT (AAMT) as compared to direct AMT (DAMT) and indirect AMT (IAMT).**

**AMT Implementation Steps**

Based on literature (Badiru 1990; Schroder and Sohal 1999; Efstahiades, Tassou, and Antoniou 2002) eight steps are identified for effective AMT implementation. These eight steps are ‘planning’, ‘concept development’, ‘requirement analysis’, ‘cost/benefit analysis’, ‘technology assessment’, ‘development and implementation’, ‘training’, ‘post-implementation evaluation’. Companies with varying importance use these steps. This discussion leads to formulation of proposition 4.

**Proposition 4: Indian automotive companies are using AMT implementation steps by giving varying importance.**

Above four propositions are framed based on gaps identified in the literature. These are related to various issues in manufacturing strategy. The aim is to test these propositions through a survey of Indian automotive manufacturing companies. The research design can be summarized in Table 3.

<table>
<thead>
<tr>
<th>Proposition</th>
<th>Focus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposition 1</td>
<td>Identification of competitive priorities</td>
</tr>
<tr>
<td>Proposition 2</td>
<td>Companies follow competitive progression</td>
</tr>
<tr>
<td>Proposition 3</td>
<td>Advanced Manufacturing Technologies</td>
</tr>
<tr>
<td>Proposition 4</td>
<td>Relative importance to AMT implementation steps</td>
</tr>
</tbody>
</table>

**Research Methodology**

The purpose of this study is to gain in-depth understanding of manufacturing strategy (MS) practices in Indian automotive companies through survey and case studies. The objective of survey is to examine the status of manufacturing strategy in Indian automotive manufacturing companies. A database of 150 automotive sector companies has been extracted from all over the country from the CII (Confederation of Indian Industry) Industrial directory. Selection criterion was based on two parameters i.e. number of employees (≥ 100) and annual sales (≥ 0.25 million US$).

Case studies provide an in-depth, relatively unstructured, approach to develop frameworks and theories. The case studies were intended to aid in development and enrichment of the conceptual framework, thus enhancing its exploratory and prescriptive characteristics. Yin (1989) comments, the case method is suited to situations where the researcher is attempting to answer a “how?” question as well as or instead of a “what?” question. Case studies are longitudinal in nature and one attribute is to be discussed with more than one manager for collection of data, therefore non-response bias is reduced to minimum. Various researchers used case study for their research (Maruchek, Pannesi, and Anderson 1990; Shrivastava 1995; Cheng and Musaphir 1996; Menda and
Three automotive manufacturing companies were selected for case study. These include one company that is a leading four wheeler manufacturer (labeled as company A), and other two companies are two-wheeler manufacturer (labeled as Company B & C). The indicative research questions involved in the case study are:

- Manufacturing mission/vision
- Methodology used for formulation and implementation of manufacturing strategy
- How is MS formulated?
- How is MS related to marketing strategy?
- Who is responsible for the formulation of the strategy?
- How is MS related to corporate strategy?
- Competitive priorities of the companies
- Order winners/order qualifiers
- Critical success factors

**Development of Questionnaire**

Based on the literature and study of Indian automotive industry a questionnaire was designed. The questionnaire has been developed on a five point Likert scale. The questionnaire contained two sections ‘A’ and ‘B’. Section ‘A’ contained questions, pertaining to company profile and section ‘B’ contained questions related to competitive priorities, Advanced Manufacturing Technologies, order winners etc. The questionnaire also contained a few yes/no types of items and a few open-ended items to elicit the response.

**Content Validity**

Flynn et al. (1990) and Malhotra and Grover (1998) identified norms for survey research. These norms were followed in the present research. The unit of analysis in this study is a company. A company is the highest level where manufacturing strategy is integrated with marketing strategy. In our survey majority of respondents were of Vice President/Divisional Manager/Works Manager/Production Manager level and thus appropriate for research questions. Both multi-item and single item questions were included as suggested by Malhotra and Grover (1998). To reduce sampling error, a random sample of 150 companies was drawn and response rate was higher than 20% as suggested by Malhotra and Grover (1998).

To assess the content validity a “dry run” was made and few questionnaires were pilot-tested with leading practitioners, consultants and academicians. Based on their feedback, the present form has been evolved and final version of the questionnaire was sent.

**Reliability Analysis**

Inter-item analysis is used to check the scales for internal consistency or reliability. Cronbach’s coefficient alpha is calculated for each scale, as recommended for empirical research in operation management (Flynn, Sakakibara, Schroeder, Bates, and Flynn 1990; Malhotra and Grover 1998). SPSS for windows package (version 10) is used for calculation of Cronbach’s Alpha. Cronbach’s alpha values are calculated for 66 responses received. Values for few items appeared less than 0.5 and thus these scales were excluded from analysis. Cronbach’s alpha values more than 0.5 are considered adequate for the exploratory work (Nunally 1978).

