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Analysis of Value Creation and Value-Added Analysis Techniques in Published Literature. A Literature Review

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Abstract – The aim of this paper is to review available literature in the field of value-added analysis and value creation. Value added analysis techniques and approaches which are described in the literature are to be presented and systematized. Subsequently a case study is presented and suggestions for process improvement are presented. Aiming to obtain an overview from both the theoretical and practical sides, papers and books from 2006 to 2020 were collected and classified. First according to the genre of the text, secondly, according to the industry meant to be improved, and thirdly, according to the use of single or multiple approaches of value creation. The papers have been grouped into four categories: the first group relates to papers approaching Value Stream Mapping (VSM), the second group contains papers describing and/or using Seven Wastes as value identification technique, the third concerns Process Mapping (PM) approaches and the fourth group concerns a different approach of Nonvalue Added Analysis.

Keywords Value added analysis, value creation, nonvalue elimination, process improvement, manufacturing, value creation in manufacturing

I. INTRODUCTION

Today's rapidly evolving manufacturing processes and technologies are pushing towards reshaping traditional production facilities. Global competitiveness demands high quality products obtained at low cost and with short cycle times. At the same time, there is a constant need to improve both process quality and project delivery time thus, process assessment tools have never been more important.

In the last decades, several value-added analysis techniques and waste elimination tools have been developed and refined by manufacturing experts. Multiple models and guidelines are nowadays used for analysis and optimization of manufacturing processes. Some of these even combine multiple approaches for a proper identification of value adding (VA) respectively nonvalue adding (NVA) activities. On the one hand, computer-based simulations are used to aid conventional tools, but on the other hand psychometric scales are used to bring human knowledge and experience into the process analysis.

Many past studies have primarily focused on Value Stream Mapping as a method for improving manufacturing activities in various industries, with only a few using methods such as Process Mapping or Nonvalue Added Analysis.

The growing popularity of Lean can be clearly observed during the years as it became a foundation stone for the field of process improvement. As James R. Bradley (2015) describes in the introduction of his book, Lean was first applied in manufacturing and was called Lean Manufacturing [4]. Having the principles applied in multiple domains, Lean Manufacturing is often referred to as simply Lean. Lean grew out of the Toyota Production System (TPS) with the aim to eliminate waste in all areas of an organization thus, shortening lead times, improving quality and reducing cost.

While most papers in this literature review focus only on one or two standard approaches of NVA activities identification, Abdulmalek and Rajgopal (2007) use simulation in order to support the created VSM. They suggest the need of a complementary tool with VSM that can quantify the gains during the early planning and assessment stages [1]. Simulations are further described as a capable tool of generating resource requirements and performance statistics whilst remaining flexible to specific organizational details. Furthermore Wu, Low and Jin (2013) use in their paper a five-point Likert scale to rate NVA activities. Comparing to other studies, in this paper, a field work including all major contractors in Singapore who had experiences in constructing precast concrete projects was conducted aiming to identify NVA activities.

This paper evaluates Lean Manufacturing techniques such as Value Stream Mapping and Seven Wastes, as well as Process Mapping and Nonvalue Added Analysis to propose general improvements of manufacturing processes and further solve the problems presented in the case study. The objective of this work is to gather a collection of papers that use

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various value-added analysis techniques and approaches for the manufacturing sector.

For the literature review, 22 books and papers from 2006 to 2020 were collected. The reason for restricting the research to this period is for an accurate presentation and synthesis of the modern state on the subject. Although, as the topic of process improvement is not a new one, a perspective on this topic is to be discussed as presented by Flanigan (1995). In their book, published in 1995, striving to deliver the best value to the customer for survival in today's marketplace is already regarded as mandatory [8].

In this paper, relevant literature on value added analysis techniques and approaches are reviewed and classified.

First, for a better understanding, a short definition of VA and NVA activities as general terms is presented. Then, according to the genre of the text, various views will be presented followed by a classification of the papers based on the use of single or multiple approaches of value creation. Here, the importance of combining techniques is described and then NVA activities are explained in different industries.

The objective of this work is to present and systematize value added analysis techniques and approaches. Therefore, the four groups are to be analyzed: the first group relates to papers approaching Value Stream Mapping (VSM), the second group contains papers describing and/or using Seven Wastes as value identification technique, the third concerns Process Mapping (PM) approaches and the fourth group concerns a different approach of Nonvalue Added Analysis.

