CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

A comprehensive survey of literature related to this research was done. The study surfaced the core disciplines on which the research was built. Manufacturing practices used since the early 1980s up to the present time have been reviewed. The experience of transformation and detailed analysis thereon has been assessed.

Today there are many tools and techniques available but no single tool provides the complete range of capabilities to manage today’s complex manufacturing systems.

2.2 PURPOSE OF THE RESEARCH JUSTIFIED

One of my concerns after reading several books on the Toyota production system is that, while such books do outline principles and techniques with detailed explanations, their treatment of the subject is specific and anecdotal rather than systematic. For eg. Just-in-time is frequently emphasized, but there is no discussion on what has to be done in order to achieve JIT. You may begin to get the idea after reading these
books several times, but many do not tell you straight away what needs to be done. On the subject of autonomation, another mainstay of Toyota production system, these books often don't contain specific explanations beyond a description of the concept as “automation with self-tripping device” or “machines with human functions”

Leveling is another concept that is often not fully explained. Books may simply state, “If the main assembly line load is not uniform, various problems at parts-producing processes or sub-contractor plants will result.” No explanation of how to achieve leveling may be offered. Such treatment of the subject, I feel, is inadequate.

The study of Toyota production system from an industrial viewpoint has brought me to the following conclusions:

The elimination of the waste of overproduction cannot be achieved without SMED. Shortened cycle time demand small lot production and SMED is crucial here as well. SMED must be achieved if we want to be able to respond to changes in consumer demand.

Many people believe that when implementing a new system, only know-how is required. However, if you want to succeed, you must understand “know-why” as well. (Shigeo Shingo 1989)

2.3 THE GROWING COMPETENCE

Six of the drivers of change that will influence the future success of many manufacturing businesses are described below. The six generic
topics will in practice be associated with specific market and technology developments that each manufacturer employs to gain competitive advantage.

1. Internationalization: the influence of overseas markets and enterprises.
2. Changing customer requirements and sales and service networks.
3. Competitiveness through agility, focus and partnerships
4. People skills, motivation, leadership, teamwork, learning, knowledge and innovation.
5. Responses to environmental concerns and regulation.
6. Influence of information technology and communication.

David Grant et al (1998) have dealt with this at length.

2.4 REGIONAL ISSUES

Multinational companies face certain problems implementing productivity improvement programs across Asia because of the diversity of the various countries. It was found that regional factors are related to the state of industrialization and economy of the country, intensity of government QM initiatives, the role-played by multinational companies to disseminate QM technology and the maturity of such practices in the country. (Teng Heng Chan et al)
2.5 VARYING PERSPECTIVES ON STRATEGIES

Quality function deployment provides a means of translating customer requirements into technical requirements for each stage of a product or service department. However, it is not an easy tool to use. It is outlined how other analytical techniques can be combined with QFD to resolve some of its drawbacks. There are many definitions of QFD, reflecting its many facets. However, it is primarily a people system. Nothing happens without people. (Vivianne Boucereau et al 1999).

Although flexible manufacturing systems are often presented as capable of machining a wide range of products, there are many intrinsic constraints that limit their use.

FMSs are all different: each has a specific level of constraint, which are influenced by the deployment envisaged by the user. As each configuration may be viable in the circumstances in which it is introduced, users need to ensure that when they design their configuration to meet their initial needs, they do not shape constraints in a way that will preclude realization of future objectives. (R.W. Batchelor et al 1999)

There are many common themes between QS-9000, QS 9000 : 2000 and EFQM Excellence Model. QS-9000 is the most prescriptive of the three, which is understandable as it details the customer requirements that suppliers/ subcontractors need to achieve. (John Piggott 1999)
The use of FMEA in industry depends on the type of industry, the knowledge required of the product/process and the legal/customer requirement. (Chris McCollin 1999).

WCM makes operators owners of the processes and the first line of attack on the wide array of problems that spring up on any shop floor.

A full range of elements of production are affected, management of quality, job classifications, labour relations, training, staff support, sourcing, supplier and customer relations product design, plant organization, scheduling, inventory management, transport, handling, equipment selection, equipment maintenance, the product line, the accounting system, the role of the computer, automation and others (Richard J. Schonberger 1982).

Increasing pressures to produce high-quality products with fewer resources can cause degradation in procedural compliance, particularly when compliance conflicts with the ability to meet production schedules. Reaction to out of control condition through Statistical Process Control is one such procedure. SPC procedure often requires that processes be shut down until the cause of an out-of-control condition is identified and removed. Poor integration of SPC procedures into the existing business systems makes compliance with this type of procedure stressful for many levels of the organization. Using focus group data, sample surveys, and focused interviewing, a model is to be derived (Harrison W. Kelly et al).

