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Literature review using the concept of Value Stream Mapping in the manufacturing industry

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ABSTRACT

Value Stream Mapping (VSM) has become a valuable tool for decision-making and identifying opportunities for lean manufacturing practices. This study reviewed literature from various sources, including Google Scholar and Science Direct, to explore the application of VSM in different sectors of the manufacturing industry. The study used specific keywords, such as "Value Stream Mapping," "Manufacturing Industry," "Waste," and "Waiting Time" to identify relevant literature. The study analyzed 42 research papers published between 2017 and 2022 to examine the development and application of VSM in the manufacturing industry. VSM has been widely adopted in various industries such as automotive, food, and textile, among others, and has been used to create action plans that combine different lean techniques to achieve optimal results. The process of VSM involves two stages, which are describing the current and future conditions. From the descriptions, areas for improvement can be identified and developed to create a lean process. Based on the reviewed literature, VSM has been found to be highly effective in the manufacturing industry.

1. Introduction

The manufacturing industry is a broad sector involved in the production of goods and services. It plays a significant role in the Indonesian economy by producing exportable products. However, compared to other ASEAN countries, Indonesia's manufacturing industry has faced challenges due to the rapid pace of technological developments. Despite this, the industry has been able to compete by focusing on producing high-quality products. Effective and efficient production processes are crucial for ensuring successful product sales. In line with business science, higher product quality leads to higher profits. To meet the high demand for products, the manufacturing industry often faces several challenges, such as wasted time, non-value-adding activities, unnecessary production costs, and bottlenecks in the production line. These challenges can affect and reduce productivity in the manufacturing industry. Waste in the production cycle can take different forms, including energy, time, motion, and resources. Many manufacturing organizations use lean tools and techniques to identify and eliminate waste continuously. The main objective of lean manufacturing is to reduce costs [1].

The manufacturing industry often uses VSM as a method to identify and address problems related to wasting production time. One common problem is an increase in Lead Time during the production process, which can lead to decreased time efficiency and failure to meet predetermined production standards. Overcoming this issue is crucial, and VSM is considered the most accurate method for doing so [2].

VSM is a method that also involves mapping the reengineering process into a future state by streamlining and making information flows and process steps more efficient. By identifying and simplifying inefficient activities within the company, VSM can also eliminate non-value-added actions. This can help companies gain a competitive advantage, particularly in improving productivity and quality. Implementing VSM can bring many benefits, such as reducing long waiting times, improving information flow, and enhancing the efficiency of all business processes and production lines.

The article was primarily created to improve productivity in various companies so that they can compete with other companies in a market where many businesses imitate each other. Implementing the VSM method to increase prices and maximize profits can be

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challenging for most companies, especially in the manufacturing industry. Therefore, cost reduction through the VSM method is a more viable strategic option for several companies to remain competitive.

The purpose of this paper is to conduct an analysis of the VSM method in the manufacturing industry, specifically in relation to reducing Lead Time or Cycle Time in the production process. The importance of this analysis stems from the fact that many production systems are not optimized and may contain non-value-added activities and long lead time factors. Therefore, this paper aims to study articles related to the application of VSM in various industries, including the textile industry, handicraft industry, automotive industry, and other industries. The articles to be analyzed were published within a certain year range and are spread across various continents, with a focus on Asian countries.

2. **Material** and method

Value stream mapping (VSM) is one of the most useful methods for making decisions and identifying good starting points for lean manufacturing concepts. This paper study is taken from several descriptions of literature review by review, using the Google Scholar and Science Direct databases as services and access, which provide quality articles and are easily accessible. The purpose of this study is to dig deeper into the implementation (VSM) in the manufacturing industry. The papers studied are papers published in the last 5 years, namely 2017 to 2022. The collection of papers is only for the last 5 years because, to maintain scientific credibility, the VSM method used is relevant to current developments and technology.

