CHAPTER 7

ANALYSIS OF LEAN MANUFACTURING TOOLS IN LEAN SUPPLY CHAIN

This chapter shows an analysis of lean tools on a survey study of manufacturing companies involved with lean manufacturing principles. This study focuses on the identification of lean tools that are essential for the lean supply chain performance. This study has identified fourteen lean tools that are linked to the lean supply chain and also substantiated the evidence that implementing lean supply chain using the lean manufacturing tools helps to increase productivity. Managerial implications based on the study are also presented.

7.1. Analysis of Lean Manufacturing Tools in Lean Supply Chain

Shah and Ward (2003) examined lean manufacturing tools on unionization, plant age and plant characteristics using the secondary data taken from Industry Week's (IW) Census of Manufacturers. The data present a rich picture and a deep insight into the organizations implementing lean manufacturing practices. They identified and presented an overall analysis of twenty two lean manufacturing practices based on the above three contextual factors.

The present research survey analysis also uses an analogous secondary data available from the IW. The present survey analysis was done to identify and examine precise lean tools that are linked to the performance of lean supply chain. An analysis of lean tools for supply chain on the best plant award winning manufacturing plants for eight years (2000-2007) has been done. A total of eighty-eight manufacturing plants have been taken for the study. This study was focused on distinguishing the lean tools on the following supply chain factors that were reflected in this research work: lead time, set up cost, inventory, production-delivery, rework and number of inspections. The lean tools that are linked to the reduction of these supply chain processes are examined. This study also looks into the lean tools that have been applied to achieve optimal batch size, optimal cycle length and quality improvement that were considered in this research.

The remainder of the chapter is organized as follows. Data collection and plants characteristics are studied. The fourteen lean tools identified in this study are defined. Lean manufacturing tools that are linked to the individual performance of each of the supply chain factors are examined. Finally an overall analysis of these tools is also done.

7.2 Data Collection and Plants' Characteristics

Manufacturing plants were defined according to the criteria established by IW. The companies winning the best plants included those companies with a majority of their business in a manufacturing industry and a few computer software companies whose primary business is the manufacture of software programs (Drickhamer 2004). The best plants were selected by Industry Week based on the management practices and plant performance in such areas as quality, customer and supplier relations, employee involvement, application of new technologies, productivity, cost reductions, manufacturing flexibility and responsiveness, inventory management, environmental and safety performance, new product development, and overall market results. All the plants had used the lean manufacturing principles by applying lean tools to gain competitive advantage and become leaders in their respective fields.

In this study, the award winning plants were classified into six types based on the similarity of their products as shown in Fig. 7.1, which interestingly shows that, bulk of the plants were involved in manufacturing various automotive components.

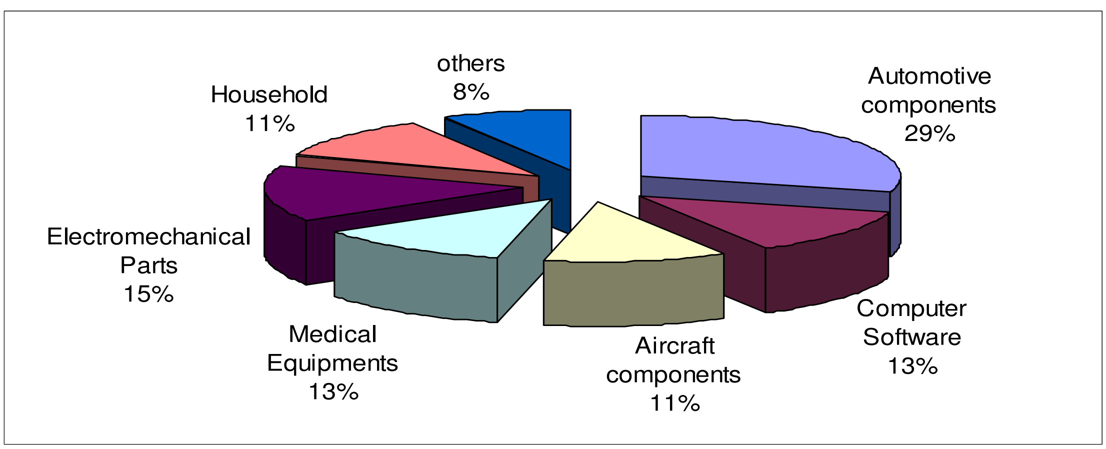

Fig. 7.1 Classification of manufacturing plants based on similarity of products

7.3 Lean Manufacturing Tools

The fourteen lean manufacturing tools that were significant in this study on lean supply chain were identified as follows:

(i) Hoshin Planning
(ii) JIT/pull System
(iii) Kaizen
(iv) Kanban
(v) Poka-yoke
(vi) Research and Development (R&D)
(vii) Safety Practices
(viii) Six Sigma
(ix) Statistical Process Control (SPC)
(x) Total Predictive Maintenance (TPM)
(xi) Total Quality Management (TPM)
(xii) Toyota Production System (TPS)
(xiii) Value Stream Mapping (VSM)
(xiv) 5 S

Table 7.1 provides a comprehensive description of all the above lean tools.