Much of the existing literature on longitudinal TQM development in organizations is anecdotal and descriptive, without any
obvious theoretical base. This should fill the void by examining organisational practice with the view to develop underpinning theoretical models through grounded theory research (Denis Leonard et al).

Perishable goods cannot be made for stock in slack times and the manufacturing business needs to be very 'agile' to adapt closely to the fluctuations of demand:

- weekly pattern, with peaks at the weekend
- monthly cycles inline with receipt of paychecks
- seasonal demand changes in line with temperature, holiday and Christmas
- promotional demand peaks, often not very well co-ordinated with the retailer
- random demand fluctuation

The business needs to be able to adapt to these demand changes. For example, make too much and there is a loss of profit plus angry retailers.

The underlying principle is that the business develops a master schedule of what it wants to produce, i.e. a plan of what to make in the future, balancing the overall demand against resources. Customer orders are accepted against this master schedule. Periodically (daily or weekly), the master schedule is exploded through a recipe or bill of material, which holds data of all materials needed to make a product, including all intermediates and packaging materials. The calculated gross requirements are matched against existing stocks and supply orders in the pipeline. Any
shortfall, or 'net requirements', form the manufacturing and purchasing quantities to be made or bought to fulfill the plan as laid down in the master schedule.

ERP has great appeal and frankly, there is no practical alternative today. It has many shortcomings and it can be very rigid, but it is still the best corporate-wide transaction-based system and data repository available today. Unfortunately it is often used inappropriately.

ERP is a complex system – not because it requires superhuman skills and intelligence, but rather because it covers such a wide range of company activities and touches more people’s lives at work rather than any other application software package. (Rod Jones et al 1999).

Criticism of statistical quality control – Shingo broadly criticizes statistical quality control, saying “It took 26 years for me to free myself completely from the spell of inductive statistics. “ His two main criticisms are that “ as a result of focusing on inductive statistics, people neglect qualitative improvements in informative inspections, that is, the performance of 100 percent checks or increases in the speed of corrective action”. Shingo asserts that shortcomings in SPC result from induction and that the focus on statistical methods tends to deemphasize feedback and corrective action.

Shingo’s concern with inductive statistics is that sampling by definition is intermittent. This is a concern because abnormalities occur unpredictably, and sometimes intermittently. “The probability that statistical sampling will find abnormalities at just the right time is far
lower than 100 percent sampling”. He adds “statistics is really no more than qualified guesswork” (John R. et al).

2.6 IMPLEMENTATION ISSUES

Even though quality management has been addressed on a national level since 1980, it is still not clear, as to what extent TQM practices are implemented effectively at the organizational level. Based on the study and experiences, it is observed that the Chinese Organisations do not have a good understanding of modern quality management principles. A recent survey of USA Managers working in China found that 60 percent complained of quality control problems and 89 percent believed China lacks qualified management candidates. It has been reported that the problems and obstacles to implementing TQM in China include the lack of competitive pressure on quality from the market place, management deficiencies, workforce issues, the pay systems, lack of quality commitment, lack of quality training, inadequate technology, lack of communication in terms of quality standards and work ethic problems. Less effort, however, has been made to examine empirically the TQM practices in China.

Most companies are disappointed or unsuccessful in key aspects of their innovation projects, according to the 11th annual Bourton Group survey of manufacturing industry. Only 10% of companies responding to the in-depth study reported ‘great success’ in meeting such critical criteria as project cost targets, planned volumes and market plans. All this despite an overwhelming majority identifying ‘product innovation’ as one of the top challenges facing their company.
Bourton group director Tim Washington accuses companies of ‘disturbing complacency’ in viewing the strengths and weaknesses of the innovation process. Significantly this affects most business across the board, regardless of the industry sector, competitive performance or innovation strategy.

Only one company in eight formally monitors cost, time, customer satisfaction and product performance when marketing a new product. The average product replacement rate over the past two years is only 20% of products by value, and there is little expectation of this improving. (Development Skills lacking - editorial)

2.7 MANUFACTURING STRATEGIES

The thesis focusing on appropriate manufacturing practices has an exclusive Chapter 4 on the selected practices. The literature for a few of the practices is given below.