The keywords used in this study, "Value Stream Mapping" and "Manufacturing Industry," are relevant and specific to the research topic. Using these keywords will help to retrieve articles that are related to the implementation of VSM in the manufacturing industry. It is true that VSM is a widely used method in recent years, and it has been applied in various manufacturing industries such as automotive, food, textile, and more. By focusing on recent articles, this study aims to provide relevant and up-to-date information on the application of VSM in the manufacturing industry. This paper has several systematic stages in its preparation, as shown in Figure 1. The systematic stages are as follows:

1. First step: Article search by keyword "Value Stream Mapping" and "Manufacturing Industry". A total of 42 articles related to Value Stream Mapping case studies in the Manufacturing industry were collected and reviewed.
2. Second step: International or national classification of articles with a time range from 2017 to 2022.
3. Third step: Summarize 42 articles based on manufacturing industry sector, such as textile industry, handicraft industry and automotive industry and other industries.
4. Step four: Review each article and identify research results on the application of the VSM method.
5. Step five: Summarize each article and arrange it based on the author's name, year of publication and research results in the article.
6. Step six: Analyze the gap of the VSM method by identifying each article related to the application of VSM in the industry regarding similarities and differences in ideas. In addition, it also analyzes the shortcomings of each article to be developed in further research.

3. Results and discussions

3.1. Summary

Table 1 presents a summary of the 42 papers featuring research on the use of the VSM method taken from national and international papers published in the last 5 years (2017-2022), aiming to investigate the development of methods, especially related to the application of VSM in the manufacturing industry. The VSM research results based on papers from different years are classified in Figure 2, while the results based on papers from different countries or continents are classified in Figure 3. The description of Lean Manufacturing waste in Figure 4 is indeed related to the VSM method as it is a crucial tool in identifying and reducing waste in manufacturing processes. By using the VSM method, manufacturers can visually map out the value stream, identify non-value-added activities, and optimize the flow of materials and information to eliminate waste.

