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ORIGINAL ARTICLE

Value stream mapping: literature review and implications for Indian industry

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Abstract Value steam mapping (VSM) is a lean manufacturing technique and it has emerged as the preferred way to support and implement the lean approach Grewal (Int J Manuf Technol Manag 15:3–4, 2008); Singh and Sharma (J Measuring Business Excellence 13:58–68, 2009). VSM is different than conventional recording techniques, as it captures the information at individual stations about station cycle time, up time or utilization of resources, set-up time or change over time, work in process inventory, man power requirement and the information flow from raw material to finish goods. It covers both value adding as well as non-value-adding activities. This paper covers the review and classification of literature on VSM, as there is hardly any paper on literature review of VSM, so it will be very beneficiary for both academician and industry people. Applications of VSM are also presented by a case study of a small manufacturing Indian industry and reduction in lead time, processing time, work in process inventory and manpower requirement at individual stations are noticed

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Keywords VSM · Takt time · Current and future state map · Lead time · Station cycle time

1 Introduction

Value stream mapping is an enterprise improvement tool to help in visualizing the entire production process, representing both material and information flow. Defined value stream as collection of all activities value added as well as non-value added that are required to bring a product or a group of products that use the same resources through the main flows, from raw material to the end customers [33]. A very important part of the value stream mapping process is documenting the relationships between the manufacturing processes and the controls used to manage these processes, such as production scheduling and production information. Unlike most process mapping techniques that often, only document the basic product flow, value stream mapping also documents the flow of information within the system, where the materials are stored (raw materials and work in process, WIP) and what triggers the movement of material from one process to the next are key pieces of information. In this paper, an attempt has been made to review and classify the literature in to four categories (1) conceptual work (2) empirical/modeling work, (3) case studies, (4) survey articles and then 23 attributes of value steam mapping (VSM) are identified form the available literature. These identified attributes are discussed according to importance given to them by various authors. Finally, the applications of VSM are shown with the help of a case study of an Indian industry and key findings are highlighted.

2 Related work

This paper covers available literature published in refereed journals, conferences and books on VSM and its applications in different areas all over the world from 1990 and classified it according to classification scheme given by [13] in to four categories (1) conceptual work, (2) empirical/modeling work, (3) case studies, (4) survey articles as shown in Fig. 1

2.1 Conceptual work

Value stream refers to those specifics of the firms that add value to the product or service under consideration and it is necessary to map both inter- and intra-company value-adding streams [45]. The rate at which value is added to a single product from the raw material stage through dispatch and delivery to the customer and changing view of organizations towards improvement to processes is discussed [4]. A new scheme of classifying operations into three generic categories as non-value adding (NVA), necessary but non-value adding and value adding is suggested. This scheme proved to be more generic and was extended to different areas [31]. Individual tools to understand different value streams maps and regarding their overlapping nature and use were developed [23]. The five tenets of lean manufacturing were enumerated and it was emphasized that VSM has to be carried out as the first step towards lean implementation [44]. A classification scheme about seven new mapping tools (namely, process activity mapping, supply chain response matrix, production variety funnel, quality filter mapping, demand amplification mapping, decision point analysis and physical structure mapping) and their applications areas were suggested [20]. It was shown that unnecessary inventory, defects, inappropriate processing and transportation were the most serious wastes in the system, further suggested to adopt five of the VSM tools: process activity mapping, supply chain response matrix, quality filter mapping, demand amplification mapping, and decision point analysis [24]. A new approach for VSM in detail including a summary of the previous VSM approach and its weaknesses was described. The new approach involves a strategic review of a business or supply chain's activities, the delimitation of key processes and the mapping of these processes. It also highlighted limitations of VSM and categorized them under main heads such as: limitations related to VSM method: VSM did not take care about other wastes such as wasted energy or wasted human potential, areas of overlap between value streams were not covered such as finite capacity planning. Limitations of VSM related to general environment use: lack of understanding of what becoming lean means, lack of formal education step in the process at either senior level or operational levels, lack of understanding of a particular firm’s position in a supply chain and the implications of their actions, lack of linkage to corporate strategy and wider market environment, lack of review of other key processes in different business and supply chain environment such as new product development and in order to avoid “shop floor myopia”, lack of understanding about human resource issues such as the appropriate internal or external culture, language, and relationships required by organizations [19]. It was noted that VSM may not serve the purpose when it is used to map a production line which produces different types of product families that are having different processing times and set-up times for each processing step apart from different number of shifts [28]. It was rightly argued that whenever there is a product for a customer, there is a value stream. The challenge lies in seeing and working on it. VSM can be done in the same way for practically any business activity and expanded upstream or downstream. This powerful tool not only highlights process inefficiencies, transactional and communication mismatches but also guides about the improvement [33]. Anything other than the minimum amount of equipment, effort, materials, parts, space, and time that are essential to add value to the product was defined as waste. They also told that waste takes many forms and can be found at any time and in any place. It may be found hidden in policies, procedures, process and product designs, and in operations [34]. The use of value stream mapping to the field of accounting to determine the process costs of a value stream was extended. The information contained in value stream maps can be used to calculate current and future state process costs and create value stream profit-and-loss statements [27]. A classification scheme to serve as a link between manufacturing waste problems and lean manufacturing tools was proposed. A manufacturing organization can match its manufacturing wastes with the appropriate lean manufacturing tools. This classification scheme systematically organizes lean manufacturing tools and metrics according to their level of abstraction, appropriate location of application of the tool in the organization, whether it addresses management waste or activity waste, the type of resource waste it addresses, and whether it identifies waste, measures waste, eliminates waste, or a combination of the three [32]. Value stream maps for determining the beliefs, behaviors, and competencies possessed by business leaders were described and with the help of current and future states map, the ineffectiveness of most senior managers as well as traditional leadership development programs were highlighted [12]. Practical issues like how to calculate Takt time, where to place supermarket, where can we use continuous flow processing, what process improvements can be done, and how to handle different product families while mapping job shop operations using a standard VSM were explored and it was also explained that while drawing a standard VSM in job shop operations, all pertinent information should be collected from the last to the first operation in contrast to other production system where all information are collected from the first to the last operation, lastly as in job shop operation the future demand is not certain, so the average demand in the previous years should be considered for mapping a particular product family [7]. Braglia et al. pointed out in his article that VSM is basically a paper-and-pencil-based technique, so, the accuracy level is limited, and the number of versions that can be handled is low; in real situations, many companies are of a "high variety–low volume type", this requires many value streams and cannot be addressed by simple VSM. They also proposed an alternative and innovative framework for a structured application of VSM to products requiring nonlinear value streams, based on the preliminary analysis to identify the longer critical production path using the temporized bill of material. After identification of the critical path, possible improvements were searched and then all sharing with secondary paths were considered as further constraints. Finally, when the main value stream got improved, a new path became the critical one. Thus, the analysis proceeded iteratively until the optimum is reached or the WIP level has decreased under the desired level [47]. Singh et al. suggested industries to apply VSM techniques to find money drain points in their balance sheets and also apply these techniques to cut down operational cost to save business during recessionary times [42].

