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Improvement of Manufacturing Production Process using Quality Value Stream Mapping

Harmeet K. Chhabra[a];
Ashish Manoriya [b]
Department of Mechanical Engineering
Samrat Ashok Technological Institute,
Vidisha, (M.P)-464001

Abstract - **In this research work is to develop a quality value stream mapping (Q-VSM) for a production in a heavy transformer manufacturing company in India. The process begins with creating a current state map (CSM) and understands the production flow and the current cycle times. This provides the current information needed to produce a future state map (FSM). The goal is to identify and eliminate the waste, and non- added materials which is any activity that does not add value to the final manufacturing product, in the production process of the company. To collect the information needed, the study was conducted within the manufacturing production facility to enable the researcher gained knowledge and familiarized with the production flow and the activities being performed at the shop floor of the company. Parameters such as working time, cycle times, brake down times, and work in process for inventory and manufacturing materials, and information flow paths were recorded. High performance computer based "ARENA" simulation software was used to simulate and analyze the process flow and working process times. Result from the analysis shows that there are areas where the company can further improve their Manufacturing Production System (MPS). The results show the improvement of the manufacturing efficiency up to 64% based on the new proposed arrangement of the layout. Therefore propose of shop floor layout will be guided to the company in order to improve their manufacturing production system.**

Key words - Lean manufacturing, Quality value stream mapping, manufacturing production system, wastes, Arena software.

INTRODUCTION

The lean manufacturing tools and techniques are widely used by the products manufacturing company and industries. The focus of the approach is on cost reduction by eliminating non value added activities and waste. A quality value stream is an accumulation all activities that have to bring a product or service over the main passes, starting with raw materials manufacturing products and ending with the customer requirements. Taking the quality value stream viewpoint means working on the big picture and not individual processes. Q-VSM creates a common basis for the production process, thus facilitating more thoughtful decisions to improve the value stream system.

Quality Value Stream Mapping (Q-VSM) is often used in process cycle time improvement manufacturing products since it demonstrates exactly how a process operates with detailed timing of step-by-step activities of manufacturing cycles. It is also used for process analysis and improvement by identifying and eliminating time spent on non- value-added activities as real waste. Lean Manufacturing is a buzzword. More often it is used with the terms like benefits, cost reduction, lead time reduction, work in time etc. but if you have not started implementing lean manufacturing yet and if you have not started benefiting from lean manufacturing yet; you will need some numbers to be motivated. We shall look into some quantified benefits of lean manufacturing where the principles of lean are implemented successfully.

Quality value stream mapping is a tool used to visualize where the waste is present in the whole stream from the supplier's raw material delivery until it sees its way through till delivering to the end customer. It is a collection of manufacturing waste and all activities both value added and non value added that are performed to produce a product of manufacturing cycle**.** It is also a tool used to identify which lean techniques have to be used to cut down the wastes and be more productive**.** Some of the lean tools are setup reduction of waste, just in time, total preventive maintenance of machinery, and total quality management (TQM). When one member of the supply chain systems becomes lean, other members in the process also have to be lean, in order to reap the benefits**.** Thus Quality value stream mapping (Q-VSM) is a powerful tool to spot where the waste is and where in the supply chain management the actions have to be taken to be efficient. Quality Value Stream Mapping is the process of visually mapping the flow of information and material as they are preparing a future state map with better methods and performance of the manufacturing system. It helps to be visualize the work station cycle times, inventory at each stage, manpower and information flow across the supply chain managements system. Q-VSM enables a company to 'see' the entire process in both its current and desired future state mapping of the manufacturing cycle, which develop the map that prioritizes the working projects or tasks to bridge the gap between the current state and the future state mapping. The quality value stream mapping is used to analyze & map in order to reduce the waste in processes, enable flow, and to make the process for better efficiency a manufacturing products. The purpose of quality value stream mapping is to highlight sources of waste and eliminate them by implementing the future-state mapping of the value stream that can become a reality.

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RESEARCH METHODOLOGY

The adoption of the value added and non value added analysis is demonstrated through a case study in a well known heavy electrical transformer. This case company is located in India and started to introduce lean manufacturing since 2014. The case company is actively involved in a market that is expected to grow at an average of 10 to 15 % annually over the next few years. To achieve this, the company focuses on Quality and Productivity as its key thrust in attaining competitive advantage for the transformer manufacturing company. To improve manufacturing productivity, it is essential to identify the production waste products and eliminate the waste by applying Q-VSM principles and methodology in the production lines of the heavy mass productions of the products. For the case study, the Thin Small Leadless Package taping production line was chosen because the personnel efficiency level was above the Target manufacturing Cost Roadmap. The various steps undertaken in the Q-VSM implementation are shown in Figure 1.The goal of Q-VSM is to identify, demonstrate and decrease waste in the process. Waste being any activity that does not add value to the final product, often used to demonstrate and decrease the amount of `waste' in a manufacturing system. VSM can thus serve as a blue print for Lean Manufacturing. This section presents a methodology to develop a Quality value stream mapping to identify material and information of current state.