The outline of the paper is as follows: "Research methodology" section presents the research methodology used for selecting the books and papers and it illustrates the searching methodology. "VA and NVA Activities" section defines the two terms from different point of views. "Classification according to the publication genre" section describes the different genres of the selected publications. "Classification based on the use of individual or multiple techniques" section aims to describe the importance of using different techniques. "Classification based on industry" section provides an overview of various VA activities in different industries. "Value added analysis techniques" section presents the four above mentioned groups. Lastly, final remarks and conclusions are delivered.

In this paper, literature relating to the topic of value-added analysis and techniques was thoroughly selected. This topic covers, value creation, nonvalue elimination, waste reduction, value added processes and so on. The selected books and papers were searched for from the Oria search engine which allows searching through the online database accessible to students of HiMolde University College. Several 23 books and articles published from 1995 to 2020 were selected.

II. RESEARCH METHODOLOGY

The research methodology of this paper is illustrated in Fig. 1. The aim of this taxonomy is to select only publications that focus on value creation in the manufacturing sector and further on value analysis techniques and approaches of manufacturing processes.

Publications concerning for example Economic Value Added (EVA) or VA activities in other sectors are neglected. Theoretical books presenting various value assessment methods were considered important as they describe the fundamentals of the previous mentioned techniques and approaches.

Only papers available on the Oria search engine of the HiMolde University College online database were included in this literature review. The search criteria for the database were: value creation, value added analysis, value creation, value stream mapping, process improvement, process mapping, nonvalue elimination.

Looking for multiple points of views regarding the value-added analysis approaches, any published text genre such as books, articles, thesis, dissertations and other were considered during the search. Moreover, to present an accurate synthesis of the modern state on the subject, papers between 2006 and 2020 were selected.

Taking into consideration the above-mentioned criteria of presenting the modern state of the subject, papers published after the middle of the 2000s were more relevant. Even so, process improvement techniques and value-added analysis approaches are dating back to the middle of the 20th century. Thus, a book published at the end of the century was selected as it is described by its authors as a geared for the person who is looking for a practical guide to process improvement Flanigan (1995) [8].

Based on these conditions, a number of 23 publications varying from books to articles and dissertations, published between 1995 and 2020 were marked as suitable for conducting the literature review. As it will be further described, the selected publications relate to value assessment in various industries.

During the selection process, each publication had to contain one or more of the following criteria: contains value analysis techniques, contains value identification techniques, contains nonvalue elimination techniques, contains process improvement techniques. After passing a final review step, publications were considered as selected for the literature review.

