Critical analysis of tangible gains post lean ERP implementation in an Indian SME.

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Abstract: Global competition have impacted SMEs in manufacturing across the world and Lean manufacturing is considered as competitive solution for eliminating all wastes in the system and operate with minimal inventory. This paper will present a case study of tangible benefits of lean manufacturing post ERP implementation in an Indian SME.

Key words: ERP implementation, lean manufacturing

Lean manufacturing embodies several concepts of Just-in-time (JIT) methodology. Hence we will cover both the definitions as per APICS. JIT is defined as "A philosophy of manufacturing based on planned elimination of all waste and continuous improvement of productivity. It encompasses the successful execution of all manufacturing activities required to produce a final product, from design engineering to delivery and including all states of conversion from raw material onward. The primary elements in just-in-time are to have only the required inventory when needed; to improve quality to zero defects; to reduce lead times by reducing set-up times, queue lengths and lot sizes; to incrementally revise the operations themselves; and to accomplish these things at minimum cost. In broad sense, it applies to all forms of manufacturing –job shop, process and repetitive- and to service industry as well."

> Different companies use different terminologies to mean JIT. IBM calls them continuous flow manufacture, HP calls them both stockless production and repetitive manufacturing system, Motorola calls them short cycle manufacturing and several Japanese companies call them The Toyota system and finally some companies call them time based competition.
>
> Lean manufacturing is defined as "A philosophy of production that emphasises the minimization of the amount of all resources (including time) used in various activities of the enterprise. It involves identifying and eliminating non-value-adding activities in design, production, supply chain management, and dealing with customers. Lean producers employ teams of multi-skilled workers at all levels of the organisation and use highly flexible, increasingly automated machines to produce volumes of products in potentially enormous variety".

Pre-requisites of Lean manufacturing - Stabilize production schedules ; Increase production capacities of manufacturing work centres; Improve product quality; Cross train the workers so that they are multi-skilled and competent in several jobs; Reduce equipment break down through preventive maintenance; Develop long term supplier relations that avoid interruptions to material flows.

Elements of Lean manufacturing:

Elimination of waste-Eliminating all kinds of system wastes is the deep –seated ideology behind Lean. Shigeo, a JIT authority at Toyota, identified **seven wastes** in the production that must be eliminated. They are listed below-

- Over production- Make only what is needed now
- Waiting- Coordinate flows between operations and balance load imbalances by flexible workers and equipment.
- Transportation- Design facility layouts that reduce or eliminate material handling and shipping.
- Unneeded production- Eliminate all unneeded production steps
- Work-in-process (WIP) inventories-Eliminate by reducing setup times, increasing production rates, and better coordination of production rates between work centres.
- Motion and effort- Improve productivity and quality by eliminating unnecessary human motions, make necessary motions more efficient, mechanize, and then automate.
- Defective parts-Eliminate defects and inspection. Make perfect parts.

Enforced problem solving and continuous improvement- In traditional manufacturing, in-process inventories allow production to continue even if production problems occur, thus, high machine and worker utilisation is achieved. If defective parts are discovered, machine malfunction, or material stock outs occur, in-process inventory can be used to feed what would otherwise be idle workers and machines. But lean systems strive for continuous improvement in production and process and reduce inventory. By reducing inventory all production problems will surface and thereby would lead to real solution. Lean is really a system of enforced problem solving as there are very few safety factors as every material is expected to meet quality standards, every part to arrive exactly at the time promised and precisely at the place it is supposed to be, every worker is expected to work productively, and every machine is expected to function as intended without break down. Lean implementation reduces process inventories incrementally in small steps and at each level different production problems are uncovered and lean cross functional team works to eliminate the problems and an ideal state is reached with no process inventories. This incremental continuous improvement is called in Japanese practice as *kaizen*. To reduce production cycle time, set up times may be studied as changeover to concept of Single minute exchange of dies (SMED) and the goal of tool changes in less than a minute.

People make Lean work: Like business success is always through people , Lean is also no exception to this rule and relies heavily on dedicated cross functional teams , strong training initiatives and involvement of workers in all phases of manufacture. Another important aspect is the empowerment of workers allowing workers to take initiative to solve problems. In general people, suppliers, workers, managers and customers must all be motivated and committed to team work to achieve lean effectiveness.