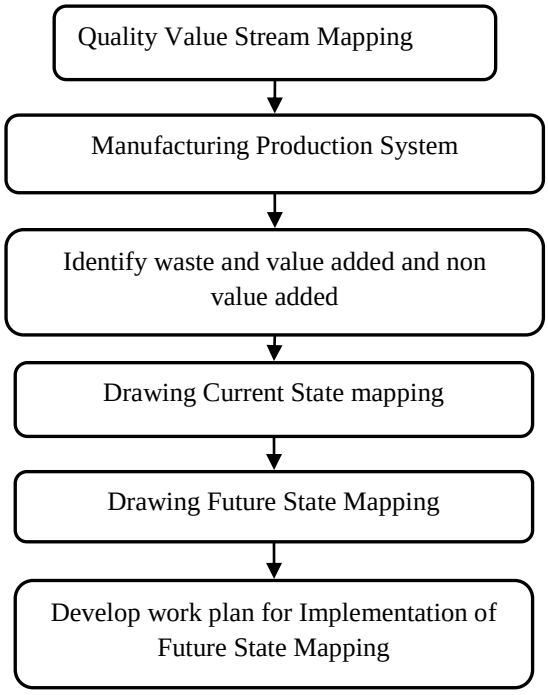

Figure 1: - Implementation of manufacturing products using Q-VSM

In the Heavy Manufacturing Transformer Industries in India making 60000 Products are manufactured there. But main tunnel floor was chosen because it was most critical product from the point of view of safety purpose of the customer. There is a lot of scope for study and go for further improvement in the process to enable higher production rate. Hence this was selected for the case study. In order to collect the information needed, the study was conducted within the transformer manufacturing production facility whereby the manufacturing method and sequence of the activities being performed at the shop floor of the company that had been studied. Parameters such as cycle times, down times, work in process for inventory and material, and information flow paths were recorded. Current layout and value stream map also had been studied in order to identify the wastes and also method for eliminating that wastes. ARENA software was used to evaluate the proposed process design and effective utilization of different work station.

Takt Time = Available Time/ Customer demand

Takt time = 27*1320*60/60000

Takt time =36 sec

1	09:00 – 12:45	Working hours with 10 mints including Tea Break.
2	12:45 – 13:30	Lunch Break.
3	13:30 – 17:00	Working hours with 10 mints including Tea Break.

Table.1. Employees working hours at Manufacturing Company

1	Number of shifts per day	3
2	Number of working days	27
3	Net working time per day	1320 min.
4	Customer Demand for month	60000
5	Manufacturing Cycle time	36 sec
6	Manufacturing Lead time	10 sec

Table.2. Input Parameters of Arean Software

Production per day = 1320*60 / (36+10) =1721 parts per day.

Improvement production per day=1320*60/ (18+10)
Improvement production per day =2828 parts per day.

RESULTS AND DISCUSSION

When cycle time for each process is compared with takt time it is found that cycle time of manufacturing process exceeds the takt time so there is need to improve the process capability of transformer manufacturing process to meet the demand of customer requirements within the time. So it can be improved by using various lean manufacturing tools but here we are improving the cycle time of manufacturing process by introducing a new

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manufacturing machine process as shown figure 3 and figure 4 and by improving layout of manufacturing shop.

Cycle time before improvement = 36 sec.
Cycle time after improvement = 18 sec.
% improvement in production = (2828 – 1721)/1721

Current state mapping

The analysis of the quality value stream current state extended value stream map was conducted using lean manufacturing principles. The analysis of the QVSM current state began immediately with a focus on improving transportation links i.e. working toward a quality value stream Future State map**.** This is because the manufacturing facility had essentially implemented lean production. The first step in the analysis of the current state was to create an extended value stream map. This allowed the team to locate the areas where the value stream was not lining-up with lean manufacturing principles. The current state extended value stream was consequently mapped with these elements as shown on Figure (3). Lean metrics data for each of the elements was obtained in order to complete the value stream map. The cross-functional team members obtained the data by consulting and validating process documentation. It was then handed over to the project manager to populate the value stream map with the data. Obtaining the lean metrics data for the manufacturing facility, however, required an extra step. A separate facility value stream map for manufacturing company had to be created. Once again the data for the facility value stream map was provided by the cross functional team. Once the facility value stream map was created, the aggregate lean metrics were used in data box for manufacturing company in the extended value stream map. The facility and the extended value stream maps were analyzed using lean manufacturing principles as shown in figure (4).

