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Improving Cost Competitiveness of Small and Medium Enterprises by Using Participatory Lean Approach - A Case Study

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Abstract- .Cost competitiveness of Small and Medium Enterprises (SMEs) in developing countries such as Pakistan can be improved using lean manufacturing premise. Benefit realization of lean implementation has been a challenge because of implementation cost and employees' ownership. This study aims at developing a lean implementing methodology for SMEs that can help in designing and implementing low-cost interventions by involving stakeholders especially employees and management in the implementation process. The proposed methodology is a seven steps cyclic approach based on the concept of continuous improvement where lessons learned from the implementation process provide opportunities for organizational learning. These could help in developing sustainable organizational change. The proposed methodology has been validated through a case study. Different tools and techniques like process-flow analysis, line balancing, time study, fishbone diagram, TAKT time, Work-in-Process (WIP) have been used to quantify key Performance Indicators (KPIs). As mentioned that the implementation approach is based on the participation of stakeholders; so, KPIs have been quantified at pre and post-intervention phases where low-cost interventions suggested by the employees have been implemented and their effects in terms of performance improvements have been quantified. Results indicate that as a result of the implementation of interventions Work-in-Process (WIP) and Batch travel distance (BTD) is reduced by 64% and 86%, respectively. It is also found that the average production per day and line balancing efficiency is improved by 38% and 133%, respectively. Furthermore, the suggested interventions help in achieving higher labour productivity by reducing the number of workers 22%. It is concluded that the development and implementation of low-cost interventions through active participation of employees, during the process of lean implementation, can significantly improve the process performance, which ultimately leads to achieving cost competitiveness in SMEs.

Keywords-Cost competitiveness, Small and Medium Enterprises (SMEs), Lean manufacturing, interventions, Process performance, Employees' participation

I. INTRODUCTION

In the modern era, competitiveness is a real challenge, which is directly linked with the ability of an organization to produce high-quality products at the lowest cost. The SMEs are considered as the backbone of the local and global economy as these provide 60% job opportunities worldwide have great potential to be established across various business spectrums [5].[6].[8] Like others, SMEs survival and growth is also deeply linked with their potential of goods and services into bottom-line profits that can be increased by improving the customer base through providing satisfactory services [7]. Keeping in view the significance of SMEs, many SMEs development initiatives can be witnessed worldwide [9]. Like many others, Pakistan being a developing country is also dependent on the performance of SMEs [1]. SMEs are contributing nearly 30% of Pakistan's GDP and are providing 80% of the non-agricultural workforce employment. They are also responsible for 35% of manufacturing value addition and have 25% share of the export revenue [2]. Therefore, increasing the cost competitiveness of SMEs can help Pakistan to improve the employment rates [3]. It has been concluded that average annual labour productivity growth rate of Pakistan for the period starting from 2010 to 2015 is only 1.8% and lower than other developing countries of the region, like Sri Lanka (5.7%), India (5%) and Bangladesh (4.1%) for the same period [4]. SMEs can overcome the pressing challenge of cost competitiveness by using lean manufacturing premise. The competitive external environment is continuously forcing the SMEs to improve the way of doing business, especially to reduce the cost of production [10]. To achieve this goal, there are different philosophies that provide systematic approaches

towards improvements; such as, Total Quality Management (TQM) and Lean Manufacturing. It has been concluded that SMEs face a number of barriers that affect their operational performance. These include lack of top management commitment, panic embodied to transform from conventional business practices, unbalanced workload among the employees, inadequate quality improvement infrastructure and lack of employee's engagement in continuous improvement activities [11]. Lean manufacturing approach improves organizational productivity through the elimination of production wastages[12].

The role of top management is instrumental in the success of lean initiatives [13-14]. Successful implementation of lean in SMEs can improve their product quality, manufacturing lead time and response time to customers [15]. Appropriate selection, combination and implementation of lean tools are important to achieve the desired short term and long term organizational goals [16]. Performance excellence can be achieved through the use of different sets of lean tools depending upon the nature of job, type and size of the organization [17]. Lean tools and techniques such as 5Ss (sweep, sort, spotless, standardize and sustain), Value –stream mapping, line balancing, time and motion study, TAKT time, layout design, wastage quantification and cellular production have been found effective for improving organizational productivity [18, 19]. It was emphasized by Lee (1997) that SMEs should adopt less cost-intensive tools for improving their performance. It is recommended that a lean initiative should be started as a pilot project at some selected model area in an organization and. Moreover, it's highly important to train a team that has a capacity to upscale the results of pilot testing by implementing the same strategy at an overall organizational level. Another very important aspect is the awareness of each and every stakeholder especially employees of the organization [20, 21, 22, 23].

