



# The use of costing methods in lean manufacturing industries: a literature review

## *O uso dos métodos de custeio nas indústrias de manufatura enxuta: uma análise da literatura*

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**Abstract:** The adoption of Lean philosophy by companies has motivated the need for improvements in the traditional accounting system. Such a system has not been seen with favor by Lean organizations under the accounting focus when it comes to waste elimination. After all, the traditional costing system is not conceptually prepared to operate efficiently under the Lean production model. Therefore, the aim of this research was to evaluate the degree of integration of costing methods (ABC, TDABC and VSC) in Lean enterprises observing how these methods integrate to the reality of the Lean Manufacturing model. A literature review encompassing the period 1994-2014 was carried out. Studies were critically analyzed to develop a method of classification in order to obtain data and produce results and conclusions under a qualitative and quantitative approach. The results showed that, although costing methods are applied, these mostly serve only as a reference for the process of formal identification of costs, theory or comparative analysis to the traditional cost system, but are not actually integrated to the production analysis process.

**Keywords:** Lean manufacturing; Activity-Based Costing; Time-Driven Activity Based Costing; Value Stream Costing.

**Resumo:** *A adoção da filosofia Lean pelas empresas motivou a necessidade de melhorias no sistema de contabilidade tradicional, tal sistema tem sido visto como desfavorável sobre o foco contábil na eliminação dos desperdícios pelas organizações enxutas, afinal, os sistemas de custeios tradicionais não estão conceitualmente preparados para operar de forma eficiente no modelo de produção Lean. Portanto, busca-se avaliar qual o grau de integração dos métodos de custeio (ABC, TDABC e VSC) junto às empresas enxutas observando a integração desses métodos à realidade do modelo de manufatura enxuta. O estudo realiza uma revisão na literatura existente do período de 1994 a 2014, no qual se fez uma análise crítica dos estudos disponíveis e, a partir desta, desenvolve-se um método de classificação a fim de se obter dados, fornecer resultados e conclusões utilizando uma abordagem quali-quantitativa. Os resultados da pesquisa demonstram que, apesar de aplicados, os métodos de custeio em sua maioria somente serviram como referência para o processo de identificação formal dos custos, teorização ou análise comparativa ao sistema tradicional de custos, não sendo integrado de fato ao processo de análise na produção.*

**Palavras-chave:** *Manufatura enxuta; Custeio Baseado em Atividades; Custeio Baseado em Atividades e Tempo; Custeio do Fluxo de Valor.*

## 1 Introduction

Industries today seek the reduction and elimination of waste through continuous improvement projects that enable increased productivity within the production process, while preserving quality and serving the customer within (Gracanic et al., 2014). These operational improvements proposed to

maximize efficiency and effectiveness throughout the production system, reducing the non-value added activities, costs and eventually increase net income (Ruiz-de-Arbulo-Lopez et al., 2013).

In view of these perspectives becomes evident the increasing global competition among companies

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that have adopted new production approaches such as Lean Manufacturing in order to make them more competitive (Ruiz-de-Arbulo-Lopez et al., 2013). Some industries have been through physical and cultural transformation processes by adopting the Lean concept (Abuthakeer et al., 2010). Briefly Lean Manufacturing is a model that seeks to increase productivity by reducing or eliminating waste through activities that do not add value in the production processes (Ohno, 1997; Shingo & Dillon, 1988; Womack et al, 1991).

The adoption of Lean by companies implies the need for improvement in the accounting system. The lean organizations see the traditional accounting systems as unfavorable on the focus of eliminating waste. After all, the traditional costing system is not conceptually prepared to operate efficiently in the lean production model (Malta & Cunha, 2011; Pike et al., 2011) In fact, even in usual companies where it has a wide range of products the traditional approach to cost when applied has a distortion in the cost information (Gunasekaran & Sarhadi, 1998; Kaplan & Copper, 1998). Given this paradigm emerges Lean Accounting, as a way to adapt or change the traditional costing methods in order to support businesses and lean industrial processes (Gracanin et al., 2014; Wang & Yuan, 2009).