**TABLE 4**

Statistics of the Respondent Companies

<table>
<thead>
<tr>
<th>Number of employees</th>
<th>Respondent companies (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 100</td>
<td>09 (12)</td>
</tr>
<tr>
<td>2. 101-500</td>
<td>10 (15)</td>
</tr>
<tr>
<td>3. 501-1000</td>
<td>16 (24)</td>
</tr>
<tr>
<td>4. 1001-3000</td>
<td>25 (38)</td>
</tr>
<tr>
<td>5. 3001-5000</td>
<td>07 (11)</td>
</tr>
<tr>
<td>Total</td>
<td>66 (100)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Annual Sales (million US $)</th>
<th>Respondent companies (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 0.25-1.25</td>
<td>07 (11)</td>
</tr>
<tr>
<td>2. 1.25-2.5</td>
<td>10 (15)</td>
</tr>
<tr>
<td>3. 2.5-12.5</td>
<td>15 (23)</td>
</tr>
<tr>
<td>4. 12.5-25</td>
<td>12 (18)</td>
</tr>
<tr>
<td>5. &gt; 25</td>
<td>22 (33)</td>
</tr>
<tr>
<td>Total</td>
<td>66 (100)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exports (% of total sales)</th>
<th>Respondent companies (in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Nil</td>
<td>24 (37)</td>
</tr>
<tr>
<td>2. 10%</td>
<td>30 (45)</td>
</tr>
<tr>
<td>3. 10-20 %</td>
<td>05 (7)</td>
</tr>
<tr>
<td>4. 20-30 %</td>
<td>04 (6)</td>
</tr>
<tr>
<td>5. &gt; 30 %</td>
<td>03 (5)</td>
</tr>
<tr>
<td>Total</td>
<td>66 (100)</td>
</tr>
</tbody>
</table>

Figures in **bold** refers to modal responses
Questionnaire Administration

Final version of the questionnaire was sent to CEO of 150 Indian automotive manufacturing companies. After the reminders, phone calls, e-mail and re-reminders, 66 filled responses have been received, which gives 44% response rate. Table 4 gives the statistics of the respondent companies. Average profile of the respondents is given in Table 5.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sample average</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age of respondents</td>
<td>40.4 years</td>
<td>[27, 52]</td>
</tr>
<tr>
<td>Experience</td>
<td>18.3 years</td>
<td>[5, 30]</td>
</tr>
<tr>
<td>Number of employees</td>
<td>1350</td>
<td>[100, 5000]</td>
</tr>
<tr>
<td>Annual sales</td>
<td>&gt; 14 million US $</td>
<td>[0.25, &gt;25]</td>
</tr>
<tr>
<td>Exports</td>
<td>&lt; 9% of total sales</td>
<td>[0, &gt;30]</td>
</tr>
</tbody>
</table>

Competitive Priorities

Table 6 shows the mean and standard deviation of competitive priorities i.e. quality, delivery, flexibility, and cost. For each priority, respondents were asked to indicate the degree of importance on a five point Likert scale (1 - least important, 5 - most important). Table 6 depicts that top most competitive priority is quality. Flexibility and cost are the least preferred competitive priority for Indian automotive manufacturing companies. The above results support the Propositions 1. Table 7 shows the correlation between 4-items of competitive priorities. All competitive priorities are significantly correlated ($p \leq 0.05$) with other priorities. The correlations imply that the manufacturing companies in the survey are strongly emphasizing on these competitive priorities. The Cronbach’s alpha for the scale is 0.7898, which indicates a high level of internal consistency among items (Nunally 1978).

<table>
<thead>
<tr>
<th>Competitive Priorities</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality</td>
<td>4.65</td>
<td>0.91</td>
<td>1</td>
</tr>
<tr>
<td>Delivery</td>
<td>4.36</td>
<td>1.03</td>
<td>2</td>
</tr>
<tr>
<td>Flexibility</td>
<td>3.93</td>
<td>1.12</td>
<td>3</td>
</tr>
<tr>
<td>Cost</td>
<td>3.52</td>
<td>1.22</td>
<td>4</td>
</tr>
</tbody>
</table>

**italics - Highest score**

Competitive Progression Theory

It is observed from Table 6 that Indian automotive manufacturing companies (n=66) are giving importance to quality, delivery, flexibility, and cost in descending order. This supports the competitive progression theory (Figure 1) proposed by Roth (1996). Presently, Indian manufacturing companies are trying to achieve superior quality, then delivery, flexibility, and cost respectively. Roth (1996) empirically tested this theory in US, Japanese, and European samples and observed strong support to the competitive progression theory. Indian companies are not following a similar path i.e. quality to delivery to flexibility to cost. Therefore it can be said that Indian companies although started late, but moving in similar direction as that of their counterparts in developed economy. This supports Proposition 2.