The above discussion reveals the need for developing some systematic approaches for lean implementation that can help SMEs in improving their performance. This study aims at developing a lean implementing methodology for SMEs that can help in designing and implementing low-cost interventions by involving stakeholders especially employees and management in the implementation process.

II. METHODOLOGY

A seven steps lean implementation methodology for SMEs is developed and validated through a case study. Proposed implementation approach is shown in Fig. 1. As mentioned, due to lack of funds and comparatively smaller business volumes as compared with large organizations, lean implementation and then benefit realization has been a real challenge. The proposed implementation approach attempts to address these challenges through active and useful participation of stakeholders especially top management and employees for getting real-time feedback on implementation issues and sustainability of interventions during the whole process. The implementation process starts with setting goals and Key Performance Indicators (KPIs) which provide a starting point of discussion for performance improvement. Assessment of existing work practices against set KPIs can be considered as the diagnosis of current methods, procedures and practices with reference to their suitability in terms of cost, time and ease of work. Data is collected against well-defined KPIs and analysis is carried out to develop an understanding about how currently prevailed system is performing and what are the strengths and weakness so that appropriate strategies could be developed to further promote good practices and eliminate bad work practices. Participation of employees and support from management and key points in this process as the design and implementation of suggested strategies is not possible with these. Bottlenecks identified as a result of discussions and data analysis are discussed with stakeholders and possible interventions are suggested by them. Valuable and practically viable interventions are further discussed in terms of their impact and sustainability. Ownership of employees and management helps in achieving long term sustainability of improvements. Key strength of adopted methodology is to engage stakeholders especially employees at each and every step during the transformation process. However, employees' contribution is extremely important in setting goals, data collection against set KPIs and development of interventions or action plans for improvement. Involvement of employees in key decision making processes increases the level of motivation and ownership of the system. This finally helps in achieving sustainable organizational cultural change where everybody is thinking about improving the system.

Predefined KPIs are reinvestigated so that the impact of implemented interventions could be measured. This helps in analyzing the effectiveness of interventions in terms of improvements in performance and their impact on competitiveness. There could be some procedures, processes and methods that are more useful as compared to others. Similarly, there could be some implementation challenges because of cost constraints, employee's resistance and culture of the organization; are also documented so that Key lessons learned from the implementation process could be used in future as a reference. Goals were set at the start of the process are compared with the achieved one and this cyclic process could be repeated again by setting new goals. The proposed method is a continuous improvement process.

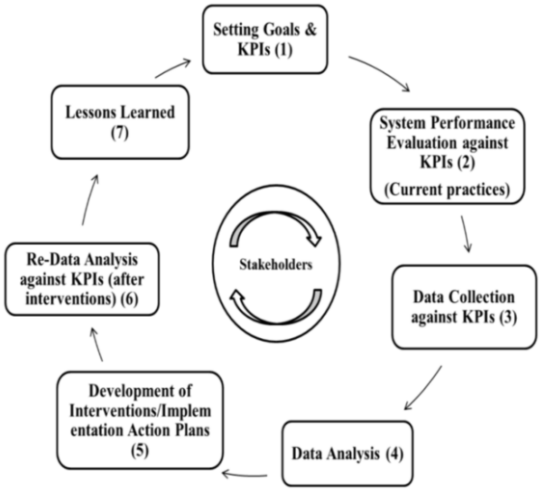

Fig. 1 Lean Implementation Framework

III. Validation Case Study

To validate the proposed lean implementation method for SMEs, a case study was developed. A medium sized company, employing around 200 personnel was selected for this purpose. The above-mentioned framework has been followed as a lean implementation strategy, further explanation and effectiveness of the adopted methods have been discussed in the proceeding sections. The implementation process took around 9 months; starting from goal setting to formalizing key lessons learned during the whole process. A key element of this approach, as discussed was the involvement of stakeholders especially employees and management where special attention was given to the suggestions forwarded by the employees during the decision making process.