In the period to which predates the adoption of Lean Accounting and due to the increasing demand for changes in traditional accounting, appears in this transition the Activity-Based Costing (ABC), a first response to the lack of costing methods for use in lean manufacturing companies (Arbulo-López & Fortuny-Santos, 2010). The purpose of the ABC method in modern manufacturing is to facilitate the identification of activities making the connection between the activities and resource costs (Gunasekaran & Sarhadi, 1998 however the application of the ABC method requires continuous efforts of employees in research for its preparation (Stout & Propri, 2011). Faced with problems encountered in application of ABC, arises the Time-Driven Activity-Based Costing (TDABC) model that eliminates the time-consuming need and subjectivity of the interview process and surveys making it practical to update the information of costs through time equations (Oker & Adiguzel, 2010).

From that moment, the Lean companies now have these two costing methods (ABC and TDABC), the actual adoption of Lean Accounting brings the Value Stream Costing (VSC). A costing method that attention concentrating the business on the resources that are being used throughout the value chain, rather than individual products (Ruiz-de-Arbulo-Lopez et al., 2013; Maskell & Baggaley, 2004). The VSC starts to make a connection between the operational aspects

and lean accounting, meeting the needs of Lean companies, eliminating the need for calculations in the allocation of indirect costs (Gracanin et al., 2014).

This study conducted a review and analysis of the literature through articles focused on the topic and is divided into sections which describes the objectives, the state of the art, the methodology used for the execution of the study, the classification method used to prepare the analysis articles and a session that deals with analysis of the results and conclusions.

## 1.1 Objectives

The objectives of this investigation is measuring which the degree of integration among the methods, Activity-Based Costing (ABC), Time-Driven Activity-Based Costing (TDABC) and Value Stream Costing (VSC), in companies that have adopted the concept and techniques of lean manufacturing. The objective is, evaluating the studies published between the period 1994 to 2014 that are related to the use of costing methods (i.e. ABC, TDABC e VSC) in industries that have adopted the concept of Lean Manufacturing, observing the integration of these methods to reality of Lean model.

Face of this premise on which the investigation is based on analysis of published articles that reference lean manufacturing and costing methods. proposes an analysis of the relationship between cost accounting practices applied by lean companies, suggesting the creation of a classification as a second objective on which intends to get an assessment of what methods were used, application areas, degree of integration, type of companies or processes studied and analysis of the advantages and difficulties in the implementation of the methods.

## 2 Literature background

The literature background, discusses concepts and theories related to the topic focus of the research, its purpose is to provide the study principles to collaborate with a more current perspective of content that are the basis for the research. This section seeks to general framework provides concepts that led the Lean approach and costing methods.

### 2.1 Lean Manufacturing

Lean Manufacturing was created with the purpose to increase productivity and reduce operating costs through the elimination of waste in the production process (Liker, 2004; Ohno, 1997). Owes its success to Toyota engineers that by using a new concept of production flow (pull production), supply and components feeding (Just-in-Time and Kanban)

developed a new standard of production from changes made in mass production model.

The Lean philosophy behind the model enabled the identification of waste in the production process, reducing operating costs and guaranteed early delivery of the products ordered (Ohno, 1997; Villa & Taurino, 2013).

The purpose of Lean Manufacturing is to increase efficiency of the production system, eliminating waste as expected, excess inventory on production, movement, transportation, overprocessing, defects, underutilized people (Ortiz, 2006), and deploy an improved system continues (Kaizen), specify value and standardize the process.

## 2.2 Activity-Based Costing

The Activity-Based Costing (ABC) is a costing system that provides relevant information for decision making (Dickinson & Lere, 2003). The ABC method has become known from the 80s with the work developed by professors Robert Kaplan and Robin Cooper, (Afonso, 2002), its relevance in the eighties overlapped the traditional costing method, which had its design where hand labor and raw materials had preponderance in cost of goods (Afonso, 2002).

The ABC model emerged as a response on the need to better assess costs in modern production environments and by virtue of dissatisfaction with variable costing and full costing for not meet the expectations and needs of managers (Thyssen et al., 2006). According to Pike et al. (2011) the modern production environments incorporated the philosophy of Lean Manufacturing to minimize waste and optimize their production processes. This process gave rise to the need for improvements in traditional accounting systems, due this are not prepared to operate efficiently in lean model.

ABC proposes for organizations an understanding of cause and effect between the costs and activities needs, in addition to direct costs of these activities to cost objects (Askarany et al., 2010). Originally, the ABC is focused on consumption of activities, providing more accurate information for the preparation of calculating product costs (Afonso, 2002).