Advanced Manufacturing Technologies (AMT)

Based on the literature, 16 AMT were identified for the Indian companies to address issues in manufacturing strategy. These include Direct AMT (DAMT- 8 items), Indirect AMT (IAMT-5 items), and Administrative AMT (AAMT-3 items). A detailed list and explanation of each AMT is given in (Appendix A). Respondents were asked to indicate degree of investment in above AMT in their companies on a five point Likert scale (where 1 - No investment and 5 - 100% investment). Table 8 shows the mean and standard deviation for these 16 AMT. Overall mean score is represented for all three AMT i.e. DAMT (overall mean=2.50), IAMT (overall mean=3.09), and AAMT (overall mean=3.16). It is observed that Indian automotive companies are investing more in administrative AMT and the least preferred is direct AMT. It seems that automotive sector companies have started restructuring themselves to keep pace with the global competition. The above results support proposition 3.
**Direct AMT (DAMT)**. Figure 2 represents normalized results for the mean score of eight direct AMT as responded by Indian automotive companies. A normalized score is calculated by finding the difference between a score of each activity and the average of all activities. For example, the mean score of CNC is 3.24 and average of 1-5 Likert scale is 3, thus normalized score for CNC is (3.24-3)/2 i.e. 0.12. This procedure eliminates the inter-company bias i.e. some respondents tend to assign higher values to all activities than other respondents (Kim and Arnold 1996). If the normalized score is positive, it is inferred that the company has preferred more investment in that activity as compared to other negative scored activities. Figure 2 shows that normalized score for computer numerical control (CNC) is positive others are negative. It reflects that the most preferred DAMT is computer numerical control (CNC, mean=3.24), whereas the least preferred DAMT is automated guided vehicle (AGV, mean=2.07).

Table 9 shows the correlation between 8-items of direct AMT. All DAMT are significantly correlated (p ≤ 0.05) with each other except AGV and CNC. The correlations imply that the manufacturing companies are emphasizing on these activities. The Cronbach’s alpha for the 8-item scale is 0.8946, which indicates a high level of internal consistency among the items.
To eliminate inter-company bias, a normalized score is calculated by finding the differences between a score of each activity and the average of all activities.

**Indirect AMT (IAMT).** Figure 3 shows the normalized results for the mean score of each 5 indirect AMT. It is observed that Material requirement planning (MRP) is the top preferred indirect AMT (mean=3.42). MRP is the first step in the integration of various engineering departments. Therefore, it seems that Indian companies have realized the importance of this and have started integrating their functions. MRP is also important in the present era of supply chain management. Table 10 shows the correlation between 5-items of IAMT. All IAMT are significantly correlated (p ≤ 0.05) with other except bar coding (BC). Bar coding have insignificant correlation with SPC, MRP and MRPII. The Cronbach’s alpha for the 5-item scale is 0.7433, which indicates a high level of internal consistency among items.

**Administrative AMT (AAMT).** Mean score for 3-items of AAMT is given in Table 8. It is observed that companies are investing highly in office automation (OA) activities (mean = 3.45). This activity got highest mean score among all 16 items of AMT i.e. direct AMT, indirect AMT, and administrative AMT. Figure 4 shows the normalized results for the mean score of 3 administrative AMT. Table 11 shows the correlation between 3-items of AAMT. Only activity based costing (ABC) is significantly correlated (p ≤ 0.05) with enterprise resource planning (ERP). The Cronbach’s alpha for the 3-item scale is 0.5247, which is more than 0.5 as suggested by Nunally (1978).

**AMT implementation steps.** Respondents were asked to give importance to these eight implementation steps on five point Likert scale (Interval scale 1-5: 1 - least important and 5 - most important). Table 12 gives mean and standard deviation values. It is observed from Table 12, that ‘development and implementation’ step is most important and ‘requirement analysis’ is the least important AMT implementation step for
Indian automotive manufacturing company. This supports proposition 4.

Correlation between eight AMT implementation steps is given in Table 13. It is observed that all AMT implementation steps are positively correlated and significant at the 0.01 levels. Correlation between ‘planning’ and ‘concept development’ is the highest (0.84), however correlation between ‘planning’ and ‘training’ is the lowest (0.418). It seems true because concept development is not possible without proper planning.

<table>
<thead>
<tr>
<th>AMT implementation steps</th>
<th>Mean (N = 66)</th>
<th>Standard deviation</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIS 1</td>
<td>3.92</td>
<td>1.22</td>
<td>2</td>
</tr>
<tr>
<td>AIS 2</td>
<td>3.70</td>
<td>1.24</td>
<td>7</td>
</tr>
<tr>
<td>AIS 3</td>
<td>3.58</td>
<td>1.30</td>
<td>8</td>
</tr>
<tr>
<td>AIS 4</td>
<td>3.81</td>
<td>1.18</td>
<td>4</td>
</tr>
<tr>
<td>AIS 5</td>
<td>3.84</td>
<td>1.24</td>
<td>3</td>
</tr>
<tr>
<td>AIS 6</td>
<td>4.00</td>
<td>1.17</td>
<td>1</td>
</tr>
<tr>
<td>AIS 7</td>
<td>3.80</td>
<td>1.09</td>
<td>5</td>
</tr>
<tr>
<td>AIS 8</td>
<td>3.80</td>
<td>1.22</td>
<td>6</td>
</tr>
<tr>
<td>Overall statistics</td>
<td>3.80</td>
<td>1.20</td>
<td></td>
</tr>
</tbody>
</table>