2.2 Empirical/modeling work

A simulation model was used in conjunction with VSM to improve the performance of British Telecommunications PLC and demonstrated the transportation from current state to future state for service industry [10]. A simulation to answer questions that could not be addressed was used using only the static view provided by value steam mapping and described both the current state and the future state for the product line, as well as the analysis and results obtained from simulation [28]. The use of rough set theory was demonstrated after the current state VSM to identify where lean control is required and also developed a simulation model in arena to model a factory of Taiwan-funded enterprise in Mainland China that produces oval gear flow meters to understand the effect of implementing lean control approaches in the factory [22]. A simulation model in arena was developed to demonstrate the production system of Orient Hand bag limited, a high-variety batch manufacturer [8]. A conceptual model identifying the key factors that determine the responsiveness of a supply chain system was developed and three dimensions of responsiveness were identified: first—simple logic that aligns itself to a wide range of manufacturing strategies, second—product, process, and volume, third—there cannot be one single "holy grail [21]." A model to implement lean manufacturing initiatives was developed and VSM was used to evaluate the effectiveness of this model. It reduced and eliminated the non-value-added time in a particular value stream. It also revealed the percentage reduction in lead time, waiting time, and inventory [15]. VSM was used for the process sector as a main tool to identify the opportunities for various lean techniques and a simulation model to contrast the before and after scenarios in detail was developed in order to illustrate to managers potential benefits such as reduced production lead time and lower work in process inventory [1]. A simulation model to study the impact of certain lean principles was built for enhancing the flow of construction material and found that the lesser the time spent in the value stream, the leaner is a process [2]. The application of VSM-based simulation generator was discussed in a manufacturer of poultry and pig raising equipments for feeding, drinking, feed storage, and feed transportation systems [26]. Discrete event simulation quantified through a detailed VSM exercise was used to model the current system's functioning and to identify operational inefficiencies in warehouse-receiving process at a large food distribution center, which comprises of trucks with goods reaching the destination warehouse, unloading and finally putting away the contents to the specific aisles [14]. A new cycle time performance tracking matrix derived from the factory physics queuing model was introduced to explore a systematic way to structure the hierarchical cycle time key performance indicators framework and also to define the right owner to improve those measurements. Further, VSM was used to reduce factory variability [46]. A stabilization problem for a nonlinear multiple time-delay large-scale system was considered and neural-network (NN) model to approximate each subsystem was employed. They established linear differential inclusion (LDI) state-space representation for the dynamics of each NN model and a robustness design of fuzzy control is proposed to overcome the effect of modeling errors between subsystems and NN models. Finally, a set of fuzzy controllers is synthesized to stabilize the nonlinear multiple time-delay large-scale system [48]. The Takagi–Sugeno (T-S) fuzzy model representation was extended to analyze the stability of interconnected systems having time delays in subsystems. They used LDI state-space representation to represent the fuzzy model and employed the linear matrix inequality optimization algorithm to find a common solution and then guarantee the asymptotic stability [49].