## 2.3 Time-Driven Activity-Based Costing

The “Time-Driven Activity-Based Costing” (TDABC) is a costing model that considers the time as the only inducer costing. Its purpose is to provide costs of activities with base in consume of time per activities. According to Kaplan & Anderson (2007) the method has the ability to measure simply and precisely the cost to a more targeted level, enabling companies to carry out further analysis of the costs

by drawing a parallel between the activities that add a higher percentage of value compared to those who, though add value, generate large operating costs and become less profitable for the company.

The advantage over ABC is in simplifying the costing process. The TDABC eliminates the costly process of research, in order to collect information on the cost allocation of resources and activities before directing it to the cost object.

The proposed of TDABC is to assign resource costs using a leaner structure, based on cost capacity rate and equations of time, that provide time spent in each activity (Kaplan & Anderson, 2007; Oker & Adiguzel, 2010).

## 2.4 Value Stream Costing (VSC)

The Value Stream Costing (VSC) results from the evolution of cost accounting on the basis of the principles of Lean Manufacturing and Lean Accounting. The method follows the principles of mapping the value stream, which uses the concepts provided by Lean to map and identify the value stream of the production process. According with McVay et al. (2013) VSC is a system that demonstrates the costs with base in value stream able to provide more relevant information to Lean companies, this costing system for Lean companies offering better internal cost management. In the view of Maskell & Baggaley (2004), the VSC is simple enough for anyone to understand the information of a financial nature and costs. In the method cost information is presented for each value stream and not per demand, work or product produced.

Value Stream Costing proposes to make a costing of production process by mapping the value stream which are detailed in the activities (in terms of cycle time, shift number, distance, etc.). As McVay et al. (2013), to use VSC is necessary to organize resources in value stream. For this it is necessary to develop an information collection plan and use the plan to guide the development of implementation of actions.

## 3 Research methodology

The literature review aims to conduct a summary and critical analysis of research available on the subject studied (Hart, 1998). That is, a method which is fully investigates the different approaches to a theme (Lage & Godinho, 2010). Its purpose is to enable the reader to assess the literature of a subject in a space of time and it can acquire a base to address other purpose and may this serve as a justification for further research in the area (Cronin et al., 2008). A good literature review gathers information from

various sources on a particular subject and contain little or no personal bias (Carnwell & Daly, 2001).

This study follows steps in order to achieve the objectives proposed by a literature review:

- First step: defining the subject focus of analysis in the application of costing methods in manufacturing companies using the template or Lean production concept.
- Second step: to prepare a classification model.
- Third step: to apply the created classification model.
- Fourth step: organize and present the literature review, based on the established classification method.
- Fifth step: analysis and review of the topic and to propose suggestions for future research.

After identifying and analyzing the articles, a classification model is created (Step 2). From this classification model will be possible visualization the literature an organized manner by the degree of relevance of the topic discussed (Step 3). Sorting and identification of items according to the degree of integration allows a more objective analysis (Step 4). Finally, the analysis reached by the study, providing a wider knowledge on the topic researched (Step 5).

To achieving these objectives of investigation, the research was based on the analysis of articles in the period 1994-2014, which are related to the use of costing methods (ie ABC, TDABC and VSC) within the production system. The study was directed to articles focused on the topic Lean Manufacturing and costing methods for planning and production control.

Scientific journals were the basis for a search, due to being more commonly used resources to acquire information and report new findings (Ngai et al., 2008; Carnwell & Daly, 2001; Cronin et al., 2008; Hart, 1998; Lage & Godinho, 2010). The articles were collected in electronic databases: Science Direct; B-On; Taylor and Francis, considered extremely comprehensive in the topics production and costing methods, because this scope, were not considered in other research bases.

Table 1 shows the combination of keywords that served as the basis to search for articles in the construction of research. The line identification versus column with an X is the combination of the search word in the above-mentioned databases. Example: ABC and Lean manufacturing.

### 3.1 Classification method

The classification method to Neuman (2007) is a procedure in which you can organize logically and practice complex and abstract concepts that make it possible to establish a new classification that will combine feature simpler concepts (Neuman, 2007).

Referring the affirmation Neuman, it was developed a classification method that specified the scope of search in five categories in order to obtain as much information that lead to understanding and developing the study.

The research classification method was to function, gather related studies and provide a defined understanding of the analyzed articles. Generating a classification structure that provides a picture of what is currently available on the application of costing tools in lean production processes.