2.7.1 Lean Manufacturing

From the research two-thirds of the companies said that a strategic advantage had been generated by the adoption of lean approach, with the greatest improvement stemming from market competitive positioning, customer relationships and quality constraints. The improvements are listed in Table 2.01.
Table 2.01 Characteristics of Lean Approach In Comparison to Traditional Approach

<table>
<thead>
<tr>
<th>TRADITIONAL APPROACH</th>
<th>LEAN APPROACH</th>
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<tr>
<td>• Scheduled assembly lines/Fabrication with functional product design and functional manufacturing organisations focussed on direct labour productivity.</td>
<td>• Philosophy and corresponding technology are based upon flow manufacturing techniques, which concentrate on process Quality design and which focus on product material cost and overhead support cost.</td>
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<tr>
<td>• Tracking Ghost- sophisticated scheduling and tracking system have been developed in the western world such as MRP-I, MRP-II etc. with computer support.</td>
<td>• Pull material flow with very little computer support.</td>
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<tr>
<td>• Quality is considered not as one of the requirement of the customer.</td>
<td>• Quality is built into the product through development of the process plus tools and techniques of taking quality to the employees and machines that actually create the product.</td>
</tr>
<tr>
<td>• Sub assy. &amp; machines part manufacturing</td>
<td>• Mixed model flow process</td>
</tr>
<tr>
<td>• Scheduled quantities /dates</td>
<td>• Total demand and daily rate</td>
</tr>
<tr>
<td>• Pick grouped parts [KITS]</td>
<td>• Demand Pull Kanban</td>
</tr>
<tr>
<td>• Lead times [Days]</td>
<td>• TAKT time [min]</td>
</tr>
<tr>
<td>• Inspection</td>
<td>• Total quality management</td>
</tr>
<tr>
<td>• MRP-II managed by report</td>
<td>• Management by Eyes</td>
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<td></td>
<td>• Flow based costing</td>
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The important principle that governs Lean Manufacturing is referred in table 2.02 and the consequent benefit to business and employees is indicated in table 2.03

**Table 2.02 Lean Principles**

<table>
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<th>Lean Principles – 5 Steps</th>
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<tr>
<td>1. Fundamentally review and agree customer requirements for a specific product</td>
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<td>2. Define the complete order winning process (or Value Stream) for the specific product</td>
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<td>3. Move towards continuous, single piece flow</td>
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<td>4. Balance flow, effective use of resources</td>
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<td>5. Continuously improve by rigorously attacking waste</td>
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**Table 2.03 Benefits of Lean (Adapted from Womack, Amrik. S. Sohal)**

**BENEFITS TO THE BUSINESS AND EMPLOYEES**

- Increases labour productivity all through the system
- Increased Flexibility
- Cuts production through time by 90%
- Reduces inventories by 90%
- Cuts errors and scrap and accident by 50%
- Halves time to market for new products
- Greater sensitivity to market changes
- Stronger focus on performance
- Improved supplier bond
- Change from reactive to proactive organisation
- Teamwork
- Involvement and Empowerment
- Greater job flexibility and wider job skills
From the research conducted by Amrik S. Sohal, figure shows the areas in which greatest benefits had been achieved by the companies (Figure 2.01) Twenty two percent of the companies surveyed were reported to have achieved benefits higher than those expected from lean approach. Nearly two-thirds of the companies were able to identify waste more readily through the lean approach.

![Graph showing benefits of lean approach](image)

**Fig. 2.01 Benefits from Introduction of Lean Approach (Amrik S. Sohal)**

Increasing customer focus is another major area in which organisations are trying to improve their performance and to a large extent lean approach is very useful in meeting the challenge. The other areas in which lean approach has helped the companies to improve include:

- Standardisation of products, processes and procedures
- Improved training
• Improving research and development turnaround
• Improvements in the technical side of the business through world best practices
• Improved level of service
• Installation of better energy management system and other methods of waste elimination in a systematic way.
• Lower material-handling levels
• Improving the key business ratios or success factors which delight the shareholders (E.g. Stock turn, Value added / employee, Sales/employee, Capital turn ratio.)

Makes manufacturing operations business process more effective in meeting the total requirements of the market.

To summarise, the overall benefits of Lean approach are increased company flexibility to meet customer needs, lowering of lead times, greater sensitivity to market changes, higher productivity levels, stronger focus on performance, improved supplier bonds and a change from reactive to proactive management style. It is clear that there is a string of benefits to be gained from implementing lean approach by every company regardless of size or field of trade.

The lean supply model proposed by R. Lamming (1995) relies heavily on the Japanese experiences and is designed to capture the present position of the leading manufacturing and assembly companies in the automotive industry.
Lamming (1995) definition of lean supply is: “The state of business in which there is dynamic competition and collaboration of equals in the supply chain, aimed at adding value at minimum total cost, while maximising end customer service and product quality.”

He shows that it is not the individual abilities or strategies of buyers or sellers that are important, it is the mutual relationship between the two.