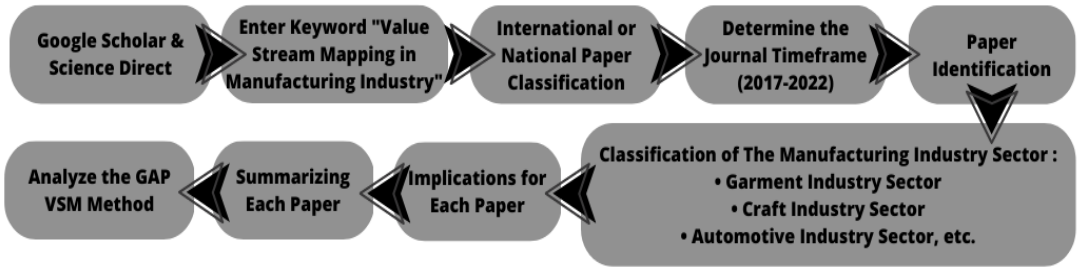

Figure 1. Steps of literature review

Table 1.
Literature review

No	Author	Research result
1	Tebiary et al. [1]	The results of the research show the value of the effectiveness of PT. Dumas Tanjung Perak Shipyard Surabaya has now reached 85%. In the repair process with the application of value stream mapping the value of effectiveness reaches 91%.
2	Deshkar et al. [5]	Lead time increased from 15% to 89.85%, Takt time decreased from 46.6 minutes to 26 minutes, Number of reels made increased to 50 per day.
3	Liu & Yang [7]	In-factory lead time was reduced from 8.5 days on the initial "push" line to 2.5 days.
4	Hernadewita et al. [4]	The results of the research are current state value stream mapping (CSVSM) to reduce waste in the 1WD model engine production process
5	Li et al. [3]	Research shows that Value Stream Mapping has spread to many regions of the world, helping to reduce every type of waste, offering innovative insights.
6	Li et al. [6]	Case studies prove the applicability and validity of Sankey's EVSM tool to transfer from case to case and demonstrate integrated visualization of energy materials.
7	Meudt et al. [8]	Enterprise results can digitize and enhance production processes using VSM4.0
8	Ellingsen [42]	The results of this study are very important for reducing the CONQ and TtM of the BOP process to maintain competition over time and commercialize new product technologies.
9	Stadnicka et al [41]	The improvements enabled a 63% reduction in lead-time and through the VSM and VSA methods it was possible to prove that the process cycle efficiency has increased.
10	Lugert et al. [40]	Findings - The benefits and drawbacks of VSM have been confirmed by previous publications. A serious challenge is the method's lack of flexibility.
11	Heisler et al. [39]	Currently developing technology allows reducing the release of substances up to 86%. In this new way it is possible to produce both complex foam parts and simple systems that are environmentally friendly.
12	Ahmad et al. [38]	Development of learning in the industrial world with techniques that study ERP systems with project and activity-based learning methods. The ERP system will be integrated into the factory environment and training facility
13	Stadnicka and Litwin [37]	VSM and SD make it possible not only to identify and eliminate waste, but also to understand the impact of identified problems.
14	Rosa et al. [36]	significant increase in productivity. Allows a 43% increase in line output.
15	Sime et al. [35]	Computer simulation techniques can be used for effective systems analysis in the apparel industry. Production increase by 10%.
16	Zahrotun and Taufiq [34]	Lead time reduced by 80 minutes. From the analysis using PAM, there was a decrease in NVA activity from 3.10% to 1.01%.
17	Rahani and al-Ashraf [33]	Production line F's delivery time was reduced from 40.24 days to 15 days.
18	Patil et al. [32]	Lead time decreased from 85 hours to 53.1 hours, PCE ratio increased from 4.81% to 7.7%.
19	Narkea & Jayadevab [31]	Value Stream Mapping is a very useful tool for SMEs to increase productivity and this theoretical framework will greatly assist SMEs for the implementation of VSM within the organization.
20	Ayu [2]	Proposed future state mapping for dummy production with processing time of 14.7300 minutes and waiting time of 5 days.
21	Pratama et al. [30]	The design improvement proposals made resulted in a lead time of 2301.83 seconds with an added value of 1096.66 seconds.
22	Kays et al. [29]	With the effectiveness of integrated VSM and Yamazumi chart systems to identify waste, restore line balance and improve operational performance in the RMG industry.
23	Manupati et al. [28]	The results showed that the value-added time decreased from 68 minutes to 37 minutes, the lead time decreased from 8.5 days to 6 days.
24	Wang et al. [9]	By using current value stream maps and lean production concepts. After researching and creating a flow map that can optimize the layout.
25	Antonelli & D. Stadnicka [27]	Lead Time decreased by 4.26 days or 55.39% from previously 7.69 days to 3.43 days, this caused productivity to increase.
26	Busert & Fay [25]	As a result, manufacturing companies are forced to increase the efficiency of controlling their operational processes by prioritizing technology integration.
27	Papettia et al. [24]	Based on the case studies that have been carried out, it shows effectiveness in identifying energy flows/power sources (electricity and compressed air).
28	Masuti & Dabade [23]	The results of this study are being able to apply lean kaizen and contribute to reducing production waiting time by 586 minutes.
29	Monteiroa et al. [22]	The result of this study is that switching to a slim SMED tool results in a 40% reduction in time wasted on vertical milling machines.
30	Jimeneza et al. [21]	Improve factory organization and process time, which results in reduced complaints.
31	Suhardi et al. [20]	The production time for the Bra model is 3 minutes which is an increase of 6.17%.
32	Schoeman et al. [18]	It was found that waste was reduced by 28%, and waste disposal costs by 45%. It is estimated that 3.14 tonnes of general iron and steel compaction waste is generated per year.
33	Piprani et al. [17]	The results show that building an integrated supply chain rating is one of the most important practices in increasing supply chain resilience.

No	Author	Research result
34	Kundgol et al. [16]	Cycle times reduced from 39 minutes to 20 minutes and 109 minutes to 90 minutes, buffing wait times reduced from 9 days to 0.0243 days.
35	Zahraee et al. [15]	Production lead time (PL) decreased from 17.5 days to 11 days, and value added time decreased from 3412 seconds to 2415 seconds.
36	Mudgal et al. [14]	The results of this study present a systematic approach to developing VSM in a make-to-order manufacturing environment.
37	Baldah et al. [13]	From the results of this paper, it can be concluded that after implementing VSM and improving the process section of the Clutch Disc track, productivity increased from 38 to 34 workers.
38	Baldah et al. [26]	The results showed a decrease in total lead time of 25.75 from 82.8 hours to 61.54 hours, in the value added (VA) category of 80.8% from 1.26 hours to 0.24 hours, nonvalue added (NVA) by 25% from 80.9 hours to 60.72 hours, at (NNVA) there was no decrease.
39	Marquina et al. [12]	The application of this tool is presented in the case study to support decision making from an operational perspective.
40	Pathania et al. [11]	The result of this study is that VSM was successfully applied to ferrite core manufacturing companies which experienced rejection rates of around 9% to 2% per day.
41	Tatar & Ingaldi [10]	The results of this study can determine that the partial digitization of a single production operation in SMEs has a positive effect on process flow, motivation to improve organization and work efficiency, especially in SMEs.
42	Gunaki et al. [19]	The results of this study demonstrated a 7.6% reduction in waste in non-value-added value stream operations, resulting in a 10.6% reduction in overall cycle time.