Table 7.1 Comprehensive description of lean tools used in lean supply chain

S.No.	Lean tool	Brief description of the lean tool
1	Hoshin Planning	A strategic planning and management methodology tool that uses “Plan-Do-Check-Act” cycle to create goals and control daily activities.
2	JIT/pull System	An inventory strategy tool implemented to reduce the inventory by ensuring that products are manufactured as per the customers pull.
3	Kaizen	A tool use in the method of speeding the rate of process improvement in manufacturing settings. Kaizen aids in continuous betterment of the production operations, always driving for innovation methods.
4	Kanban	Kanban (kan-visual, ban-board) is a tool related to lean and JIT production. It is the means through which JIT is achieved.
5	Poka-yoke	A mistake proofing mechanism tool that helps an equipment operator to avoid mistakes. This mechanism is used to eliminate defects in product by preventing the defects from occurring, correcting the defects, as soon as they are detected by drawing attention to the errors as they occur.

6	Research and Development (R&D)	A scientific and technological development tool. Market research is carried out to find what is needed and the product is developed to make the production processes more efficient and to make the products technically superior, to have a natural advantage in the market place.
7	Safety Practices	A tool to identify the way in which safety is managed in the workplace, and often reflects the attitudes, beliefs, perceptions and values that employees share in relation to safety.
8	Six Sigma	A statistical lean tool that uses standard deviation method to improve the processes in manufacturing and eliminate defects.
9	Statistical Process Control (SPC)	An effective tool of monitoring a process through the use of control charts. They can lead to a reduction in the time required to produce a product or service from end to end by identifying the bottle necks, wait times and other sources of delays within the processes.
10	Total Predictive Maintenance (TPM)	An auto-maintenance tool where the machine operator performs all of the routine maintenance tasks themselves. It is a maintenance reduction by proactive approach.
11	Total Quality Management (TPM)	A management approach for an organization, centred on quality, based on the participation of all its members and aiming at long-term success through customer satisfaction. This requires that things are done right the first time and that defects and waste are eliminated from operations.
12	Toyota Production System (TPS)	An integrated socio-technical tool, developed by Toyota that comprised its management philosophy and practices. The main objectives of TPS are to design out overburden (muri) and inconsistency (mura) and to eliminate waste (muda).
13	Value Stream Mapping (VSM)	A tool to identify the material and information flow in a supply chain. It is done to identify opportunities for improvements in lead time and setup time.
14	5 S	A methodology tool to organize the production area. The objective of 5S is that things like tools, materials are kept in appropriate locations, so that the time taken to look for things is minimized. The basic principles of 5S are: sort, straighten, shine, standardize and sustain.

7.4 Analysis of Lean Manufacturing Tools

From the data obtained by the IW best plants, various lean tools listed by the best plants were noted. It is an interesting fact that some lean tools have multiple names and some of them overlap with other tools. Pavnaskar et al., (2003) also reaffirmed the same in their classification of lean tools. In this research, for example kaizen is also called as continuous R&D category. Hence, the number of tools selected for the analysis was classified into fourteen different tools. Also every individual plant had used multiple sets of tools to increase their productivity and there has been repetition in the usage of tools. For instance if a plant has used kaizen, JIT and kanban as lean tools another plant has used JIT, kanban, six sigma and kaizen as lean tools for their productivity gains. Due to the one-to-many correspondence situations, throughout the analysis the cumulative of eighty-eight plants is not shown and instead the study focuses on the number of plants using the tools and the percentage usage of the tools individually.

Examining the performance gains reported by the eighty-eight plants that actually made them the best plant winners, the analysis is based on the increase in productivity which the plants ascribed to using lean manufacturing tools. Although some plants supplied numerical responses for these categories, it was not possible to meaningfully summarize improvements statistics from the data available from IW best plants, maybe due to likely diverse set of measures the plants relied on, for these factors. The same opinion was reiterated by Wemmerlov and Johnson (1997). Consequently, in this study, only percentages of firms reporting improvements in these areas are presented. It is also to be noted here that each plant had reported multiple achievements by using at least two to three lean tools. They did not provide information on which tools were directly linked to the specific performance gains. Hence, all the tools listed by a plant were linked to each of its achievements, again using a one-to-many correspondence approach. For example, a plant reported reduction in setup cost and lead time using the tools 5S, TPM, kaizen, and SPC. Since there was no obvious relation between the tools and the individual achievements, for each of the two performance gains, all the five tools were attributed. Correspondingly, similar performance gains were brought into a single category. For example, reduction in rework, scrap and repair are not listed as separate achievements but grouped into a single category as rework.