2.7.2 Supply Chain Management

Supplier Development can also be seen as the quality relationship. This kind of view is proposed by Levy et al. (1995). The author’s research identified the main issues in a successful total quality relationship. They see the first step as the recognition of the existence of a supply relationship and the establishment of a clearly defined shared strategy between the customer and the supplier. The relationship between both should not only be co-operation but collaboration. The linking of possibly conflicting organisational cultures is enabled by a clear process for continuous improvement and a flexible structure. The relationship is maintained through the use of appropriate tools and techniques and influenced by the learning process. Also in this model the authors see trust, openness, honesty and interdependence as the necessary elements of success.

The quality of purchased materials is critical to the quality of a company’s finished products. Philip Crosby estimates that 50 percent of a company’s quality non-conformances are caused by defective parts or
material supplied. According to Chrysler poor quality is a “Vampire like creature which takes bite after bite out of productivity’ (John Bache 1985).

Lean supply is one which calls for shared responsibility in all matters of supply between manufacturers and suppliers and quality issue is no exception for this. The key feature of the shared responsibility must be an agreed plan for joint continuous improvement with clear milestones and target. This needs to be present and explicit in every individual supply relationship and there should be joint working groups with responsibility for completing the objectives of the plan.

The jointed approach has really had an impact over the last five years and during the research it was seen that many of the companies supplying in automotive sectors are meeting very high quality standards and the defect levels are in ‘parts per million’.
Suppliers of the raw materials (Steels, Plastics, Chemicals, etc.) are seen as a limitation to the development of product quality, due to apparent reluctance to discuss performance improvements and reluctance to discuss performance improvements and flexibility in supply. To improve the quality levels of the product in the supply chain it is necessary for the vehicle manufacturer to start intervening with such firms.

Technical capability of suppliers in lower tiers of supply is also seen as a source of quality problems and it is apparent that, some improved communication is necessary at these levels, in order to develop a lean supply throughout the supply chain.

Warranty is an important factor related to product quality and some suppliers are prepared to take a greater role in its provision (i.e. take warranty responsibility for their parts, even when they are used in conjunction with others in assembly of the vehicle) in return for a greater involvement in the design process. It should be noted that increased involvement of suppliers in product design would improve the possibilities of sharing warranty responsibility.

The origin of this tool is from the time compression and logistics movement. It became popular after its use in textile industry supply chain setting (New 1993). This is often referred as ‘Time Based - Process Mapping’ in a more wide ranging work areas like the automobile, aerospace sectors and construction.

This mapping approach is shown in figure (Figure 2.02), it seeks to portray in a simple diagram the critical lead-time constraints for a particular process.
The example illustrated towards explaining the tool, is cumulative lead-time in a distribution company, its suppliers (Fig 2.03) and its downstream retailers.

The horizontal measurement shows cumulative lead-time for the product both internally and externally. The vertical measurements show the average amount of standing inventory at specific points in the supply chain.

In the example the horizontal axis shows the cumulative lead-time to be 42 working days. The vertical axis shows that a further 99 working days of material are held in the system. Thus the total response time in this system is 141 days. Once this is understood, each of the individual lead times and inventory amounts can be targeted for improvement activity.

![Fig. 2.03 Supply Chain Response Matrix- A Distribution Example](image-url)
2.7.3 JIT

Ford has set up the system, called Just in Sequence with its suppliers that allows Just-In-Time delivery (Figure 2.04). It is a technique whereby strategic suppliers site manufacturing plant alongside the main production lines. From these cells the component manufacturers produce parts "in sequence" with the main line in a constant drive to eliminate waste and double handling (Montimer, 1994). The Principles of JIT are depicted in Fig 2.05.

**Just-In-Time is.......**

A Manufacturing system which produces:

- What the customer wants
- In the quantity the customer wants
- When the customer wants

While using the minimum of
- Raw Materials
- Equipment
- Labour
- Space

*There is a focus on Waste Elimination and Lead time reduction this would be the criteria for measuring the results of JIT efforts*

Fig. 2.04 JIT Philosophy
JIT – Characteristics

- Machines in order of processes
- Small and inexpensive equipment
- One-piece flow production
- “U” shaped workflow - counterclockwise
- Multi-process handling workers
- Standing operations - moving while working
- Ergonomically correct operations
- Production paced to takt time
- “Standard operations” defined and implemented

Fig. 2.05 JIT Principles
2.7.4 E-Manufacturing

One of the technologies which can help to reduce the cost of supplier's co-ordination by improving the ability of a purchasing manager to manage suppliers and enhancing buyer-supplier relationships is Electronic Data Interchange.

