Applying Value Stream Mapping in Manufacturing:
A Systematic Literature Review

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Abstract: Value Stream Mapping is a critical tool when it comes to implement the lean approach and it has spanned to many sectors in industry. Although previous studies justify its use in manufacturing sector by identifying previous cases within the literature, none to the best of our knowledge has used our approach to explore the aspects covered it this review, yet the potential exists. Based on a systematic approach, we analyzed available literature published in refereed journals, providing academics and researchers with valuable findings related to the evolution, application and performance of the Value Stream Mapping in context of the manufacturing sector.

Keywords: Value stream mapping, logistics in manufacturing, business process management systems, lean manufacturing, methodologies and tools for analysis of productive systems

1. INTRODUCTION

Lean Manufacturing has proved to be a resilient alternative that, when adequately adopted by the different actors through the supply chain, provides satisfactory results in terms of profits (Suhadak et al., 2015). This systematic approach focuses in doing more with less resources by eliminating non-value added activities and wastes (Womack et al., 1990); originating from Japan in the Toyota Production System, has been defined by its founder, Taichi Ohno, as "looking at the time line from the moment the customer gives us an order to the point when the cash is collected; and waste is reduced by removing the non-value-added wastes" (Liker & Meier, 2006)**.**

Lean tools and principles have been widely used (Cox & Ulmer, 2015). Yet, Value Stream Mapping (VSM) is a lean manufacturing technique that since its creation has spanned to many sectors in industry and it has emerged as the preferred way to support and implement the lean approach (Grewal, 2008). It deepens the understanding of work systems that deliver value to customers and reflects the workflow from a customer's perspective; as a result, the process of VSM provides effective ways to establish strategic directions for better decision making and work design (Li, 2014). Thus, it receives great attention when it comes improve enterprises.

2. CONTRIBUTION OF THE RESEARCH

The application of VSM has expanded to many industry sectors in recent years due to its ease of adaption to a wide range of environments. It is possible to apply it in solving different kind of issues related to reduce waste. An exemplary sample with real research and application of VSM in environments different from manufacture of parts is shown in Table 1. Regarding manufacturing environment, previous studies justify the use of VSM in several industries by identifying its successful applicability through review and identification of literature (Table 2); however, none to the best of our knowledge has explicitly explored the same aspects that we did it in our literature review, yet the potential exists. Based on a systematic approach, this study covers available literature published in refereed journals, providing valuable information about aspects of evolution, application and performance of VSM in the field of manufacturing.

Table 1. VSM applied in different fields

Sector	Source
Construction	(Matt, et al., 2013)
Healthcare	(Kaale, et al., 2005)
Services: call centre	(Piercy & Rich, 2009)
Transport	(Villarreal, 2012)
Architecture	(Lima, et al., 2010)
Software product lines	(Musat & Rodríguez, 2010)
Product development	(Tyagi, et al., 2014)
Innovation management	(Peek & Chen, 2011)
Services: government	(Krings, et al., 2006)
Mining	(Kumar, 2014)
Industrial product-service systems	(Morlocka & Meier, 2015)
Reduction of food Looses	(Steur, et al., 2016)
Maintenance service	(Kasava, et al., 2015)

Based on a systematic review approach, this study considered the first to aggregate and examine evidence on the application of VSM in the manufacturing industry. The next section of this

article outlines the procedure that was used to search and select studies, from which relevant data was obtained. The third section gives an overview of studies characteristics, application of lean manufacturing mainly focusing on VSM and identification of wastes. The fourth section is devoted to a discussion of important findings which is followed by a conclusion.