Since this study is focused on supply chain factors that are directly linked to the productivity, only those performance gains that relate to the leanness of supply chain are considered. Thus, the performance gains reported by the plants were organized into nine parameters as follows: Optimum cycle length, optimum batch size, JIT- inventory, JIT-production and delivery, rework reduction, lead time reduction, setup cost reduction, quality improvements and reduced inspections. Figure 7.2 shows that these performance gains were firmly contributing to the productivity increase.

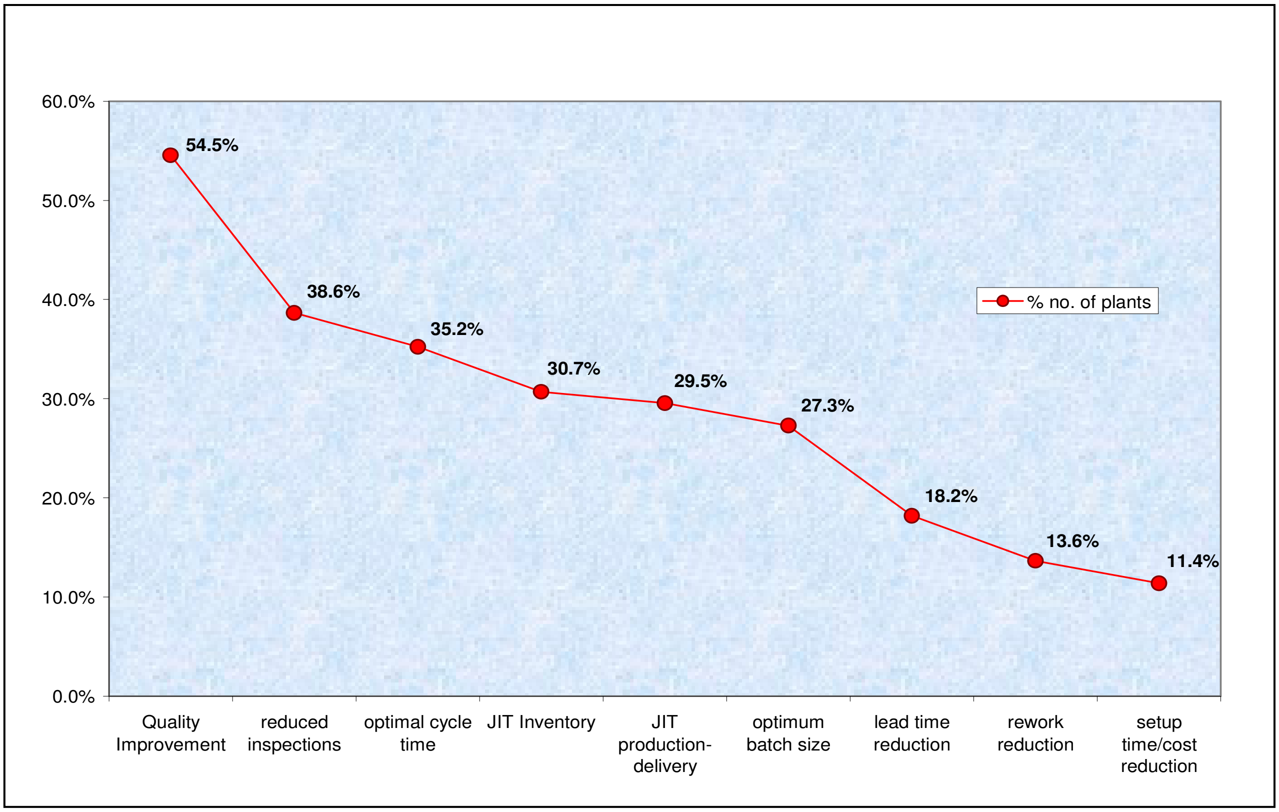

Fig 7.2 Analysis of plants achievements based on supply chain parameters

From the Fig. 7.2 it is clear that majority of the plants reported increase in productivity due to quality improvements. The trend shows that reduced number of inspections, optimum cycle time and batch size along with JIT inventory and production-delivery are almost in the same level substantiating the need for integration of these factors for better performance. Reduction in lead time, rework and setup time and cost contribute 11% to18% of the productivity increase.

7.4.1 Analysis of lean manufacturing tools for quality improvements

Figure 7.3 shows that the major trend towards quality improvement is based on kaizen (66.7%) and 5S (52%) implementations. Kanban (37.5%), VSM (35.4%), JIT (27.15%) and six sigma (27.1%) are other important tools in obtaining this performance gain. TPM, TQM, TPS and pokayoke also share an average contribution of 15% whereas other tools have less significance.