2.3 Case studies

The steps used to produce the 'Value analysis Time Profile' by a case study from within the LEAP project (automotive

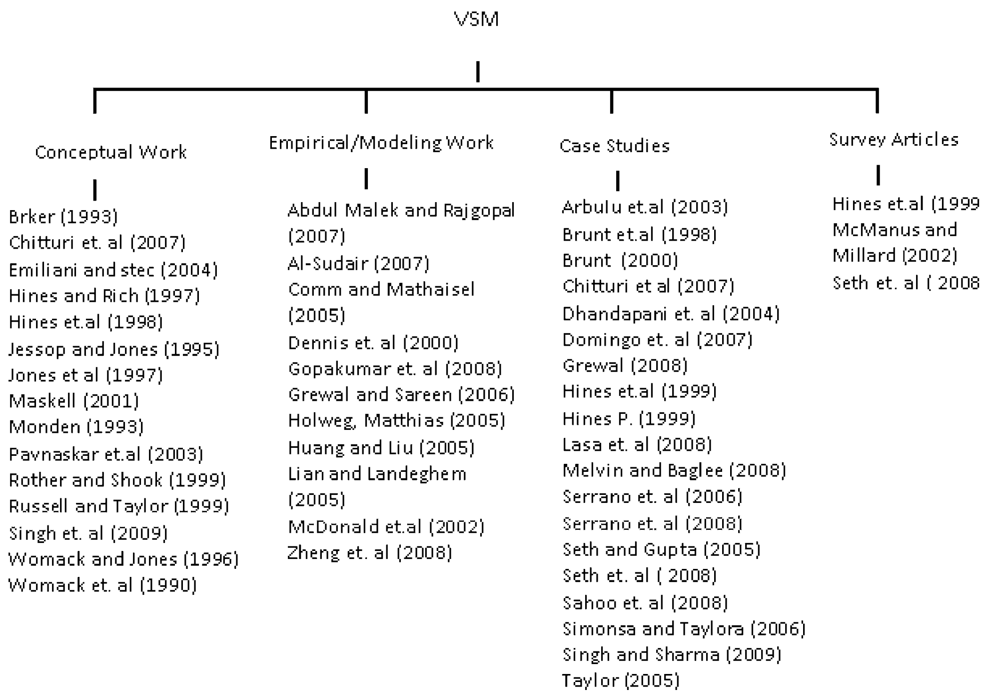

Fig. 1 Available literature on VSM

supply chain) was explained and the methodology to highlight the role of this tool as a simulation device to quantify the impact of improvement activities was illustrated [5]. The application VSM to the development of a supplier network around a prominent distributor of electronic, electrical, and mechanical components was described. This involved mapping the activities of the firm, identifying opportunities for improvement and then undertaking with the firm an improvement program by involving around 50 key suppliers across eight product category areas [18]. The concept of value stream management to solve the problems of a UK-based American-owned computer manufacturing company was implemented. Current state and future state maps are drawn in order to identify and eliminate the causes of the problems [17]. The application of the mapping tool across the whole supply chain—from steel, through steel service centers, to first-tier component manufacturers was explained. Current and future state maps have been highlighted to illustrate the benefits of a lean system pictorially and a method of constructing an action plan has been discussed [6]. With the help of current state and future state maps of how work flows throughout the design, procurement, and fabrication phases of pipe supports and highlighted value-added and non-value-added times, lead times and improvement areas was explained [3]. A case study of a steel company with the help of VSM was presented and production cost can be reduced 8% of turnover and capital equivalent to 3.5% of turnover can be released only through the removal of inventory were claimed [9]. VSM technique was used to achieve productivity improvement at supplier end for an auto industry and reported gain in production output per person, reduction of work in process, and finished goods inventory [38]. Value stream analysis (VSA) was used and significant opportunities to improve to a complete supply chain for a food product from farm to consumer were highlighted [43]. VSM technique as the first stage of analysis was used and planning of the improvement project on the sheet metal cutting line and reduced the number of sheet metal formats from 160 to 40 (75%) and changed the average supply period from 7 to 3 days and managed to reduce the average raw material stock by 37.5% [36]. Food value chain analysis (FVCA) on eight value chains in the UK red meat industry was applied based on lean paradigm and evaluated FVCA on four subsystem- goals and values, logistics, human resources and management structure. Positive potential logistics benefits were finally found along the chain, but identified two key implementation issues; inter-company alignment of other subsystems and chain organizational stability through time [7]. Practical issues in job shop using a standard VSM were explored and how an improved VSM can eliminate some limitations of old VSM was explained [11]. Data with VSM from assembly line of a

