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Implementation of Lean Manufacturing in Discrete Industry

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ABSTRACT
To survive in the era of fierce competition, companies need new standard to address the requirements of increased customization, product proliferation, heterogeneous market, shorter product life cycle and development time, responsiveness towards customer and waste minimization. This paper focuses on how discrete industry can improve their performance in the aforementioned area by adopting an appropriate strategy of VSM to improve in all aspect of business and simultaneously developing and refining the manufacturing processes by minimizing the waste right from the design to dispatch and distribution.
KEYWORDS: Lean Manufacturing, VSM, Material and Information flow, Customer Takt, Current State Map and Future State Map.

I. INTRODUCTION

Lean Manufacturing is a systematic approach by which the wastes i.e. non-value added activities are identified and eliminated in the process through continuous improvement. Simultaneously it helps to maximize productivity and fulfilling the customer's desire of maximum value at the lowest price. (Parthiban et al., 2017) shown on his work that many companies have realized the advantage of producing high-quality products economically even at low volume by doing a fraction amount of work in process inventory. Companies may have different approach but they all have one thing common: the aspiration to produce as efficiently, quickly, flexibly and leanly as possible to be capable of following the changing needs of the customers cost-effectively and competitively at all times. To retain the customers in this competitive environment, Lean Manufacturing has proved to be a very well established management approach. One of the most effective tools of Lean manufacturing is Value Stream Mapping (VSM). It is a set of methods to visually display the flow of material and information through the production process. The objective of VSM is to identify value added activities and non- value added activities. It is often used in process cycle time improvement by identifying and eliminating time spent on non-value added activities.

Further section of the paper is arranged as follows: Section 2 of the paper highlights the key literature related to the use of VSM in different industries. Section 3 of the paper presents a case study. Section 4 highlights the results and discussion of the case study. Finally the paper is concluded in Section 5.

II. LITERATURE REVIEW

The paper aims to implement lean manufacturing in the discrete industry. Accordingly the literature is reviewed as described below.

(Womack et al., 1990) published a book named "The Machine That Changed the World" often referred to as an MIT Study described the Lean philosophy and opened an area for further development in this area. When the book was published, Toyota was half the size of General Motors and the two-third size of Ford. Now we can see, how Toyota has surpassed them and lead in the industrial enterprise in the world. It clearly describes two fundamentally different business system, the two ways of human thinking that how human works together to add value. In the 1920s with Mass production, General Motors passed Ford to become the world's largest industrial enterprise.(Stamm, 2008)introduced three categories that classify operations as non-value adding (actions that should be eliminated, such as waiting), necessary but non-value-adding (actions that are wasteful but necessary under current operating procedures) and value-adding (conversion or processing of raw materials via manual labor).The activities for which customers are willing to pay such activities are called value-adding activities which one wants to optimize and those which do not lead to the increase of value are called Non-value-adding activities. Non-value-adding activities are those that are necessary and that support the value-adding activities which are to be minimized and which are unnecessary are to be eliminated. Those seven type wastes are listed below:(I)Overproduction, (II) Inventory(III) Errors/Rework(IV) Transport(V)Waiting Time(VI) Space,(VII)Unnecessary movements. (Rother & Shook, 2003) used their knowledge of Toyota practices and created a simple way for managers to see the flow of value and presented the Value Stream Mapping method in the workbook of lean Enterprise Institute, „Learning to see". Value Stream maps were first