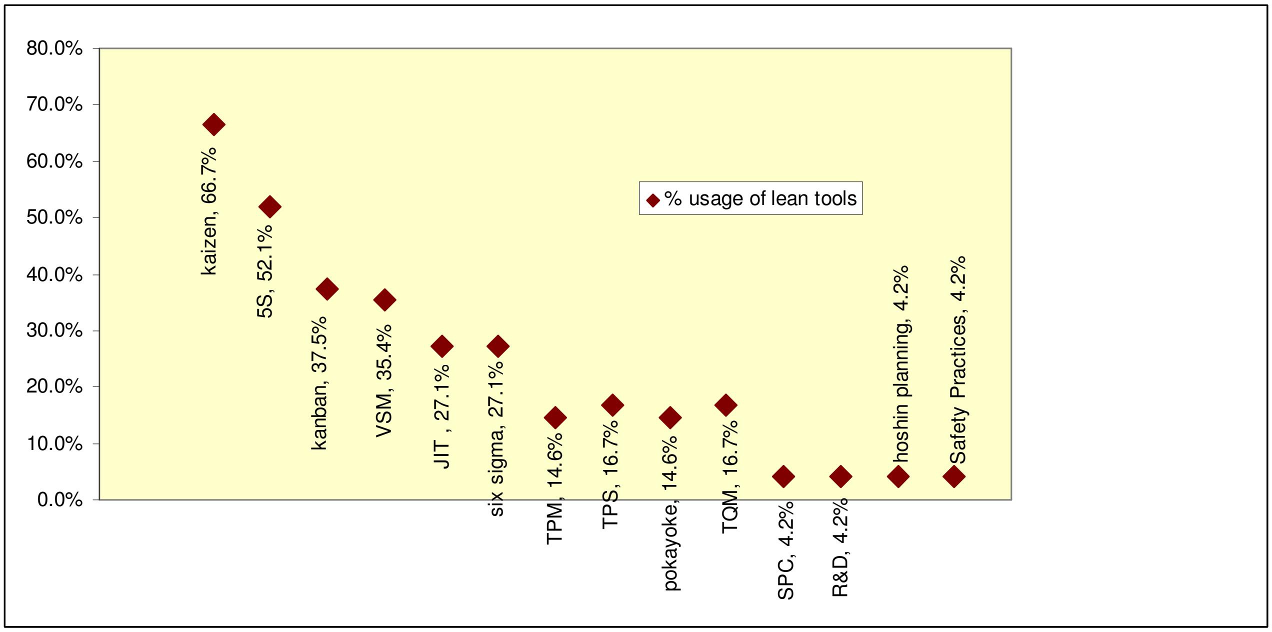

Fig 7.3 Analysis of quality improvements

7.4.2 Analysis of lean manufacturing tools for reduced inspections

All the fourteen lean manufacturing tools have contributed in achieving the reduction in number of inspections which is evident from figure 7.4. Kaizen (41.2%) emerges as the most important tools followed by TQM (26.5%), six sigma (23.5%), 5S (20.6%), JIT (20.6%), kanban (17.6%) and VSM (17.6%). The remaining seven lean tools are having similar contributions as shown in figure 7.4.