TABLE 12
AMT Implementation Steps

**Correlation is significant at the 0.01 Level (2-Tailed)**

Company ‘A’

The Setting. Company ‘A’ is a leading manufacturer of all types of four wheeler vehicles. It produces a wide range of diesel commercial vehicles (heavy, medium and light commercial vehicles) and passenger cars. It manufactures 24 models of these vehicles. The company is the largest motor vehicle manufacturer in India and sixth largest commercial vehicle manufacturer in the world. It was established in 1945 and belongs to a giant industrial group of India, which produces diverse range of product in the plants all over the country. The company operates in multi-plant environment with 3 plants in various parts.

The Cases

Three cases are investigated with a focus on the items as given in Table 14.

TABLE 14
Research Focus

**Italics - Highest score**

<table>
<thead>
<tr>
<th>Item</th>
<th>How it is obtained</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing mission/Vision</td>
<td>From published reports, discussions</td>
</tr>
<tr>
<td>Formulation and implementation</td>
<td>From brainstorming sessions/meetings involving manufacturing and marketing managers</td>
</tr>
<tr>
<td>of MIS</td>
<td></td>
</tr>
<tr>
<td>Organization structure</td>
<td>Discussions with respondents</td>
</tr>
<tr>
<td>Competitive priorities</td>
<td>Through discussions and filled questionnaire</td>
</tr>
<tr>
<td>Order winners/order qualifiers</td>
<td>Identified by managers during discussions</td>
</tr>
<tr>
<td>Improvement activities</td>
<td>Through discussions and observations</td>
</tr>
<tr>
<td>Critical success factors</td>
<td>Identified by managers</td>
</tr>
<tr>
<td>Human resource policy</td>
<td>Discussions with personnel manager and labor representatives</td>
</tr>
<tr>
<td>Business performance measures</td>
<td>Drawn from annual audited reports and published documents</td>
</tr>
</tbody>
</table>

TABLE 13
Correlation among AMT Implementation Steps

**Correlation is significant at the 0.01 Level (2-Tailed)**

AIS 1 - Planning
AIS 2 - Concept development
AIS 3 - Requirement analysis
AIS 4 - Cost/benefit analysis
AIS 5 - Technology assessment
AIS 6 - Development & implementation
AIS 7 - Training
AIS 8 - Post-implementation evaluation
of the country. It enjoys 60% market share in domestic market for light commercial vehicles and 72% in medium and heavy commercial vehicles. Annual turnover of the company is 500 billion US $. The company exports are about 30% of total sales. It exports its products to the countries such as Paraguay, Hungary, Argentina, and Chile.

Vision. To develop the company with excellent capabilities in design, engineering, manufacturing and marketing.

Mission. To be a leader in all types of vehicle manufacturer

Marketing strategy: The company sets high target for future. The company focuses at a time one-market segment, develop capability and then move into the next segment, taking advantage of previous one. It is reflected with following facts:

• From 1956~1985: devoted to development of heavy commercial vehicles (trucks and buses).
• 1986~1993: development of light commercial vehicles (diesel Jeep type four wheelers)
• 1994 onwards: development of diesel passenger car (1000 cc four door car)

Corporate strategy:
• Develop indigenous competence with acquisition of technology from abroad
• Upgrade the manufacturing technology
• Producing a variety of products which can cater to all major segments
• Development of a large dealer network
• Systematic human resource development
• Continue investment in research and development

Manufacturing strategy development methodology: The company has an informal method of formulation of manufacturing strategy (MS) in line with marketing strategy. Figure 5 shows the process of manufacturing strategy formulation method of the company ‘A’. Vital elements of its MS are

• High investment in advanced manufacturing technology such as CAD, CAM, Shop floor automation, and concurrent engineering.
• Emphasis on continuous improvement of manufacturing system
• High innovation rate, (the company has its own engineering research center with 1100 employees. It’s R & D expenditure is about 50 million US $.