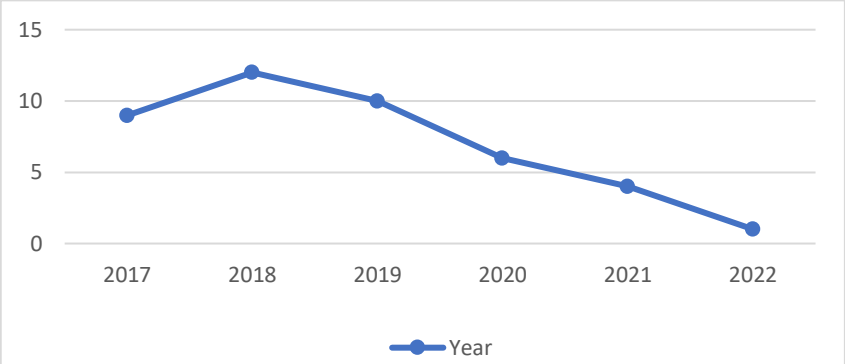

Figure 2. Total paper per year

Figure 3. Total articles per continent

Overall, the VSM method is an effective approach for identifying and reducing waste in manufacturing processes and can help manufacturers achieve greater efficiency and profitability. The eight types of waste mentioned in Figure 4 are widely recognized in Lean Manufacturing and are often referred to as the "8 Wastes". By eliminating or reducing these wastes, manufacturers can improve their efficiency, productivity, and quality while reducing costs and lead time. The VSM method can help to identify and address each type of waste by analyzing the value stream and identifying areas where improvements can be made. For example, overproduction waste can be reduced by implementing a pull system, while transportation waste can be reduced by reorganizing the production layout to minimize movement.

Figure 4. Waste of manufacturing

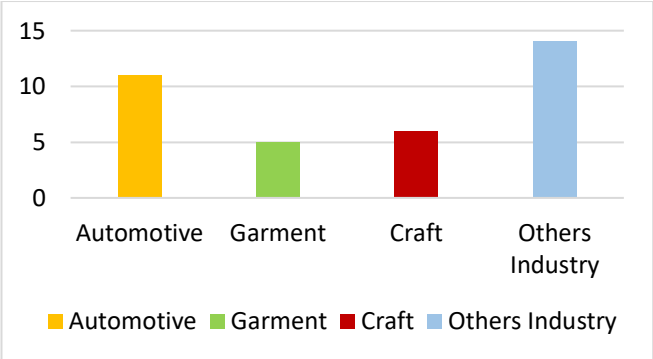

Figure 5. Industry sector diagram

The methodology for analyzing value streams using VSM tools explicitly states that it is necessary to draw a map of the current state and a map of the future state. The industry where the research is conducted is in various sectors of the manufacturing industry, namely the automotive, garment, handicraft, and other industries. The available literature on VSM in the manufacturing industry can be seen in Appendix 1.

The application of VSM tools has been widely used in the manufacturing industry sector in the last 5 years. This paper presents a study on the application of VSM in the manufacturing industry sector. The results show that the automotive industry sector had 11 VSM implementations, the garment industry sector had 5 implementations, the handicraft industry sector had 6 implementations, and other industrial sectors had 14 implementations. The distribution of VSM implementations based on the industrial sector classification can be seen in Figure 5.

3.2. VSM method development

The VSM method must be developed for each material flow, using the VSM method to analyze only one product or the same type of product in one VBC activity. Furthermore, the VSM method requires the use of numerous simulation models. Obtaining effective simulation results can be expensive and time-consuming. It is important to note that simulation is not an optimization process since the simulation model does not generate a solution. However, it can provide a means to evaluate the results of an optimal solution.

Opportunities arise with the VSM method when you increase the selling price or reduce costs. Increasing the selling price is a good option if the company does not have competitors or if competitors are not able to imitate the product. However, if there is a need to reduce costs, the VSM method is very effective. Cost reductions can occur because the VSM method helps to control costs by comparing real costs to standard costs. This comparison helps to identify the advantages and disadvantages of a company, and by using the VSM method, each process can be evaluated to identify opportunities for cost reduction.