The classification method has the following classification structure:

**Table 1.** Keywords and combinations.

	Lean Manufacturing	Industry and Integration	Production	Lean Manufacturing	Manufacturing	Production system
ABC	x	x	x			x
TDABC	x	x	x			x
VSC	x	x	x			x
Costing Methods	x			x		x
Activity-Based Costing			x	x		
Time-Driven Activity-Based Costing			x	x		
Value Stream Costing			x	x		

Source: authors.



AA – publication year;

AB – application areas of costing methods within the industry;

AC – level of integration between costing method with Lean Manufacturing;

AD – the advantages in the application of costing methods in the production process;

AE – the difficulties in the implementation and use of costing methods in the production process;

The categories adopted have their relevance by the object of study and the similarity of content focus.

The AA category concerns the year of publication of the article and will be dated directly, because although the research had been carried out within the 1994 time period to 2014 few works related to the theme were found;

The AB category is related to the application areas of costing methods within the industry. From the review of the literature we were able to sort and catalog the items via their object of study resulting in a model structured by application areas, number of items and used costing methods, ie it was possible to identify the number of found articles focused to areas of application and type of method, which led to the creation of a table providing the grouped data and encode each application area and correlating the funding methods and the number of related publications.

Table 2 shows the coding for papers in relation to the application areas and the quantity of papers and the cost method applied in the study.

The category AC defining four corresponding levels dividing the degree of integration and application of costing methods within the production process, or within the industry as a whole, delimiting of lowest to highest level integration between the methods according to their level of application within the object of study. This category proposes levels that take into account the mode of use, the way we applied the method and

the area in which there was the application within the production process. This category (see information in Table 3) is possible to identify the number of articles, methods, and the level of integration between them, another information the present in table is a quantity of papers by integration level, codification by category and costing method.

Table 3 shows the level of cost method for integration with the production process. Furthermore the table shows the amount of work and the code adopted for each level of integration.

The AD category is related to the advantages in the application of costing methods in the Lean companies, namely the advantages of using the methods and benefits provided by cost method when applied in the production process. The category aims to present the advantages presented by papers regarding the use of the cost method applied to the object focus of each study.

Table 4 presents the application advantages of costing method used Lean companies are divided into five main level of benefits.

Unlike the category AD category AE, presents difficulties in the deployment and use of each method in Lean companies. Category is proposing the classification of costing methods from the disadvantages encountered in relation to implementation and use of the costing method applied to the production process.

Table 5 shows the apparent difficulties found in the implementation and use of costing methods for Lean companies are divided into five levels.

From this moment, with the adoption of this categorization and classification system can be identified in a practical way the application area of costing methods, the level of integration, the advantages and disadvantages of each method. Based on this further analysis, the observed data as a basis for development of a fifth table, which has a proposal to group and provide all the information from the

**Table 2.** AB – Application area from costing method.

Code	Application area description	Papers	Costing methods used
A	Product costing	1	ABC
B	Manufacturing system	5	ABC/TDABC/VSC
C	Product development process	1	ABC
D	Simulation model in manufacturing	2	ABC
E	Just-in-time and production	1	ABC
F	Process development	1	ABC
G	Product and manufacturing	1	ABC
H	Lean operation	2	TDABC/VSC
I	Manufacturing and delivery	1	TDABC
J	Beverages industry	1	TDABC
L	Operation and Planning	1	VSC
M	Manufacturing industry	3	TDABC/VSC

Source: authors.

**Table 3.** AC – Level of integration between costing methods and production process.

Code	Integration Level	Description	Costing method		
			ABC	TDABC	VSC
PI	Low Integration	Presents the theory of the costing method (i.e. ABC, TDABC, VSC), but does not apply in practice within the process.	5	0	3
MI	Moderate integration	Uses a cost method to manage costs in the company’s specific area serving as a reference to assess one area or sector.	2	0	2
I	Integration	Apply one of costing methods (i.e. ABC, TDABC, VSC) throughout the production process.	3	3	0
RI	Robust Integration	Uses the concepts and apply one or more costing methods (i.e. ABC, TDABC, VSC) together within the production process.	0	2	0

Source: authors.

