CHAPTER IV

e-MANUFACTURING MANAGEMENT IN GARMANT INDUSTRY

Manufacturers in general in all sectors and across the globe, garment industry inclusive of, are under tremendous pressure to improve their responsiveness and efficiency in terms of product development, operations, and resource utilization with a transparent visibility of production and quality control, as these are normally expected of them and also as a natural response to remain strong in a competitive world. Today’s competition in manufacturing industry depends not just on lean manufacturing but also on the ability to provide customers with total solutions and life-cycle costs for sustainable value. Lead times must be cut short to their extreme extent to meet the changing demands of customers in different regions of the world [citations]. Products are required to be made-to-order with no or minimum inventory, requiring an efficient information flow between customers, manufacturing, and product development. Manufacturing trends and predictive intelligence are enabling tools to meet such needs. Recently, web-based technologies have had an impact on design, manufacturing, logistics and aftermarket service of products.

4.1 Garment Manufacturing History

Garment manufacturing, dates back to years before the American Revolution. Clothes were produced for slaves working in American Southern plantations. Before the mid-nineteenth century, majority of Americans made their own clothing with basic skills. However, the affluent purchased "tailor-made" clothes. By the 1820s, an increasing number of ready-made garments of a higher quality were being produced for a broader market.

The production of ready-made clothing continued to grow and got transformed to an "industrialized" profession with the invention of a practical and commercially viable sewing machine in 1850s. Elias Howe patented the first sewing machine in 1844 although Isaac Merritt Singer, whose name is synonymous with the machine, added modifications and marketed the sewing machine for the first time to the mass public in the early 1850s [citations].

Sewing machines were used at home. The machines were carried to their dwellings and completed by hand as depicted in Figure 4.1.
Garment industry expanded further with thousands of ready-made soldiers' uniforms during the Civil War. Even before the invention of the sewing machine, as early as the 1820s, clothing manufacturers contracted work to female workers who would do the job for wages 25% to 50% less than that of male tailors. These women seamstresses would complete their assigned sewing tasks in their homes. In the 1880s the nature of the garment industry experienced another significant change. Factories produced the fabric and the designs, which were then distributed to contractors on credit. The contractor was responsible for the fabric to become clothing. It was then sold to stores and other retail outlets. Factory machinery became more sophisticated in the 1870s and 1880s, parts of a piece of clothing could be mass-produced and women working at home did finishing work rather than making whole pieces of clothing from scratch.

By the end of the nineteenth century, manufacturers provided the raw materials, designed the clothes, and marketed the final product, but the work of making the clothes was again handed over to contractors. Consequently, contractors, in order to make profit, forced longer hours and lower wages on their workers. In the 19th century, garment units were moved
uptown to consolidate workers in more factories. Retailers purchased the fabric from the mills, and redistributed the material to a cutting contractor, who would be paid a piece-rate to cut the material into the garment design. Upon receiving the cut designs, the retailer would re-contract the material, this time to a sewing contractor (i.e. Harris Levine). Often the system of contracting was highly diversified with each shop performing a specialized task. A single clothing firm might employ as many as 75 different contractors to work on their clothing line. Thus the garment started evolving since 19th century, after the industrial revolution [37].

4.2 Garment Manufacturing System

Typical Garment manufacturing unit has departments as depicted in the Figure 4.2 below in the operation-flow order.

Fig. 4.2 – Garment Manufacturing Unit departments

Source: https://www.slideshare.net/PriyambadaKhushboo/apparel-manufacturing-process
It is evident from figure 4.2 that data play a key role in departmental information. Any merchandiser is involved in at least 10 process connecting internal and external audiences. Their involvement leads to multiple documents with various touch points. Each of these documents requires entering diverse data, which are entered manually. Data on Suppliers of raw materials, samples and accessories need to be updated by merchandisers. Both Inbound and outbound communications that occur across departments may not be captured and thus important information may be lost. Information on Purchases, return of materials and reorders also happen across multiple touch points and need to be captured for communications. If these data are not captured, analysis becomes less accurate which in turn consumes precious decision-making time. Manually captured data, if not captured properly, may be lost and the entire wheel has to be rotated again. The importance of departmental information cannot be ignored in data capture and e-manufacturing.

4.3. Indian Garment Manufacturing Processes

India is viewed as a labor intense country in the global economy. This created business opportunities for developed countries to outsource labor intense manufacturing processes to India. Indian garment industries began to expand their operations using this opportunity. Mass projects were undertaken, shifting the focus on the development of this sector.

Long-term capabilities of Indian firms started to depend on production efficiency. Production efficiency is dependent on a manufacturer’s ability and willingness to create new development of patterns, adopt efficient mechanisms and technology. In this transformation, manufacturing firms, especially garment industries need to focus on internal and external efficiency improvements, while reducing their operational costs. In typical industrial manufacturing processes, few aspects play a key role for the success of the sector like Flexible manufacturing [7], on-demand manufacturing and manufacturing based on design templates. Further, the global pressure of open markets and changing customer needs, felt by manufacturing firms created the need for mass customizations, [8]. Customization is sometimes based on design. Indian firms could not deliver designs in a global scenario and thus failed to capitalize on the benefits of its labor intensiveness and was not a major beneficiary in the global supply chain revolution. Even seasoned businessmen and tailors failed to realize the fact that patterns could be developed to increase customer counts.
Creating standard patterns reduces production time and improves delivery mechanisms. Patterns became the key to apparel industries. The patterns were refined further by designers. India’s lesser productiveness forced Indian garment industries to shift their focus towards flexibility in design, thus creating a healthy competition between small and big players. Slowly more creative designers started emerging in the Indian garment history.

Garment industry goes through several processes from orders till shipment. The manufacturing processes in a garment industry can be categorized into three kinds namely pre-production, production and post-production processes as detailed below.

- **Pre-production processes:** This is the first step for production in the garment industry. The processes depend on many factors. The samples are prepared based on design in pre-production. It is then sent to the production department, where changes, if any, are noted based on feedbacks from the production department. The final requirements are then intimated to the procurement division and based on the procurement notification material sourcing is done.

- **Production processes:** This is the second stage where garments are produced based on samples from pre-production processes and materials sourced. In this phase processes are included or discarded based on garment requirements. Certain kinds of cloth need to be washed before stitching. Clothes are also ironed at various stages based on the cloth or its previous process. Cutting of cloth vary based on designs or customized needs. The buyer sometimes provides trims and accessories like buttons. They are also sourced from suppliers, identified by the buyer. Quality is checked at each stage for specifications, thus creating a need for various products.