Table 2. Previews literature research regarding VSM

Brief description	Source
It is part of a master thesis. Exposes the most relevant of VSM from about 13 sources including books and journals, without charts or graphics.	(Li 2014)
It is about the application of VSM reducing food loses. They considered the year and country of the publication and the types of wastes found	(Steur et al. 2016)
It is a review of 10 case studies, taking into account the Key Performance Indicators, and they presented percentage of improvement by graphs.	(Saraswat et al. 2014)
Reviews 47 works among books and journals. Authors focused on the type of work, and the attributes considered in each paper/book.	(Singh et al. 2011)
A review of 6 papers where VSM was applied. Improvement of Key Performance Indicators and applicability to diferent sectors is reported.	(Patel, et al., 2015)
This book chapter is a review about different types of value mapping tools, it offers an overview of each technique and their characteristics.	(Romero & Chávez, 2012)
A review of 57 papers from 1999 to 2013. Authors identified the main limitations to develop the actual state of VSM, and guidelines for its use.	(Forno, et al., 2014)
A review about how the use of VSM in new product development affect organizational learning in development processes, from 18 papers.	(Schulze, et. al, 2013)
Presents some of the techniques commonly applied to analyze and the value stream. Authors include a table with 5 articles reviewed.	(Gunaki, et al., 2015)

3. METHODS

The structure of this systematic review follows applicable guidelines set in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Statement. Studies were identified by searching EBSCO, Science Direct and google scholar databases from 1990 to 2016. This time period was selected in order to cover a timeframe from when lean manufacturing started to be documented in literature to date (Womack et al., 1990).

The search targeted articles written in English and was not only limited to studies published in indexed Journals. Manuals, editorials and commentaries were disregarded. The search syntax used included the following search terms referring to lean and VSM. For confirmatory purposes and to identify additional studies, a reference list of a review on VSM (Singh et al., 2011) was also utilized. The search for articles was done by one researcher in October 2016.

The inclusion criteria used for selection of relevant studies, after removal of doubles, was initially based on title and abstract screening to ascertain the existence of both VSM and manufacturing related key words. A full paper review was performed where a more stringent inclusion criteria was applied. Studies that utilized VSM as (one of) the lean tool(s) were kept to carry out the systematic review. We found two papers where literature review in the field of manufacturing was performed and these were not considered as part of the article.

Key aspects were identified and gathered on a data extraction sheet. This was used to systematically extract and code necessary data from the studies. The information was related to: year and country where the study was carried out, type of VSM used (whether adapted or traditional), type of issue to solve, performance indicator utilized and results obtained, tools used along with VSM, and type of industry where it was applied.
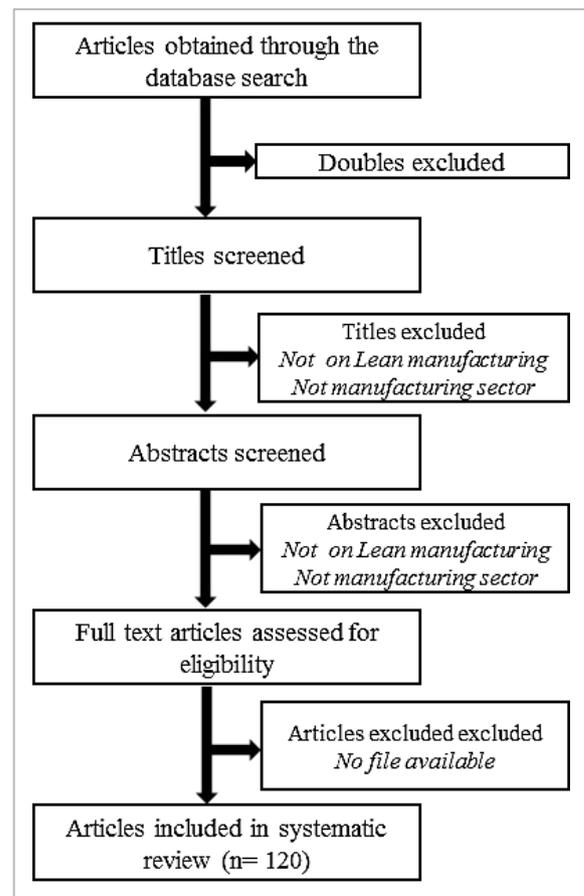

Fig. 1. Flow chart of selection of papers for the review