drawn with paper and pencil, originally called „material and information flow maps" presented as a one-page diagram that depicts the process used to make a product i.e. not only material flows are mapped but also the information flow mapped in the one-page diagram. (McCarthy, 2006) emphasized the reduction of lead time for job shops as the equivalent of the reduction of the stock in mass-production. He concluded that one of the main approaches during a lean implementation of a Make to Order Company should be like reducing the lead time. A member of the US LAI team in MIT (Darwish et al., 2010), produced a manual of product development value stream mapping (PDVSM). After a lot of industrial case studies and research, it was developed. The result was a near-cookbook to brief the creation of the current state map and how to develop a future state map using this.(Alves et al., 2005) investigated the usage of Value Stream Mapping for manufacture to order products in a job shop environment. They concluded that Value Stream Mapping for a job shop environment has to be flexible to deal with the dynamic nature of it. For the fabrication of Heat venting and Air Conditioning, Value Stream Mapping used in the fabrication of sheet metal ducts.(Belokar et al., 2012)reported a case study of the application of Value Stream Mapping in the automobile industry where they achieved around two-third improvement in cycle time by improvising the value-adding activities.(Chukukere et al., 2014)presented a dynamic value stream mapping model applied to an automobile collision repair shop which was developed and validated which help to monitor the performance of production time, identify the bottleneck and improve the resource utilization and then future model was proposed which would reduce cycle time and eliminate waste.(Yuvamitra et al., 2017)presented a work on rope manufacturing process. They firstly applied the lean concepts to information flow and by changing the setup sheets, two-third of the processing time to be reduced as estimated which shows a dramatic effect on waiting time for each order. And implementing the lean concepts in both material and information flow, save estimated to be three-fourth of the time of manufacturing of rope. Thus shipping the order from 36 days to 9 days was suggested.(Melvin, 2007) discussed about value stream mapping in a food and drink industry where inefficiencies and inappropriate maintenance activities affecting flow of goods results in excessive downtime. He concluded by developing a process to avoid unnecessary movements of goods and reduction of defect rate by adopting new machines.(Wongso, 2010)implemented Value Stream Mapping to identify bottleneck process in a MTO industry where 27% reduction in manufacturing lead time was seen and an expansion of heat treatment furnace was suggested by capacity analysis.

III. METHODOLOGY

The objective of this work is to evaluate the potential opportunity to develop a process that incorporates lean manufacturing principles into an existing manufacturing process by applying VSM.The steps to apply Value Stream Mapping for waste reduction is shown in Figure 1 and described below:

1. Firstly, define the area under consideration by selecting a specific product family or a representative product/type.
2. Value Stream Mapping begins with the customer or dispatch and runs contrary to the material flow through to the supplier. In the process, the material and information flows and process data are recorded (cycle time, Overall Equipment Effectiveness, number of associates, etc.). The determination of the lead time as well as the distribution of stocks at the time of the recording are also included.
3. Depending on expectations to achieve with value stream planning, the visualization of the value stream can have different focus topics – for example, we can represent processes with varying levels of detail.
4. The current situation is always recorded on-site in the real value stream so everything can be seen with eyes.
5. Potential for improvement can be identified from the view of the current situation.
6. This potential is further converted for improvement within the framework of Value Stream Design into future conditions of the value stream.

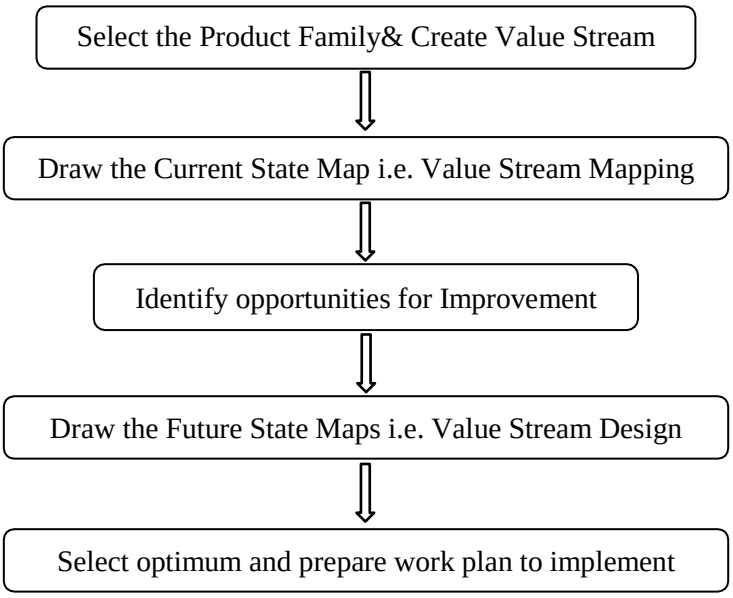

Figure 1: Steps to apply VSM

A CASE STUDYIN A DISCRETE INDUSTRY

A case study is conducted in a discrete industry for the applicability of VSM. The study is done for reducing the non-value added activities and improving two major parameters i.e. Process lead time and Inventory for a component named "Short DRV" of the discrete industry. The monthly demand for the part is 39,000 pieces considering 26 working days which is produced in two-shift daily with 45 mins break per shift (30 minutes for lunch, 5 minutes for 5S and 10 minutes for shift change).The selected area is critical that needs improvement to tackle the problems associated with the delivery of the product to the customer. Therefore value stream mapping is done for the existing process as discussed below:

Value Stream Map for existing process

Value Stream Mapping is a pictorial view of the entire process through which the product passes that include both material and information flow. The mapping is done with the help of some symbols such as boxes, arrows, numbers and then envisioning the future state map which must be better than the existing one considering the process parameter. The flow of the part in the value stream is shown in Figure 2

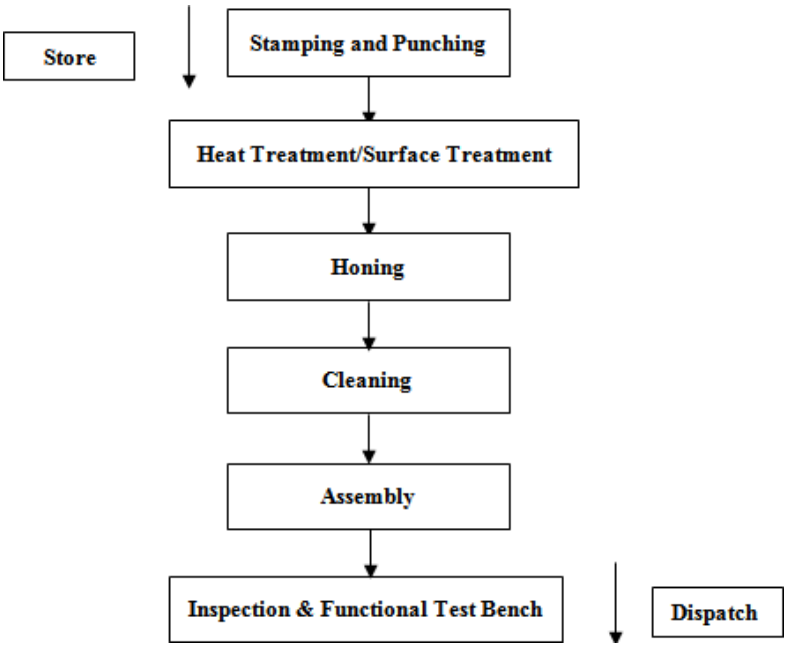

Figure 2: Material flow of the part

Further Rother and shook recommends the data needed for value stream mapping must be collected from customer to supplier end. Therefore all the data needed is collected by observation and software available in the industry is shown in Tables 1 & 2.The data collected are Cycle time, number of associates, inventory between stations, changeover time, etc. The terminology used in the data set are defined below:

Cycle Time (CT): Time interval between one part and next.

Changeover Time (C/O Time): There are some technical and organizational task which has to be carried out to change the production of different type of parts.

Overall Equipment Efficiency (OEE): Clarifies the utilization of available time.

$$\text{OEE} = \frac{\text{Net Production Time}}{\text{Planned Operating Time}}$$

Lot Size: The total number of parts that are produced between two consecutive changeovers.

Customer Takt: The time interval in which the parts need to exit the process to satisfy the demand of the customer.

Delivery Takt: The time interval in which parts leave the value stream

Table 1: Value stream map input data

S. No.	Process Parameter	Data value
1	Demand/Day	1500 Nos.
2	Planned Operating Time	52200 Sec.
3	Customer Takt	34.8 Sec/Pc.

Table 2: Process Parameter of different processes

S. No.	Operation	CT	C/O Time	OEE	Operators	Types	Shift	WIP	Lot Size	Cust. Takt	Del. Takt
		Sec	Mins.	%	Nos.	Nos.	Nos.	Pcs.	Pcs.	Sec./ Pcs.	Sec./ Pcs.
1	**Stamping& Punching**	7.85	25	75	0.5	9	1	1	800	34.8	10
2	**HT/ST**	72	0	80	3	9	3	-	2400	34.8	76
3	**Honing**	25.14	0	80	2	9	2	16	200	34.8	29.5
4	**Cleaning**	3.07	0	85	1	1	1	100	200	34.8	2.43
5	**Assembly**	6	15	67	1	1	1	14	200	34.8	8.95
6	**Inspection & FT**	18	0	-	2	2	1	1	200	34.8	-

All the data available in the table is used in MS Visio software to draw the value stream map for the existing process which is shown in Figure 3. A critical analysis of this value stream map indicates that some non-value added activities need some improvement. The non-value added activities identified are: Supermarket at the end of the inspection process and two honing machines.