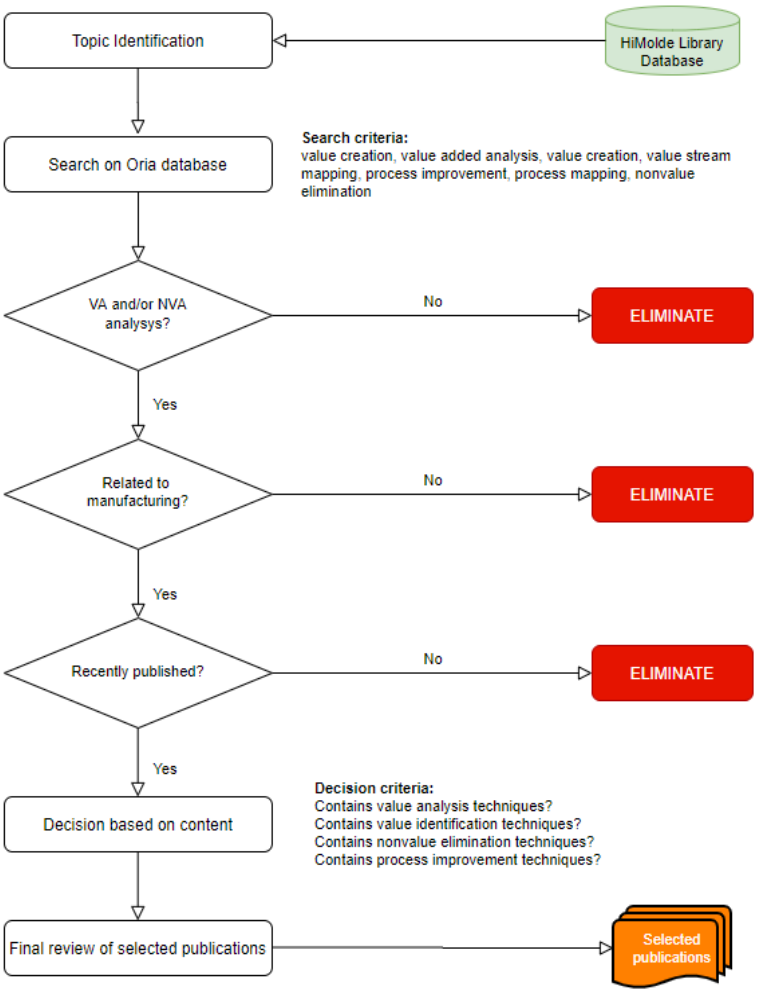

Figure 1 – Research Methodology Schematics

III. VALUE ADDED AND NONVALUE ADDED ACTIVITIES

A. Defining VA and NVA Activities

Ensuring that value is added at each manufacturing activity during the process, is one of the most important things to do order to run a successful production line. The saying, time is money, is still followed by many manufacturing companies but, at the same time, it is crucial to understand which activities add value to our organization and which do not. Analyzing these activities might lead us to the following conclusion: not all the performed activities are essential in sustaining operations, some might even cost us resources and vital time.

In his book, Flanigan (1995) suggest asking a simple question for each input and step within the process: What would happen to the end output that the customer values, if I eliminated this input or step? He further explains if the answer is nothing, then the step adds no value and should be marked as NVA. If the answer is something, then the input should be marked as VA [8].

Carreira (2006) goes a step forward in defining nonvalue adding activities as waste. As defined by one of the Lean Six Sigma models that we will later discuss, waste is categorized as follow: overproduction, excess inventory, transport, process, rework, waiting and unnecessary motion. The author describes value added as work through which the product is being advanced to a more finished state and the customer is paying for this activity to occur [5]. Thus, nonvalue added activities do not contribute to a more complete product or service and the customer is unwilling to pay for these activities.

On the other hand, in a more recent publication, Bradley (2015) suggests answering to four questions for each process step to determine if a step is a VA step or an NVA step [4]. Opposing to Carreira (2006), Bradley (2015) introduces value-added ratio (VAR) as a relation between VA and NVA. The VAR is presented as being used to compute the percentage of lead time where something productive is being done to the product [4].

A third category of value assessment is introduced by Carreira (2006). Required nonvalue added activity is presented to the readers through two real scenario examples. In case of a manufacturing process where the client requires specific inspection parameters to be performed together with detailed documentation, these activities might be regarded as nonvalue added

activities. However, it is required by the customer, and the customer is paying for this service to be performed, therefore the organization marks this activity as required nonvalue added [5]. Table 1 classifies publications that define or describe VA and NVA activities.

B. Difficulty of Value Creation

Understanding the difference between value added and nonvalue added activities in the manufacturing processes is vital. However, when thinking about manufacturing, industries such as automotive, metallurgical and electronic manufacturing cross our mind. Value creation methods in these domains have been studied by many researchers during the years, thus value creation methods do not represent a burden.

Publications analyzing value creation from a different perspective were added to be reviewed in this work. Son, Lee and Chung (2017) are analyzing and defining value creation of social enterprises in manufacturing industry in Korea while Rajagopal (2014) talks about sustainable value creation in the chemicals industry.

The difficulty of analyzing the performance of social enterprises (SEs) from Korea is presented in a paper published in 2017. The scope of the SEs is very wide, making it hard to evaluate performance uniformly. It is stated that previous researches developed measurement methods that are too specific for some fields and difficult to apply to SEs. The social value creation is an ultimate goal of SEs and according to prior studies, the main difference between for-profit companies and SEs is that the former pursues the maximization of financial performance, while the latter focuses on the social value creation. Crucke and Decramer (2016) also argue that it is not easy to develop general performance analysis models suitable for all types of SEs, because SEs vary on size, industry and purpose [6].

Sustainable value creation seems to be a greater challenge in the fine and specialty chemical industry. Rajagopal (2014) defines this industry as a multiproduct and multilocation one, with a global footprint that is being shaped by diverse mega trends driven by the climate change [14]. Value in the chemical industry will be described in a later chapter. Table 2 lists the publications describing a different approach of value creation.