- **Postproduction processes:** After a garment is produced, these processes are used for the final delivery of garments. The processes include thread trimming, quality checking, folding and packing. The final and packed products are inspected before shipping.

**4.4 e-Manufacturing – Tech Trend in Garment Industry**

In a traditional garment industry, distinct from its new genre counterpart, manufacturing or the actual production is just 25 % of the entire supply chain operation. Traditionally, but
myopically, automation is synonymously used for IT enabled manufacturing. Like other major manufacturing industries, garment industry too focused on automating majority of production processes. Hence technology spend was more focused on automation. ERP majorly focused on the backend process of the manufacturing process and the key role was to focus on reducing the manufacturing cost.

Track of all the merchandising and shop floor operations like order lead management, costing, material planning and procurement, raw material processing, production planning, inventory management, EXIM processes were the key functions executed by traditional ERP solutions. Considering the geographical advantages, multiple manufacturing units are commissioned. IT enabled systems like ERP/SCM, help in total integration of multiple units and process. Globally, garment industries manufacturing segment expectations are changing.

**Diagram A: Changing Manufacturing Ecosystem**

https://www.slideshare.net/WazirAdvisors/role-of-indian-textile-and-apparel-industry-in-changing-global-supply-demand-scenario

Diagram A clearly indicates the need for change in process across manufacturing segment. In garment industry, this change is very eminent and needs immediate attention as customers are scattered, customer preferences change frequently, orders are based on multiple factors and sourcing is scattered. Unless technology helps in coordinating with all
these multiple touch points, it would be very tough for the new age manufacturing units to succeed.

In a typical ERP/SCM operation, software providers, focus on aspects/functionalities such as finished goods management, capacity planning and supply chain planning. This is a kind of static process followed across all manufacturing industries. Need of the hour is that IT has to provide data related to shop floor metrics, real time monitoring and help in decision making.

Keeping this in mind, the technology needs of e-manufacturing process can be captured in three aspects, namely manufacturing health management related technology, process efficiency technology and supply chain technology as shown in Diagram B.

![Diagram B: Three Functions of e-manufacturing](image)

**Fig. B: Three Functions of e-manufacturing**

The manufacturing health management related technology takes care of plant/machinery/equipment health monitoring, maintenance, wear & tear and impairment issues, besides other incidental ones. These are monitored using technology. Based on data analysis, coupled with big data analysis, plant/machinery performance is predicted with the help of health monitoring technology leading to reduction in breakdown, impairment, production delay, etc with many implications.
**Monitoring the health of machines:** IoT plays a major role in monitoring the health of machines. A sensor is used along with the machines to interact with the IoT software. IoT also keeps a clear track of interdepartmental logistics/in-bound logistics that happen during manufacturing process.

Diagram C gives RFID, IoT and Big Data technology needed in manufacturing with the production functions that use these technologies with advantage.
Diagram C: RFID, IoT and Big Data technology in Garment Manufacturing; as per industry reports & respondents views

The **RFID technology providers** include vAlien tech, IMPINJ, Insync, adverly dennison, Checkpoint, Infor and Globe Ranger. Presently, among the respondents, majority of them are focused only on asset tracking and monitoring supply level for production. Other solutions mentioned are dependent on IoT applications and RFID installations. Surprisingly, awareness level of these technologies was very minimum among majority of respondents.

**Need for Big-Data analytics:** In an industrial process, data can be captured in multiple forms. But, if the data captured are not put to right use, there is no value to the efforts made. To make effective interpretations, data need to be captured at ‘appropriate touch points’ or ‘point of happening’ and using proper tool in a proper format.

If technology were properly used to capture information across points, most of the garment industry would be sitting on a huge pile of data. To make use of these data and derive actionable points, data analytics software/business intelligence (BI) software is required.

**Efficiency enhancing technology:** Improving employee efficiency and giving better user interphase to increase the adaptation of e-enabled technologies have been the core focus of companies providing transactional technologies like App, Mobility etc. In the e-SCM/ERP segment, building interphase through mobile or apps have been more up-comeing as more and more start-ups are focusing this segment. There are both advantages and disadvantages to this. Increasingly, mobile platform is used to build overall technology or apps that can talk to the existing technology and processes. Platform as a Service (PaaS) is emerging as the latest trend. Solutions are built over existing platforms used by the industries and apps are developed for ease of use and transaction. More add-ons could be added to the existing solution over a short period of time. Apps like Arena PLM (a product lifecycle management app), and RootStock (a material requirements planning app) play a major role in the manufacturing segment.
The technology providers for e-manufacturing for garment Industry are as listed below.

<table>
<thead>
<tr>
<th>Company</th>
<th>Usages</th>
<th>New Links</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPINJ</td>
<td>The Impinj platform uses RAIN RFID to deliver timely information about these items to the digital world, thereby enabling the Internet of Things.</td>
<td><a href="http://www.laundryandcleaningnews.com/news/newsdata/mars-and-impinj-announce-rfid-partnership-5833366">http://www.laundryandcleaningnews.com/news/newsdata/mars-and-impinj-announce-rfid-partnership-5833366</a></td>
</tr>
<tr>
<td>InSync</td>
<td>InSync Software, Inc. provides the fabric for the world's leading RFID, GPS, and sensor-driven software applications. InSync's renowned iApp Platform and iApp Solution Templates allow customers to rapidly develop and deploy applications to locate and track assets, improve operational efficiencies, and manage risks.</td>
<td>-</td>
</tr>
<tr>
<td>Avery Dennison</td>
<td>Avery Dennison delivers an array of field-proven RFID solutions that can work to reduce costs, gain efficiencies, enhance customer experience, authenticate asset pedigree and help increase sales and profitability.</td>
<td><a href="http://www.labelsandlabeling.com/news/latest/ll-avery-dennison-host-rfid-webinar">http://www.labelsandlabeling.com/news/latest/ll-avery-dennison-host-rfid-webinar</a></td>
</tr>
<tr>
<td>Check Point</td>
<td>A range of solutions for your RFID needs, from label stock through to a customized RFID solution; from asset tracking through to product authentication. The ability to convert the various demands within the industry into a viable product and then distribute to global suppliers at source is vital to the successful launch of an RFID project.</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Primary Data (Compiled)

**Mr. Venkatraman**, Senior Purchase Manager, Evolv Clothing Co Pvt Limited (100 % EOU) with 20+ years of experience in this field observed that majority of export rejections are quality based rejections/style rejections; and many samples that are not accepted by the overseas buyers due to production delay and all are sold in their own self-styled retail showrooms.