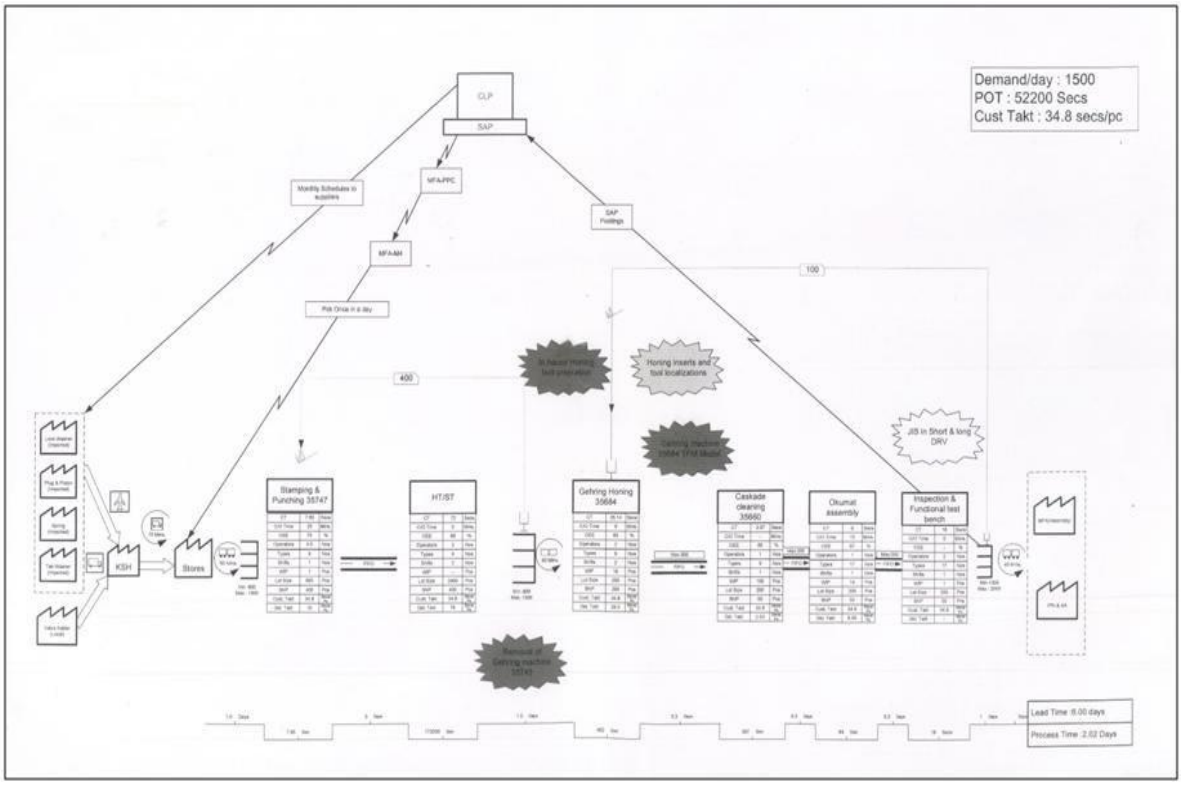

Figure 3: Existing Value Stream Map

Value Stream Map for the proposed process

The target areas are highlighted to improve the existing value stream map. Then with the help of kaizen, the number of proposed value stream map is drawn. The best out of them is selected and a good work plan of various activities that are needed to be carried out is made to implement them and get the ideal result. The proposed value stream map is shown in Figure 4. Here it can be observed that the process lead time in the existing value stream map is 6.0days and in the proposed value stream map, it gets reduced to 5.6 days. Further, the supermarket is removed from the existing value stream map and one honing machine is also eliminated without affecting the demand of the customer.