4. Gap in VSM

Often, this method is not widely used to solve problems that arise because some of the data needed for VSM analysis will not always be available or may be incomplete. The VSM analysis process is also quite complicated, especially in the Manufacturing Industry sector. As explained above, VSM analysis consists of two stages, namely the description of current conditions and future conditions that require standardization of symbols in categories such as process categories, materials, and information. Additionally, an analysis is needed to calculate activity cycle time (CT), turnover time (C/O), and other calculations to determine the time required from one operation to another.

In future condition analysis, new situations with new rules or activities are required. If these two things are not properly addressed, there is a possibility that the situation will revert to its previous state, resulting in the failure of planned improvements or developments. Moreover, articles, papers, or books about the indexed VSM method are also essential as a definitive reference to obtain more optimal results.

5. Conclusions

Based on the results of various articles on the VSM method, it is found to be effective in identifying each production flow layout and information flow needed by the production process. Among the 42 national and international papers we reviewed spanning from 2017 to 2022, VSM was found to be particularly effective in the manufacturing industry. The VSM method has been applied in several sectors such as automotive, garment, handicraft, and other industries. Therefore, VSM is influential in the world of the manufacturing industry, as it can improve efficiency in companies by increasing production yields, identifying production flow issues or errors, improving quality, and reducing time wastage.

The suggestions from this research are based on a screening of the last 5 years to obtain more up-to-date information that aligns with current issues. Through the identification of several articles on the application of Value Stream Mapping in the manufacturing industry, some deficiencies were found that need to be addressed. GAP analysis is generally used to identify gaps or shortcomings in research suitability for practical application. The drawback of using the Value Stream

Mapping method is that research in the field of the manufacturing industry tends to focus solely on identifying waste through the creation of a Current State Map and designing and defining efforts in the preparation and analysis of the Future State Map.

Declaration statement

Tito Antonio: **Conceptualization, Methodology, Supervision, Project administration, Funding acquisition**. Sunu Surya Anggara: **Software**. Elkiopas Sedubun: **Resources, Validation, Formal analysis**. Siti Farah Nurhaliza: **Resources, Visualization, Investigation**. Rohmat Setiawan: **Data curation, Validation**. Indra Setiawan: **Writing - Original Draft**. Shafa Azzahra: **Resources, Validation**.

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The authors report there are no competing interests to declare.

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Data availability statement

The authors confirm that the data supporting the findings of this study are available within the article and its supplementary materials.

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Appendices

Appendix 1

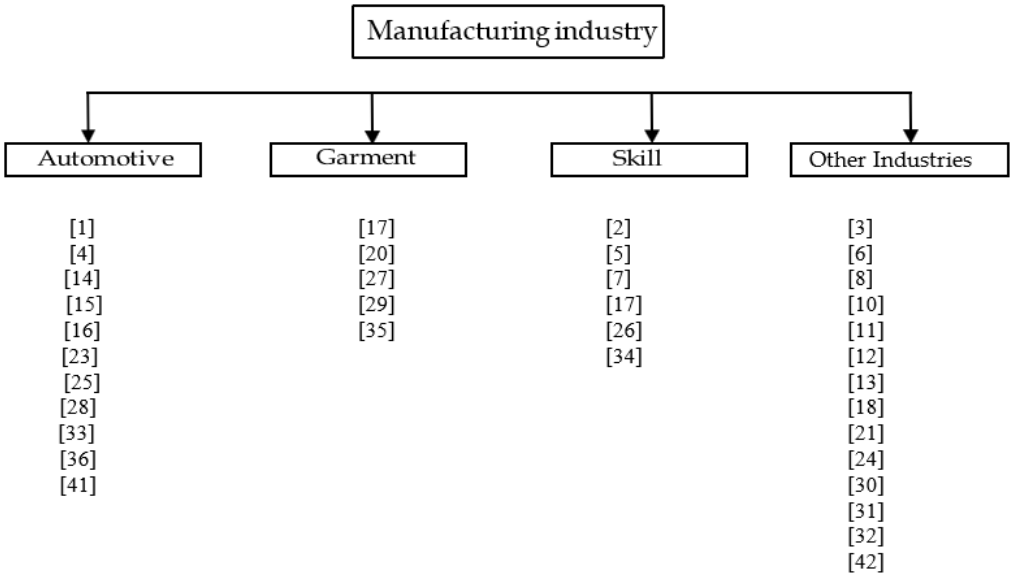

Figure A1. VSM Literature

Antonio et al. (2023), Journal Industrial Servicess, vol. 9, no. 1, pp. 37–46, April 2023