3.1. Setting goals and the establishment of KPIs

As a first step, our team shared the objective with the management of the company and constituted a steering committee responsible for follow up of the whole process. The committee was covering a broad range of employees representing different work groups; for example representative of top management, managers, production and quality related shop floor employees, health and safety, human resource, finance etc. so that wider wisdom could be captured. However, the majority of the members were from design, production and quality departments. The team set a goal for productivity improvement through designing interventions against the following KPIs:

- Reduction in Work-In-Process
- The decrease in Batch Travel Distance
- Increase in Average Production per Day
- Improvement in Line Balancing Efficiency
- The decrease in the Number of Workers

3.2. Performance evaluation of current practices, data collection and data analysis

Existing work practices were evaluated against the set KPIs by using a number of commonly practiced tools and techniques like process flow analysis, spaghetti diagram, value stream mapping, cause and effect diagram, Pareto analysis, 5S and time study. The company produces three different types of fans, namely, ceiling, pedestal and bracket and louvre with 69%, 22% and 9% of overall production respectively. Four sections of ceiling production line were selected for the activity. Process flow charts of the selected activities are shown in Fig. 2.

The processes being followed consist of the machining of ceiling body and plate, motor's stator wining and fitting. Process flow analysis (PFA) is a powerful tool for quantifying material travel distance, WIPs, no of workers and value-adding times against each activity. Moreover, the time study technique was used to calculate cycle time (CT) of each activity and then standard time after adding allowances as per the process requirements. This data helped in developing line balancing graph for the whole process.

The PFA summary shown in Table 1 displays that 45 workers produce a lot of 600 pieces per day, where value-added time is 1005 seconds per piece and material travel distance is more than 26KM per day. Surprisingly, Work in Process (WIP) is over 8000 means an average inventory of about 14 days is stuck on the production floor. The layout of fan manufacturing industry is usually designed on the basis of processes rather than products; therefore the high value of material travelling distances has been witnessed in table 1. Additionally, production processes have not synchronized those results in more temporary storage places. The current layout of body machining and fitting is shown in Fig. 3 below. For the purpose of developing line balancing graph, the following values have been used: Start time (8 am); End time (5 pm); Total hours per day (9); No of breaks (1); Working hours per day (8 hours, 480 minutes and 28800 seconds). Previous data was used to understand variations in production demands and Takt time (working time / monthly demand) calculations were made accordingly. Three monthly demand values (15000, 22500, and 30000 pieces per month) were used to find Takt time (48, 32 and 24 sec/pc) respectively. Three options were generated in view of the current and future demand as forecasted by the factory management. TAKT time is a dynamic function which will vary corresponding to the demand in hand. However, existing demand value of 22500 pieces per month, with 45 workers were used to develop a line balancing graph shown in Fig. 4, which clearly identifies the bottleneck operations in plate, body, stator and fitting operations.

Initial investigations revealed that there is wastage of time because of multiple factors and there is a need to quantify these in terms of non-value-added time so that their impact could be quantified. The problems interrupting the production line include machines breakdown, set-up changes, material shortages, worker absenteeism, and defective quality. Calculation of non-value added time help in identifying causes of process destabilization. The goal of sustainable balanced production line could not be achieved without addressing these causes. The problems interrupting the production line can include machines breakdown, set-up changes, material shortages, worker absenteeism, and defective quality. Pareto chart of the wastages quantified is given in Fig. 5. Major losses in term of non-value added time are related to rework, material shortages, material loading and unloading. Further case studies could be developed in other manufacturing organizations so that the understanding on employees involvement and its effectiveness could be improved.

Set KPIs mentioned in section 5.1 were measured and found as WIP (8374 pieces, travel distance (26145 meters), average production per day (666), line balancing efficiency (36%) and the number of workers (45).

