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A Bibliometric Review of Time-Driven Activity-Based Costing

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Abstract

The company must be able to manage costs to achieve efficiency and maintain competitiveness. This article conducts a bibliometric review of the literature on the TDABC system to analyze its evolution and scientific contribution.Descriptive, relational, and content analysis techniques were applied to expand the vision of the field and identify the objectives and motivations for using TDABC. 258 articles retrieved from Scopus, Web of Sciences, and PubMed databases.Data reveals a growth in TDABC publications after 2010, the majority have been based on case studies and implemented within healthcare and manufacturing sectors. involved 947 authors who largely represent academia, and come from countries including the USA, UK, and Australia. Scientific journals specializing in health issues, business management, and accounting were most responsive. Its objectives indicate the value of TDABC for costs determination, time identification, cost-savings, and decision-making. Finally, the most cited publications are Kaplan and Anderson (2004) and Kaplan and Porter (2011) have the theoretical bases.This review provides information to academics and practitioners for the use TDABC modern cost management tools. On the other hand, TDABC is considered an innovative methodology for its application in any market segment and integral to business management

Keywords: *Time-Driven Activity-Based Costing, Bibliometric Literature Review, Case Studies.*

Introduction

Cost accounting and management control have evolved significantly since the 18th century due to the demands of the productive environment, the organizational structure of companies, mass production, and the need to obtain accurate data on the cost of products or services. Several researchers highlight the importance of managing and controlling the allocation of production costs and the distribution of indirect manufacturing costs in different economic fields. The literature includes the textile industry (Boyns et al., 1997), logistics (Rodríguez González et al., 1996), and the metallurgical industry (Gutiérrez Hidalgo, 2006).

Companies need a costing system for three main functions: a) inventory valuation and measurement of cost of goods sold for financial reporting; b) estimating the costs of activities, products, or services, and c) providing economic information on the efficiency of processes. The first need is driven by investors, creditors, regulators, and tax authorities. The second and third functions arise from internal managers' need for information to make strategic decisions and operational improvements (Kaplan and Cooper, 1998).

Over time, cost systems have evolved in response to changes in technology, business practices, and regulatory requirements. During the Industrial Revolution, companies focused on monitoring the costs of direct labor and materials, but today, they need to allocate indirect costs efficiently. One of the latest innovations in cost systems is the Time-Driven Activity-Based Costing (TDABC). It is a cost accounting methodology that builds upon Activity-Based Costing (ABC) principles, developed to allocate accurate and practical way costs to products (Kaplan and Anderson, 2004). TDABC is particularly useful in industries with significant variability in process times and activities, such as healthcare, professional services, and manufacturing (Kaplan and Porter, 2011).

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This article aims to conduct a comprehensive bibliometric literature review on TDABC to generate an updated overview of the field of study.

The paper is structured as follows: section two includes an overview of the evolution of the cost systems, section three describes the methodology, section four details the results and discussion, and, finally, the last section is devoted to the conclusions.

Cost Systems and Tdabc

Among the most used cost systems, "full costing" and "direct costing" models were widely applied until the 1970s by with the industrialization of processes and technological advances, indirect costs have become an important part of total costs. (Gutiérrez Hidalgo, 2006). The direct costing method became inefficient for allocating indirect costs concerning resource-consuming activities, areas, or functions.

In 1970, the standard costing system emerged, followed by the system called GPK created by the mentors Kilger and Plaut, German academics and professionals (Kilger, 1991) who designed it based on the foundations of standard costing and flexible budgets. It incorporates two basic principles: (1) For cost planning, cost control, and product cost, it is based on responsibility cost centers, and (2) It makes an explicit distinction between fixed and variable costs (Kaplan and Cooper, 1998).

In the mid-1980s, the Activity-Based Costing (ABC) system emerged which presents advantages in cost management compared to previous approaches. In this sense, cost generators or cost inducers were the indicators allowing indirect and support expenses to be directed, first to activities and processes, then to products, services, and customers (Kaplan and Anderson, 2007). This system gives managers a clearer picture of their operations' economics due to the objectivity and rigor level, based on the company's activities(Kaplan and Cooper, 1998). However, in the late 90s, some authors criticized this system mainly for its expensive implementation and the long process of interviewing employees to collect the necessary information about their activities (Cardinaels and Labro, 2008; Kaplan and Anderson, 2004).