An in-depth discussion with Mr. Venkatraman, gave an idea of how much each department is interlinked and how one such can cause a ripple effect till the full product is ready. For
instance, during wasing stage, if the fabric is of poor quality and shrinkage happens, this needs to conveyed to Procurement department, Supplier, Manufacturing department and QC - Quality department( if they have a separate QC department).

A garment sample passes through multiple phases and is depicted in the Figure 4.3.

![Diagram of sample to garment process](image)

**Fig. 4.3 – Phases in Sample to Garment as explained during in-depth study**

In the absence of such an information: Manufacturing department will have shortage of raw material, Procurement department would not have had the opportunity and time to identify anther supplier and source the material and all this would cause delay in the final output and finished product cannot be shipped on time.

As Mr. Venkatraman mentions, presently, manually, these issues are noted and fabric coming in and going out are counted and recorded manually. These informaiton, at times, upon asking, get’s conveyed to the other departments, orally.

**4.5 Challenges in Indian Garment Manufacturing**

The Qualitative and Quantitative Research Approaches Adopted revealed certain important things. The qualitative research focus is based on in-depth interviews, contacts with industry experts, group discussions, etc while quantitative research focus is on data based analyses which are given in charts, tables and tests of hypotheses, wherever relevant.
Indian garment industries face many challenges irrespective of their size. Capacity utilization is the first and foremost challenge. Most of the garment units end up in over production and maintain unnecessary inventory. In manufacturing garments, goods arrived or returned due to quality are not intimated and lack of co-ordination on this information, causes excess production.

Moreover, priorities defined by the customer during the sampling stage cause excess and unwanted production. Non-availability of goods is another challenge. After production of a garment, the order may wait for availability of trims and accessories. Goods and accessories rejected due to quality issues cause trouble when they are unnoticed or the information are not captured.

This in turn leads to the restart of the entire processes leading to issues in planning, shortage in goods and lack of a clear procurement plan. Manual entry of information without sharing, delayed or improper decisions at stages are other challenges in the Indian garment sector.

Lack of awareness and clarity on technology and the way technology works got clearly indicated in the responses; Disruptions, retraining, high initial investments and lack of internal support were some of the most agreed upon factors. Respondents didn’t have clear knowledge on the risk of obsolescence and security and hence, respondents were more neutral towards these factors.
Table 4.1 gives the total and mean scores of the challenges or shortcomings of Applications of e-enabled manufacturing. High initial investment is a deterrent viewed by most manufacturers and also the respondents of the sample survey with 4.7 points on the 5 points scale. Similarly, ‘New technology disruptions - reorganization, retraining’ requirements, with 4.26 points also hold-on-to-status-quo factor.

Table 4.1 Challenges of e-enabled manufacturing

<table>
<thead>
<tr>
<th>Variables</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>DA</th>
<th>SDA</th>
<th>Total Score</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>New technology disruptions - reorganization,</td>
<td>150</td>
<td>40</td>
<td>15</td>
<td>6</td>
<td>2</td>
<td>213</td>
<td>4.26</td>
</tr>
<tr>
<td>retraining</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High initial investment</td>
<td>200</td>
<td>20</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>235</td>
<td>4.70</td>
</tr>
<tr>
<td>Risk of obsolescence</td>
<td>0</td>
<td>0</td>
<td>150</td>
<td>0</td>
<td>0</td>
<td>150</td>
<td>3.00</td>
</tr>
<tr>
<td>Problem with security and privacy</td>
<td>20</td>
<td>24</td>
<td>120</td>
<td>0</td>
<td>0</td>
<td>164</td>
<td>3.28</td>
</tr>
<tr>
<td>Lack of support of employees due to lack of</td>
<td>100</td>
<td>72</td>
<td>21</td>
<td>10</td>
<td>0</td>
<td>203</td>
<td>4.06</td>
</tr>
<tr>
<td>organizational culture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>965</td>
<td>19.3</td>
</tr>
</tbody>
</table>

Test of Hypothesis

H₀: Mean score = 3.5 (on a 5 point scale.)   H₁: Mean score >3.5

<table>
<thead>
<tr>
<th>Total Score</th>
<th>Mean Score</th>
<th>SD</th>
<th>N</th>
<th>SQRT N</th>
<th>SE</th>
<th>Z Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>965</td>
<td>3.86</td>
<td>0.994</td>
<td>250</td>
<td>15.81</td>
<td>0.0629</td>
<td>5.7255</td>
</tr>
</tbody>
</table>

The null hypothesis is rejected and the Mean Score exceeds 3.5. It is comfortable at 3.86.

4.6 e-manufacturing

E-Manufacturing is a transformation system that enables the manufacturing operations to achieve predictive downtime performance while synchronizing business systems through the use of web technologies. It integrates information and decision-making among data, information and cash flow of business systems[^vsn].

E-Manufacturing is a business strategy as well as a core competency for companies to compete in today’s e-business environment. It is aimed to complete integration of all the elements of a business; suppliers, customer service network, manufacturing enterprise, and plant floor assets with connectivity and intelligence brought by the web-enabled
technologies. e-Manufacturing is a transformation system that enables e-Business systems to meet the increasing demands through tightly coupled supply chain management (SCM), enterprise resource planning (ERP), and customer relation management (CRM) systems as well as environmental and labor regulations and awareness, as depicted in Figure 4.4 [^1].

![Diagram](https://www.hindawi.com/journals/isrn/2011/193124/fig2/)

Fig. 4.4 - The transformation of e-Manufacturing for unmet needs

Source: https://www.hindawi.com/journals/isrn/2011/193124/fig2/

E-Manufacturing includes the ability to monitor the plant floor assets, predict the variation of product quality and performance loss of any equipment for dynamic rescheduling of production and maintenance operations. Dynamically updated information and knowledge
about the capabilities, limits, and variation of manufacturing assets for various suppliers
guarantee the best decisions for outsourcing at the early stages of design. In addition, it
enables customer orders autonomously across the supply chain, bringing unprecedented
levels of speed, flexibility, and visibility to the production process reducing inventory,
excess capacity, and uncertainties. The intrinsic value of an e-Manufacturing system is to
enable real-time decision-making among product designers, process capabilities, and
suppliers.

The most basic adoption of e-manufacturing started with the internet after companies
acquired basic accounting software. IT adoption in firms are mainly dependent on the
management’s commitment towards a change, willingness to invest and implementation till
the last level. The management focus shifted on specific problems like scaling up of
operations, optimal cost sourcing and efficient decision making. Thus the first e-
manufacturing came into existence in the garment manufacturing industry. A need for software that could connect multiple functions like
Global customer databases, process standardisation, centralised decision
making and controlled information sharing was felt.