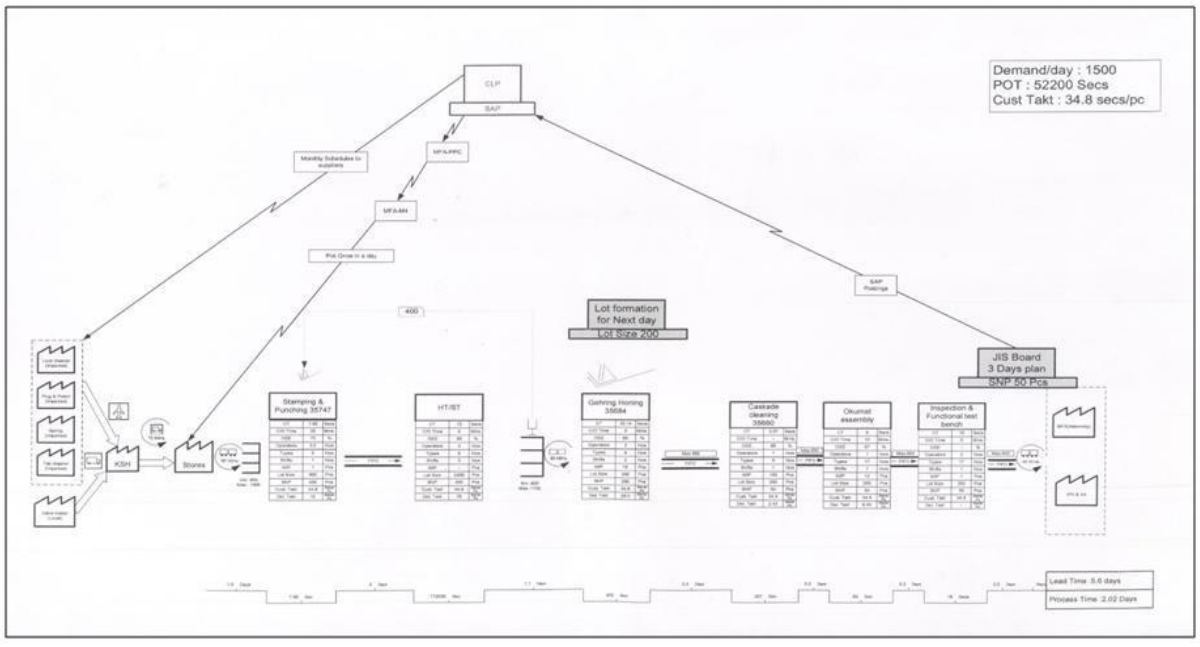

Figure 4: Proposed Value Stream Map

IV. RESULT AND DISCUSSION

The proposed value stream map indicates that the implantation of FIFO will be beneficial instead of storing the parts in the existing supermarket at the inspection end. Further, one honing machine is removed in the proposed value stream map without affecting the customer demand. One more observation indicates that the supermarket maximum size is increased from 1500 units to 1700 units at the entry of the honing machine. Improvement in all these activities results in a reduction of process lead time from 6.0 days to 5.6 days as shown in Figure 5. The percentage reduction in lead time is observed as 6.66%.