Table 1. Summary of process flow analysis (before)

Section	Material Travel (m)	Value-added Time (sec)	Workers (Nos)	Quantity Pcs)
Body	9760	191	9	3928
Plate	3855	108	5	1015
Winding	9650	460	18	1371
Ceiling fitting	2880	246	13	2060
Total	26145	1005	45	8374

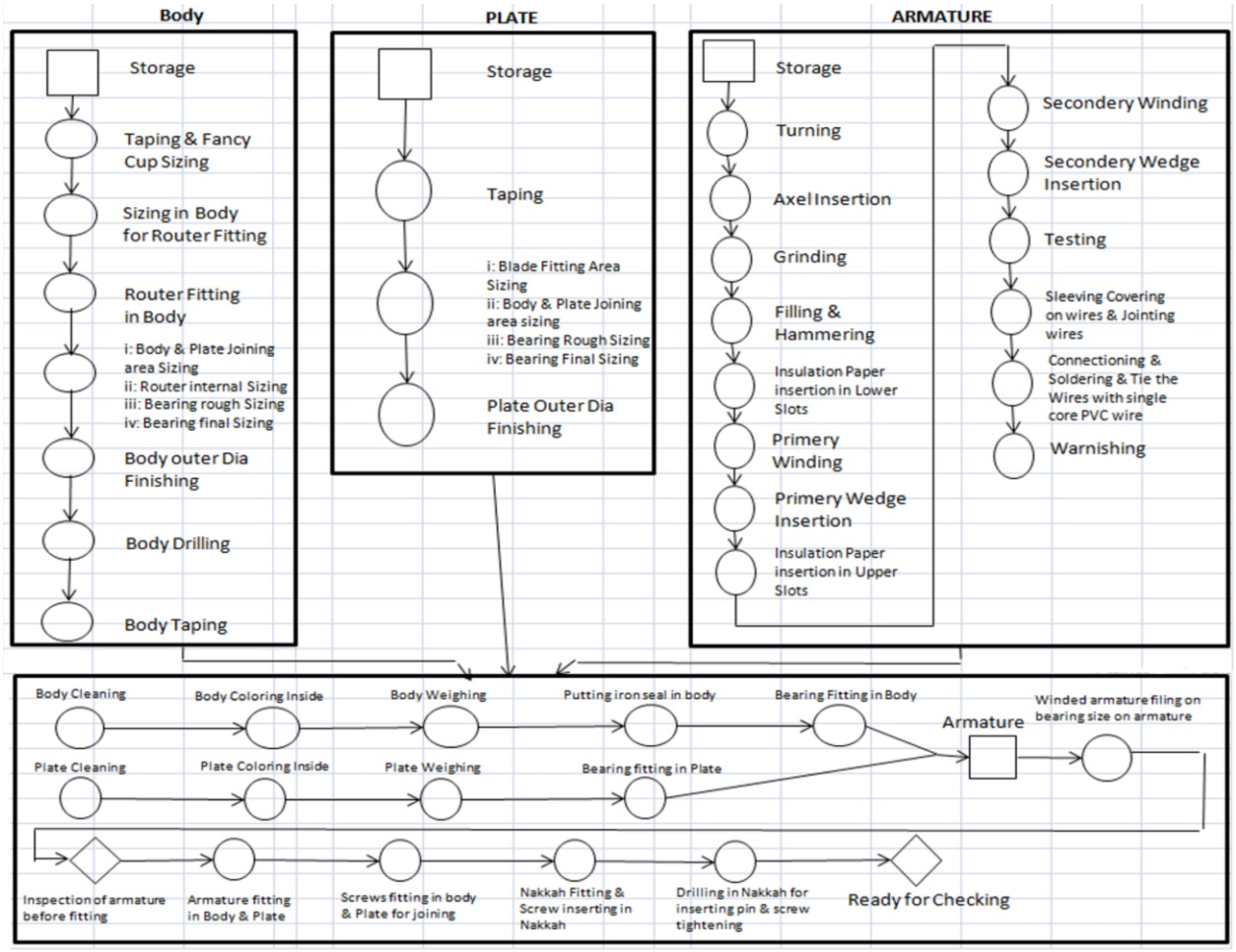

Fig. 2 Process Flow Charts

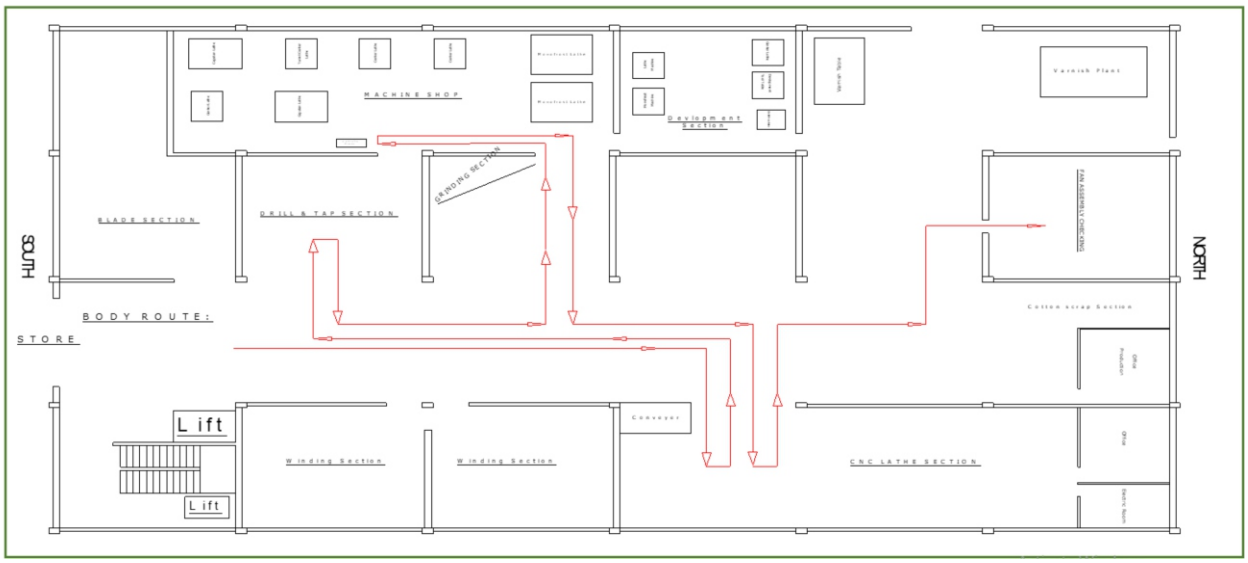

Fig. 3 Layout Body Machining and Fitting

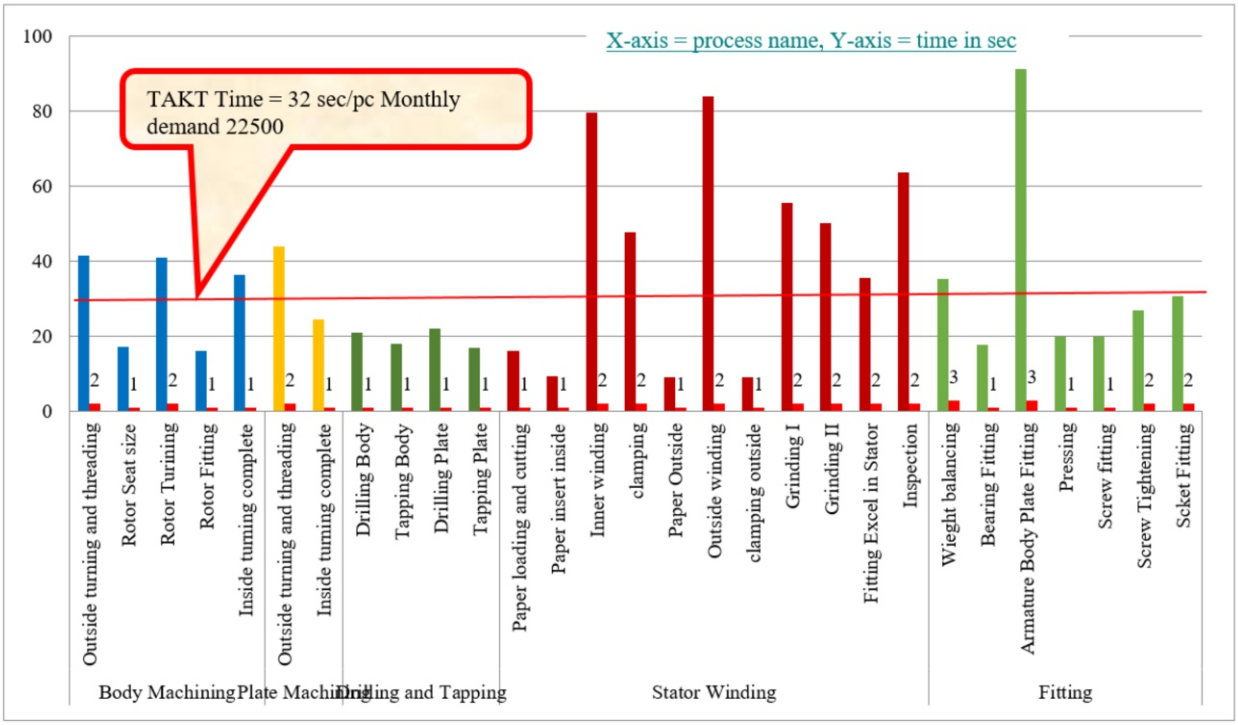

Fig. 4 Line balancing graph (before)

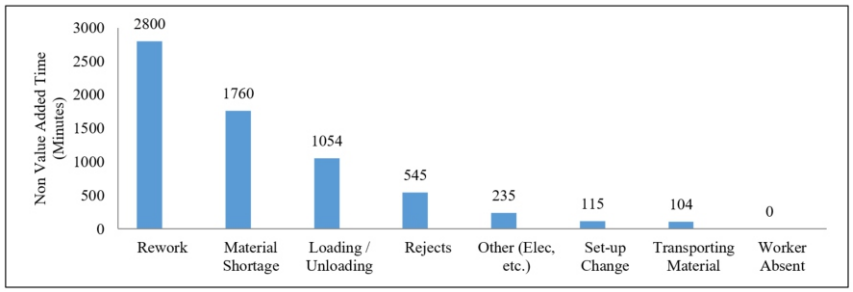

Fig. 5 Pareto chart of wastages

3.3. Development of an interventions implementation plan

As the implementation framework is mainly based on the active participation of employees and top management in the decision-making process. So the investigations were shared with the stakeholders and they were requested to help out in designing practically feasible low-cost interventions so that these could be implemented easily. Focus group discussions were made with the representatives where they shared their ideas about the improvements in the performance. This helped in capturing a diverse pool of suggestions