ERP played a major role in realizing this dream. Similar to procurement, e-manufacturing
adoption happened at a very low speed. Many firms focused on complete ERP solutions,
while some focused on individual software modules. ERP’s focus in the initial stages was
on services and merchandising and failed to cater to manufacturing. These challenges
invariably stopped the penetration of ERP into Indian garment firms. ERP automation was
tried across stages and was successful in saving money, time and errors.

**Aditya Exports production manager** felt that majority of technology focus was on
automation; especially, ERP, as an IT enabled service, focused more on the process
automation across departments.

**Marketing research firms** found ERP’s capabilities in churning daily production report,
production analysis, finishing quality report, rejection analysis and many more required
processes of manufacturing. In spite of ERP’s complexity and usefulness, data entered at
each stage could not authenticate for correctness at stage touch-points.
4.7 Issues in ERP implementation:

In India, few major global ERP players penetrated the entire market in the early stages. These global players had their own challenges in the market.

Before meeting garment firms with a proper questionnaire, the researcher had initiated an in-depth study to understand the working pattern of the industry; day-to-day pain points with respect to production and IT related pain points and benefits. Based on the understanding, researcher noticed that IT penetration/e-enabled manufacturing or ERP implementation, has not grown or expanded the way it has done in global market.

Mr. Mani, Partner of SKL Exports and K. Sampath, Production In-charge, Indigo Fashions, reiterated the fact that garment industry has the most complex structure in the business process. Most of the ERP players are hiring Textile consultants to implement packages across industries. The issue lies in the development of ERP package, where majority of the complexity are not considered. Overall departmental automation has been the core focus.

Mr. Balaji of Celebrity Fashions depicted the Complex working environment of garment industry. Garment manufacturing has a very complex manufacturing process. Procurement/purchase department gets instruction from merchandiser / production team directly; this is majorly because the entire design and sample creation of production team are captured separately. Customers taste keeps changing during the sample making process. At each touch points, the supervisor manually captures the changes and the design gets altered at the production process; all these changes are not captured in any e-enabled system. Based on the initial order, the procurement department orders the supply requirements. Interdepartmental communication gap has been a major challenge.

Outdated software/hardware: Over the several years, manufacturing team has started using multiple software’s in silo’s that has helped them at each stage; for example,
CAD/CAM. With repeat modifications at multiple stages, these software’s are individually updated and this doesn’t get reflected in the main ERP.

Though many global ERP players claim to handle this situation intelligently, researcher noticed the following situations across many players:

Even after technological advancements, still lots of ERP packages are not interoperable with the legacy software’s that are mostly in silos. During implementation of e-enabled software’s, this has been a major challenge to garment firms, especially, large enterprises. This implementation consumes lot of money, delay in implementation and huge infusion of money.

Hence, SME’s are not able to match up to the repeat investments that attack them in the form of up gradation, expansion plans, adding a new module to suit the technology change, etc; This is also due to poor penetration of cloud form of e-enabled solutions.

Ms. Sarmeeela of Systech Info System mentioned that their product ‘Trade Wings’ a lighter ERP version was used by lot of companies, as it was simpler to Oracle or SAP. Moreover, they were considered for the after sales service support that they provided and were absent with the ERP biggies. In spite of cloud recommendations, these industries preferred software to be deployed on premise. Such ‘On Premise ‘solutions hinder the technological transformation and bring in interoperability issues.

4.8 Information technology - A game changer in Indian Garment Manufacturing Sector

Globally, most of the garments industries are moving towards technology-based advancements. Indian garment industry is predominantly labor oriented which includes knitting, yarn, washing, dyeing etc. Though labor oriented manufacturing can be automated, the level of automation differs. When a design is finalized, multiple operations like washing, dyeing, and ironing, trimming are involved based on the chosen fabric. These intermediary processes may not be captured, thus creating issue in external processes.
Lack of interconnectivity between these operations, quality related issues, returns or replacements or rejections of the fabric are not captured and mapped with the overall procurement process.

With emerging applications of Internet and communication technologies, the impact of e-intelligence is forcing companies to shift their manufacturing operations from the traditional factory integration philosophy to an e-factory.

**Findings on applicability of e-manufacturing**

![Chart 4.2 - Manufacturing and Design Units Strategies.](image)

Chart 4.2 gives a clear indication the respondents were confused about the word automation based on the data that has been captured. Respondents had responded to both fully automation and IT enabled services, clearly indicating respondents did not understand the difference between automating the industrial process and enabling the process with the IT enables software packages to monitor the process and capture the data wherever required.

Table 4.2 gives the preference scores of the core manufacturing design alternatives that a garment unit could go far. There is a great preference for Fully automated and Equipped with IT enabled services with sores exceeding 4.6.
### Table 4.2 Core Manufacturing Design Formats- Total and Mean Scores

<table>
<thead>
<tr>
<th>Core Manufacturing Design Formats</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>DA</th>
<th>SDA</th>
<th>TS</th>
<th>MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manually driven</td>
<td>0</td>
<td>40</td>
<td>120</td>
<td>0</td>
<td>0</td>
<td>160</td>
<td>3.2</td>
</tr>
<tr>
<td>Equipped with IT enabled services</td>
<td>200</td>
<td>0</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>230</td>
<td>4.6</td>
</tr>
<tr>
<td>Semi automated</td>
<td>0</td>
<td>20</td>
<td>69</td>
<td>42</td>
<td>1</td>
<td>132</td>
<td>2.64</td>
</tr>
<tr>
<td>Fully automated</td>
<td>230</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>246</td>
<td>4.92</td>
</tr>
</tbody>
</table>

Table 4.3 gives details for chi-square test as the opinions are divided. The null hypothesis is rejected, stating that there is some pattern in preference. Equipped with IT enabled services and fully automated manufacturing formats are favored the most.

### Table 4.3 Core Manufacturing Design Formats- Chi-Square Test

<table>
<thead>
<tr>
<th>Core Manufacturing Design Formats</th>
<th>$O_T$ for Agree</th>
<th>$O_T$ for Disagree</th>
<th>Total</th>
<th>$E_T$ for Agree</th>
<th>$E_T$ for Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manually driven</td>
<td>50</td>
<td>0</td>
<td>50</td>
<td>35</td>
<td>15</td>
</tr>
<tr>
<td>Equipped with IT enabled services</td>
<td>16</td>
<td>34</td>
<td>50</td>
<td>35</td>
<td>15</td>
</tr>
<tr>
<td>Semi automated</td>
<td>45</td>
<td>5</td>
<td>50</td>
<td>35</td>
<td>15</td>
</tr>
<tr>
<td>Fully automated</td>
<td>30</td>
<td>20</td>
<td>50</td>
<td>35</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>141</td>
<td>59</td>
<td>200</td>
<td>140</td>
<td>60</td>
</tr>
</tbody>
</table>

$H_0$: No Relationship between Disposition (Agree or disagree- Grouped) of Views and Core Manufacturing Design Formats **Chi Square: 67.71**.