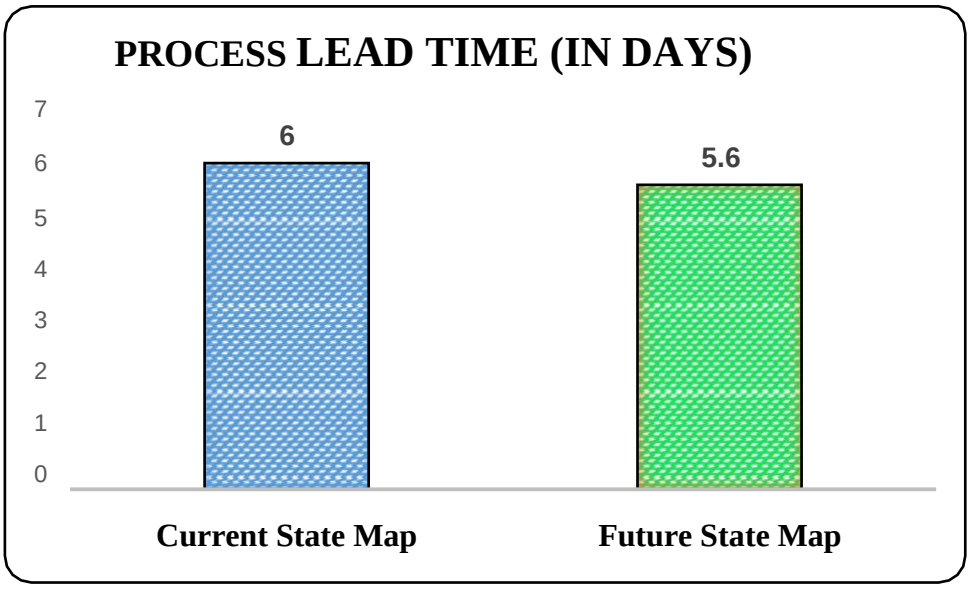

Figure 5: Comparison of lead time in existing and proposed VSM

V. CONCLUSION

The paper presented a brief description of the value stream mapping which is used as a tool to visualize the information and material flow from the customer's end through the process to the supplier end. Based on the value stream map of the existing value stream map, several activities are identified as non-value added activities and eliminated from the process. Finally a new process is proposed and the value stream map of the proposed process is drawn. A comparison of these two maps indicates that there is a 6.66% reduction in process lead time in the proposed value stream map. Thus it can be concluded from the study that VSM helps to visualize the non-value added activities and eliminate the non-value added activities that help to improve the existing process.

In this study, VSM has been applied in a discrete industry to improve the existing process. In the future, it can be implemented in other areas of the same industry for the overall improvement of the organization. Further it can also be integrated with the Internet of Things that would help in the time-saving process.

REFERENCES

[1]. Alves, T. da C. L., Tommelein, I. D., & Ballard, G. (2005). Value stream mapping for make-to-order products in a job shop environment. *Construction Research Congress 2005: Broadening Perspectives*, 1–10.

[2]. Belokar, R. M., Kumar, V., & Kharb, S. S. (2012). An application of value stream mapping in automotive industry: a case study. *International Journal of Innovative Technology and Exploring Engineering*, *1*(2), 152–157.

[3]. Chukukere, A., Castillo-Villar, K. K., & Wan, H. (2014). Improving operations through dynamic value stream mapping and discrete-event simulation. *IIE Annual Conference. Proceedings*, 938.

[4]. Darwish, M., Shehab, E., & Al-Ashaab, A. (2010). Value Stream Mapping and analysis of Product Development (Engineering) processes. *International Conference on Manufacturing Research*, *Table 1*, 590–597.

[5]. McCarthy, B. P. (2006). *Lean enterprise transformation in a job shop environment*.

[6]. Melvin, A. (2007). *Supply Network and Operations Analysis in the UK Food Industry*. *December*.

[7]. Parthiban, M., Perumalsamy, M., & Aravinddinesh, G. (2017). Manufacturing Lead Time Reduction in Monoblock (SWJ) Pump Industry. *International Research Journal of Engineering and Technology (IRJET)*, *4*(12), 1801–1807.

[8]. Rother, M., & Shook, J. (2003). *Learning to see: value stream mapping to add value and eliminate muda*.

Lean Enterprise Institute.
[9]. Stamm, M. L. (2008). Value Stream Mapping (Vsm) in a Manufacture-To-Order Small and Medium Enterprise. *3rd World Conference on Production and Operations Management, Tokyo, Japan*, 1–15.
[10]. Womack, J., Jones, D., & Roos, D. (1990). The machine that changed the world. New York: Rawson. *Mc. Millan*.
[11]. Wongso, R. (2010). *An Application of Value Stream Mapping to Reduce Lead Time and WIP in a Make-to-Order Manufacturing Line*.
[12]. Yuvamitra, K., Lee, J., & Dong, K. (2017). Value stream mapping of rope manufacturing: A case study. *International Journal of Manufacturing Engineering*, *2017*.
[13]. Implementing Lean and Agile Manufacturing System in the Electric Motor Industry for Sustainable Environment" in an International Journal for Manufacturing Technology and Research, Jan-June, 2014, Vol. 10 No. 1, ISSN No. 0973-0281, Pg. 36-43.
[14]. Utilizing Value Stream Mapping for Scheduled Optimization of Heavy duty Earth-moving Vehicles" in an International Organization of Scientific Research- Journal of Engineering (IOSR- JEN). ISSN: 2278-8719 (Print), ISSN: 2250-3021 (Online), Volume 04, Issue 9 Ver. 4 (September 2014), PP 22-31.
[15]. Application of Agile Manufacturing in Small and Medium Scale Industries" in an International Journal of Science Engineering and Technology (IJSET) Volume 4, Issue 6, Nov-Dec 2016, pp. 805-814.

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