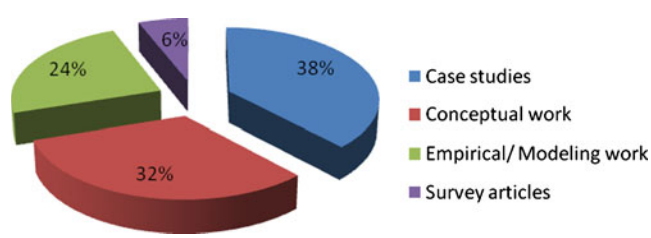

Fig. 2 Category wise percentage of the available literature on VSM

Table 1 Frequency of VSM attributes in literature

Author	VSM attributes discussed																						
	Bottle necking	Continuous improvement	Current state map	Cycle time Reduction	Electronic information	Finished goods inventory	Flexible supplier	Future state map	Kaizen burst	Kanban	Lead time reduction	Proximity of suppliers	Pace maker process	Reduction in manpower	Raw material inventory	Setup time reduction	Small shipment size	Suppliers involvement	Takt time	Value addition	Waste of transportation	WIP	Zero defects
Abdulmalek and Rajgopal (2007)		*	*	*				*			*		*			*			*	*	*	*	
Al-Sudair (2007)				*					*											*			
Arbulu et.al (2003)			*	*				*			*								*	*		*	
Brker (1993)											*									*	*		
Brunt, (2000)	*	*																	*				*
Chitturi et. al (2007)			*					*											*	*			
Comm and Mathaisel (2005)			*	*				*								*			*	*	*		
Dhandapani et. al (2004)						*															*	*	*
Disney et.al (1997)		*			*		*		*	*	*										*		
Dennis et. al (2000)		*														*				*	*		
Domingo et. al (2007)	*			*		*				*									*	*			
Emiliani and stec (2004)		*			*	*					*				*				*	*	*		
Gopakumar et al. (2008)			*		*			*			*			*						*	*		
Grewal (2008)			*	*	*	*		*		*	*	*	*		*	*	*		*	*	*	*	
Grewal and Sareen (2006)	*	*							*							*		*			*		*
Hines And Rich (1997)						*									*				*	*	*	*	*
Hines et.al (1998)	*	*	*					*	*			*	*					*			*		*
Hines et.al (1999)						*					*	*	*					*				*	
Hines P. (1999)			*	*		*		*	*	*	*		*		*		*		*	*			
Holweg (2005)				*							*		*						*				
Huang and Liu (2005)	*	*														*			*	*	*		
Jessop and Jones (1995)	*	*			*				*										*	*	*		
Jones et al. (1997)					*						*	*			*	*	*	*	*	*		*	
Lasa et. al (2008)		*	*		*			*	*	*			*			*		*		*			
Lian and Landeghem (2002)	*	*															*		*				
Maskell (2001)	*	*	*		*	*		*			*								*	*	*		
McDonald et.al (2002)			*	*	*			*	*	*	*		*		*				*	*	*	*	
McManus and Millard (2002)	*	*		*	*																*		*
Melvin and Baglee (2008)	*					*						*			*	*	*	*		*			
Monden (1993)		*										*								*			
Pavnaskar et.al (2003)	*	*							*	*										*			*
Rother and Shook (1999)		*	*	*	*	*	*	*		*	*	*	*	*	*	*	*	*	*	*	*	*	
Russell and Taylor (1999)	*					*									*						*		*
Sahoo et al. (2008)			*	*							*				*	*			*	*		*	*
Serrano et. al (2006)		*	*			*		*						*	*				*			*	
Serrano et. al (2008)						*	*	*				*	*		*			*	*	*	*	*	*
Seth et. al (2008)		*	*	*	*	*		*			*		*	*	*				*	*	*	*	
Seth and Gupta (2005)			*	*	*	*	*	*		*	*	*	*		*	*	*		*	*			

Table 1 (continued)

Author	VSM attributes discussed																						
	Bottle necking	Continuous improvement	Current state map	Cycle time Reduction	Electronic information	Finished goods inventory	Flexible supplier	Future state map	Kaizen burst	Kanban	Lead time reduction	Proximity of suppliers	Pace maker process	Reduction in manpower	Raw material inventory	Setup time reduction	Small shipment size	Suppliers involvement	Takt time	Value addition	Waste of transportation	WIP	Zero defects
Simonsa and Taylora (2006)											*	*					*			*			
Singh and Sharma (2009)			*	*	*	*	*	*	*	*	*				*	*	*		*	*			*
Singh et.al (2009)		*									*											*	*
Taylor (2005)			*					*												*			*
Womack and Jones (1996)	*	*					*		*								*	*					*
Womack et. al (1990)			*					*		*									*	*	*		*
Zheng et. al (2008)			*	*		*		*												*		*	
Total papers per attribute	14	21	20	16	14	17	7	20	11	11	20	11	12	6	14	14	10	9	25	32	23	15	15

Table 2 Attributes in accordance to their decreasing order of importance in the literature