Human resource policy:
• The company had established a full fledge training center in eastern part of the country in 1966.
• Linked career progress with skill development
• Recognition of employees for excellent work

Competitive priorities.
Rank wise competitive priorities of the company ‘A’ are:
• Quality
• Delivery speed
• Low cost
• Flexibility

Order qualifiers.
• Technology leadership
• On time delivery
• Product quality

Order winners.
• User friendliness
• Cost effectiveness
• After sales management

Critical success factors.
• Excellent dealer network all over the country
• Clarity of vision
• Brand image
• High quality of products
• Good after sales service
• Investment in core technology
• High innovation rate

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Continuous improvement of manufacturing
Strong customer focus

Company ‘B’

The Setting. Company ‘B’ is one of the oldest two-wheeler automobile manufacturing company (established in 1945). It belongs to a big industrial group and operates in a multi-plant environment (two plants). Other companies of this group produce electrical appliances, sugar etc. Both plants of the company ‘B’ are located in central part of India. The company produces two wheeler (9 models) and three wheeler (3 models) vehicles. Two wheelers include Scooters (5 models), two stroke and four stroke Motorbikes (3 models), and Mopeds (1 model). In 1960 the company came into technical collaboration (for scooter manufacturing) with a leading Italian two wheeler manufacturing company. In 1984 it entered in motorbike and moped production segment after technical collaboration with Japanese two wheeler giant. In 1985 it established second plant after relaxation in industrial policy. With 11000 employees, it enjoys 40 % market share in two wheeler segments. Presently the company ‘B’ is the 3rd largest manufacturer of two and three wheeler vehicles in the world and has 15% exports of total sales.

Previous approach. During 1950-1980, an era of limited supply, government’s industrial policy was restrictive and regulative, therefore company’s production was very less than demand. During this period waiting list for scooters was 10 years. Being the oldest company in two wheeler sector, the company enjoyed monopoly status in earlier years. Initially the company did not have a marketing department since demand outstripped capacity and it enjoyed a protected seller’s market. Therefore it had no specific strategy till 1980s. After relaxation in industrial policy many new companies have entered in this sector with Japanese collaboration. In 1980s company grown explosively and its production volume increases from 172 to 800 thousand units a year.

Due to increased competition the company created a marketing department (in 1993), which focused on increasing annual sales to 1 million units. The company decided to modernize plants and increase production efficiency. It invested in advanced manufacturing technologies (AMTs) such as CAD, CAM, CNC machines etc. and framed a marketing strategy

Vision. To become market leader in two wheeler segments.

Mission. To provide low cost, fuel efficient two wheelers to customers.
Elements of marketing strategy:
- Increase dealer network all over the country including rural area.
- Dealers are not to be permitted to have other two wheeler brands.
- Periodically introducing new product (company increased its models from 5 in 1985 to 12 in 1992)
- 50 % components to be produced through vendors.
- To improve product distribution and service network by deploying 50 service engineers at dealership to upgrade the technical capability of dealer service personnel.
- To provide service and advertising support to the dealers, by giving training to their staff in company’s plants.
- To sell the product at competitive price i.e. lowers than competitors.
- Increase investment in advertising and describe additional features.
- To address competitor claims head on.
- To start its own financing company to finance the vehicles.

Manufacturing strategy development methodology:
After setting up of marketing department, CEO of the company discussed with key marketing managers and framed a manufacturing strategy. Figure 6 shows the manufacturing strategy development procedure of the company A. Essential features of its manufacturing strategy are:
- Speed up the new product development by using AMT’s like CAD, CAM.
- Mission of manufacturing is continuous improvement with zero defects.
- Quality circles to be established to get suggestions for improvement at shop floor.
- Matching competitor product features by constantly improving existing product.

After implementation of manufacturing and marketing strategy company improved its lost market share. It increased its dealer network. The company had computerized distribution system with 30 % of dealers connected through network and orders were directly fed into company’s production schedule.

Competitive priorities.
Rank wise competitive priorities of the company are:
- Low cost
- Quality
- Delivery speed
- Flexibility

Order qualifiers.
- Low cost
- Product durability
- Resale value

Order winners.
- Brand image
- New product development
- User friendliness
- Cost effectiveness
- After sales management

Critical success factors.
- Product durability
- Large and loyal dealer network
- Brand image
- Advertising
- Economic price
- Use of AMT
- Better HR policy

FIGURE 7
Manufacturing Strategy Formulation at Company ‘C’
Company ‘C’

The setting. The Indian market for two wheelers is the second largest in the world after China. Scooters represented 45% of these unit sales, motorbikes 37%, and mopeds 18%. Indian two wheeler industry has witnessed a proliferation of entrants into this sector following the liberalization of the economy. The major two wheeler manufacturers of the world such as Kawasaki, Honda, Piaggio, Yamaha etc. have entered into the Indian two wheeler market. The two wheeler industry today has a significant role in the Indian economy. With an annual turnover of 155 billion US $ and a compounded average growth rate of 10% in recent years, it is one of the few industrial sectors in the growth phase today. The consumer who wants to be mobile today considers personal transportation as one of his/her basic needs. In India two wheeler is used for a variety of purposes, particularly in urban areas like commuting to work, visiting people, carrying loads, for outdoor jobs etc. as opposed to the leisure/fun use common in developed countries. In rural areas, where the rough road conditions requires a sturdy vehicle, it enables people to travel more frequently to nearby towns for their daily needs. Younger, single male consumers, between 21 and 30 years of age, looks for power and style, prefer a motorbike for his personal transport. A series of favorable climatic conditions for agricultural commodities have increased the purchasing power of rural customers. Today the rural market of over six lakh Indian villages contributes about 35% of two wheeler sales.