Table 1 – Publication classification based on VA, NVA description

Topic	Authors
VA and NVA activities	Flanigan (1995), Carreira (2006), Bradley (2015), Valhed and Pavkovic (2017), John X. Wang (2010)
Requested NVA activities	Carreira (2006)

Table 2 - Publication classification based on value creation

Topic	Authors
Value creation in SEs	Son, Lee and Chung (2017), Crucke and Decramer (2016)
Sustainable Value Creation	Rajagopal (2014)

IV. CLASSIFICATION ACCORDING TO THE PUBLICATION GENRE

Looking for multiple points of views regarding the value-added analysis approaches, multiple published text genres such as books, articles and dissertations were included as references to this work. Theoretical books published between 1995 and 2016 presenting various value assessment methods were considered important as they describe the fundamentals of the previous mentioned techniques and approaches.

A. Books

With Lean Manufacturing and Lean Six Sigma as the most popular methodologies when it comes to process improvement, various authors relayed on them to further describe value assessment techniques and approaches in their books. At the same time, Moore (2007) perfectly describes the history and how Toyota Production System (TPS) evolved into Lean Manufacturing. Citing multiple authors in his book, he further states that the inherit limitations after WWII led Toyota to develop techniques to manage its production in a very “lean” environment [13]. At the same time Bradley (2015) states that the primary genesis of TPS was the need to maximize the production of automobiles with the minimum possible resources, contributing to the success of Toyota [4]. Definitions for Lean Manufacturing can be found in multiple books published used as references in this literature review.

Contrary to other authors, Flanigan (1995) does not refer to any of the Lean Manufacturing or Toyota methodologies and relies solely on process mapping to identify NVA and eliminate it. However, his book is an easy, straight forward guide for anyone interested in improving the processes of its organization.

Table 3 lists the books based on the methodology they describe.

B. Articles

With articles being the main source of reviewing value added analysis techniques and approaches, a number of 13 articles have been selected for this paper. The articles refer to case studies in different industries and vary in value assessment techniques. All of these categories are detailed in further chapter of this literature review.

Table 3 - Publication classification based on methodology description

Methodology	Authors
Lean Manufacturing	Wang (2010), Bradley (2015), Carreira (2006), Fredendall (2016), Moore (2007)
TPS	Moore (2007), Bradley (2015)
Other	Flanigan (1995), Rajagopal (2014)

C. *Dissertations*

Interested to see a perspective from the postgraduate perspective, dissertations are included in this work. Valhed and Pavkovic (2017) refers to a case study at a global grocery supplier and tries to eliminate nonvalue-added activities related to information sharing in the eGrocery order fulfilment process. To answer the purpose of the study, a case study was performed and by using Value Stream Mapping, all activities have been mapped and nonvalue added activities have been identified [18].

On the other hand, Zhan (2016) focuses on Time-based process mapping (TBPM) applied into a practical case. By comparing the difference between traditional process mapping tools and TBPM, his research finds out which kind of company and situation is suitable for TBPM and the reasons why the TBPM is suitable [22].

V. CLASSIFICATION BASED ON THE USE OF INDIVIDUAL OR MULTIPLE TECHNIQUES

Aiming to analyze the approaches and techniques used for value assessment, we are further focusing on the selected articles, leaving the theoretical publications aside for now. Screening through the case studies, two patterns are visible. Authors are either using an individual technique such as Value Stream Mapping and Time-Based Process Mapping or they make use of multiple techniques to identify non value-added activities.

Table 4 - Publication classification based on the use of individual or multipe techniques

Approach	Authors
Individual Techniques	Valhed and Pavkovic (2017), Jasti and Sharma (2014), H. Singh and A. Singh (2013), Moin, Iqbal, Malek and Haque (2020)
Multiple Techniques	Ratlalan, Tama and Sugiono (2017), Raschke and Sen (2013), Abdulmalek and Rajgopal (2007), Anand and Rambabu (2011), Brito, Ramos, Carneiro and Goncalves (2018), Son, Lee and Chung (2017), Bowles and Gardiner (2018), Wu, Low and Jin (2013), Zhan (2016)

Table 4 categorizes the publications based on the use of individual or multiple techniques.