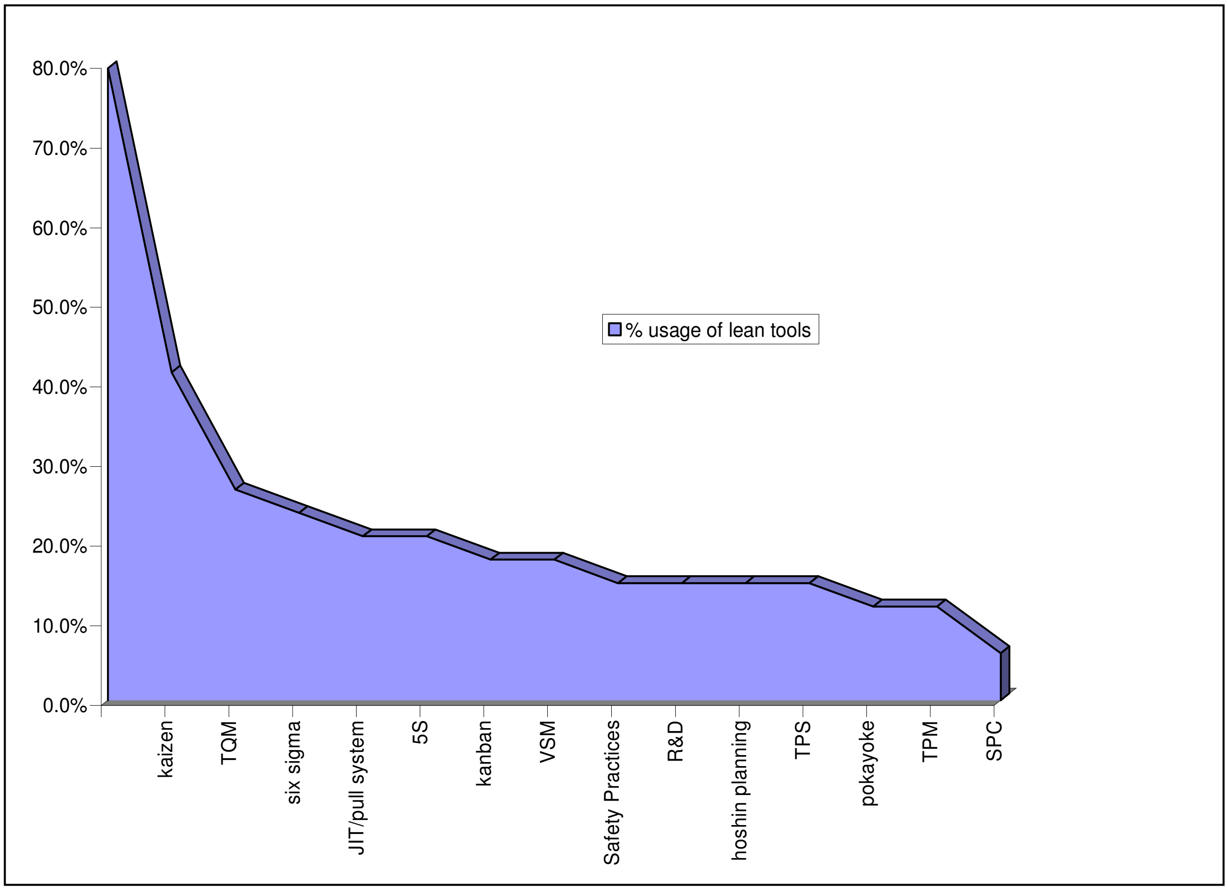

Fig. 7.4 Analysis of reduced inspections

7.4.3 Analysis of lean manufacturing tools for JIT methods

The JIT techniques used for inventory reduction and on time production and delivery of products are listed in figure 7.5. The graph shows that the lean tools follow the same trend for inventory reduction and JIT production-delivery. Kaizen has a major role in JIT production-delivery and inventory reduction with 90% share and 65% share respectively. This is followed by JIT/pull system, kanban, six sigma, TPS and VSM.

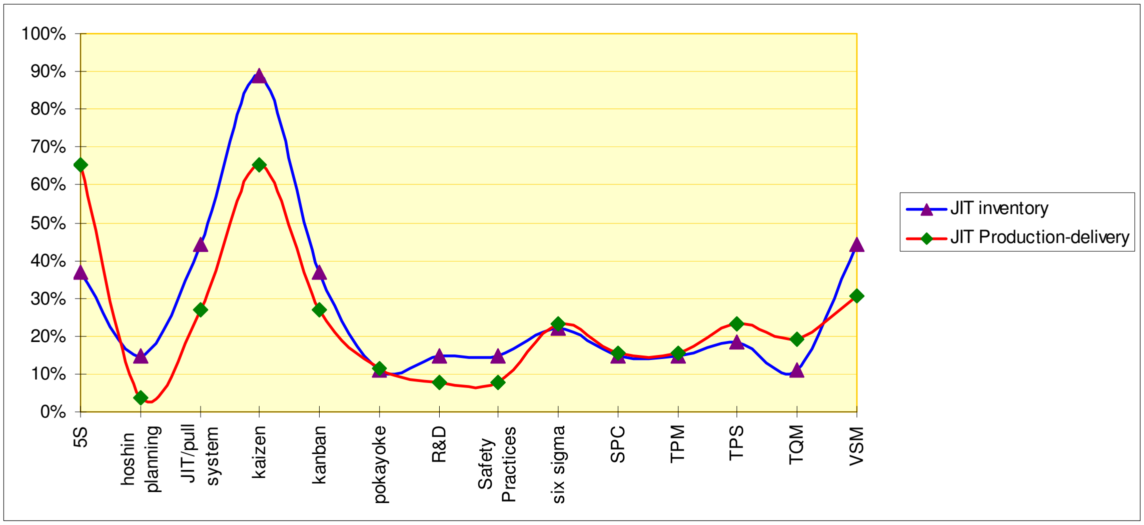

Fig. 7.5 Analysis of JIT methods

7.4.4 Analysis of lean manufacturing tools for setup cost reduction

Another important supply chain factor that accounted for the productivity gains in the plants is the reduction in setup costs. Fig. 7.6 shows the usage of the six key tools viz. kaizen (50%), TPM (50%), VSM (40%), kanban (30%), TQM (30%) and 5S (30%) that were having considerable effect in reducing the setup costs.