Time-Driven Activity-Based Costing (TDABC)

Companies with increased operations required tools that allowed them to treat better costs. emerges "Time-driven activity-based costing" TDABC as an ABC innovation, adding a "time-based approach" (Kaplan and Anderson, 2004). Kaplan and Porter (2011) the implementation of TDABC is remarkable in the healthcare sector, In this regard, designed a pilot project for United States and European hospital systems, this methodology is structured in seven steps for a successful implementation, that facilitates the implementation of TDABC through properly structured time equations adapted to the company's processes and activities.

TDABC estimates activity costs, based on the unit cost of supply capacity and the time required to perform an activity "Time drivers" were established (Abdelbar et al., 2019). On the other hand, the capacity cost rate was understood as the relationship between the supplied capacity's cost and the supplied resources' practical capacity, keeping in mind that practical capacity generally ranges between 80% and 85% which is the actual amount of time dedicated to carry out the activity (Da Silva Medeiros et al., 2017). Besides, allows an immediate update of cost information (Abdelbar et al., 2019; Park et al., 2019). As a result, it provides greater efficiency in estimating the cost of products or services (Adıgüzel and Floros, 2020; Afonso and Santana, 2016; Alves et al., 2018; Yang and Hao, 2017).

TDABC system has been applied to different industries or companies with different degrees of complexity since it is comprehensive and versatile and uses a process mapping tool that allows companies to understand better the value flow during the patient care process (Au y Rudmik, 2013). This process will enable them to capture operational processes that serve as a basis for estimating costs (Akhavan et al., 2016; Chen et al., 2015; Tibor et al., 2017).

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Dalci et al. (2010) applied a case study in hotel in Turkey to demonstrate the implication of Customer Profitability Analysis (CPA) using TDABC. Soufhwee et al. (2019) used TDABC in an automobile factory, which reflected a decrease in production costs by eliminating unnecessary processes. Ribadeneira et al. (2019) analyzed the effectiveness of TDABC in using Information Technology (IT) at an Ecuadorian university. Furthermore, Siguenza-Guzman et al. (2016) focused their study on two university libraries in Belgium.

TDABC in Healthcare

In healthcare sector, TDABC research has been conducted through different methodologies, such as case studies (Blumenthal et al., 2018; Dutta et al., 2018; Ganorkar et al., 2018), literature reviews (Alves et al., 2018; Da Silva Medeiros et al., 2017) (Alves et al., 2018; Da Silva Medeiros et al., 2017)or articles based on mathematical simulation models (Cardinaels and Labro, 2008).

Some previous research estimated that the TDABC, focused on the cost of medical care for each patient, generates value in the service provided by avoiding unnecessary processes, provides a more precise measure of the real use of resources, and supports the continuous improvement of processes and their quality (Allin et al., 2020; Al Amiri and El Khmidi, 2018; Andreasen et al., 2017; Au and Rudmik, 2013). It is the only costing tool that allows process improvement by combining clinical and financial performance (DiGioia III et al., 2016). They observed that personnel were the dominant cost factor in this sector and the possibility of reducing general costs without compromising the quality of care is a challenge (Araújo et al., 2016; Demeere et al., 2009). Many companies in the health sector implemented this cost system and reported the results.

For example, Allin et al. (2020) conducted their study in a health insurance company. Al Amiri and El Khmidi (2018) evaluated cost management and control in a nursing area, Crott et al. (2016) implemented TDABC in Oncology they designed process maps and obtained more accurate estimations. Akhavan et al. (2016) state that by carrying out case studies, the contribution of TDABC is directly observed, finally, Da Silva Etges et al. (2019) contribute to costing healthcare literature by proposing an eight-step framework to apply TDABC.

TDABC Previous Reviews

A few reviews have analyzed the published literature on TDABC as it is a relatively new cost system. On the one hand, some focus on comparing the TDABC with other cost systems. For example, Da Silva Medeiros et al. (2017) from 1994 to 2014, analyzed 20 articles using ABC, TDABC, and Value Stream Costing (VSC). Besides, other reviews focus on the TDABC itself, Keel et al. (2017) selected 25 articles identified in seven databases that addressed cost issues in healthcare using this cost system. Niñerola et al. (2021) selected and analyzed 431 articles using ABC or TDABC in the health sector from 2009 to 2019, identified in two databases. Vargas Alves et al. (2018) used a period of 25 years in which they identified 27 articles from four databases, published from 1990 to 2016, in which they applied the ABC and TDABC in the area of oncology.