A. *Individual Techniques*

When it comes to using individual techniques for identifying value added and nonvalue added activities, VSM is mainly preferred. However, previous studies have also used Time-Based Process Mapping (TBPM) as an alternative.

Jasti and Sharma (2014) suggest that the case study approach has been used to show the applicability and importance of VSM in an Indian auto components company and further come to the conclusion that VSM brings out the positive impact on process ratio, TAKT time, process inventory level, line speed, total lead and process time and reduced manpower [19]. In the same manner, H. Singh and A. Singh (2013) address the application of lean manufacturing using VSM concepts in another auto-parts manufacturing organization. The authors concluded that VSM is a very powerful tool to highlight the process inefficiencies and improvement areas [17].

In their article, Valhed and Pavkovic (2017) follow the three steps on how to perform a VSM (according to Paradiso and Cruickshank 2007). First steps consist of identification of the process, aiming to give an understanding of the process and settle the grounds for the value stream mapping. The second step is designing the VSM by Executing a detailed map of the process included all the activities. The third step is called the evaluation step and it is the identification step for nonvalue added activities [18]. By performing a VSM of the unmapped and confusing order fulfilment process towards the company, a reduction of the nonvalue added time within the process has been made [18].

On the other hand, TBPM can also be found in articles as a stand-alone technique. Moin, Iqbal, Malek and Haque (2020) argue that the identification of value-added time through-out the supply chain is a key research area in apparel industries. They made us of activity wise time-based process mappings for thirty contracts help to identify VA and NVA activities [7]. The article is concluded stating that the time-based process mapping is an effective tool to diagnose the process which able the supply chain to take initiatives for better utilization of time [7].

B. *Multiple Techniques*

Combining multiple techniques in order to achieve a more accurate value assessment has been preferred among the big majority of publications. Simulations and various rating techniques are used to aid VSM and other NVA identification approaches.

Ratlalan, Tama and Sugiono (2017) make use of multiple tools to minimize the waste that occurs in the manufacturing process of military products. The use VSM to describe the overall information from the flow of raw materials to finished products, waste relationship matrix (WRM) for waste identification and analytical hierarch process (AHP) to conduct further

analysis. Using multiple tools helped in a more efficient waste elimination analysis.

Focusing on NVA activities, a comprehensive literature search was conducted, NVAs were categorized and ultimately an NVA analysis has been performed. These steps were followed by Raschke and Sen (2013) during their case study as part of a more complex analysis using Activity Based Mapping.

Meanwhile, Abdulmalek and Rajgopal (2007) use simulation to support the created VSM. To evaluate potential gains based on the implementation of the value assessment tools, a detailed simulation model was developed using System Modeling Corporation's Arena 5 software. They concluded their paper arguing that for managers who might be considering implementing lean manufacturing but are uncertain about the potential outcomes, a detailed simulation model can be used to evaluate basic performance measures and analyze system configurations [1]. The availability of the information provided by the simulation can facilitate and validate the decision to implement lean manufacturing.

In a likely manner, Anand and Rambabu (2011) argue that value stream mapping suffers from various shortcomings and that is the reason why researchers have suggested the use of simulation along with VSM [10]. Similarly, simulations are a tool to provide an idea to the managers of the case organization a real-time perspective of how the organization will be after following lean manufacturing guidelines and how the implementation of these lean manufacturing decisions will affect the performance measures of the organization.

An interesting study combines lean manufacturing tools and ergonomic methods to improve productivity while eliminating the waste that occurs during the production processes and improving working conditions. Brito, Ramos, Carneiro and Goncalves (2018) highlight through a case study in four production areas of a metallurgical industry, the benefits of using an integrated operations management approach to improve productivity and ergonomic aspects. They make us of several ergonomic methods, such as Rapid Upper Limb Assessment (RULA), Strain Index (SI), and Rapid Entire Body Assessment (REBA), to evaluate the ergonomic situation and lean manufacturing tools such as Value Stream Mapping (VSM) and seven wastes to increase productivity.

It is hard to argue if using multiple techniques is better than using an individual one. This decision should be made according to the size and complexity of the organization that needs to eliminate nonvalue adding activities. In the selected articles, both methods seem to be effective. While simulations are used to aid VSM in organizations where the management is not used to lean manufacturing methodologies, in organizations where lean manufacturing is already implemented, using VSM as a stand-alone technique saves both resources and time.