VSM attributes discussed	Value addition	Takt time	Waste of transportation	Continuous improvement	Lead time reduction	Current state map	Future state map	Finished goods inventory	Cycle time Reduction	Zero defects	WIP	Setup time reduction	Raw material inventory	Electronic information	Bottle necking	Pace maker process	Proximity of suppliers	Kanban	Kaizen burst	Small shipment size	Suppliers involvement	Flexible supplier	Reduction in manpower
Percentage importance received in literature	64	50	46	42	40	40	40	34	32	30	30	28	28	28	28	24	22	22	22	20	18	14	12

Spanish Bosch factory was identified and lean metrics, such as dock-to-dock time and lean rate, milk run to improve materials flow were used [40]. VSM techniques as lean implementation initiatives were used in small manufacturing firm and claimed 33.18% reduction in cycle time, 81.5% reduction in changeover time, 81.4% reduction in lead time and 1.41% reduction in value-added time [16]. How VSM can be applied to the food and drink industry to identify areas of waste and how these can be reduced and/or eliminated from the value stream were studied [30]. Multiple case study approach was used and concluded that VSM can be used as redesign tool for manufacturing apart from enumerating the differences between theoretical concepts proposed by VSM and real world applications [37]. Various wastes in the processing side of the supply chain of the Indian cottonseed oil industry were addressed using VSM and individually attacked all wastes to reduce or eliminate them from the system [39]. The VSM is a valuable tool for redesigning the productive systems according to the lean system and it was found that there are some key points for the establishing teams that have to take into account, as follows: the time and training resources spent, the use of suitable information systems and a suitable management of the application phases [25]. Application of VSM in forging industry for identification and elimination of waste and its sources were discussed. A noticeable reduction in set-up time and WIP inventory level is substantiated [35]. VSM is a versatile tool for lean implementation by a case study of an Indian manufacturing industry was shown and 92.58%, reduction in lead time, 2.17% reduction in processing time, 97.1% reduction in WIP and 26.08% reduction in manpower requirement was witnessed [41].

2.4 Survey articles

The application of VSM to the development of a supplier network around a prominent distributor of electronic, electrical, and mechanical components was described. This involved mapping the activities of the firm, identifying opportunities for improvement and then undertaking with the firm an improvement program and involved around 50 key suppliers across eight product category areas [18]. The concept of value stream analysis and mapping (VSA/M) as applied to product development (PD) efforts was explored. They visited nine major US aerospace organizations to gather data on the sophistication of the three tools used in