The $H_0$ is rejected, as the computed Chi Square: **67.71** is more than the table chi-square.

Note: $O_T$—Observed frequency, $E_T$—Expected frequency.

Previous studies have indicated [cit] the role of Information Technology in changing manufacturing of garments. Moreover, it can help Indian garment manufacturers to compete globally by helping in product differentiation, improving operational efficiency and managing data at each stage of operations. IT is adopted widely by manufacturing firms across all verticals of garment manufacturing. Need for IT in manufacturing vary based on business needs and challenges. In developed nations, IT is used to focus on productivity gains [cit], while developing nations use IT for improving product quality and process efficiency [cit].

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As described during the discussion, there was mixed reaction among respondents to focus on productivity. Majority of the respondents didn’t agree to the fact that IT / e-enabled services helped in increasing the productivity of the manufacturing unit. Automation tools and software can focus on designing, embroidery and office automation.

4.9 Benefits of e-enabled manufacturing:

IT enabled services can help plan business strategies, improve customer service, showcase controlled process and reduce cost in terms of inventory and transportation. Organizations can benefit in terms of operational excellence with implemented SCM solutions.

Variations in manufacturing operations make it difficult to create a ‘one-size-fits-all’ solution. It was noticed that mass customization happen to a certain extent in Knitwear industries and Mills, while in the case of Ready-made garment firms mass customizations rarely occur.

The key benefits implied e-enabled manufacturing improves cost efficiency. Data from different touch points streamline manufacturing. Garment Exports production managers were unable to quantify the success of e-enabled manufacturing software, but agreed on data’s support in strategic decision-making.

Charts 4.3 and 4.4 depict the benefits and efficiency gained

![IT implementation benefits in Manufacturing and Design Units](image)
Mrs. Sumathi of Ahuja Fashions and K. Sampath, Production In-charge mentioned that there was no system to capture and calculate the efficiency of the e-enabled services that were used; but definitely, process oriented operations and well-planned ordering helped to control unwanted expenses and focus on the production without fear of non-availability of raw material.

<table>
<thead>
<tr>
<th>Benefits</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>DA</th>
<th>SDA</th>
<th>TS</th>
<th>MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improved manufacturing cycle</td>
<td>230</td>
<td>16</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>246</td>
<td>4.92</td>
</tr>
<tr>
<td>Improved cost efficiency</td>
<td>45</td>
<td>116</td>
<td>27</td>
<td>6</td>
<td>1</td>
<td>195</td>
<td>3.9</td>
</tr>
<tr>
<td>Global outsourcing of product</td>
<td>0</td>
<td>20</td>
<td>69</td>
<td>42</td>
<td>0</td>
<td>131</td>
<td>2.62</td>
</tr>
<tr>
<td>Total</td>
<td>275</td>
<td>152</td>
<td>96</td>
<td>48</td>
<td>1</td>
<td>572</td>
<td>11.44</td>
</tr>
</tbody>
</table>

$H_0$: Mean score = 3.5 (on a 5 point scale.)

$H_1$: Mean score > 3.5

The test of significance of difference between actual mean, 3.81 and hypothesized population mean of 3.5, is rejected at 5 per cent level, with $Z$ value at 3.4268. The actual mean score exceeded hypothesized value indicating a better position.
Table 4.5 gives the industry opinion on the level of Efficiency gained due to IT Enabled Services in manufacturing, that is, whether the benefits exceeded or fell short of expectation and the like.

<table>
<thead>
<tr>
<th>Levels of Efficiency gained</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>DA</th>
<th>SDA</th>
<th>Total Score</th>
<th>Mean Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than the expectation</td>
<td>15</td>
<td>72</td>
<td>9</td>
<td>52</td>
<td>0</td>
<td>148</td>
<td>2.96</td>
</tr>
<tr>
<td>Below the expectation</td>
<td>0</td>
<td>0</td>
<td>150</td>
<td>0</td>
<td>0</td>
<td>150</td>
<td>3</td>
</tr>
<tr>
<td>No significant impact</td>
<td>150</td>
<td>80</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>230</td>
<td>4.6</td>
</tr>
</tbody>
</table>

4.9.1 Level of automation/technology adopted

A typical garment industry value chain extends from spinning, knitting, weaving to garment manufacturing. Spinning and other allied industries modernized their infrastructure by taking advantage of government provisions.

Industries upgrade and modernize their processes on production optimization thus optimizing maintenance costs. Data showed that technology push was not a priority with a lesser levels of penetration in E-enabled process modernization.
Chart 4.5 Views on Adoption of IT enabled and new technology in manufacturing

Chart 4.5 depicts the industry opinion on adoption of IT enabled services and adoption of new technology in manufacturing and design units. Chart 4.5 indicates that adoption has been an issue when it comes to new technology. A need for a strong management framework and users’ limited awareness on advanced technology caused a delay in adoption. User friendliness or complex IT structure can again delay implementations and adoption of technologies. The Level of absorption or IT adoption depends on the type of technology or system chosen and its perceived benefit to the organization and employees. IT solution providers have to prove to the implementing firm about the usefulness of IT enabled SCM solution.

Mr. Kannan of SKL exports mentioned that if the software is not user-friendly and the interface doesn’t have straightforward entry procedures, this change will not be adopted by the employees. This will lead to employees avoiding entry, entering wrong data or lack of understanding will still lead to manual entry at most of the crucial touch points. Surprisingly, most Production In-charge personnel were not aware of the technology advancement in e-enabled manufacturing.

Mr. Kumar, Floor Supervisor, Evolv, indicated the confusion that a non-user friendly system interface brings to the failure of non-entry of data. Mr. Venkat, Textile Consultant, mentioned that all ERP or e-enabled systems had complex user interfaces and in most of the cases, language is also an issue. Terminologies used by the software developers, most of the time, didn’t match with the local terms used by the workers. Fear of wrong entry and lack of understanding prevents employees from not entering all the required information.

Mr. Sivasakthivel of AXN Infotech mentioned that most of the owners ask for cost effective solutions. Training is given only to the key people of the organization. Management, at times, are reluctant to train all the employees as the cost of training and level of understanding varies. More than 60% of AXN Infotech customers prefer departmental based suite (in e-enabled software language, it is standalone packages)
Adoption driving factors could be cost, adaptability, interoperability and other factors that would help the organization towards a smooth transition. In the case of employees, adoption is based on the rewards or benefits that they would get by adapting to the new system. A majority of this depends on the maturity of the management and the organization as a whole.