Table 5 - Publication classification based on industry

Industry	Authors
Metallurgical	Brito, Ramos, Carneiro and Goncalves (2018), Abdulmalek and Rajgopal (2007)
Carpentry	Anand and Rambabu (2011)
Equipment Production	Bowles and Gardiner (2018)
Automotive	Jasti and Sharma (2014), H. Singh and A. Singh (2013)
Precast Concrete	Wu, Low and Jin (2013)
IT	Raschke and Sen (2013), Valhed and Pavkovic (2017)
Logistics	Zhan (2016)
Apparel	Moin, Iqbal, Malek and Haque (2020)
Plastic Box Production	Ratlalan, Tama and Sugiono (2017)
Social Enterprises	Son, Lee and Chung (2017)
Chemical	Rajagopal (2014)

VI. CLASSIFICATION BASED ON THE INDUSTRY

Focusing on value added analysis techniques and approaches in the manufacturing field, multiple case studies have been selected. These case studies vary from the metallurgical industry to the automotive, apparel and many others. It is interesting to observe how versatile Lean tools and other value assessment techniques are. As they will be detailed in the following section, these techniques have been used by authors to improve processes in multiple industries. Table 5 categorizes the studies based on the industry.

A. Metallurgical

In the metallurgical industry, Abdulmalek and Rajgopal (2007) apply VSM via simulations to improve the manufacturing process of steel that are used primarily in appliance manufacturing. The focus on one product family, annealed products. By trying to answer a series of structured questions, they come up with an ideal future state map that will further help them in eliminating or reducing different types of nonvalue added activities [1]. Moreover, they use simulations and demonstrate that a detailed simulation model can be used to evaluate basic performance measures and analyze system configurations. On the other hand, in the same industry, Brito, Ramos, Carneiro and Goncalves (2018) focus on reducing nonvalue added activities by focusing on the workers. As previously described, the authors combine several ergonomic methods and lean manufacturing tools to increase productivity. In both case studies a drastic improvement in productivity could be observed.

B. Automotive

Fighting with a high competitiveness, the automotive industry is a major subject in process improvement and waste elimination. Both case studies by Jasti and Sharma (2014), respectively H. Singh and A. Singh (2013) rely on value stream mapping concepts for improvement. Using value stream concepts, current and future states maps of the shop floor scenarios have been discussed to identify sources of waste between the existing state and the proposed state for improving the competitiveness [17;19]. In addition, Jasti and Sharma (2014) further implemented kaizen on the current state map and developed future state map while including these kaizens. They conclude their study arguing that most of the Indian manufacturing organizations or auto-component industries are still not able to implement advanced manufacturing systems [19]. Contrary to this statement, H. Singh and A. Singh (2013) conclude that most of the organizations are very keen to adopt latest techniques, namely VSM [17].

C. IT

The versatility of VSM is also proven by Valhed and Pavkovic (2017), who use this tool in their dissertation to deal with nonvalue added activities in the process within the eGrocery. As an alternative, Raschke and Sen (2013) try a different approach by using activity-based mapping and rate nonvalue added activities to achieve process improvement. They propose a value-based management approach for assessing the potential for process improvements enabled by an information technology solution. In their paper, they address management's need for appropriate methodologies for *ex-ante* evaluations of IT-enabled business process improvement projects. Furthermore, they demonstrate how such pre-assessment methodologies can subsequently enhance the selection of the appropriate IT solution to achieve the desired process improvement [15]. As a result of their study, due to the lack of research and the need for additional theoretical contribution regarding eGrocery Valhed and Pavkovic (2017) have developed a framework. The framework presents how companies in the grocery industry can eliminate the nonvalue added activities related to information sharing in an order fulfilment process within eGrocery [18].

D. Other industries

An interesting approach on value creation in the *chemical industry* is presented by Rajagopal (2014) in his book. Focusing on sustainable value creation, he argues that the fine and specialty chemicals industry, a multiproduct and multilocation industry with a global footprint, is being shaped by diverse mega trends driven by climate change, changing demographics, urbanization, food security and technology convergence [14]. These mega trends impact the industry in vastly different ways and creating value is often a compelling task. Moreover, he states that no specific model exists for enabling sustainable value creation [14]. Value creation in the chemical industry has several dimensions, each of which is unique to specific regions and companies. The highly complex nature of the industry makes it very difficult to evolve one correct model to create value [14].