Total quality management (TQM) - Lean depends on TQM system and it is expected that everyone in the organisation is involved and committed to in this movement.
Parallel processing- Parallel manufacturing takes out huge chunks of manufacturing lead times and this similar to concept of simultaneous engineering or concurrent engineering.
Kanban Production control- Lean is considered as a pull system of production planning and control. Kanban in Japanese means card signalling to upstream work station that downstream work station is ready for the upstream station to produce another batch of parts. There are two type of kanban- conveyance (C kanban) and production (P kanban)
Lean purchasing- Same pull type approach in lean is applied to purchasing shipment of parts from purchasers. Suppliers use the replacement principle of kanban by small, standard-size containers and make several shipments daily to each customer. Purchase department develops long-term relationships and ensures supplier development to ensure sustained cost-effective and high –quality supplies.

Literature survey*:*
The implementation of lean manufacturing like any other productivity improvement initiative is believed to have enormous difficulties as per researcher Denton and Hodgson (1997). Safayeni et al. (1991) highlighted the difficulties and controversies in implanting many lean manufacturing techniques known as just-in-time. This problem may be further compounded by a lack of standardised mechanism of analysis and measure of value-adding capabilities within organisations such as lean concept (Baker, 1996; Iyer and Jha, 2004).

Also, SMEs by virtue of their size are constrained by a number of key factors that include a lack of adequate funding and leadership deficiencies (Achanga ET al.2004, 2005). Hayes (2000) discussed that successful corporate initiatives like lean manufacturing, should be properly planed before implementation. Management involvement and commitment are perhaps the most essential prerequisites in aiding any of the desired productivity improvement initiatives (Anthony and Banuelas, 2001; Coronado and Anthony, 2002; Eckes, 2000; Henderson and Evan, 2000)

Several authors have also emphasized the need for examining and executing such significant factors deemed critical for the successes of implementing any new productivity initiative in an organisation. Holland and Light (1999) asserted that in attempting to implement any productivity improvement drive in any organisation, a business should have clear vision and strategy in forecasting a project's likely costs and duration. Their inference is derived from ERP case studies where 90 percent of its implementation are late or over budgeted. These are attributed to poor cost and schedule estimation and planning. This argument is supported by Al-Mashari et al. (2003) and Volkoff (1999) who confer that despite the significant benefits any productivity improvement packages provide to the business community, they often cost significantly and end up disrupting organisational framework. Many times, changes brought about by new productivity initiatives like lean manufacturing may cause disruptions in the very process it is meant to improve. This is because, employees in many cases, derive fear of infringement and job losses and are, therefore prepared to cause sabotage.

Irrespective of how it is perceived, the concept of lean manufacturing has been discussed extensively in the past decade. However, there appears to be little empirical evidence in publications of the implementation of lean practices and the factors that might influence them in SMEs (Brunn and Mefford, 2004). With the notable exception of White (1999) and Conner (2001), most of these publications have tended to focus on premise of large sized enterprises only (Bozdogan ET al.2000; Cook and Grase, 2001: Murman ET all.2002)

Organisation profile: This study was conducted in an Indian SME in Bangalore who are suppliers of mass production of precision engineering parts to a major MNC automotive ancillary giant. The company is a four decade old, multi-unit, multi-location group and aggressive growth has commenced from last one decade. The structure is a flat organisation with respective units organised on group technology and similarity of part families and is in direct contact with the customer on a daily basis almost works as an extended arm of the customer's supply chain. Production system is made to order type and moving towards a lean manufacturing with super market concept of Kanban for quick replenishment. Unit is organised as Plant manager as the Head with all functions-production, quality, stores, administration reporting to him. Unit is certified for ISO and TS standards. ERP has a backend SQL server database with modern web technology connecting all the units and service provided by a small central group. The ERP captures all the purchase, sales, material and machine and labour utilization data along with other standard data. The total strength of the Unit is around 75 employees.

Problem definition: Existing ERP has details of all parts in the system covering raw material conversion yield, cycle time, cost and quality data. This part for the case study is called 'Barrel" and company had a business situation where in the demand for this part is likely go up by 20-30% per day, needing additional space, finance, machines and labour. Management decided to explore the possibility of lean manufacturing as a business solution.

Objectives of the study: To demonstrate in this case study **tangible** benefits of lean implementation in an ERP environment as both ERP and lean initiatives will reduce organisational slack/wastages.

