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Application of Value Stream Mapping (VSM) as a Lean Manufacturing management tool.

Aplicación del Value Stream Mappping (VSM) como herramienta de gestion del Lean Manufacturing

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Abstract:

The Value Stream Mapping (VSM) tool is the graphical representation of the current and future state of the production system, used to identify waste in a specific process and is recommended for companies that want to start on the Lean Manufacturing path. This article presents a documentary analysis of its application to know the benefits and limitations that can be found at the moment of making decisions about it. As a result, it was found that the VSM is easy and simple to apply and consists of five main steps for its development; however, inadequate application, lack of knowledge of the processes, and their complexity requires the use of other tools to complement its results when making decisions.

Keywords:

VSM, Application, Lean Manufacturing, Benefits, Limitations

Resumen:

La herramienta Value Stream Mapping (VSM) es la representación gráfica del estado actual y futuro del sistema de producción, usada para identificar desperdicios en un proceso específico y es recomendada para las empresas que quieran iniciarse en el camino del Lean Manufacturing. Este artículo presenta un análisis documental sobre su aplicación con el fin de conocer beneficios y limitaciones que se pueden encontrar al momento de tomar decisiones en torno a ella. Como resultado se obtuvo que el VSM es de fácil y sencilla aplicación que consta de cinco pasos primordiales para su desarrollo; sin embargo, la aplicación inadecuada, el desconocimiento de los procesos y la complejidad de los mismos requiere que para la toma de las decisiones se haga uso de otras herramientas que complementen sus resultados.

Palabras Clave:

VSM, Aplicación, Lean Manufacturing, Beneficios, Limitaciones

Introduction

Nowadays, companies are looking for organizational techniques to face the competitiveness of the market, taking Lean Manufacturing as an ally for its high effectiveness; although commonly the interest in this system is developed in large companies, being unknown among small and medium enterprises (SMEs) or else, qualified as difficult to implement [1]. However, there is a simple but effective tool recommended by experts for those companies seeking to start on the Lean path, its name is the Value Stream Map, better known as Value Stream Mapping (VSM) [2]. The VSM allows a graphical

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representation of the current and future state of the production system [3].

Therefore, this paper aims to conduct a documentary analysis about the application of the Value Stream Mapping tool in small and medium enterprises in order to know the benefits and limitations that can be found at the time of making decisions about it. Initially, the fundamental theoretical aspects of the application of VSM will be presented, as well as cases of companies published in the last six years that have used this tool to solve waste problems in production processes.

Value Stream Mapping

The term Value Stream Mapping (VSM) was introduced in the book "The machine that changed the world" in 1990 and strongly popularized in 1966 by Womack and Jones; categorized as the sequence of activities that an organization assumes to meet customer requests [4]; due to the ability to collect, analyze and present information in a short period of time, this method gained popularity in continuous improvement [5]. As described by Meneses et al. (2019), it is a specialized flowchart where the steps of a process are represented sequentially, in each step the value that the customer gives to the final product or service is considered, and it is oriented at the process point where the results are given; this tool gives the ability to map not only the flow of material, but also the information flows that signal and control the production [6]. Mainly, VSM can be used to diagnose problems associated with production and to recognize the value of each process, thus differentiating it from waste; or it can be used to develop optimization plans [7].

Assuming that the value added refers to the set of activities that the final customer contributes to a product or service [8]; then the *muda* or called by some as waste, represent everything that is not the minimum amount of equipment, parts, time, even workers and that are not essential to add value to the product or service [9]. Taiichi Ohno, one of the precursors of Lean Manufacturing identified seven forms of waste in the manufacturing of a service or product: overproduction, inventory, over processing, waiting, reprocessing, transports and movements [10].

The VSM has proved to be successful in identifying and generating proposed solutions to such waste and is reflected in various studies in different types of industries and procedures, in fact, among the characteristics that make the VSM unique are that it can be applied to any type of business and process; it can also be supported by other qualitative or quantitative tools to ensure that the decisions made from this tool have objective and scientific databases [11].

As examples of application and results obtained from VSM are the following researches:

Table 1. Reviewed documents

Author(s) and year	Objective	Results	Specific observations
Nilsson, E. (2018) [12].	Explore options to improve material flow in the production area for the manufacture of cast iron, steel and aluminum mechanisms	Material handling depended on the right amount of handling equipment to facilitate movement and cut distances from the warehouse to the production area.	X
Cardoso, W. (2020) [13].	Analyze the production environment of a university hospital in the area of emergency care; identify bottlenecks and waste.	It was suggested to invest in training for reception staff or to use technology to store patient information, reducing errors and deviation of information, which could reduce the total waiting time by 3.7%.	X
Escartin et at. (2020) [14].	Evaluate the internal process of monitoring department activities in a transportation company.	An activity that was not generating value was identified, resulting in a reduction of monthly economic expenses and a reduction in time value of -46%. The application of the VSM was extended to other areas, facilitating the delivery of merchandise to the client and reducing expenses due to traffic violations.	X