Therefore, the review aims to get an update of previous ones and complement bibliometric data with content analysis to identify the main objectives pursued by academics and practitioners when using TDABC.

Methodology

This review uses a bibliometric approach to get an overview of a field. It consists of synthesizing research evidence based on the principles of transparency and replicability (Kitchenham et al., 2007). We will focus on the design proposed by (Tranfield et al., 2003) based on three stages. The first corresponds to planning the review, the second is implementation, and finally, the third stage is presenting the results.

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Three sub-stages of the first stage are presented below: the selection of databases, key search terms to identify papers related to the topic, and the definition of inclusion or exclusion criteria for reaching the final sample of documents to analyze.

Databases Selection

Three scientific databases were chosen. Scopus and Web of Science (WOS) are two of the most important scientific databases, with great impact worldwide, and are widely applied in studies of this type (Keel et al., 2017; da Silva Etges et al., 2019).

Moreover, as we observed a remarkable number of papers from the health field in the preliminary searches, it was considered appropriate to use a third database to complement Scopus and WOS. MEDLINE-PubMed was used to be sure to identify the most relevant papers. However, most of them were already included in the two previous bases.

Keywords

The systematic search was implemented using five words: TDABC, Time-driven activity-based costing; Time-driven activity-base cost; Td activity based costing and Td activity-based cost. For Scopus, these keywords had to appear in the abstract, the keywords, or the title. And in WOS and MEDLINE – PubMed, they should be in Topic.

Article Selection Criteria

The search was limited to published articles in English and not in the process of publication, books, editorials etc. No limits were set about the year of publication since the aim was to include all the articles that address cost issues using TDABC. Finally, the study period covered 2004 to 2020 (17 years).

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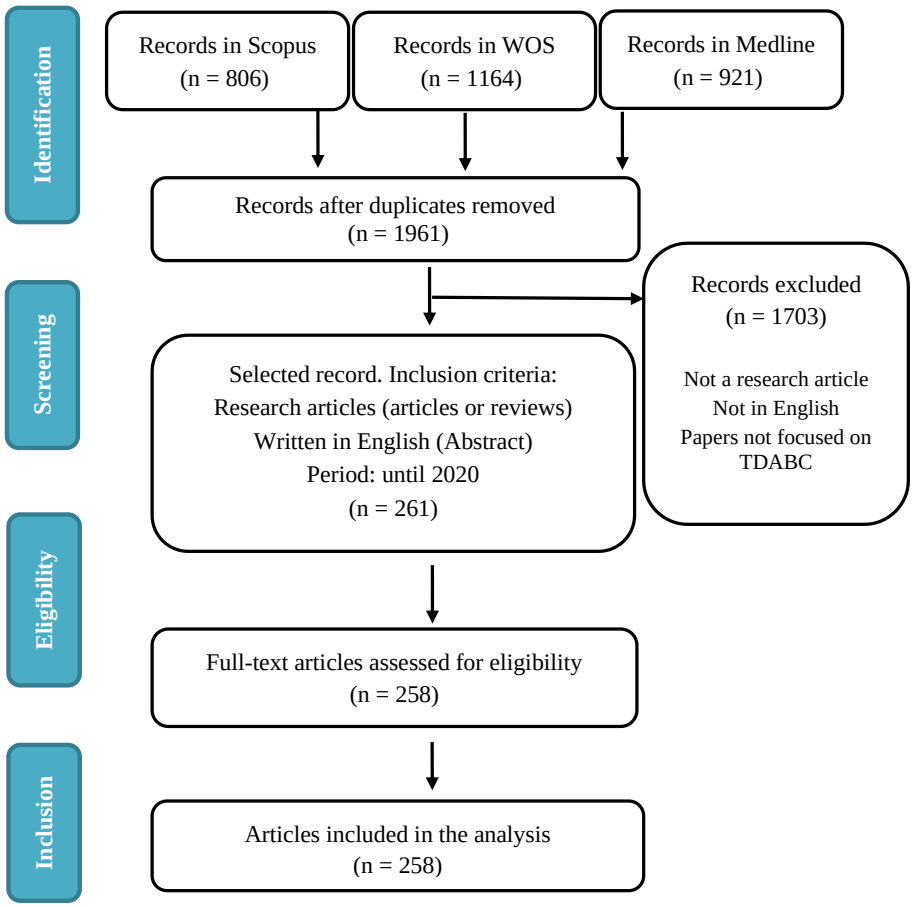