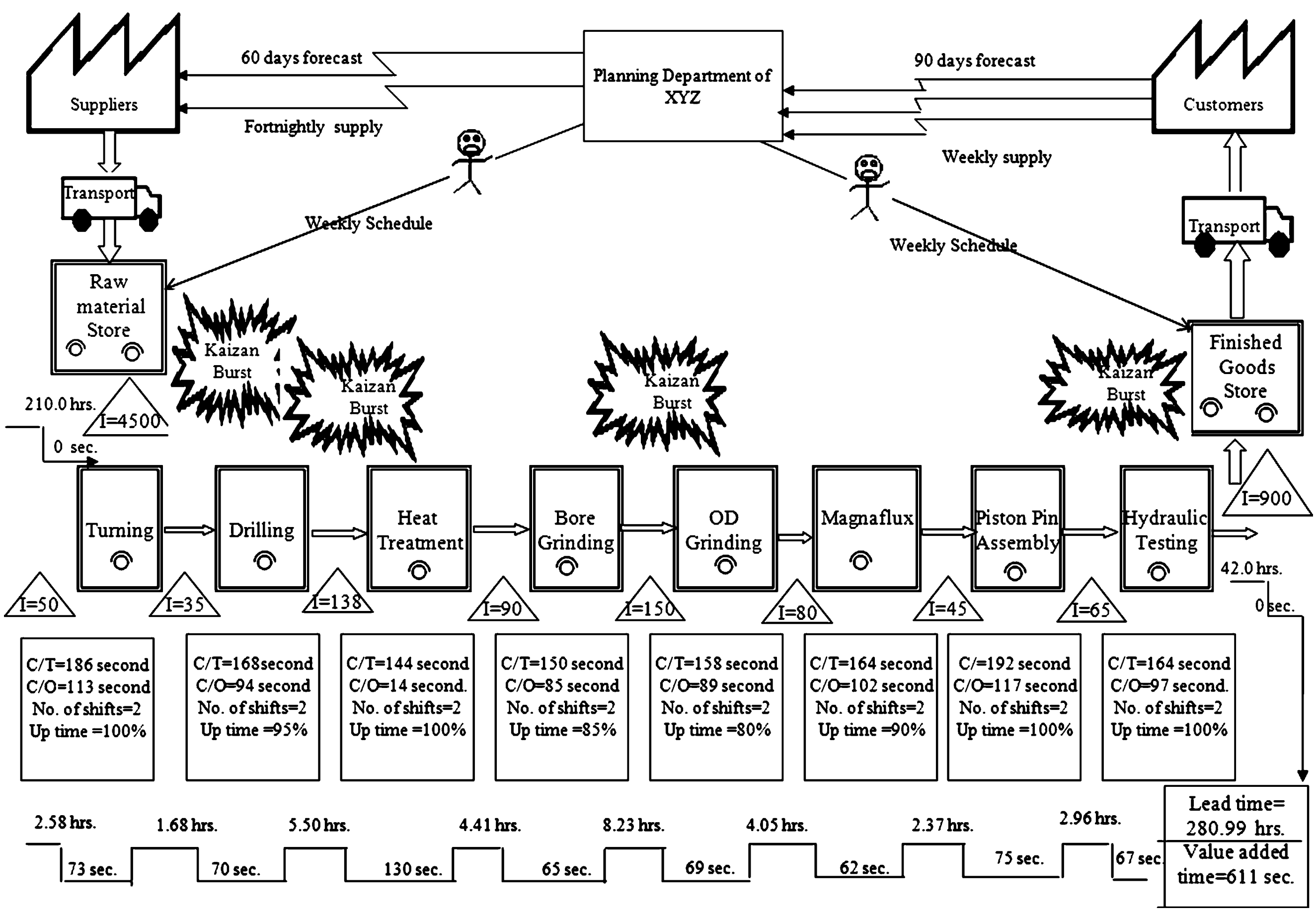

Fig. 3 Current state map

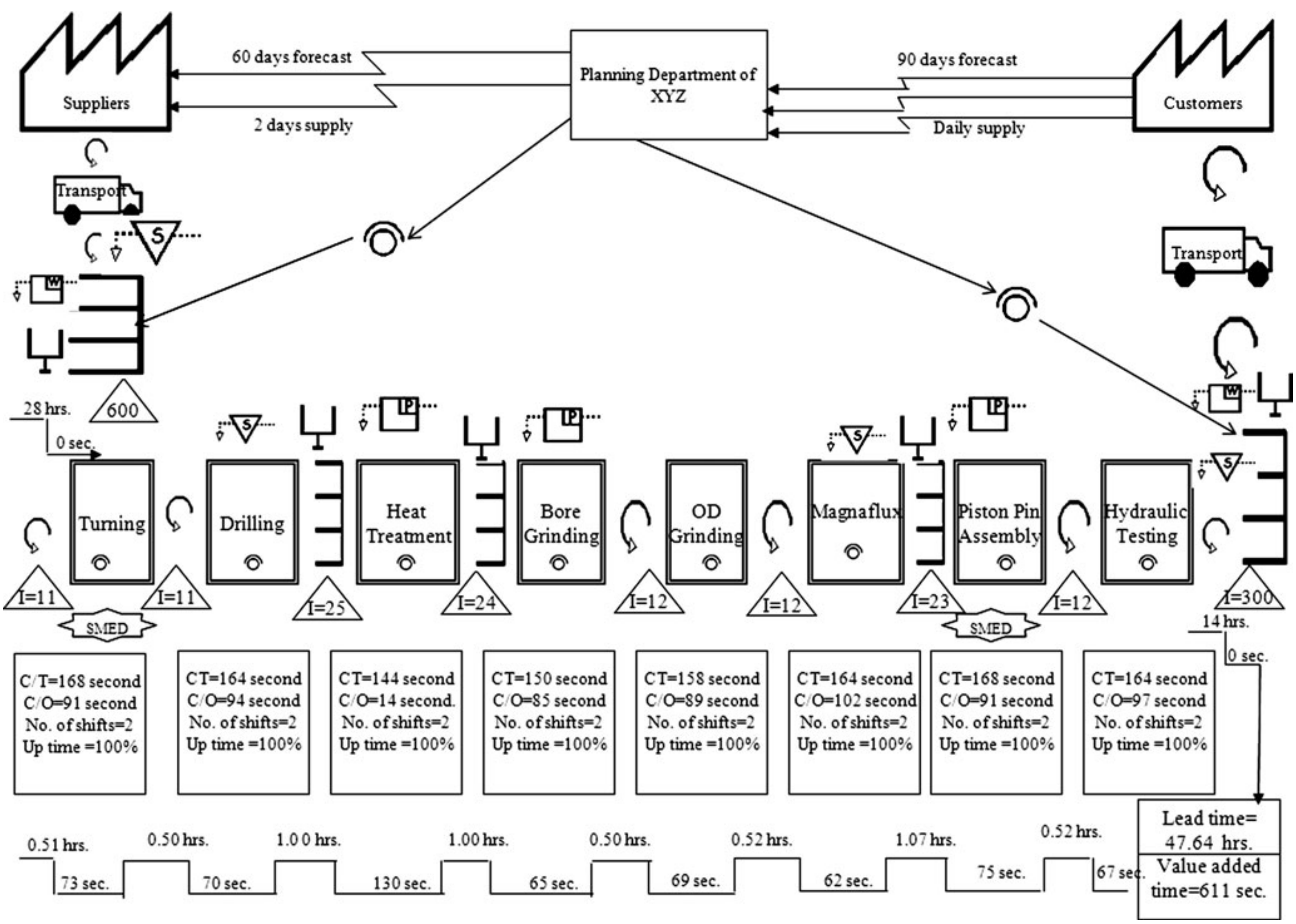

Fig. 4 Future state map

PD as process improvement efforts, the lean context of the use of the tools, and success of the efforts by interviews, discussions, and participatory events. It was found that all three factors were strongly correlated; suggesting that success depends on both good tools and lean context. Finally, a general VSA/M method for PD activities is