for improvements against the highlighted bottlenecks. Later on, all suggested interventions were analyzed by a team of experts and their conclusions were shared with the employees so that they could learn about other ideas and enrich their knowledge about the work practices and their relationship with production performance.

As a starting point, the production demand was fixed at 22500 pieces per month and TAKT time calculated accordingly (32 seconds per piece). This step helped in determining resources required to match the requirements. To improve the line balance efficiency, ECRS technique was applied to balance the load on workers by Eliminating the unnecessary processes (E), Combining of processes (C), Rearranging the processes (R), and Simplifying the processes (S). A strategic change in the policy of working hours was made where the shift time was raised from 8 hours to 9.5 hours in order to satisfy the demand of 22500 pieces. Importantly, this change was brought after having deliberated discussions with the workers, this increased the TAKT time from 32 to 38 seconds. Process requirements and material handling requirements were found to be critical in this respect and new plans were developed accordingly. Another major intervention suggested and implemented was to change the layout from process layout to product layout. This helped in ensuring a proper sequence of operations eliminating sources of contaminations, difficult to access areas and practices curtaining the flow of production. This improved the travel distance from 26145 meters to 3680 meters. The new sample layout of the fitting shop and line balancing diagram after interventions is Fig. 6 and 7.

Additionally, workers were trained on new procedures so that standardized work practices could be promoted. They were made aware of health and safety, well-being and work ergonomics-related issues and their implications for productivity. Workers were given the opportunities to share their views on lean implementation and how these issues could be addressed so that the sustainability of interventions could be ensured. This helped in promoting a healthy work environment where management and workers were ready to play their role in adopting a cultural change towards lean thinking.