Future state mapping

In the quality value stream future state map as shown on Figure (4), the cross-functional team concentrated on the lean manufacturing principle of moving the value stream closer to the customer while being mindful of cost implications and improvement of value additive activities such as improvement of production efficiency. In this case study, the project manager was in charge of leading the cross-functional team in the development of quality value stream maps. On the other hand, sales were in charge of the business case analysis. Sales used a spread sheet to keep track of the business case. As a result, two types of documents were used to communicate how the cost savings and improvement of production efficiency were achieved.

There is near about ***"64%"*** improvement by improvement in value adding activities. The efficiency of Quality Value Stream Mapping is revealed when the team goes to the production process, talks to workers and observes how the product is actually made from the beginning to the end. Quality Value Stream Mapping must be drawn in such a way that can be understood by anyone: all the operators, the management, suppliers and the customer. Only on this condition the team can discover the real problems from the current process flow and create a vision of how the process should look like by making improvement.

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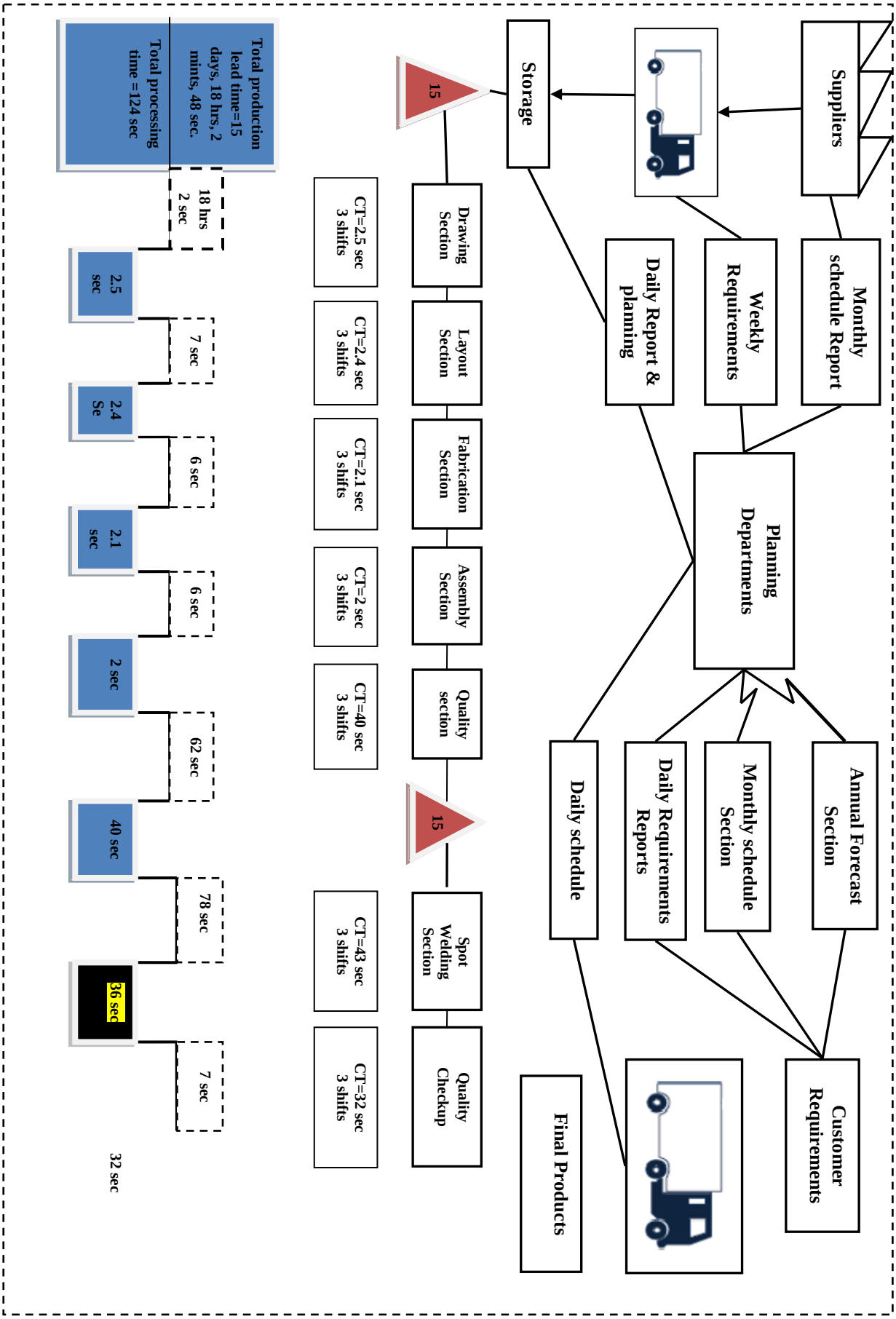