**Table 4.** AD – Advantages resulting from the application of costing methods.

Code	Description	Costing method		
		ABC	TDABC	VSC
AD1	Easy application and quick knowledge dissemination		x	
AD2	Provides better visibility of cost items	x	x	x
AD3	Measures the cost per value stream through the Lean model			x
AD4	Not dependent on Lean Manufacturing implemented	x	x	
AD5	Easy to deploy and does not depend on many resources		x	

Source: authors.

**Table 5.** AE - Difficulties in the deployment and utilization of costing methods.

Code	Description	Costing Method		
		ABC	TDABC	VSC
AE1	Take a long time in preparation and deployment process	x		
AE2	Practical application requires extreme attention	x	x	x
AE3	Requires additional effort to obtain information for the analysis	x		
AE4	Depends on lean manufacturing implantation			x
AE5	Depends on time equations		x	

Source: Authors.

articles surveyed here proposing a literature review of this classification.

### 4 Analysis and discussion

The application of a costing method in manufacturing helps to visualize the allocation of costs and expenses throughout the production process by providing important information, which is used as a decision basis for management and control purposes (Drury, 2004; Gunasekaran & Sarhadi, 1998; Kaplan & Copper, 1998).

The papers related with Activity-Based Costing have kept the main focus of the method, which has as main objective to calculate the costs of activities. The product cost calculations become a secondary operation. In this context, the product costs become the sum of the costs of activities that occur for product manufacturing (Özbayrak et al., 2004). The presentation of the ABC por Brierley et al. (2006), Ben-Arieh

& Qian (2003), Gunasekaran & Sarhadi (1998) complement the concept presented by Özbayrak, proposing the analysis of product cost, driving the cost of activities to product costing, leaving aside the analysis of the operational part with the method.

Hoque (2000) and Özbayrak et al. (2004) present the implementation of the ABC model in the industry as a model to estimate manufacturing costs using the cost information for making management decisions. That is, ABC enables to calculate in a lean company costs within the various operations of providing knowledge to support production (Gottmann et al., 2013).

The use of ABC as a parameter to estimate costs, is mentioned by Qian & Ben-Arieh (2007) as being an effective method that provides significant improvements as estimate of project costs in development for the industry, which is to simulate production planning. The application of Activity-Based costing provides

information related to production costs, inventory, and stock costs in cells, serving as a reference to simulate production planning in companies (Zhang et al., 2012).

The financial benefits of the application of ABC in the lean manufacturing model, were presented in a concise way, therefore, it's seen from the improvements resulting from the reduction and stabilization of inventories within a Lean company (Meade et al., 2006). In general companies are more likely to adopt and use the ABC (Schoute, 2011), however the application of the ABC method requires continuous effort of employees in its preparation (Stout & Propri, 2011).

The journals related to Time-Driven Activity Based Costing, consider that the model has a very close relationship to Lean, due both to focus on activities like using the time to measurements. The use of TDABC Lean companies are linked to the practices of Lean methodology, which seek to reduce costs that occur through the reduction of activities that do not add value. Pryor (2010) refers to use of Lean as a method that seeks to reduce waste in the activities, and in this context TDABC fits quantifying the cost of those activities, Both value added like non value added. Unlike ABC, the TDABC it is easy to apply because it is based on time equations to verify the activity time consumption (Stout & Propri, 2011). Advantages according to Kaplan & Anderson (2007) is the quick and easy preparation of the model in its simple integration into the management system, the facility to provide monthly information provided fast feedback to managers, the availability of information accurately, low maintenance cost and easy interpretation of information that allow identifying the source of problems.

The TDABC proved to be a methodology that serves as a thermometer for the activities within the lean manufacturing by providing information about the financial transactions (Pryor, 2010). On the other hand it is clear that the applicability of TDABC in companies with great instability and unpredictability environment may limit the application of the model (Avelar et al., 2012). This type of limitation is linked to the preparation of the weather equations, the time required for implementation and the intensity of resource consumption (Souza et al., 2010).

Regarding to the comparison between the traditional approach ABC and TDABC concludes that the TDABC can more accurately represent capacity utilization, it allows the analysis of capacity utilization by providing information about the excess capacity which means extra cost for Lean companies, as in the ABC the cost of carrying out the activities tends to be overestimated resulting in a less accurate information of capacity utilization (Oker & Adiguzel, 2010; Stout & Propri, 2011).