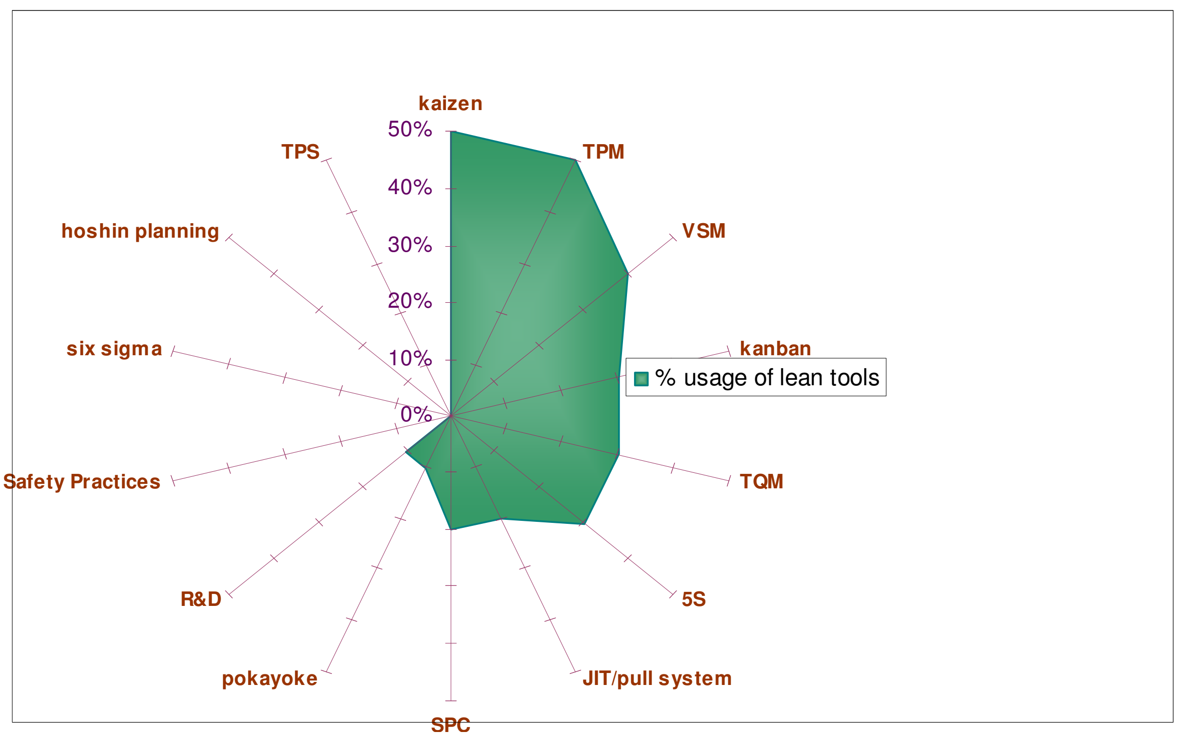

Fig. 7.6 Analysis of setup cost reduction

7.4.5 Analysis of lean manufacturing tools for lead time reduction

For the reduction in lead time it is evident from the figure 7.7 that, kaizen and JIT are the lean tools to be used invariably along with 5S, VSM, six sigma and kanban. Interestingly, R&D also has an important role in achieving lead time reduction.

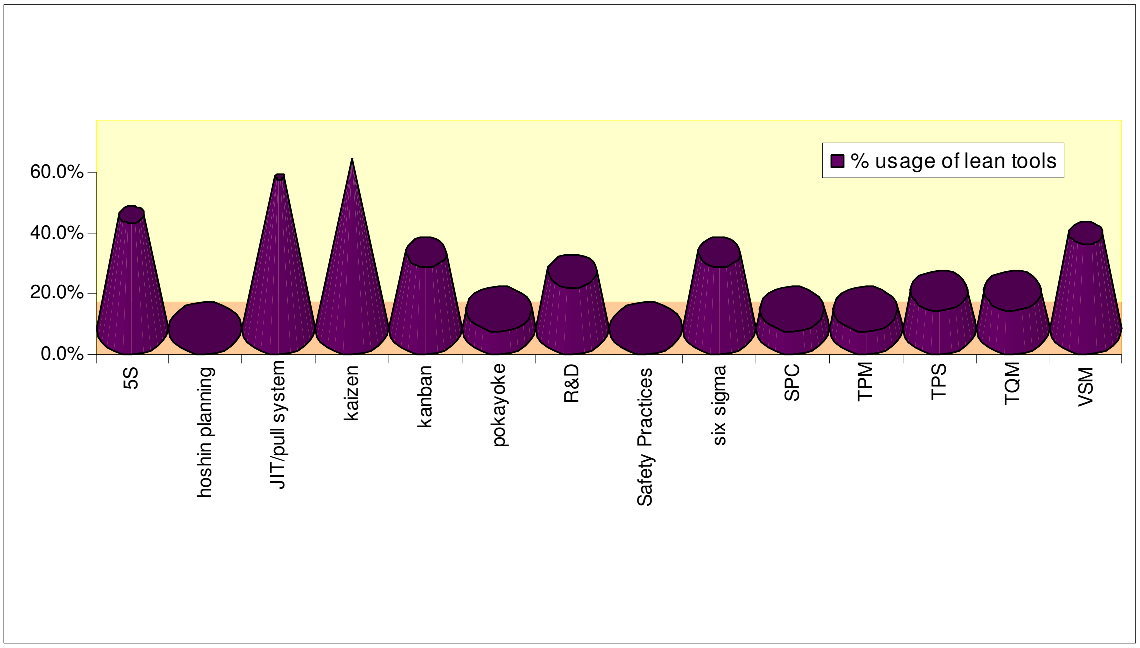

Fig. 7.7 Analysis of lead time reduction

7.4.6 Analysis of lean manufacturing tools for rework reduction

Rework and repair are time consuming processes and incur unwanted costs to the manufacturer. Reduction in rework and repair means less machine utilization and manpower and increased productivity. Figure 7.8 shows that kaizen, and 5S are the lean tools that have to be used to reduce rework. Poka-yoke is an essential aspect in rework elimination along with JIT and safety practices. The remaining tools have no fluctuation in their usage with TPS and hoshin planning not being used at all.