FIGURE: - 3 CURRENT STATE MAPPING:

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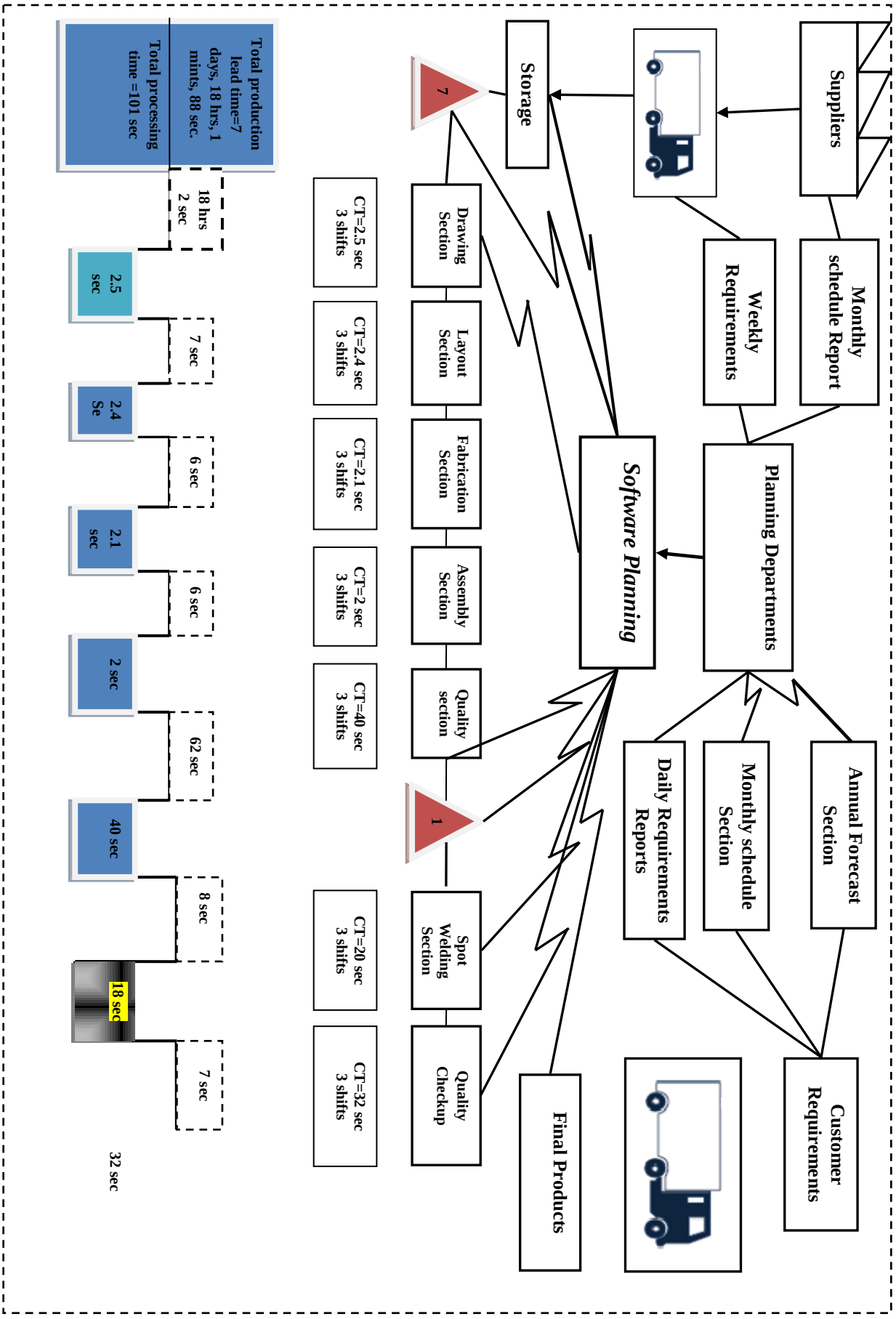

Figure:-4 Future State Mapping

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CONCLUSION

In this research paper shows the combination of quality value stream mapping (Q-VSM) with high performance computer based simulation. As could be demonstrated this combination has added synergy and strength for both tools. The simulation added the time dimension to Q-VSM, aiming to better understand the lean manufacturing production philosophy and to use the simulation as an aid to the quality value stream mapping implementation. Q-VSM is a tool used to reduce wastes and lead time in the production flow of manufacturing, increasing the company competitiveness. Beginning with a case study developed in an industrial heavy electrical transformer manufacturer, it was possible to see how Quality value stream mapping can create conditions to provide improvements if adequately implemented. It was possible to observe how the Q-VSM creates conditions for improvements.