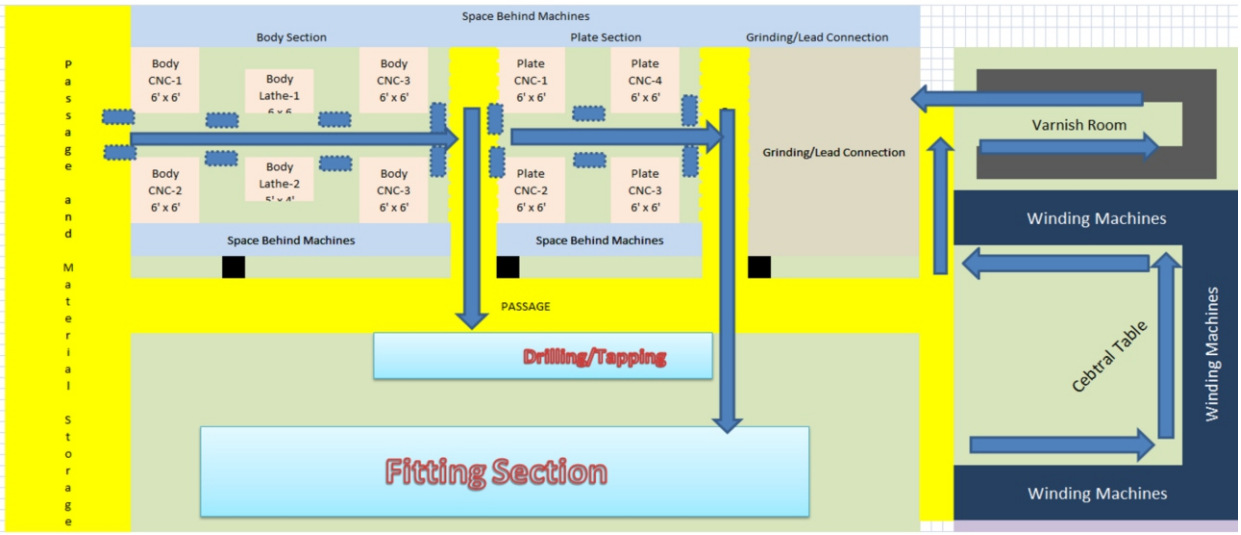

Fig. 6 New layout of the fitting shop (after)

Fig. 7 Line balancing graph (after)

Table 2 Percentage Improvement

Parameters	Before	After	Percentage Improvement
WIP (pieces)	8374	3000	64
Batch Travel Distance (meters)	26145	3680	86
Average Production per Day (pcs/day)	666	922	38
Line Balancing Efficiency (%)	36	84	133
No of Workers	45	35	22

3.4 Reassessment of KPIs and lessons learned

Key performance indicators mentioned previously were calculated again and comparison was made. Fig. 8 concludes the improvements made against each KPI. During this whole process of lean implementation strategies, it has been keenly observed that participation of employees is a good source of information for developing cost-effective intervention plans for improvement. Work performance investigation and standardization tools like time study, Pareto analysis, line balancing, ECRS etc. have been found very much useful. Being part of the process, workers showed a gesture of ownership that helped in the development and implementation of cost-effective ideas in a sustainable manner. It's concluded that the process of lean tools implementation can be made easier by following the proposed systematic approach.

IV. DISCUSSION

Adoption of 'Lean Strategy' leads towards cost reduction and value addition for customers through quality improvement and hence helps organizations to be competitive in the market [24, 25, 26, 27]. As far as the implementation of lean is concerned, it has to focus areas: one is lean philosophy whereas the second one is related to tools, techniques and their successful implementation processes and procedures [28, 29]. Achievement of desired objectives and goals through lean implementation could be made sustainable through organizational cultural change, where the behaviour of employees in terms of their roles and responsibilities are highly important [30, 31]. Employees' perceptions about Lean implementation have been a point of discussion in literature as both positive and negative perceptions exist at the same time

[31]. To overcome implementation challenges, the participatory approach could be used to increase employee's opportunities to be the part of the decision-making process that is most likely to increase the level of innovation, sense of support, ownership, control and well-being at work [32, 33].

In light of the above discussion, the challenge of successful implementation of Lean could be achieved through the use of participatory interventions approach. The proposed participatory based systematic lean implementation approach has been found useful for investigating work performance related issues and then designing and implementation of low-cost interventions. The case study presented proved that the use of lean tools in combination with the participatory approach is an effective technique for the effective utilization of human capital for bringing a positive cultural change in organizations. The effectiveness of the participatory approach is established; however, its application for the purpose of successful implementation of lean tools has been investigated and found useful [32, 33]. This shows a substantial potential for improving cost competitiveness of SMEs by using lean tools in combination with the participatory approach. Participation of employees continually helps in designing low-cost interventions which are usually the need of SMEs. Hence the employees which are the part of lean implementation process could be instrumental in the sustainability of applied interventions and designing of new ideas for future improvements.