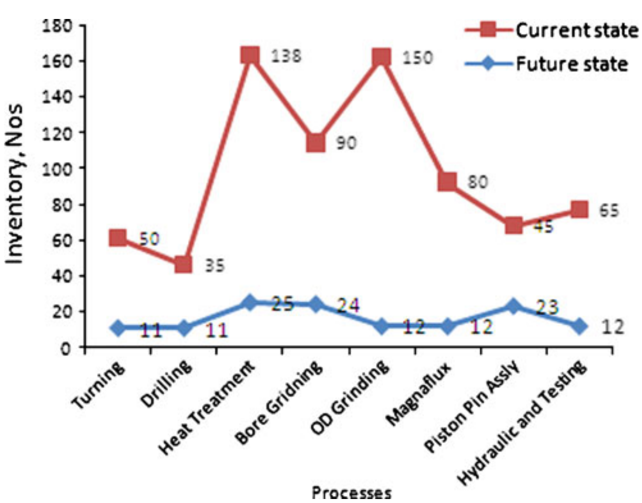

Fig. 5 Comparison of WIP in current and future state map

proposed. The method uses modified process mapping tools to analyze and improve process [29]. Observations and interviewing techniques with open-ended questions were used to understand the processes involved in the value chain of the cottonseed oil industry. VSM techniques were applied to identify and remove NVA activities and found that there is an excess cumulative inventory of 244 days in the whole supply chain [39].

2.5 Analysis of literature reviewed

After classification and analysis of available literature on VSM, it has been found that 38% of total available literature is published as case studies, 32% as conceptual work, 24% as empirical/modeling work and rest 6% as survey articles as shown in Fig. 2. Further from the available literature, 23 attributes of VSM are identified and as per the importance given to a particular attribute by the various authors, frequency of occurrence of these attribute per paper/author is presented in Table 1. After analysis of Table 1, the attributes are presented in Table 2 in accordance to their decreasing order of importance in the literature. From Table 2, it is found that value addition,

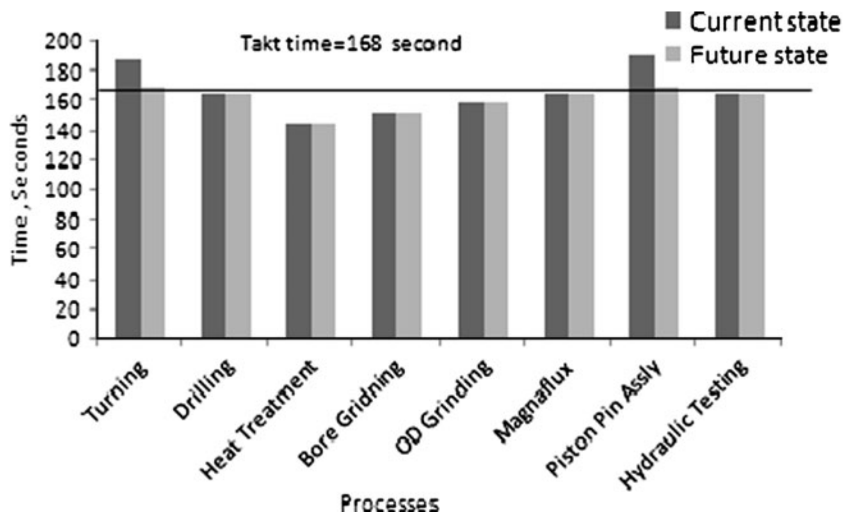

Fig. 6 Cycle time comparison with Takt time in current and future state map

continuous improvement, lead time reduction, current state map, future state map, talk time and waste of transportation are frequently discussed in the literature but suppliers involvement, flexible suppliers, and manpower reduction are given little importance and rest of the attributes are moderately discussed.

3 Application of VSM in a manufacturing industry: a case study

Case study demonstrates the application of VSM in XYZ Manufacturing Industry located in Patiala, Punjab, India. It is a small manufacturing industry and manufactures the various components used for maintenance of railway engines and in the present case, piston pin manufacturing line is selected for study. With the help of VSM technique current state map of piston pin manufacturing line is prepared and various gap areas have been identified. To address these gap areas and to bridge the gap between current state and proposed state of manufacturing, a few modifications are made in the current state. With consideration of proposed modification, a future state map is prepared and improvements achieved are noticed.