In a similar manner, Wu, Low and Jin (2013) focus on identification of nonvalue adding activities in *precast concrete* installation site to achieve a low-carbon installation. Arguing that the difficulty in understanding and quantifying the impacts of the lean principles was perhaps on reason that stakeholders hesitated to use the lean principles to be green and that is why it is only recent since lean philosophy has proven to be effective to meet the challenges of sustainable development [21].

The study conducted by Bowles and Gardiner (2018) proves that process mapping and simulations can be combined to help elimination nonvalue added activities in the *equipment production industry*. The purpose of their work is to study the effectiveness of combining process mapping and system dynamics in an organization to aid process improvement projects [3].

Likewise, Anand and Rambabu (2011) use simulations aiming to present an application of VSM with simulation during the design of lean manufacturing in the *doors and windows manufacturing industry*. Concluding their work, the authors state that there was significant improvement in the productivity, while there was significant reduction in inventory, cycle time, floor space, manpower, etc. [10]. Thus, these simulation models also proved effective for the managers and engineers to see and feel how their manufacturing system will be in the future before the actual design of LMS.

In his research Zhan (2016) focuses on how applying time-based process mapping into the practical case in the *logistic sector* with the major research happing at IKEA's DC terminal in Torsvik Sweden. To fulfill the research purpose, he introduces value stream mapping and time-based process mapping. Overcoming former prejudices for both value stream mapping and time-based process mapping, Zhan concludes that the method of VSM also could be accurate and dynamic though adding the TBPM in the retailing company like IKEA [22]. And meanwhile, the TBPM not only could be applied in isolation for supply chain analysis, but also could be applied in the integrated process [22].

Similarly, in a more recent study, Moin, Iqbal, Malek and Haque (2020), argue that identification of value-added time through-out the supply chain is a key research area in *apparel industries* [7]. Also, by using TBPM, the authors investigated detailed activities of thirty contracts of an apparel supply chain by considering the manufacturer as a coupling point of upstream and downstream.

As described in a previous section, an interesting approach by Son, Lee and Chung (2017) studies value creation mechanisms of social enterprises in the manufacturing industry. The purpose of their study is

to uncover the value creation mechanism of SEs in manufacturing industry. To verify how SEs can effectively create social value and how SEs are sustainable despite focusing on social value creation rather than profit maximization the authors have addressed several research questions [11]. Furthermore, an empirical study on the value creation mechanism of SEs in manufacturing industry and found the role of social entrepreneurship and the effects of product innovation on social value creation and financial performance in SEs. Concluding their work, authors argue that social entrepreneurs can achieve sustainable performance by creating social value through product innovation such as product simplicity, usability and standardization [11].

VII. VALUE ADDED ANALYS IS TECHNIQUES

Analyzing the selected articles, three value added analysis techniques and approaches have been identifies. Authors are using value stream mapping, process mapping and nonvalue added analysis as tools for value assessment. These tools are either used as stand-alone tools or combined with simulations, lean manufacturing tools such as seven wastes and Kaizen or even with psychometric scales. Table 6 group publications according to the technique that was used to identify and eliminate nonvalue added activities.

A. Value Stream Mapping

Clearly being the most popular choice among authors when it comes to value analysis and nonvalue elimination, the versatility of value stream mapping has been proven in the previous chapter where we saw its implementation in numerous industries. Being described in almost all theoretical books chosen for this work, value stream mapping is described in [1] as creating a common basis for the production process, thus facilitating more thoughtful decisions to improve the value stream [1]. Various perspectives about VSM can be found through the articles, authors finding descriptions such as a tool in the concept of lean manufacturing aiming to describe the overall Information from the flow of raw materials to finished products and use their studies to address the importance of VSM in lean manufacturing environment.

Jasti and Sharma (2014) encounter difficulties during their studies and argue in the chapter entitled Limitations, that the top management of the organizations should be involved to implement the tool in that organization successfully [19]. To convince management about the efficiency of lean manufacturing tools, H. Singh and A. Singh (2013) use simulations as a support for VSM. They argue that information provided by the simulation can enable management to compare the expected performance of the lean system relative to that of the existing system it is designed to replace and assuming that this is significantly superior, it provides a convincing basis for the adoption of lean [17].