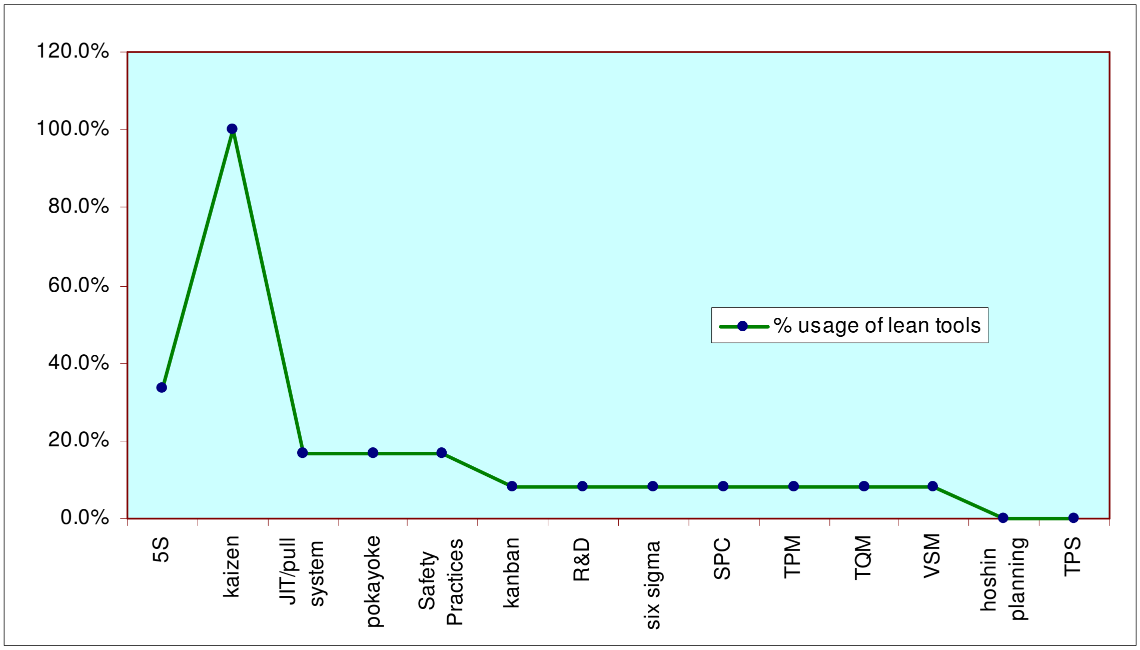

Fig. 7.8 Analysis of rework reduction

7.4.7 Analysis of lean manufacturing tools for optimum batch size and optimum cycle time

Figure 7.5 shows the lean tools usage for optimum batch size and optimum cycle time. Both the processes follow similar trend in using the lean tools with the peaks being kaizen and six sigma. The troughs belong to hoshin planning, R&D, safety practices, SPC and TPM. It is therefore clear that optimum batch size and optimum cycle time can be obtained by using the peak lean tools and ignoring the less significant ones as observed in the figure 7.9.