Table 4.6 Views on Adoption of IT enabled and New Technology in Manufacturing

<table>
<thead>
<tr>
<th>Views</th>
<th>( O ) for Agree</th>
<th>( O ) for Disagree</th>
<th>Total</th>
<th>( E ) for Agree</th>
<th>( E ) for Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>User friendly</td>
<td>40</td>
<td>10</td>
<td>50</td>
<td>35</td>
<td>15</td>
</tr>
<tr>
<td>Provides competitive edge</td>
<td>32</td>
<td>18</td>
<td>50</td>
<td>35</td>
<td>15</td>
</tr>
<tr>
<td>A bit tough as it is complex</td>
<td>45</td>
<td>5</td>
<td>50</td>
<td>35</td>
<td>15</td>
</tr>
<tr>
<td>Less awareness of advanced technology</td>
<td>41</td>
<td>9</td>
<td>50</td>
<td>35</td>
<td>15</td>
</tr>
<tr>
<td>Hesitation to adopt any new technology</td>
<td>9</td>
<td>41</td>
<td>50</td>
<td>35</td>
<td>15</td>
</tr>
<tr>
<td>Requires a strong management framework</td>
<td>42</td>
<td>8</td>
<td>50</td>
<td>35</td>
<td>15</td>
</tr>
</tbody>
</table>

\( H_0 \): No Relationship between Disposition (Agree or disagree- Grouped) of Views and Adoption of IT enabled and New Technology Chi Square: 85.24.

The \( H_0 \) is rejected, as the computed Chi Square: 85.24 is more than the table chi-square.

Note: \( O \) — Observed frequency, \( E \) — Expected frequency.

**Source:** Primary Data

Table 4.6 shows that there on User friendliness, competitive edge, bit toughness, Less awareness of advanced technology and requirement of a strong management framework, most respondents agree while as to ‘hesitation to adopt any new technology’, there is disagreement. There is some contradiction. May be initial investment, disruption with new technology and labour attitude, read with table 4.1 seen already, holds up adoption of new technology- e-enabled or otherwise.

4.9.2 Efficiency in Value addition in terms of IT enabled services:

There is always a sense of hesitation when a new process is introduced. When a firm plans to implement various IT applications, it would face lot of challenges and also derives better benefits. Since this application implementation would involve lot of money and require long training hours, they always face threat or resistance from the management and the workers.
4.6 Value addition Functions in e - manufacturing

There is less impact on the e-enabled services as respondents are not able to visualize the positive impact of e-enabled manufacturing software. It is evident that production management can be a clear value addition and is depicted in Chart 4.6.

Table 4.7 gives the opinion disposition scores on the nine enablement factors of e-manufacturing, namely Waste and downtime tracking, Product tracking, Production management, Control system integration, Process history, Real time quality management, Shop floor metrics, Decision Support and Shop floor user interface. There is a good degree of positivity.

<table>
<thead>
<tr>
<th>Value Addition Functions</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>DA</th>
<th>SDA</th>
<th>TS</th>
<th>MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Waste and downtime tracking</td>
<td>75</td>
<td>56</td>
<td>0</td>
<td>42</td>
<td>0</td>
<td>173</td>
<td>3.46</td>
</tr>
<tr>
<td>Product tracking</td>
<td>0</td>
<td>60</td>
<td>105</td>
<td>0</td>
<td>0</td>
<td>165</td>
<td>3.3</td>
</tr>
<tr>
<td>Production management</td>
<td>225</td>
<td>0</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>240</td>
<td>4.8</td>
</tr>
<tr>
<td>Control system integration</td>
<td>50</td>
<td>32</td>
<td>90</td>
<td>4</td>
<td>0</td>
<td>176</td>
<td>3.52</td>
</tr>
<tr>
<td>Process history</td>
<td>75</td>
<td>0</td>
<td>105</td>
<td>0</td>
<td>0</td>
<td>180</td>
<td>3.6</td>
</tr>
<tr>
<td>Real time quality management</td>
<td>5</td>
<td>12</td>
<td>135</td>
<td>2</td>
<td>0</td>
<td>154</td>
<td>3.08</td>
</tr>
<tr>
<td>Shop floor metrics</td>
<td>10</td>
<td>0</td>
<td>144</td>
<td>0</td>
<td>0</td>
<td>154</td>
<td>3.08</td>
</tr>
<tr>
<td>Decision support</td>
<td>0</td>
<td>0</td>
<td>48</td>
<td>68</td>
<td>0</td>
<td>116</td>
<td>2.32</td>
</tr>
<tr>
<td>Shop floor user interface</td>
<td>200</td>
<td>24</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>236</td>
<td>4.72</td>
</tr>
</tbody>
</table>

Source: Primary Data
Test of Hypothesis

<table>
<thead>
<tr>
<th>Total</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>SQRT N</th>
<th>SE</th>
<th>Z Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1594</td>
<td>450</td>
<td>3.54222222</td>
<td>1.03791999</td>
<td>21.2132034</td>
<td>0.04892802</td>
<td>0.8629457</td>
</tr>
</tbody>
</table>

The null hypothesis is accepted with mean score at .5, meeting the benchmark established. Production management and Shop floor user interface possibilities are high scoring factors.

4.9.3 Adoption from employees and management

People need to be trained to work in a similar environment. Majority of the SMB’s mentioned they were trying to cope up with this new change and many firms lacked the awareness. These factors delayed IT adoption. Large enterprises that adopted IT enabled services; management, very few at the supervisor level were aware of the adoption or benefits. Many employees were not familiar on the data capture. Chart 4.7 depicts the absorption of IT enabled services. Lack of training, lack of focus from management to implement the e-enabled software in a systematic way and fear of mistakes has delayed the adoption from employees and management. Many users were trying to cope up with the new e-enabled.