The company ‘C’ operates in a multi-plant and multi-divisional environment in northern India. It has collaboration with a leading Japanese motorbike company with 26% equity share and produces four models of 4-stroke motorbike (coded as MB1, MB2, MB3 and MB4). The company was established in 1983 and its production rate is 1000 motorbikes/day. Present turnover of the company is 18 billion US $ and market share (Indian) is about 45% in 100 CC motorbike segment. The company has about 3000 employees.

Previous approach. Before liberalization (1991) in India, company ‘C’ was following industry practice due to license regime in India. Much of the time was spent in moving papers from one department to other. The total production of vehicles was 42000 per year, whereas booking of vehicles was nearly 5,00,000. The decision making process was centralized due to rigid vertical integration.

Present approach. After liberalization, due to intense competition, spurred by entry of multinationals, CEO of the company in consultation with group and division heads set a vision and mission for the company.

Vision. To be the leader in motorbike sector by following world class practices.

Mission. Continue efforts for the development of motorbike industry through new product development, technological innovation, investment in equipments, facilities and efficient management.

Develop core competencies and human resource to become market leader in economic and dependable transport system.

The firm has developed a testing facility spending 1% of total sales on research and development in which 90% of the testing is done locally. Most of the machines are computer numerical control (CNC) type.

Manufacturing strategy development methodology. Figure 7 shows the formal procedure of manufacturing strategy development at Company ‘C’. Broad corporate strategic objectives are formulated at corporate level, which provides a set of expectations for lower level strategy formulation such as marketing and manufacturing strategies. Plant level manufacturing strategy is being formulated by manufacturing personnel of various plants, which sets the norms for division level manufacturing strategy. Assessment of manufacturing objectives is made through a monthly meeting of division heads.
Observations. After liberalization in India (1991) i.e. after 8 years of establishment, company ‘C’ has started thinking rationally towards alignment of manufacturing and marketing strategy. It is clear with the statement that inspite of having good demand (5,00,000 units) firm could produce only 42,000 vehicles in a year. After having clear cut vision and mission and top management commitment company developed a manufacturing strategy which states develop enough technological capabilities to take maximum leverage from the resources committed to the technology of the firm’s products and processes. To support this strategy and to meet the market demand, decision was made to start one more unit within 50-km area of existing plant.

Order qualifiers:
- Competitive price
- On time delivery
- Product quality
- Useful life.

Order winners:
- Excellent mileage
- New product development
- User friendliness
- After sales management

Concluding Remarks

In this research effort, a survey of Indian automotive manufacturing companies is conducted to study several manufacturing strategy issues followed by development of cases. Responses were analyzed for various structural and infrastructural issues of manufacturing strategy such as competitive priorities (quality, flexibility, cost, and delivery) Advanced Manufacturing Technologies (direct AMT, indirect AMT, and administrative AMT) based on 66 responses. It is observed that the Indian manufacturing companies are emphasizing more on quality and the least on cost. It seems that Indian companies follow a progressive path to achieve competitive advantage i.e. quality to delivery to flexibility to cost. Indian companies are investing in Advanced Manufacturing Technologies i.e. direct AMT, indirect AMT, and administrative AMT in ascending order. The top five AMT in Indian automotive manufacturing companies are given in Table 15. It is observed that among top preferred activities three are from indirect AMT i.e. MRP, MRPII, and CAD, however the first ranked AMT is from administrative AMT. Similarly among the five least preferred activities, four belong to direct AMT. Thus it can be said that Indian companies are investing relatively more in administrative and indirect AMT as compared to direct AMT (Figure 8). It seems that Indian companies want to gain competitive advantage by giving more emphasis on administrative AMT compared to hardcore technology i.e. directs AMT.

Based on the above results, it seems that Indian companies follow SIA model (Figure 9) defined as Simplify (AMS) - Integrate (IIS) - Automate (AMT). This model is briefly explained below.
- Simplify: simplification of processes with Administrative AMT
- Integrate: Integration of various functions through indirect AMT
- Automate: Deploying advanced manufacturing technologies through direct AMT

It appears that Indian companies have adopted the path of improvement by following SIA model as shown in Figure 9. It is observed that Indian manufacturing companies are investing more in infrastructural issues such as administrative AMT (overall mean=3.16) and indirect AMT (overall mean=3.09). Administrative AMT helps in the simplification of systems and indirect AMT helps in the integration of information resource. Structural issues such as direct AMT (overall mean=2.50) seem to be the last item on the agenda of Indian companies.