The advantage of this model in relation to the ABC is on the time equations, which reflect more accurately the complexity of operating transactions, paying for the time involved in the process, extinguishing control of several different activities and costs associated with a single activity (Kaplan & Anderson, 2007; Pryor, 2010; Stout & Propri, 2011).

Observed by analysis of the literature that TDABC model is best applied in service companies than manufacturing companies, this is by evaluating the capabilities that are usually measured in terms of days of work, and most often becomes more complex measure capacity in terms of working time in a manufacturing company (Oker & Adiguzel, 2010).

The papers related to the Value Stream Costing approach the method as a new cost modeling for lean companies (Ruiz-de-Arbulo-Lopez et al., 2013). The VSC meets the needs of lean manufacturing, using the value stream as a reference to measure the costs and eliminating the need for overhead allocation (Gracanin et al., 2014), another benefit presented by VSC is related to the flow of information, which makes it a support tool the implementation of operational improvements (Malta & Cunha, 2011).

The conceptual essence of the VSC is defined by the idea that instead of categorizing costs by departments the method proposes organizes them by value stream, which in turn is related to lean manufacturing, how to analyze department for costs has link with traditional production techniques (Ruiz-de-Arbulo-Lopez et al., 2013).

The literature shows the method as a tool that reduces waste by eliminating much of the transactions associated with cost accounting (Maskell & Baggaley, 2004). Its use associated with the techniques of Value Stream Mapping (VSM) allows measuring in cost level the flow of information and materials (Abuthakeer et al., 2010).

The method provides a simple financial information, where one can easily identify the meaning of this information and its origin. Simply and briefly the VSC can provide clear information without requiring a financial monitoring due to the use of value streams as the basis for representation costs (Maskell & Baggaley, 2004).

The literature review showed that implantation of the VSC and research on the model still are in early stage, however there is a growing interest related to the topic, articles and recent works seek to make comparisons between the ABC and the VSC, in this moment exist more papers dedicated at implantation in production processes (Ruiz-de-Arbulo-Lopez et al., 2013).

The literature proposes a general analysis of the costing methods, providing data that contribute to the management and financial control practices.

For businesses and industries such practices have a strong connection to support the strategy when it adopts the lean manufacturing model (McVay et al., 2013).

### 4.1 Descriptive analysis of results

The analyzed papers allowed assessment regarding the use of costing methods and their application in lean manufacturing, this analysis is aimed to more specific knowledge about this integration. Table 6 shows the result of the collation and interpretation of the data found in the articles presented on the leaderboards displayed in subsection 3.1.

Table 6 is designed to provide categorized information so that it can interpret the grouping of items, as the year of publication, performance area, level of integration, advantages and disadvantages in the application of the method.

The period examined concerning the category year of publication (AA) showed that the highest percentage of publications occurred in 2010 with about 20% of published articles, followed by 2011 and 2013 to 15% in 2006 and 2012 with about 10% of articles and other years represented each only about 5% of the publications in the period. The representativeness of ABC, TDABC and VSC methods within this universe researched were respectively 50%, 25% and 25%. See Figure 1

From the data available in Table 6 it can be concluded that the category of the method of application area (AB) has a total percentage of 25% articles that

spoke about the approach and using the cost method in item B (manufacturing system), 15% applied to the item M Industry (manufacturing), 10% in section D (simulation model in manufacturing) and H (lean operation), and 5% in the other remaining items (a, C, E, F, G, I, J and L).

Based on information obtained from Table 6 was prepared Figure 2 and 3, which has the purpose to provide visual information on the percentage of the categories integrating cost methods (AC), advantages in applying the cost method in the production process (AD) difficulties implantation and use of costing methods in the production process (AE).

Figure 2 shows the percentage of integration of funding methods and the object of study of each article. It is possible to interpret individually by cost method or the overall percentage of integration.

According to Figure 2, about 40% of the analyzed papers had little integration (PI) between the applied method and the object of study, since 30% of the papers detained in his analysis integration (I) in applying the cost method in the manufacture, 20% of the papers exhibited average integration (MI) and about 10% submitted a robust integration (RI) where one or more methods are used in common in a sector of the business focus of the study presented by the papers.