![Absorption of IT enabled services](chart.png)

Chart 4.7 Absorption of IT enabled services.
### Table 4.8 Views on Absorption of IT enabled services in Manufacturing – Chi-Square Test (Grouped Data)

<table>
<thead>
<tr>
<th>Views</th>
<th>(O_t) for Agree</th>
<th>(O_t) for Disagree</th>
<th>Total</th>
<th>(E_t) for Agree</th>
<th>(E_t) for Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Absorption</td>
<td>13</td>
<td>37</td>
<td>50</td>
<td>24</td>
<td>26</td>
</tr>
<tr>
<td>Partial Absorption</td>
<td>19</td>
<td>31</td>
<td>50</td>
<td>24</td>
<td>26</td>
</tr>
<tr>
<td>Still trying to cope up</td>
<td>38</td>
<td>12</td>
<td>50</td>
<td>24</td>
<td>26</td>
</tr>
<tr>
<td>Often avoided</td>
<td>25</td>
<td>25</td>
<td>50</td>
<td>24</td>
<td>26</td>
</tr>
<tr>
<td>Total</td>
<td>95</td>
<td>105</td>
<td>200</td>
<td>96</td>
<td>104</td>
</tr>
</tbody>
</table>

**H₀:** No Relationship between Disposition (Agree or disagree- Grouped) of Views and Adoption of IT enabled and New Technology Chi Square: 27.4839744

The \(H₀\) is rejected, as the computed Chi Square: 27.4839744 is more than the critical chi-square value for 5% level and 3 degrees of freedom 7.815.

**Note:** \(O_t\) – Observed frequency, \(E_t\) – Expected frequency.

**Source:** Primary Data

A glance over the table reveals, full Absorption is agreed to by just 25%, Partial Absorption is agreed to by about 40%. Still trying to cope with has over 75% frequencies.

### 4.9.4 Flexible Manufacturing feasibility

In today’s manufacturing world, buyers expect manufacturers to be more flexible; flexibility in terms of order management, change of design, different trials with accessories and so on.

Hence there is a need for a certain amount of flexibility that would allow the manufacturing chain or system to react to changes, both expected and unexpected. Multiple factors are involved in these kinds of operations; it could be flexibility in machine operations, production of new designs or change of style, creating technological upgrades. IT enablement/ERP and SCM can be a tough affair for SME players. Technical upgrades and instant changes in operational methodologies/practices may not be possible.

There is a need for improvised supplier performance. It was found that flexibility happens only if properly planned. Large firms like ORACLE ERP; SAP etc. claim robustness and flexibility. Interestingly, most of the respondents preferred local flexible software players to larger firms. Chart 4.8 depicts manufacturer flexibility in process re-orientations.
From Chart 4.8 it is evident that respondents answered to the question on whether manufacturers were flexible in process reorientation in a straightforward way. With customization becoming very important respondents strongly agree to the fact that manufacturer flexibility is very important. Majority of the respondents agreed to the new age system.

4.9.5 IT enabled services, boon or bane for productivity increase

Industry has been using the word IT/technology interchangeably. Typically, across industry, technology in referred to as Automation, and that has been the key for most of the manufacturing process. The respondents felt that though automation helped in productivity, using IT enabled services helped in certain process and in many other situations, IT enabled solutions was considered as additional work leading to delay in production process.

Majority of works in the production department in a SME felt that IT enablement process is extra work and it delayed processes. Moreover, lack of training, employees in operations and entering of improper data leads to failure in the overall output or data processing in decision-making process. Production in-charge of Adithya Exports explained this in detailed and has categorically classified the entire success or failure to three major aspects:

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• **Trained and educated manpower:** Software people mentioned that lot of issues can be identified well in advance; like whether the machine will fail, from my office, I can see where my goods are and so on. But, all this is possible only if my employees understand the process and make right kind of entry. Moreover, at time, the data entry user interface asks for more details and employees consider this as extra work and show reluctance to do it. They either enter partial details or avoid this process itself.

• **Process understanding:** Majority of the process success lies in making the right entry. If proper training is not provided, inputs provided become a failure. With lot of churn happening at employee level, when we recruit new employees, one interesting factor noticed is that there are multiple local software’s and each software has different set of training. Hence, we need to train the new employees again and cost spent on training is a waste.

The success or failure of IT enabled manufacturing depends on proper planning that any firm undertakes. Any new initiative and technological change needs planning to overcome the hurdles that might come in the way. Hence a properly planned execution of IT enabled service leads to increase in productivity; data management, quality data management, return goods tracking, production line quality control being the key ones.

Chart 4.9 depicts the improvements due to inter departmental connectivity. The views are highly polarized. Hence no test of hypothesis is done. Some introspection is needed.

![Chart 4.9 Improvements due to inter departmental connectivity](image)

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4.9.6 Material tracking or traceability

Most of the manufacturing firms need real time ‘track and trace’ solutions to keep them on top of the manufacturing process. Majority of respondents were not aware of the need of the tracking and traceability for manufacturing firms. Majority of the respondents were not aware of the technology that was used to track and trace.

Production heads were able to mention that barcoding was regularly used in their finished goods. This coding helped them track goods once it goes out of the production floor.

It was surprising to know that majority of them didn’t have RFID and Labeling as top of mind recall, but, when aided, respondents were able to recall labeling as part of the tracking system. Majority of respondents mentioned that they haven’t heard about RFID!

When the researcher had lengthy discussion with the software vendors locally, logistics operators and warehouses used RFID sparingly. The other interesting factor that came across the research is that RFID, as a technology has been more costly to implement; most of them have not yet tried this technology to its fullest extent.

Mr. Govindaraj of BeyondEx Solutions Private Limited and G. Kannan, Senior Programmer, Oracle (Names changed as per request), mentioned that manufacturers are not separate entities but are part of greater supply chain. Hence, need for product/badge recall, needs track and trace. Mostly, software providers integrate with RFID technology providers to implement the same. This needs a receiver and a transmitter. Since it is in nascent stage, cost is still on the higher side. If more industries adopt RFID, cost might come down.

Barcoding has been the safest option and considered to be cheaper at each department level. Track and trace are more important at each level of production; this is required to be aware of the supplier whose goods were used across the production stages.
Material Tracking with IT enabled services

Moreover, recalls are costly if the procurement team is not aware of the supplier whose goods have faced quality issues. Chart 4.10 substantiates the aforesaid observations.

**Test of Hypothesis**

<table>
<thead>
<tr>
<th></th>
<th>H$_0$: Mean score $= 3.5$ (On a 5 point scale.)</th>
<th>H$_1$: Mean score $&lt; 3.5$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Score</td>
<td>N</td>
<td>Mean Score</td>
</tr>
<tr>
<td>469</td>
<td>150</td>
<td>3.13</td>
</tr>
</tbody>
</table>

Decision: H$_0$ is rejected. Population mean is less than 3.5.