The survey effort is followed by development of three cases to have more in-sight of manufacturing strategy issues. All the three companies ‘A’, ‘B’, and ‘C’ have definite manufacturing mission (Table 17). Based on the external and internal analysis, manufacturing mission is spelt out in line with corporate vision. To arrive at this, brain storming session involving executives from marketing, design, R & D,
finance, manufacturing etc. need to be involved. Motorbike of the company ‘C’ is quite popular in local markets. Due to excellent mileage per litre, it has 49% market share in 2 wheeler market segment. Various manufacturing strategy related attributes of these three companies are summarized in Table 18.

All companies included in the study have shown awareness towards manufacturing strategy. They have gradually changed themselves to face the fierce competition. Competitive price and quality are the common order qualifiers for the firms. Order winners for the firms are different due to product nature and product range.

The following observations are made based on the study:
1. Before the process of liberalization of Indian economy, most of the Indian managers were occupied with simply selling goods through the process. This scenario was characterized by production schedules in the face of unreliable machines, uncooperative workers, fire fighting middle level managers and shortsighted top management. The short-term orientation was due to high cost of capital, frequent government policy changes, and highly protective environment. However today the scenario is different and it is driven by competition.

2. The companies are motivated to think in long term implications. Manufacturing strategy has thus become imperative. This long term orientation is reflected in terms orga-

<table>
<thead>
<tr>
<th>Rank</th>
<th>AMT name</th>
<th>AMT type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Office automation (OA)</td>
<td>Administrative AMT</td>
</tr>
<tr>
<td>2</td>
<td>Material requirement planning (MRP)</td>
<td>Indirect AMT</td>
</tr>
<tr>
<td>3</td>
<td>Manufacturing resource planning (MRPII)</td>
<td>Indirect AMT</td>
</tr>
<tr>
<td>4</td>
<td>Computer aided design (CAD)</td>
<td>Indirect AMT</td>
</tr>
<tr>
<td>5</td>
<td>Computer numerical control (CNC)</td>
<td>Direct AMT</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rank</th>
<th>AMT name</th>
<th>AMT type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Automated Guided Vehicle (AGV)</td>
<td>Direct AMT</td>
</tr>
<tr>
<td>2</td>
<td>Rapid prototyping (RP)</td>
<td>Direct AMT</td>
</tr>
<tr>
<td>3</td>
<td>Automated storage and retrieval system (ASRS)</td>
<td>Direct AMT</td>
</tr>
<tr>
<td>4</td>
<td>Robotics (RO)</td>
<td>Direct AMT</td>
</tr>
<tr>
<td>5</td>
<td>Bar coding (BC)</td>
<td>Indirect AMT</td>
</tr>
</tbody>
</table>
3. The companies have the knowledge of what needs to be done at the top level and at the operational level. The companies are adopting a strategy to have action plan in place.

The study has highlighted a number of interesting aspects of manufacturing function and strategy.

(1) In this study we have tried to map the three automotive sector companies ‘A’, ‘B’ and ‘C’ for various manufacturing strategy-related issues based on the following frameworks:
   • Competitive priorities
   • Manufacturing strategy formulation
   • Order qualifiers/order winners

(2) It is observed that manufacturing strategy seems to be linked to firms overall business strategy. Manufacturing managers are involved in the strategic formulation process.

(3) Manufacturing strategy role is significant in providing a “strategic fit” in focusing efforts and resources, so that manufacturing strategy is consistent with, and helps to support the business strategy. Manufacturing strategy can be indeed used in a proactive manner (as evident from case ‘C’). The manufacturing comparisons are exploited to create new opportunities and markets.

Key insights gained from the study include:
1. Indian companies give greater emphasis on infrastructural issues of manufacturing strategy.
2. Manufacturing contributes to competitive success.
3. Manufacturing strategy is not limited to a few key decisions about technology, capacity; but it is defined by the total pattern of decisions across the full range of manufacturing systems.

### TABLE 17
An Overview of Indian Companies under Study

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Co. ‘A’</th>
<th>Co. ‘B’</th>
<th>Co. ‘C’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product</td>
<td>All type of four wheeler vehicles</td>
<td>Two &amp; three wheeler vehicles</td>
<td>Two wheeler motorbikes</td>
</tr>
<tr>
<td>Sales(million US $)</td>
<td>5000</td>
<td>662</td>
<td>180</td>
</tr>
<tr>
<td>Number of employees</td>
<td>7000</td>
<td>11000</td>
<td>3000</td>
</tr>
<tr>
<td>Domestic market share</td>
<td>60% in LCVs, 72% in MCVs</td>
<td>40 % in scooter segment</td>
<td>45% in motorbike segment</td>
</tr>
<tr>
<td>Exports as % of total sales</td>
<td>30%</td>
<td>10%</td>
<td>10%</td>
</tr>
</tbody>
</table>