EDI is the technique based on agreed standards, which enables computers in different organisation to successfully send business or information transactions from one to the other. The documents sent in this way are best handled by utilising a "value-added network" which accepts large batch transmissions and sorts the documents into "electronic mailboxes" for each trading partner. Each company receiving documents checks its electronic mailbox and extracts the data contained. (Johnston, 1992).

EDI provides the method of exchanging documents in electronic form directly between a computer and one or more other computers. Exchange of information between departments and firms use assorted information systems, so that EDI has to combine the functions of translation (encoding to and decoding from a neutral format) storage and transmission. EDI makes use of the common networks so many organisations can be subscribed with only one link per organisation. Standardisation allows the diversity of computer systems between organisations. EDI software performs a number of functions, including data extraction, data encoding, data transmission, data receipt, data decoding and data insertion. The transmitters need to know what information to send and in what order. The other side the receiving
computer should know what the transaction comprises and how to process the information. The defined standards help to achieve these.

The automotive manufacturers in Europe, i.e. Ford, General Motors, Saab, Renault, Fiat, Austin Rover, Citroën and their suppliers like Perkins and Bosch have set up ODETTE as a collaborative agreement for common messages and protocols.

EDI provides business transaction including orders, invoices, delivery, advises and payment instructions. Information transactions convey details about a person or organisation for administrative purposes, e.g. price lists, production facilities etc.

There are two sets of triggers driving EDI, which can work independently or together. One group is external and the other internal. The major pressure driving companies into EDI is external- pressure from major customers. Many companies are building EDI capability into conditions of contract; others are imposing financial penalties for each paper document submitted. This way of approach is wrong and the companies should provide support towards implementing EDI.

2.8 PRODUCTION COMPLEXITY

The production complexity methods are divided into three groups each with its main philosophies:
1. Production is very complex. Therefore we need more and more complex computer programs and systems to regulate and control it.

2. Production is very complex. Therefore the only way to make such systems more effective is to simplify them.

3. Production is very complex. Therefore there is no chance of building a system to solve the problems. Hence the role of computers should be limited to supplying data and humans should be left to make decisions.

The first group believes that more and more complex computer programs and systems need to be developed to regulate and control production management. Such methods include:

- PICS – Production information and control system
- COPICS – Communication oriented production information and control system
- IMS – Integrated manufacturing system

These methods (and others) use logic and production theories as with previous manual methods, but by computer rather than manually. The disciplines considered include:

- Engineering design
- Process planning
- Master production planning
- Material requirement / resource planning
- Capacity planning
• Shop floor control
• Inventory management and control

The second philosophy "Production is very complex". Therefore the only way to make such systems more effective is to simplify them; this resulted in production methods such as Group Technology, Kanban and JIT.

Group Technology (started in the 1940s) preached organization of the processing departments of the enterprise into work cells, where each work cell can produce a family of products/items. A cell consists of all resources required to produce a family of parts. Item processing starts and finishes in one work cell. The workers in the cell are responsible for finishing the job on time, for the quality of the items and the transfer of items from one workstation to another. The cell is an autonomous functional unit.

The third philosophy became significant where there was no breakthrough in developing algorithms and methodology in the field of basic engineering and production management. Developing algorithms for management methods and for processing in different fields takes a lot of time and large-scale effort. Research and development in this area, although necessary is difficult. Industry needs solutions and methods without having to wait a long time for algorithms to be developed. Serious research has not been done with the excuse that manufacturing and processing is not totally deterministic. Effective operation of such systems therefore requires use of logic but also inference, institution and experience. Hence, developing management and processing methods
became a topic for the disciplines of artificial intelligence, expert systems and computer science.

2.9 CONCLUSION

The literatures on various manufacturing strategies and principles have been reviewed. It has been found that there are differences in the approach of companies in the western and eastern countries. While the western countries focused on results, eastern counties emphasized on the processes. Indian companies were choosing any one of the world class manufacturing practices. The types of orientations of were mainly due to the influence of consultants, collaborators, familiarities, knowledge etc,. It has been found from the review that the Indian companies apply the manufacturing practice which is not appropriate to their case leading to unsatisfactory results.

There is a lack of a structured approach from which any manufacturer can choose an appropriate manufacturing practice which suits his company. The survey also highlighted the need to have a manufacturing strategy which is process oriented to yield the required results. This called for a serious need for a model, which integrates all the manufacturing practices that gives a comprehensive and systematic approach towards selection and customization of an appropriate strategy with due consideration to the business objectives.

In today's competitive environment, it is necessary to have a manufacturing strategy comprising a set of manufacturing practices with a clear correlation regarding the dependency, which are process driven, to yield the required results.