Inside of this analysis it can be observed in Figure 2, before 50% of publications related to the cost method ABC, 25% of those used only theory ABC model

**Table 6.** Literature review.

AA	AB	AC	AD	AE
1998	B	I	AD4	AE1; AE2; AE3
2000	E	MI	AD4	AE2; AE3
2003	C	I	AD4	AE1; AE2; AE3
2004	B	PI	AD4; AD2	AE2; AE3
2006	A	PI	AD4; AD2	AE2
2006	D	PI	AD4; AD2	AE3
2008	B	MI	AD4; AD2	AE3
2010	H	RI	AD1; AD2; AD4	AE2; AE5
2010	M	MI	AD2; AD3	AE2; AE4
2010	M	I	AD1; AD2; AD4	AE2; AE5
2010	I	I	AD1; AD4	AE2; AE5
2011	L	PI	AD3	AE2; AE4
2011	B	RI	AD1; AD2; AD4; AD5	AE2; AE5
2011	G	I	AD4	AE1; AE2; AE3
2012	D	PI	AD4	AE1; AE2; AE3
2012	J	I	AD1; AD4	AE2; AE5
2013	F	PI	AD4	AE2; AE3
2013	M	MI	AD2; AD3	AE2; AE4
2013	H	PI	AD3	AE2; AE4
2014	B	PI	AD2; AD3	AE2; AE4

Source: Authors.



and implemented not within the production process to obtain results, 10% used the methods in a specific area of the company to manage the cost that served as a reference for the evaluation of industry and 15% of articles used the cost method in the production process as a whole.

Regarding TDABC costing method, this holds 25% of publications in the literature review, it can be seen that 15% of journals refer to use of cost method within the production process as a whole and 10% did against applying more than one method within the production process. Finally VSC costing method, also 25% of the publications had 15% of them related papers that only used the theory of VSC model, not applying the cost method to the production process and 10% of journals only made reference to the use the methods in a specific area of the company to

manage the cost serving as reference for the evaluation within the company.

The advantages and difficulties presented in the application of cost method in the production process presented in papers make relation about use of costing methods in the various segments within manufacturing. Figure 3 has the purpose to provide the related percentage each costing method.

Regarding to the ABC, it can be concluded about the articles researched that when evaluated its advantages the method was 28.57% in respect to provide better visibility of the cost of items in the preparation of costing and presentation of results (AD2) and 71.43% related to its application being independent of the implementation of Lean Manufacturing model (AD4).

In relation to the difficulties presented in the implantation or use of the method, the ABC presents a method that takes time in their development, identification and implementation (AE1) as shown 19.05% of articles have also shown to be a method in which the practical application requires a lot of attention (AE2) represented by 38.10% and finally 42.85% of the articles were identified that ABC requires an additional effort in obtaining the necessary information for the analysis (AE3).

Regarding the TDABC, The advantages were distributed in more categories, about 35.72% proposed be TDABC a method of easy application and rapid dissemination of knowledge (AD1) was also observed in 21.42% of the articles that the method costing provides better visibility of cost items (AD2), 35.72% of the publications had the advantage of not depend on the Lean Manufacturing model implemented for the application of the model (AD4).

Regarding the difficulties encountered in implementing the TDABC and presented by the publications, only two were the categories and both had 50% each, being these AE2 and SU5 that are related to application of the method requires more attention at the time of preparation, and this model it is subject to time and because of this depend on calculations involving the time directed equations for their effectiveness.

About VSC, the advantages observed for the method among the publications were 37.15% regarding the method provide a better visibility of cost items (AD2) and 62.50% reported that this is

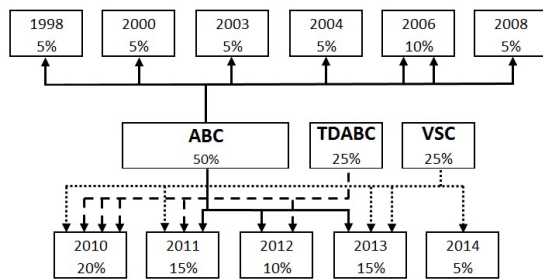


Figure 1. Percentage of publication by year.