Table 6 - Publication classification based on the used technique

Technique	Authors
Value Stream Mapping	Valhed and Pavkovic (2017), Brito, Ramos, Carneiro and Goncalves (2018), Anand and Rambabu (2011), Abdulmalek and Rajgopal (2007), Jasti and Sharma (2014), H. Singh and A. Singh (2013), Ratlalan, Tama and Sugiono (2017)
Process Mapping and TBPM	Bowles and Gardiner (2018), Zhan (2016), Moin, Iqbal, Malek and Haque (2020),
NVA analysis using Likert	Wu, Low and Jin (2013), Raschke and Sen (2013)

However, according to Anand and Rambabu (2011) it has been found out that that value stream mapping (VSM) suffers from various shortcomings and suggest that is the reason why simulations must be used alongside with VSM [10]. The authors argue that VSM as a tool is static in nature and can capture only a snapshot view of the shop floor on any day. As proof for their statement, they claim that on a given day, the production might be running smoothly without any problems, while on the other day, there might be various delays due to breakdowns of machines, late delivery by key vendors, quality problems, etc. In these circumstances, thus the VSM tend to vary according to the situations that prevail in the organization [10].

B. Process Mapping and Time-Based Process mapping

In an article published in 2018, the quality magazine highlights in simple terms, the difference between process flowcharts and process maps stating that a flowchart is a diagramming tool while a process map, or process mapping, refers to the procedure of creating a diagram. In their book, Flanigan (1995) state that a process map is a handy tool to gain a better understanding of your process and that it is especially useful when complicated processes are to be examined [8].

Similarly, to VSM, the work of Bowles and Gardiner (2018) proves that process mapping and simulations can be combined in order to help elimination nonvalue added activities. During their study, a project team used system dynamics to supplement improvement insights gained from process mapping. The authors conclude the paper by stating that their study supplements insights gained by previous case studies into the effectiveness of combining process mapping and simulation when conducting business process improvement efforts [3].

On the other hand, Zhan (2016) focuses on Time-based process mapping (TBPM) applied into a practical case. One of the research objectives of his work is to compare the traditional process-based

mapping tools and Time-based process mapping. Citing various authors, Zhan states that in contrast to the traditional process mapping that being a simple metric, time allows a rich understanding of the symptoms of poor performance and is effective in identifying and diagnosing waste [22]. In a similar manner Moin, Iqbal, Malek and Haque (2020) use TBPM to identify value-added time through-out the supply chain in apparel industries.

In his dissertation, Zhan (2016) describes the advantage of TBPM as being an easy-to-use tool as time is simple measure that everyone understands, even allowing people who have little training, to measure the performance of a process or activity. He further states that if the measures are simple to understand, it will be easier for people to figure out the big issues. Concluding, people they can directly measure the process of activities and target a process which is just adding time [22].

C. NVA analysis using the Likert Scale

Only a few publications were found to implement various lean manufacturing tools or other value assessment tools together with a Likert scale to identify nonvalue added activities.

In their paper, Wu, Low and Jin (2013) use a five-point Likert scale to rate NVA activities. Their study adopts a weighted factor model comprising 30 contractors in the Singapore construction industry and a case study. Comparing to other studies, the authors conducted, a field work including all major contractors who had experiences in constructing precast concrete projects aiming to identify and most importantly rate nonvalue added activities.

The results indicated that there are many non-value adding activities in the site layout management practices that contribute to an increase in the carbon emissions level. Similarly, a five-point Likert scale is used to identify the potential impact of the functional requirement on reducing the NVA activities in the case study conducted by Raschke and Sen (2013) [15].

VIII. CONCLUSIONS

This literature review has presented and systematized value-added analysis techniques and approaches. A total number 23 publications were selected and used during the analysis of this topic. Considering the importance of the value creation in the manufacturing process, the number of published articles on this topic is not substantial.

By far the most popular choice among authors when it comes to value assessment and nonvalue elimination is the value stream mapping tool. Recent publications have proven the importance of using simulations alongside with the VSM to both create an accurate research when it comes to variation in processes from one day to another and to allow a better understanding of the efficiency of lean manufacturing implementation in an organization.

To conclude, choosing the right value assessment technique or approach should be a result of a decision made according to the type, size, complexity and Lean experience of the organization.

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