Methodology: To implement a lean manufacturing system we need to find out the value addition and waste activities in the process chain. Value steam mapping (VSM) is used to find out the value addition activity and waste activity in the chain. Value stream mapping is a schematic representation of existing material and information flow in a manufacturing system. VSM analysed and actions are initiated to minimise the waste. To deliver goods or services as per customer **takt** time (rate of customer demand) value stream has to be re-designed. It is called value stream design (VSD) and will include the material flow and information flow with improvements made. Kanban is used in the value stream to produce only the required products as per customer demand. This will help to reduce inventory as production is planned based on customer demand-part wise and quantity wise.Following steps were used for Lean planning:

- Formation of cross functional team and setting of targets.
- Training on lean manufacturing and 5'S.
- Preparation of VSM and VSD
- Improvement of productivity and Overall Equipment Efficiency (OEE).
- Reduction in rejection levels.
- Inventory management.
- Layout modification.
- Implementation of standard trays and kanbans.

VSM and VSD details given as per Figure 1 and 2 and pre-lean post lean layout given in Figure 03 and 04 respectively.

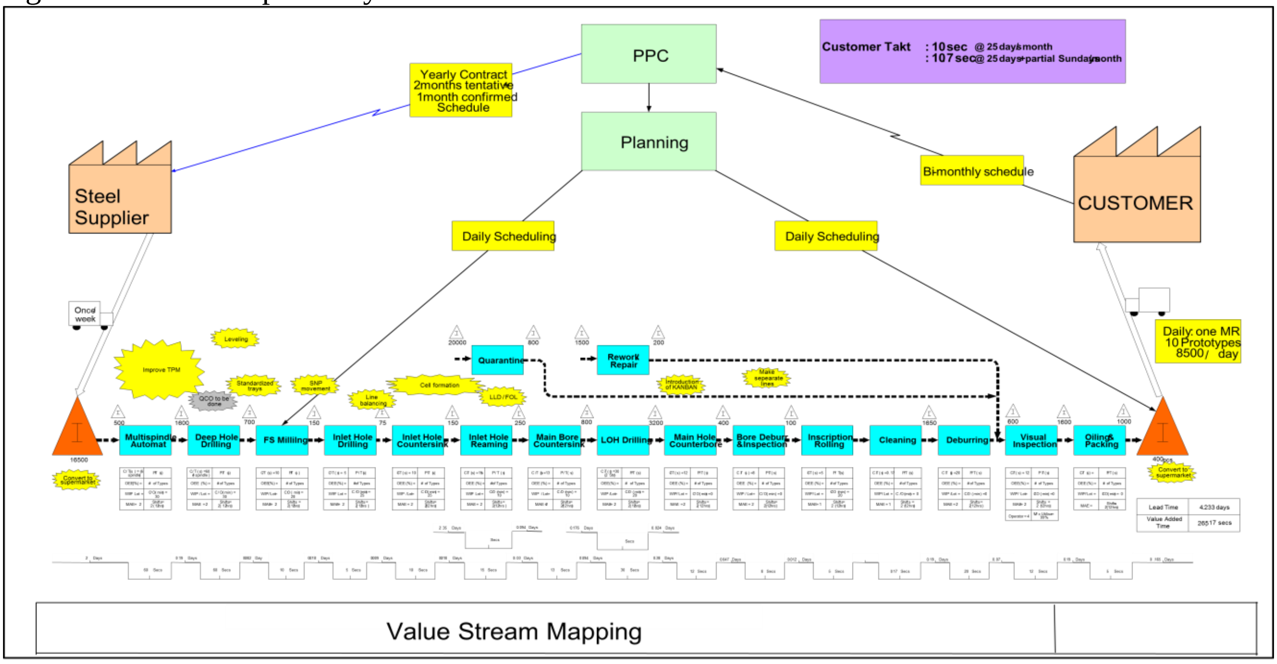

Figure-01 Value stream Mapping

Figure-02

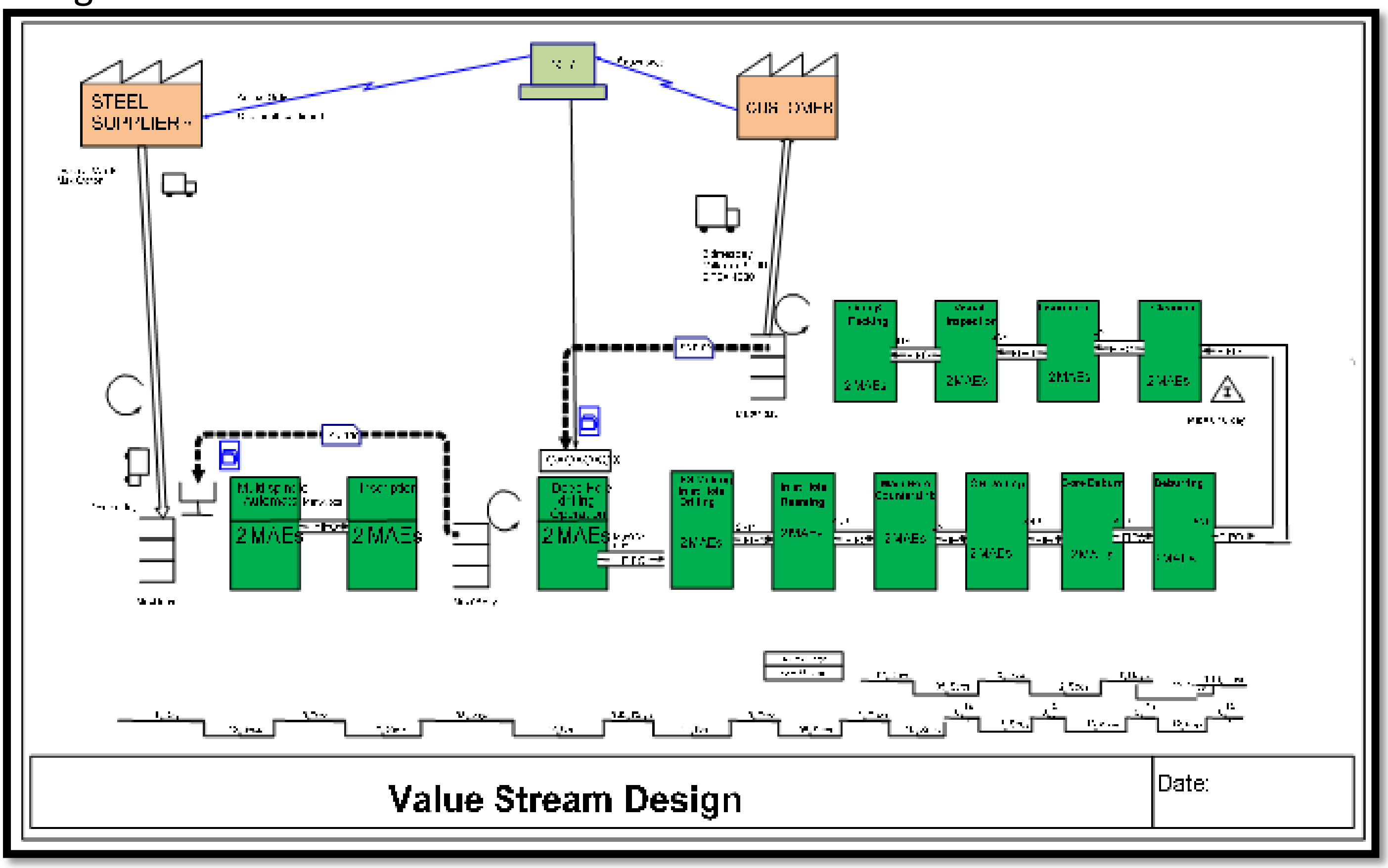

Figure 02 Value stream design

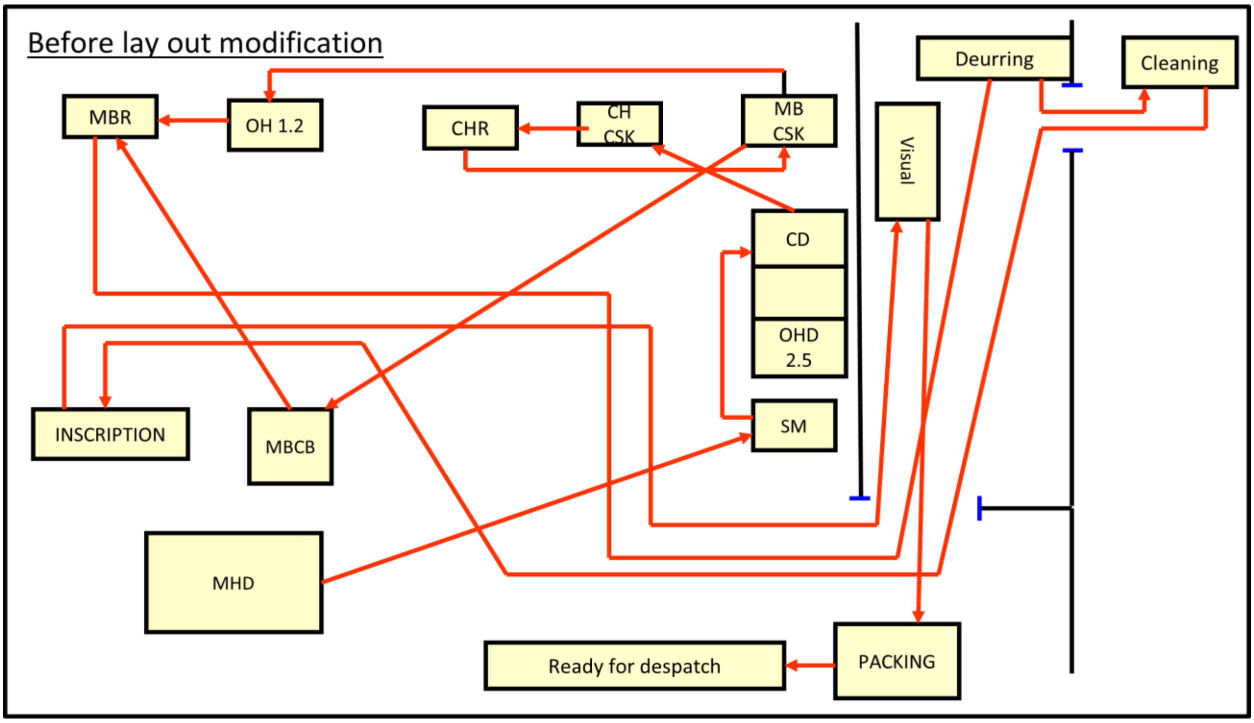

Figure 03 Layout before lean implementation

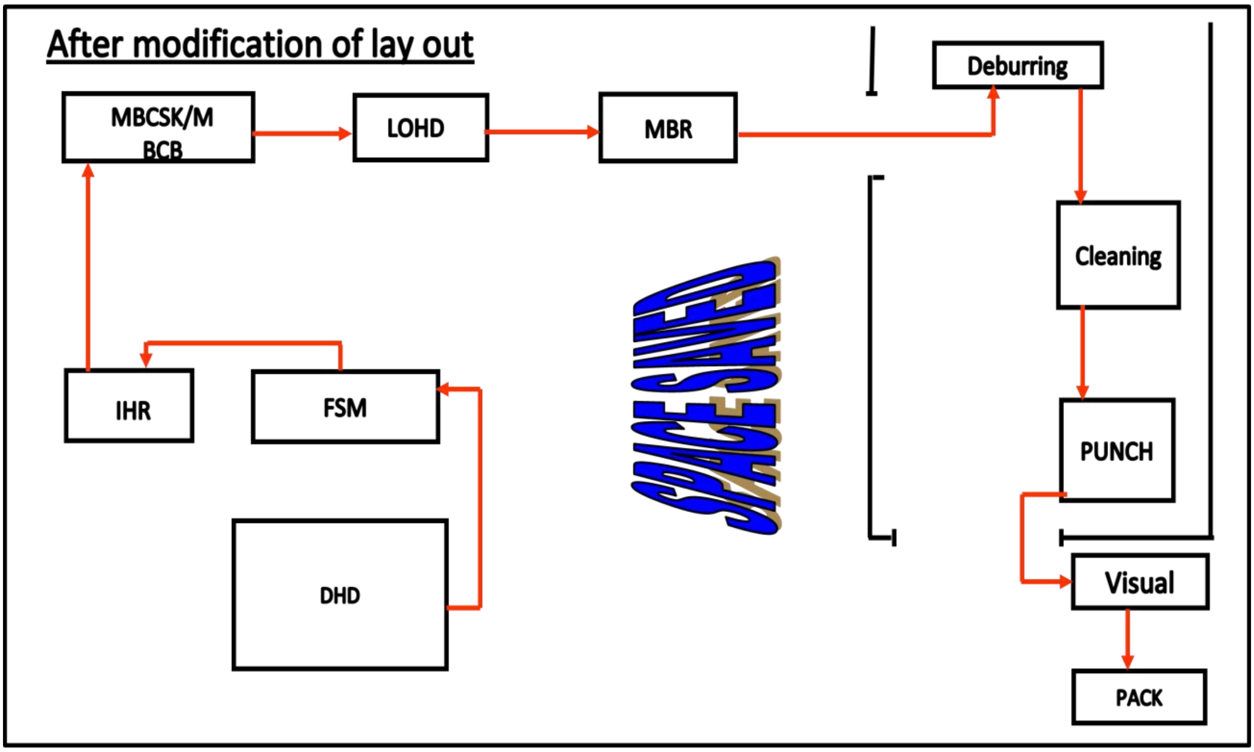

Figure 04 Layout post-lean implementation

Table 01-Operation-wise Cycle time

Before lay out modification			After lay out modification		
Operation No.	Operation	Cycle time in Sec.	Cycle time in Sec.	Operation	Operation No.
1	Turning	11	11	Turning	1
2	Identification Number Rolling	6	6	Identification Number Rolling	2
3	Centre Bore drilling	12	12	Centre Bore drilling	3
4	Slot Milling	14	12	Slot Milling/Cross Hole Drilling/Cross Hole CSK	4
5	Cross Hole Drilling	12			
6	Cross Hole CSK	10			
7	Cross Hole Reaming	10	10	Cross Hole Reaming	5
8	CSK On Shaft Side Bore	12	12	CSK On Shaft Side Bore /Counter Bore On Collar Side Bore	6
9	Counter Bore On Collar Side Bore	14			
10	Oil Hole Drilling	12	12	Oil Hole Drilling	7