Salwin et al. (2021) [15].	Adapt the production rate of steel tubes to the customer's order times.	Productivity rates on slitting lines could improve 17% and those of polypropylene tape would be reduced 1.7 times.	Under the constraint of their static nature, simulation models continue to be used to define future scenarios.
Paredes-Rodríguez A. M., (2017) [16].	Propose and implement improvement strategies in the logistics process of a company that packages glass products.	The application of the VSM made possible the identification of the problems in each sub-process (reception, unitization, storage and isolation). Subsequently, an action plan was established and implemented, resulting in considerable savings.	Among the developed techniques was the application of a 5S system.
Quishpe & Arroyo (2021) [7].	Generate an analysis proposal to optimize the production processes in the cylindrical carton container manufacturing line to improve productivity, delivery time and service level.	Bottlenecks were identified in each of the sub-processes, mainly in labeling and packaging, as well as machine failures due to obsolescence. In the future mapping, waiting times were reduced by 100%.	X
Camacaro-Peña et al. (2021) [17].	Implementation of the tool for redesigning processes, identifying activities that do not add value in the pineapple harvest and post-harvest process.	Problems associated with excessive handling, training and lack of maintenance of the organization's equipment. Improvements were proposed using other Lean tools.	5S, Jidoka, TPM and Standard Work techniques are suggested.
Cuapio et al. (2019) [18].	Design an improvement proposal focused on eliminating factors that negatively affect the production process in a ceramics company	Inefficiencies were discovered in production times due to equipment calibration failures, parameter variability, excessive machinery life and lack of preventive maintenance.	X
Guamán et al. (2018) [19].	Identify value-adding activities and areas of opportunity in the sofa manufacturing process.	Available work times were determined to cover the demands; it is suggested to hire labor at critical points, unify activities and reduce distances in the plant.	X
García et al. (2021) [20].	Perform a diagnosis to estimate preventive maintenance times for units in a specialized freight transportation company.	The company ignored the capacity of attention in preventive maintenance service and the result of maintenance policies.	The SIPOC tool was integrated during the study. This research was limited only to the mapping of the initial state.

Source: Own elaboration based on the reviewed literature.

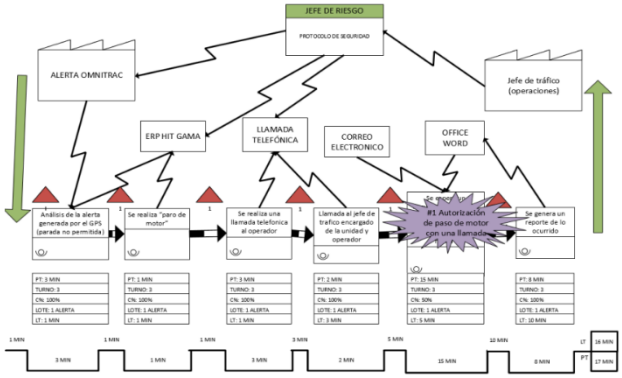
During the review of the literature, five moments were found for the development of the VSM, which coincide with the opinion of Manjunath et al. (2014): 1) Identify the product, 2) Create a current VSM, 3) Evaluate the current VSM, 4) Create the future state and finally 5) Implement the final plan, this point can be limited to the design of improvement actions; the authors also consider that for drawing a Value Stream Map, it is essential to know the current situation and the critical areas or places to be improved; have some preparations to collect information related to the situation of the company, and then make use the observation and document how the company looks without neglecting or hiding the exact situation [5].

Some concepts must be kept in mind for the development of the tool, starting with Lead Time: time that does not add value, and Value Time: time that adds value to the customer [14] or in other words, how long it should take for a part to complete the manufacturing or execution process. For the elaboration of the future VSM, Camacaro-Peña et al. (2021) add a) Cycle time: average time between the production of two consecutive units and b) Takt time: maximum cycle time allowed to introduce an element and meet the demand; since these must be equal, otherwise

there would be costs due to overproduction or shortages [17].

In the same way, symbols have a meaning, which may vary according to the convenience of the mapper. The following is a visualization of the common symbology in this type of exercises applied in the representation of a future VSM; the map will be read from left to right following the flow path. In the upper left part the supplier is represented, at the other end the customer or user that gives value to the process; the Kaizen burst marked in purple makes suggestions on the activity that requires changes and produces waste; finally in the back of the diagram a timeline with Lead Time and Productive Time is indicated.

Illustration 1 Example of future mapping



Source: Taken from "Reduction of time and activities through Value Stream Mapping in the internal process of a monitoring department in a trucking company". (p. 28), by Escartin et at., 2020, *Ingeniantes, 1*(2).

Like any tool, the VSM may face situations such as: "when", "who", "why", among other doubts that may rethink its use. Bicheno and Howlweg (2016) point out that despite being a simple and powerful tool some companies consider it to be counterproductive when the use is not adequate generating bad reputation among Lean tools [21], in fact they suggest that the first Lean tool that a company should follow is the 5S; its description and clarity capabilities would allow regulating activities, the space and standardize the company's procedures [22]. Braglia et al. (2006) state two disadvantages with the use of VSM: 1) the level of precision is limited and 2) the variety of processes and parts may require a more complex analysis method so that it can only be used in productive systems by linear routes [23].

In his case study, Salwin et al. (2021) found that the VSM is like a snapshot of the production status at the moment, which means that the day taken into account for the mapping may have run perfectly, but the next day may present different problems, so that the next VSM may vary significantly. It is perhaps true that the theory is far from the practice and application of Lean tools [15].

Conclusion

The VSM is a simple but complete tool to diagnose a process, and it is reflected in all the items analyzed; each result brought about reductions; most of them only focused on the changes in: waiting, movements and inventories (material). For the authors, correct observation was the greatest ally, followed by excellent knowledge of the process being analyzed. However, for those investigations that sought above all the implementation of the VSM on the proposal design, they chose to look for more tools such as the 5S and high-level mappings such as the SIPOC; this confirms that making decisions around the VSM can be limited, and even considered as unsubstantiated at the time of executing them. The VSM is not a tool that by itself throws determinant solutions, as mentioned by Quishpe and Arroyo (2021), it is a diagnostic tool [7]. The tool is not very accurate when the process being analyzed has many ramifications that are impossible to visualize under a “linear image”. It is possible that the VSM should always be supported by another tool so that, to detecting waste, the “why” is also revealed; in this way, in addition to creating awareness about waste, expeditious and satisfactory results will be achieved.

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