Hence, for overcoming lean implementation barriers, the proposed participatory based framework is an effective approach for lean culture transformation. This approach is based on the effective engagement of stakeholders especially employees at all stages of implementation process. Involvement of employees help in understanding the problem in more realistic way, devising strategies to overcome problems, generating more diverse kind of solution ideas and most importantly ownership of changes being made. The framework is a continuous improvement cyclic process that can help organizations in achieving their long term goals.

Implementation of lean is required long term management commitment that requires resources and time in addition to the promotion of awareness and understanding through trainings. Implementation strategy proposed in this study is a way forward for managers to learn from the experience of how to engage employees positively. Similarly, some common issues related to productivity and quality improvement have been investigated where effectiveness of suggested interventions have been reported. These findings could help managers in developing customized solutions as per the requirements of their own systems.

V. Conclusions

Promotion of 'Lean Thinking' is linked with organizational cultural change. Small and Medium Enterprises (SMEs) encounter challenges like high implementation cost and employees' ownership. These barriers could be eliminated through the promotion of the participatory approach for implementing low-cost interventions. This study proposed a participatory-based lean implementation methodology for SMEs, which is a 7-steps cyclic approach that can help in promoting a lean culture in the organization. Validation of the framework has been done through a case study in the manufacturing industry. It is concluded that participation of stakeholders especially employees is a highly useful method for the design and implementation of low-cost interventions by using different lean tools like process-flow analysis, line balancing, time study, Work-In-Process (WIP), Pareto analysis etc. Identified KPIs have been measured at pre and post interventions stages. Results indicate promising improvements in terms of reduction in batch travel distance (86%), decrease in work-in-process (64%), increase in average production per day (38%) and a decrease in a number of workers (22%). It is concluded that the development and implementation of low-cost interventions through active participation of employees, during the process of lean implementation, can significantly improve the process performance, which ultimately leads to achieving cost competitiveness in SMEs.

VI. Limitations and Future Research

The scope of this case study has been the implementation of lean practices at one production line in a fan manufacturing company due to time and resource constraints. Future research may increase the scope of such initiatives at multiple manufacturing concerns and industrial sub-sectors where key lessons learned like the validation of participatory approach for lean implementation, role of employees' engagement and improvement strategies against set KPIs could be used in future research. Substantial time had to invest on creating awareness and orientation on lean practices among the owners and employees of the company. In addition, insufficient commitment on part of the top management, inadequate resource planning, panic to transform, work burden, lacking inclusive and participatory approach to develop continuous improvement culture have been the limiting factors observed during implementations of this productivity improvement initiative.

Due to the absence of performance management system, collection of reliable data had been a major challenge as the development and monitoring of productivity related KPIs is directly linked with this.

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Appendix

SUGGESTIONS BY EMPLOYEES AND MANAGEMENT

- Some of the suggestions put forward by the management and employees are described below: The management suggested to include key personnel from various departments (production, quality, procurement, maintenance and production planning and control) as members of the productivity improvement team. This helped in better coordination of project activities and data collection.
- The production manager suggested to construct a sound proof fan testing room as part of the production line layout. Earlier the products had to travel to a separate hall for testing. This helped in reducing significant product travel distance and immediate feedback to the previous processes if there occurs any quality problem.
- The machining supervisor and his team suggested to install chuters between machines to eliminate the need of personnel for handling the in process material.
- The winding section team designed and developed trolleys to handle rotors and stators. Before these materials were staked on ground causing quality defects due to mishandling.
- The general manager suggested to train departmental managers on lean practices such as 5S, suggestion system, basic quality tools, production planning, line balancing, KPIs, cost of quality, etc. These managers were then assigned to transfer this knowledge to the team members in their respective areas of operations.
- The maintenance department personnel suggested to replace conventional electric motors with servo motors to reduce power bills.
- The company CEO suggested to organize weekly meetings on productivity improvement initiative to sustain the gains from the ongoing project and to replicate this methodology in other product lines.