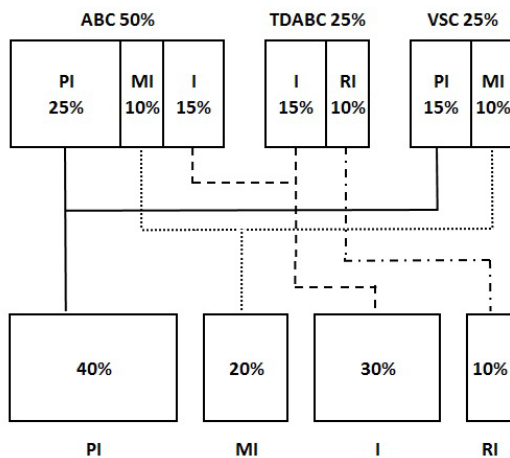


Figure 2. Integration of costing methods.

AD1 = 0.00%		AE1 = 19.05%	AD1 = 35.72%		AE1 = 0.00%	AD1 = 0.00%		AE1 = 0.00%
AD2 = 28.57%	ABC	AE2 = 38.10%	AD2 = 21.42%	TDABC	AE2 = 50.0%	AD2 = 37.50%	VSC	AE2 = 50.0%
AD3 = 0.00%		AE3 = 42.85%	AD3 = 0.00%		AE3 = 0.00%	AD3 = 62.50%		AE3 = 0.00%
AD4 = 71.43%		AE4 = 0.00%	AD4 = 35.72%		AE4 = 0.00%	AD4 = 0.00%		AE4 = 50.0%
AD5 = 0.00%		AE5 = 0.00%	AD5 = 7.14%		AE5 = 50.0%	AD5 = 0.00%		AE5 = 0.00%

Figure 3. Advantages and difficulties in applying the cost method.

the model that has the advantage to realize the cost through value stream based on the model of Lean (AD3), and the difficulties of implementation of VSC was observed by publications that 50% of them are linked to application requires much more attention at the time of preparation (AE2) and 50% in relation to its implementation and use depend on the robust implementation of the lean manufacturing model in its entirety (E4).

In general it can be observed that the application of costing methods in companies according to the publications are effective, but with reservations by the difficulties encountered in implementing them, in general terms it is possible to evaluate the methods as an evolution of the search better matching the lean enterprises.

Corresponding to ABC, it was identified that the as one of the first methods to be developed and implemented in Lean companies, there was a greater number of publications besides showing a robust method but has many disadvantages as its development.

The TDABC was presented in publications as an improvement to the ABC method, providing an elaboration more practical and fast, however his publications regarding the use in manufacturing are insufficient.

Finally, the VSC is a newer method which introduced the concepts used for Lean manufacturing and Lean accounting for the realization of cost through value stream, unfortunately the limiting factor for their application is need have a Lean model fully deployed.

## 5 Conclusion

The present study demonstrates the integration and application of employees costing methods in process or lean manufacturing companies through the analysis and classification of publications related to the theme. This paper conducted an investigation and data collection deepening knowledge about the involvement of costing methods (ABC, TDABC and VSC) in lean manufacturing, with regard more precisely to what is available current knowledge carrying out a review of this literature.

The investigation consist in interpret through a categorization the relationship between the costing methods in publications and application sectors, trying to analyze its advantages and disadvantages when applied in the lean production model. It took into account as the focus of research using the Lean concept in accounting maximizing customer value by reducing waste in the financial operations providing a continuous improvement process (Malta & Cunha, 2011). The work was based on the period between 1994-2014, and ranked publications to conduct further evaluation of the studied subject.

This study concluded that the literature review showed a limited number of publications on the subject especially when observing the most current methods like TDABC and VSC, they have shown little explored.

Furthermore it was observed that the costing methods although applied mostly only served as reference for the waste identification process theorizing or solely for comparative analysis to the traditional system not being integrated in fact the analysis process in production, the study showed that there is need to seek further deepening the theme that encompasses the process of lean manufacturing and costing methods for this purpose thus making the areas of manufacturing and cost an important area of study.

Finally this work can serve as a source of research and reference for future reference related to the theme. Note that future updates of the data studied here are necessary, given that the study is formulated in the analysis of a review of this literature.

Recommendation for deepen literature for Activity-Based Costing, Time-Driven Activity-Based Costing and Value Stream Costing in manufacturing, the authors: Gunasekaran & Sarhadi (1998), Oker & Adiguzel (2010) and Schoute (2011). As the future suggestion, we recommend further extension of this study to other costing methods here were not included before directed the research focus of the integration of new funding tools (ABC, TDABC and VSC) and the model or Lean production systems. It is also expected that this study will serve as a basis for more consistent modeling and analysis tools that can integrate the costing methods of production analysis tools.

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