11	Centre Bore Reaming	10	10	Centre Bore Reaming	8
12	De-burring	9	9	De-burring	9
13	Cleaning	2	2	Cleaning	10
14	Part Number Rolling	6	6	Part Number Rolling	11
Total		140 sec	102 sec		

Proposed results: It is expected that Lean manufacturing and ERP implementation together will significantly reduce the need for organisational resources thereby achieving cost-effective , high quality and on-time delivery goals improving overall organisational effectiveness. This trend if continued in SMEs, there will be all round improvement in SMEs as cluster and they will move towards mid- sized organisations.

Calculation of tangible gains:

Table 02-Benefits from reduced operations

		Old method			New method		
Sl. No.	Description	No. of people	cost/ person	Total cost	No. of people	cost/ person	Total cost
1	No. of skilled operators eliminated	9	126000	1134000	0	126000	0
2	No. of people down graded						
2.1	Skilled	6	126000	756000	0	126000	0
2.2	Semiskilled	0	100800	0	6	100800	604800
			Total	**1,890,000**		Total	**604,800**

Total yearly recurring savings **1,285,200** INR

Table 03-*Cycle time reduction*

Benefits from cycle time reduction											
Old method						New method					
Opr.No.	Operation	MC HR Rate	Cycle time Sec.	Eff. %	Cost per part INR	Cost per part INR	Eff. %	Cycle time Sec.	MC HR Rate	Operation	Opr. No.
1	Turning	525	11	75	2.14	2.14	75	11	525	Turning	1
2	Identification Number Rolling	125	6	75	0.28	0.28	75	6	125	Identification Number Rolling	2
3	Centre Bore drilling	950	12	80	3.96	3.96	80	12	950	Centre Bore drilling	3
4	Slot Milling	150	14	75	0.78	1.04	80	12	250	Slot Milling/Cross Hole Drilling/Cross Hole CSK	4
5	Cross Hole Drilling	100	12	75	0.44						
6	Cross Hole CSK	100	10	75	0.37						
7	Cross Hole Reaming	100	10	75	0.37	0.37	75	10	100	Cross Hole Reaming	5
8	CSK On Shaft Side Bore	125	12	75	0.56	0.83	80	12	200	CSK On Shaft Side Bore /Counter Bore On Collar Side Bore	6
9	Counter Bore On Collar Side Bore	125	14	75	0.65						
10	Oil Hole Drilling	125	12	75	0.56	0.56	75	12	125	Oil Hole Drilling	7
11	Centre Bore Reaming	100	10	80 %	0.35	0.35	80	10	100	Centre Bore Reaming	8
12	De-burring	75	9	75	0.25	0.25	75	9	75	De-burring	9
13	Cleaning	150	2	75	0.11	0.11	75	2	150	Cleaning	10
14	Part Number Rolling	200	6	75	0.44	0.44	75	6	200	Part Number Rolling	11
				Total cost/part	11.25	10.33					