### TABLE 18
Various Issues of Manufacturing Strategy in the Indian Companies

<table>
<thead>
<tr>
<th>Issues</th>
<th>Company ‘A’</th>
<th>Company ‘B’</th>
<th>Company ‘C’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing strategy formulation</td>
<td>• Formal VPs (manufacturing) are involved in manufacturing strategy formulation</td>
<td>• Informal By CEO and marketing managers</td>
<td>• Formal By CEO, President and VPs (R &amp; D, marketing, finance, and manufacturing)</td>
</tr>
<tr>
<td>Contents of manufacturing strategy</td>
<td>• High investment in AMT</td>
<td>• Use of AMT such as CAD</td>
<td>• Use of CAD</td>
</tr>
<tr>
<td></td>
<td>• Continuous improvement of manufacturing system</td>
<td>• Benchmarking</td>
<td>• Investments are consistent with business strategy</td>
</tr>
<tr>
<td></td>
<td>• High innovation rate</td>
<td>• Faster new product development</td>
<td>• Well integrated functions</td>
</tr>
<tr>
<td></td>
<td>• Focused factory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Key competitive priorities</td>
<td>• Conformance quality</td>
<td>• Low cost</td>
<td>• Provide high performance products</td>
</tr>
<tr>
<td></td>
<td>• Product durability</td>
<td>• Product durability</td>
<td>• Conformance quality</td>
</tr>
<tr>
<td></td>
<td>• Provide high performance products</td>
<td>• Conformance quality</td>
<td>• Product reliability</td>
</tr>
<tr>
<td>Order winners</td>
<td>• User friendliness</td>
<td>• Brand image</td>
<td>• Excellent mileage</td>
</tr>
<tr>
<td></td>
<td>• Cost effectiveness</td>
<td>• Cost effectiveness</td>
<td>• User friendliness</td>
</tr>
<tr>
<td></td>
<td>• After sales management</td>
<td>• After sales management</td>
<td>• New product development</td>
</tr>
</tbody>
</table>
4. Typically the SIA model followed by Indian companies is
Simplify (administrative AMT) - Integrate (indirect AMT) - Automate (direct AMT)

Implications of the Study

Managerial Implications
This study provides several important implications

By building on the work of previous studies conducted in the industrialized countries, this study helps to provide a better understanding on manufacturing function and points out what manufacturing strategy means for Indian manufacturers.

The results underscore the importance of competitive priorities (such as quality, flexibility, delivery, and cost) and Advanced Manufacturing Technologies (Direct AMT, Indirect AMT, and Administrative AMT) to achieve the same.

Manufacturers can no longer be comfortable competing on the basis of one or two functional area competencies. The globalized environment requires that manufacturers have multiple competencies such as quality, delivery, flexibility, and cost.

Implications for Academia
The study also provides several implications for academics:

The questionnaire developed can be improved further to examine linkages with other business functions and evolving paradigms such as Supply Chain Management.

The findings of the study can act as a foundation for developing a resource based view of a particular sector.

Limitations and Scope for Future Work
This study has some limitations, which future researchers could consider. First, mono-respondent approach is adopted due to high cost associated with multi-respondent approach. Second, other sectors can be included in the study and/or the present sectors can be further classified (for example further classification of Automotive into vehicle manufacturers and component manufacturers).

REFERENCES


[한국어 요약(Korean Abstract)]

경쟁력화로 인해 기업들은 비용절감과 품질향상을 위한 새로운 방법을 찾아내기 위해 지속적으로 노력하고 있다. 인도의 제조업체들은 이에따라 기업역량을 통한(capability–driven) 성장보다는 기회성(opportunistic) 접근을 통한 성장을 해왔다. 따라서 지난 몇 년간 작업현장에 대한 전략적 접근이 부족하였다. 도래하고 있는 경쟁 시나리오 속에서 이제 인도기업들도 생산전략을 수립할 필요성을 느끼게 되었다. 이번 연구는 구조적인 질문지를 활용하여 여러 생산 현장 이슈들을 탐색한 서베이와 3개의 케이스 스토리들로 통해 평가하였다. 질문지의 최종문은 인도의 여러 지역에 위치한 150여 개의 자동차 관련 생산업체들에게 배포되어 66개의 결과물(44%의 응답률)이 분석되었다. 그 결과, 우선 경쟁 요소와 진보된 생산 기술(AMT: Advanced Manufacturing Technology)이 확인되었고 대부분의 인도 기업들은 운영적(administrative) AMT에 가장 많은 투자를 하고 있는 것으로 나타났다. 그 다음으로 간접적 AMT(indirect)를 통해 여러 시스템을 통합하고 마지막으로 직접적(direct) AMT를 통해 생산 시스템의 자동화를 진행하는 것으로 나타났다. 인도의 자동차 관련 기업들은 SIA모델: 단순화(simplify) ~ 통합화(integrate) ~ 자동화(automate)의 흐름을 따라가는데 것으로 나타났다. 3곳의 자동차 기업의 케이스 스토리를 통해 서베이에서 발견된 사항들에 대한 검증이 진행되었다.