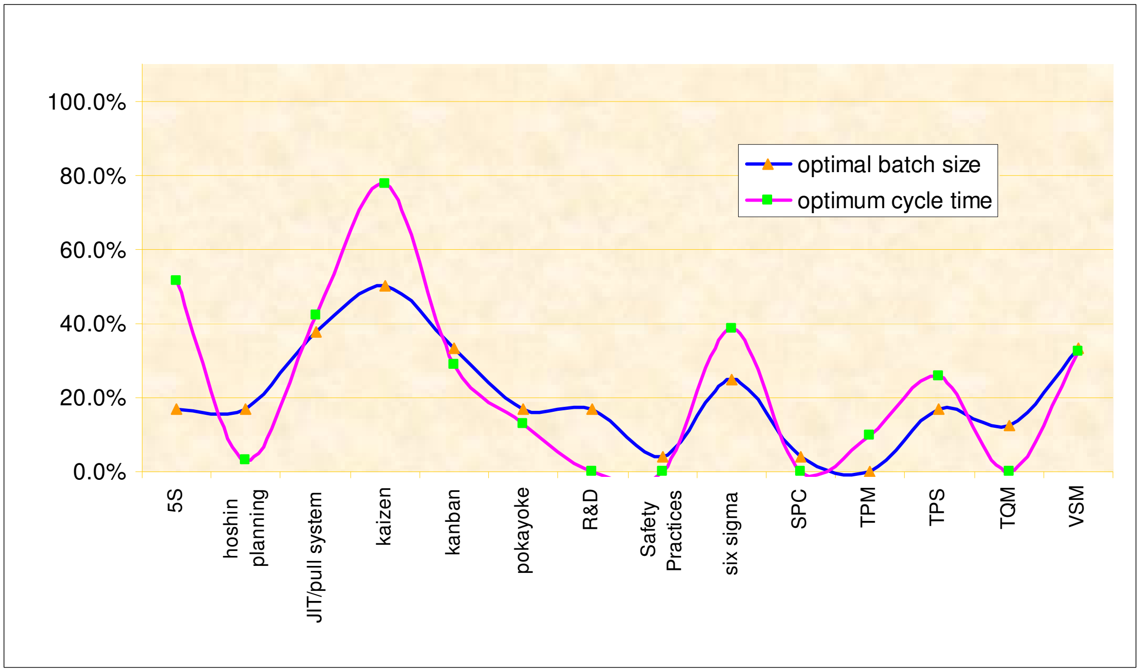

Fig. 7.9 Analysis of optimum batch size and optimum cycle time

7.5 Managerial Implications

Figure 7.10 shows the summary of the fourteen lean tools that were used in the analysis of lean supply chain performance. The managerial implications are as follows:

1. Kaizen (65.4%) has emerged as the most important tools followed by 5S (40.4%), JIT (32%), VSM (31.1%), kanban (28.9%) and six sigma (24.6%).
2. This is because, the most important aspect in successfully implementing lean is kaizen, a continuous improvement process, which is total involvement of the employees from the shop floor workforce to the office top executives.
3. Also for proper implementation of lean, the locations and activities should be planned and prearranges according to 5 S principles.
4. After 5S, smooth work flow is enabled and then JIT is required to ensure that the products are made as per the customers' pull.
5. VSM should be done initially to detect the wastes for tracing the product flow and for a proper VSM, 5S is a prerequisite.
6. Six sigma aids in detecting the defects and eliminating the wastages made in producing defective products.

7. An important aspect in successfully implementing lean supply chain systems is total involvement of the employees, which includes the shop floor laborer to the top management personnel. For lean supply chain to be effective, total dedication from the employees and familiarity with the lean systems is required. It has been recognized in this study that the workforce involvement through kaizen, has been a crucial feature in the productivity gains. Job satisfaction is another facet of employee dedication.

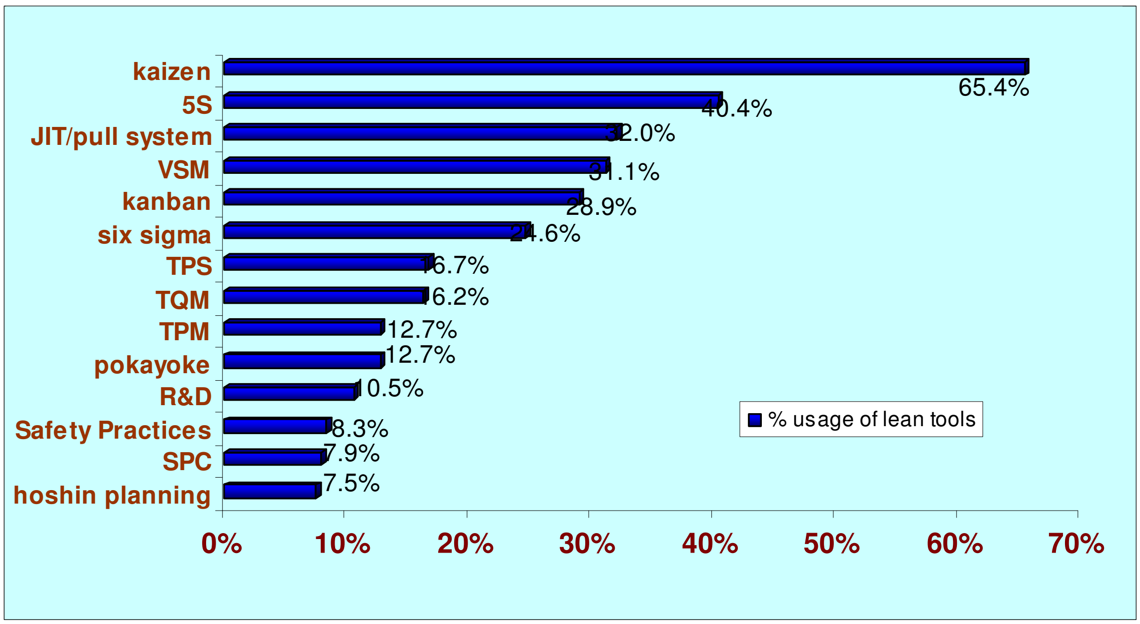

Fig 7.10 Major lean tools used in lean supply chain