Savings/part-INR	0.92
No. of parts produced in 2011	38,84,509
Annual savings-INR	3,578,784

Table 04-*Space cost savings*

Details	
Standard size of the shed	6000 Sqft
Required space for new line for business opportunity	3000 Sqft

Rent per sqft per month	18
Rent cost per month	54000
Yearly rent – INR	648000

Table 05-*Capital expenditure at historical cost for a new line*

Operation No.	Operation	Machine	Machine cost
1	Turning	Multispindle automat	3,500,000
2	Identification Number Rolling	Rolling machine	175,000
3	Centre Bore drilling	Gun drilling machilne	5,200,000
4	Slot Milling/Cross Hole Drilling/Cross Hole CSK	Semi automated machine	1,150,000
5	Cross Hole Reaming	Drilling machine	65,000
6	CSK On Shaft Side Bore /Counter Bore On Collar Side Bore	Semi automated machine	650,000
7	Oil Hole Drilling	Drilling machine	175,000
8	Centre Bore Reaming	Drilling machine	65,000
9	De-burring	Deburring machine	15,000
10	Cleaning	Semi automated cleaning machine	580,000
11	Part Number Rolling	Rolling machine	175,000
		Total	**11,750,000**

Table 06 –Quality yield

SL No	Operation	Cycle time	operation cost A	Overhead B	A+B	stage wise cost	Rejection %	Rejecti on qty.	Rejection cost
1	Turning	11	2.14	0.13	2.27	10.37	1.1	43,755	453,779
2	Identification Number Rolling	6	0.28	0.07	0.35	10.72	0.001	40	426
3	Centre Bore drilling	12	3.96	0.14	4.10	14.82	0.8	31,822	471,696
4	Slot Milling	14	0.78	0.17	0.95	15.77	0.15	5,967	94,086
5	Cross Hole Drilling	12	0.44	0.14	0.59	16.36	0.025	994	16,266
6	Cross Hole CSK	10	0.37	0.12	0.49	16.85	0.01	398	6,702
7	Cross Hole Reaming	10	0.37	0.12	0.49	17.34	0.012	477	8,276
8	CSK On Shaft Side Bore	12	0.56	0.14	0.70	18.04	0.11	4,376	78,923
9	Counter Bore On Collar Side Bore	14	0.65	0.17	0.82	18.85	0.17	6,762	127,491
10	Oil Hole Drilling	12	0.56	0.14	0.70	19.55	0.001	40	778
11	Centre Bore Reaming	10	0.35	0.12	0.47	20.02	0.001	40	796
12	De-burring	9	0.25	0.11	0.36	20.38	0	0	0
13	Cleaning	2	0.11	0.02	0.14	20.51	0	0	0
14	Part Number Rolling	6	0.44	0.07	0.52	21.03	0.02	796	16,730
							2.4	**95,466**	**1,275,951**

Stage wise cost involves cumulative material, labor and overheads

Summary of findings:

- From Table 01-No. of operations reduced by 27% (14 to 11) and Total cycle time per part reduced by 37% , savings of 38 Sec. (140 to 102)
- Line output increased by:16% (from 4243 to 4950)
- Lay out simplified and Space saved: 140 sq ft.
- Part flow distance decreased by 41% (61mts to 43 mts.)
- Quality (yield) improvement of 2.4% from 95.85 % to 98.25%
- Better part and information flow
- Total tangible gains yearly of (a) reduced number of operations from Table 02 (b) Cycle time reduction from Table 03(c) space cost avoided from table 04 (d) capital expenditure saved from table 05 (e) quality yield improvement from Table 06 amounts to a total of Rs 188.38Lakhs or **18.84 Million INR**

Conclusion: Lean implementation under ERP implementation has yielded significant tangible gains making manufacturing units more effective and competitive in this era of globalization and also reduces slack or the wastages in the manufacturing system leading to better contribution by the SME sector to the industrial economy of the nation.

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