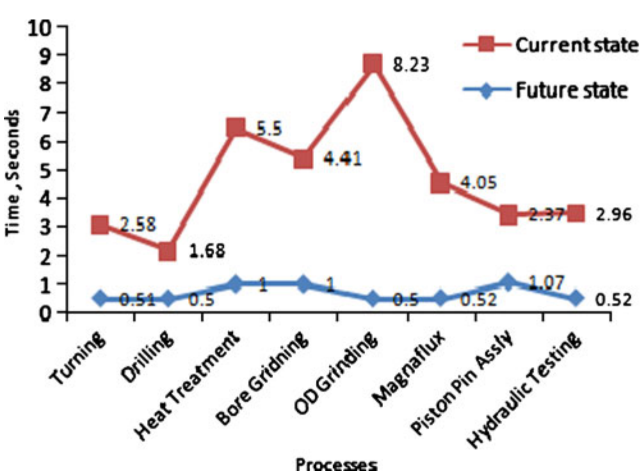

Fig. 7 Lead time at individual stations of production line in current and future state map

3.1 Preparation and analysis of current state map

Current state map is prepared keeping in view of the lean manufacturing principles as discussed by [33, 38]. All the data required for this map is taken from the shop floor of the selected industry followed by discussion with workers, supervisors and managers of the industry. A few assumptions are also made for preparation of current state map. From past sales data at the industry under study, it is assumed that maximum demand of piston may reach up to 8100 per month. The current state map captures information at a particular instance, which may vary from shift to shift. For the sake of analysis, the shift and operator-wise variation (which may be there) is not considered. Effective numbers of working days are 27 per month, number of shifts per day is two and working hours per shift are seven. Available working time per day is 50,400 s. As per [33], Takt time can be calculated

Takt time = {(Available working time per day (seconds)/ customer demand per day (units)} = {(50400/(8100/27)} = 168 s. Current state map is shown in Fig. 3. The demand comes from the customers to planning department of the industry, then planning department send its requirement to different suppliers by manually or by electronics media. Industry keeps raw material inventory of 15 days in their store, material moves from raw material store to finished items store through a number of processes/machines turning, drilling, heat treatment, bore grinding, OD grinding, Magnaflux, piston pin assembly and hydraulic testing. Details regarding inventory, cycle time, lead time, up time and number of shifts are shown in Fig. 2 against every machine. Actual processing time or the real value-adding time for the existing process is 611 s, whereas production lead time is 210.0 h. High work in-process inventory of 653 piston pins and total inventory of 6,053 piston pins are there at factory end. Total manpower required in existing state of piston pin manufacturing line is 12 persons/operators.

3.2 Future state map

Working on the gap areas identified by the VSM of the current state of piston pin manufacturing line, some modification are proposed as indicated in Fig. 4. Store persons are asked to fulfill hourly demand instead of supplying shift-wise. It requires a high degree of information flow and coordination to fulfill hourly demand. To track hourly demand, a Kanban system is proposed. It is suggested that withdrawal Kanban should flow from planning department to dispatch. Similarly, the production Kanban is suggested flowing from dispatch to raw material store, as shown in Fig. 4. The Kanban system brought the necessary schedule and delivery discipline. It is also observed that inventory was high in the production line. Industry was holding 15 days' inventory in the store because of poor communication and a play-safe tendency. Electronic information flow is proposed for the suppliers. It helped in reducing order quantity and inventory at raw material stores. This also helped in making whole supply chain lean and flexible. It is observed that change over time is very high at turning operation and piston pin assembly operation, to synchronize station cycle time with Takt time single-minute exchange of die is proposed at these stations.

4 Results and discussions of case study

After the analysis of current state and future state map shown in Figs. 3 and 4, some important findings of the case study are listed below:

1. It is found that total inventory is reduced from 6,053 to 1,030 and WIP is reduced from 653 to 130, reduction in WIP at individual stations in production line is shown in Fig. 5.
2. Cycle time is reduced from 1,330 to 1,280 s and synchronized with Takt time as shown in Fig. 6.
3. Change over time is reduced from 711 to 663 s.
4. Manpower is decreased from 12 to 10 persons.
5. Total lead time is reduced from 280.99 to 47.64 h and production lead time is reduced from 37.78 to 5.68 h, reduction in lead time at individual stations in production line is shown in Fig. 7

5 Conclusion

The objective of this paper is to highlight some of critical issues relevant to value stream mapping. The available literature is categorized as (1) conceptual work, (2) empirical/modeling work, (3) case studies, (4) survey articles. Vast literature on value stream mapping and its growing adaptation in developed and developing countries indicate the interest shown in this area by researchers and practitioners. Results of the case study conducted in XYZ Indian Industry shows that VSM is a very effective technique for identification and reduction of various types of wastes. The reduction in work in process inventory by 80.09%, finished goods inventory by 50%, product lead time by 82.12%, station cycle time by 3.75%, change over time by 6.75% and manpower required by 16.66%.

Based upon the literature reviewed in this paper on VSM, few areas need further scrutiny.

1. There is a need to discuss cost–benefit analysis of proposed changes made in future state map while applying value stream mapping technique for any specific application.
2. Little work has been done with the help of this technique in the area of vendor management.
3. Effect of changes done in current state during VSM implementation has not seen yet on human factor
4. Comparison of this technique with other waste reduction techniques can also be made

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