**4.10 Mobility in e-manufacturing**

During secondary research, research reports and articles focused on penetration of mobility in the manufacturing segment. Globally, mobile devices have become a part of plant supervisors and key processes in plant management across industries. In India, though mobility has taken an upper hand, in garment manufacturing segment, role of mobility is not clearly defined.
Mrs. Sumathi of Ahuja Fashions, Mr. Rajesh and Mr. Balaji of celebrity fashions had better exposure to technology and during in-depth discussion, it was evident that implementation was a major issue and being not ‘On Cloud’ doesn’t permit use of newer technologies. Mobile usage needed a lighter version and its success depends on the interoperability feature present in the system. Moreover, mobile app providers develop standalone applications and majority of them are not serving the right purpose. Mobile technologies are very important for line supervisors; but might depend on the investment required in terms of training, buying mobile devises and purchase of licensed software.

At employee level, lack of clarity on the role of Mobility in garment industries was more dominant; when aided, they mentioned that mobility could be effectively used for preventing data in-accuracies and monitoring flow of goods.

There was confusion on how mobility could integrate data across different shop floors. Chart 4.11 depicts the impact of mobility solutions.

![Impact of mobility](image)

Chart 4.11 Impact of mobility solutions
Table 4.9: Impact of Mobility Solutions

<table>
<thead>
<tr>
<th>Views</th>
<th>SA</th>
<th>A</th>
<th>N</th>
<th>DA</th>
<th>SDA</th>
<th>TS</th>
<th>MS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevents data in-accuracies</td>
<td>225</td>
<td>20</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>245</td>
<td>4.9</td>
</tr>
<tr>
<td>Helps Data integration from different shop floors</td>
<td>75</td>
<td>20</td>
<td>90</td>
<td>0</td>
<td>0</td>
<td>185</td>
<td>3.7</td>
</tr>
<tr>
<td>Helps in monitoring flow of goods</td>
<td>200</td>
<td>20</td>
<td>15</td>
<td>0</td>
<td>0</td>
<td>235</td>
<td>4.7</td>
</tr>
<tr>
<td>Creates Scope of alterations in process</td>
<td>175</td>
<td>16</td>
<td>33</td>
<td>0</td>
<td>0</td>
<td>224</td>
<td>4.48</td>
</tr>
<tr>
<td>Total</td>
<td>675</td>
<td>76</td>
<td>138</td>
<td>0</td>
<td>0</td>
<td>889</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Primary Data

Test of Hypothesis

<table>
<thead>
<tr>
<th>H₀: Mean score = 3.5 (On a 5 point scale,)</th>
<th>H₁: Mean score &lt; 3.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>N</td>
</tr>
<tr>
<td>888</td>
<td>200</td>
</tr>
</tbody>
</table>

The null hypothesis is rejected; that is the mean score in more than the bench mark of 3.5. Actually the sample mean score is very high at 4.44. Mobility pays with great benefits.

5.11 Inferences on e-manufacturing

In a typical supply chain, each company places order with an upstream organization using inventory monitoring or control. In spite of incoming demands and depleting inventory, the company may not immediately place an order with its supplier. The bullwhip effect occurs when the demand order in the supply chain are amplified as they move up the supply chain.

Distorted information from one end of a supply chain to the other can lead to tremendous inefficiencies. Companies can effectively counteract the bullwhip effect by thoroughly understanding its underlying causes. The typical issues faced during such a situation would be excessive inventory, insufficient or excess production, backlogs, uncertainty in production planning etc. Major reasons projected to be the causes of the bullwhip effect are demand forecast updating, order batching, price fluctuation and stock availability. This is also primarily due to lack of communication between departments during decision-making processes.
In a classic successful manufacturing firm, **Bullwhip effect** can be reduced by certain methods, which are controlled by e-enabled software as depicted in Figure 4.5.

Among garment manufacturers, in both big and SME categories, information flow is different from that of spindle manufacturers or knitwear firms. Functioning of a garment industry is different and the capturing the flow according to the need is difficult and requires different level of planning.

**Inferences on e – manufacturing implementations;** Today’s modern ERP claims to have solutions to allow rapid implementation and easy expansions as per need and complexity of the manufacturing process. Moreover, IT enabled software system also supports lean initiatives and focuses on production floor.

![Fig. 4.5 - Reasons for Bullwhip effect](image)

During research the key factors that came across as value addition functions of any e-manufacturing system Product tracking, Production management and Control system integration, Shop floor metrics, Shop floor user interface, Waste and downtime tracking, Process history and Real time quality management.
5.11.1 The issues related to IT enablement are listed below

**Defects:** Defects are supposed to be the most significant one as it leads to multiple allied issues. Of this, quality related defects and its return process, production mistakes due to lack of data information.

**Talent:** Irrespective of ERP system in place, if talent/employees are not trained properly, issues related to production are more prominent.

**Inventory and return of goods:** Production has multiple issues related to quality of goods supplied for production, rejected raw materials and finished goods to be stored till next process. When this data doesn’t match with the inventory or the order schedule, production comes to a stand still.

**Process delay:** Improper reporting, data re-entry at multiple touch points, lack of standard operations, mistakes due to lack of technical operations, human error due to non-user friendly interface, and so on, could cause delay in production.

**Production in-balance:** Because of design deviation, many times, due to unclear customer need, production comes to a stop; moreover, the concept of JIT leads to problem if the production output is not in sink with the inventory management.

There were very few who were focused on shop floor metrics and user interface; waste and downtime management. Interestingly, shop floor metric is seemed to be more important as it helps in big decision making.

Shop floor metric integrates multiple operational touch points and helps in assessing the issues across each stage.

If these metrics are not captured and data entered for assessment, e-manufacturing would be a Data analysis has not captured any correlation between technology and manpower loss.

But, if the new technology training is not reaching out to employees, manpower reduction could happen. Organization culture, if properly maintained from the top, will solve majority of issues.

e-manufacturing related software, if used efficiently, can help re-engineer an existing process and there by reduce the opex. Problems can be addressed based on a pattern that the software could help us to capture. Efficiency is directly proportional to shop floor metrics and easy user interface of the system.
failure. **According to Mr. Kannan of SKL exports**, focus given to product tracking and production management was more compared to other functions of e-manufacturing. But, **Mr. Venkatraman** explained that irrespective of any form of e-manufacturing solution that we offer, companies must take serious notice of the user interface; with all multiple functionalities, if user-input interface is not friendly, entering data becomes a big major issue. Fear of tough and non-friendly interface make the employees shy away from data capturing. As explained by the respondents, even a small process change could help the industries to minimize the rejection before manufacturing; for example, if the cloths are ironed before being sent for stitching segment, wrinkles are minimized and leads to proper stitching; this leads to less number of rejections that happens in the cutting segment.

This can be identified if data are properly entered in the rejection segment and the data analytics output is analyzed by the industry.

Technology has improved to such an extent where predictive analytic software would ideally give an indication with slightest change in pattern. If required, technology can talk to the machine and give indications of possible failure of spare parts.