- ✓ 64% improvements of manufacturing efficiency.
- ✓ Reduction of 10 to 30% at idle times for suppliers and manufacturing process respectively;
- ✓ Reduction on the size of production batches, increasing the flexibility of the manufacturing process.
- ✓ Increased manufacturing productivity.
- ✓ Improved overall equipment utilization.

REFERENCES

- Lian, H., Landeghem, H., "Analyzing the effects of lean manufacturing using a value stream mapping-based simulation generator", International Journal of Production Research, Vol. 45,No. 13, 3037-3058, 2007.
- Nash, M. A., Poling S. R., Mapping the total value stream: A comprehensive guide for production and transactional processes. Taylor & Francis Group, USA, 2008.
- Abdulmalek, F.A., Rajgopal, J., "Analyzing the benefits of lean manufacturing and value stream mapping via simulation: a process sector case study", International Journal of Production Economics 107, pp. 223 236, (2002).
- A. M. Kilpatrick, "Lean Manufacturing Principles: A Comprehensive Framework for Improving Production Efficiency", Massachusetts Institute of Technology, Usa, (1997).
- I. Alony, M. Jones, "Lean Supply Chains, JIT and Cellular Manufacturing – The Human Side", Science and Information Technology Volume 5, (2008).
- Pattanaik, L.N., Sharma, B.P., "Implementing lean manufacturing with cellular layout: a case study", The International Journal of Advanced Manufacturing Technology 42, pp. 772-779, (2009).
- Shah, R., Ward, P. T., "Lean manufacturing: Context, practice bundles, and performance", Journal of Operations Management, 21(2), 129-149, (2003).
- Stock, G. N., Greis, N. P., Kasarda, J. D., "Enterprise logistics and supply chain structure", Journal of Operations Management, 18 (5), 531-547, (2000).
- N.P. Anderson, G.W. Evans, W.E. Biles, Simulation optimization of logistics systems through the use of variance reduction techniques and criterion models, Eng. Optim. 3 (2006) 441–460.
- Paez, O., Salem, S., Solomon, J., and Genaidy, A., (2005), "Moving from lean manufacturing to lean construction: Toward a common socio-technological frame wok", Wiley Periodicals, vol. 15, no., 2, pp. 233-245.
- Salem, O., Solomon, J., and Genaidy, A., "Lean Construction: From theory to implementation", Journal of Management in Engineering, vol. 22, no. 4, pp.168-176-2006.
- Chowdary, B. V., George, D., "Improvement of manufacturing operations at a pharmaceutical company: A lean manufacturing approach", Journal of Manufacturing Technology Management, Vol. 23, No. 1, pp. 56 -75, 2012.
- Li, H., Cao, H., Pan, X.,"A carbon emission analysis model for electronics manufacturing process based on value-stream mapping and sensitivity analysis", International Journal of Computer Integrated Manufacturing, Vol. 25, No. 12, pp. 1102- 1110, 2012.
- Teichgräber, U. K., Bucourt, M. D., "Applying value stream mapping techniques to eliminate non-value-added waste for the procurement of endovascular stents". European Journal of Radiology, Vol. 81, pp. 47-52, 2012.
- Xie, Y., Peng, Q., "Integration of value stream mapping and agent-based modeling for OR improvement", Business Process Management Journal, Vol.18, No. 4, pp. 585- 599, 2012.
- Wee, H. M., Wu, S., "Lean supply chain and its effect on product cost and quality: a case study on Ford Motor Company", Supply Chain Management: An International Journal, Vol. 14, No. 5, pp. 335-341, 2009.
- Chitturi, R. M., Glew, D.J., Paulls, "Value stream mapping in a job shop",IET Conference Publications", International Conference on Agile Manufacturing (ICAM 2007). Durham, UK, pp. 142-147, 2007.
- H. Sharifi, Z. Zhang. "A methodology for achieving agility in manufacturing organizations: An introduction", International Journal of Production Economics, 62, pp.7-22', 1999.

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