Figure 1. PRISMA

Source: Author's elaboration

A total of 2,891 articles were identified. 930 articles were excluded because they were duplicated in two or more scientific databases or in the publication process. Likewise, 1,703 articles were eliminated for different reasons. Some did not fulfill the inclusion criteria of language, or they were books or conference proceedings. Others were excluded after manual checks because after reading the abstracts, the content differed from the study subject. Of the 2,891 articles identified in the three databases, 258 articles (9%) were finally eligible for the study.

Figure 1 gathers the selection process using the flow diagram included in the PRISMA guide (Preferred Reporting Items for Systematic Reviews and Meta-analyses) (Liberati et al., 2009).

Data Processing

The list with the selected articles was generated from the Scopus database, and then exported in CSV Excel format with the information included (citation information, bibliographical information, abstract, and keywords). Next, the information on the variables (title, author, source, and abstract) was obtained in plain text from the WOS scientific database. Finally, a CSV file was generated from the PubMed database with the same information (title, author, citation, journal, year, and DOI).

Some standardization steps should be done after merging the three files in the same document and organizing the information. Three analyses were carried out in the review using different software and methodologies. For the descriptive analysis, we used Excel statistical functions and graphics. On the other hand, the relational analysis of keywords and authors was performed using VOSviewer (van Eck and

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Waltman, 2017). Finally, for the content analysis and objective identification of the literature about TDABC, the classification used by Niñerola et al. (2021) was followed. Two authors work independently in the coding process to identify the objectives. Afterward, the three authors discarded duplications and discussed discrepancies. These objectives were categorized under 12 structured criteria (Sánchez-Rebull et al., 2023).

Results

The results from the bibliometric literature review carried out in this paper are detailed in the following subsections. Epigraphs 4.1 to 4.4 include the descriptive analysis, while epigraph 4.5 corresponds to the relational analysis of the keywords and the last one the content analysis.

Publications Trend and Authorship

258 articles were analyzed during the period 2004 – 2020, observing an increasing trend in the number of publications about the cost system TDABC, especially from 2010 to 2016 (Table I). However, in 2018 and 2019, the number of publications has stagnated. Moreover, a significant decrease was observed in 2020, possibly due to the strong health crisis derived from COVID-19 that paralyzed regular activity.

Table I. Authorship Trend

Year	*Fx*	*Accumulated Fx*	*Professional Authorship*	*Academic Authorship*	*Mixed Authorship*
2 004	1	1	0	1	0
2 006	1	2	0	1	0
2 007	1	3	0	1	0
2 008	3	6	0	1	2
2 009	1	7	0	0	1
2 010	5	12	0	5	0
2 011	4	16	0	4	0
2 012	6	22	1	4	1
2 013	10	32	1	9	0
2 014	14	46	1	11	2
2 015	20	66	3	11	6
2 016	44	110	9	18	17
2 017	34	144	6	17	11
2 018	42	186	5	21	16
2 019	43	229	4	11	28
2 020	29	258	2	11	16
Total (%)	**258**	**100**	**32 (12%)**	**126 (49%)**	**100 (39%)**

Source: Author's elaboration.

On the other hand, we disaggregated the authorship of the articles, in the field of cost management, specifically in TDABC, the articles' authorship was mainly written by academic authors. However, 100 articles were published in co-authorship with professionals (Table I). This fact can be explained because most of the publications were developed as case studies applied to different areas of health, as will be highlighted later. In this sense, previous research has already confirmed a high level of collaboration between hospitals and universities (Sánchez-Rebull et al., 2023).

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947 authors from 18 countries published articles on TDABC during the period analyzed (Table II). However, only 36 authors who have published four or more articles. It means that 96% of the authors have published three or fewer articles, indicating a low degree of specialization on the topic and a high dispersion of the research. Thus, it seems an interesting topic for many authors, but only a few focus their research on cost issues applying TDABC.

Most of the authors only tangentially address it.

Table II. Number Of Articles by Authors

Articles	***fx***	***%***	***Fx***	***Authors***
1	736	77.72	736	
2	134	14.15	870	Various authors
3	41	4.33	911	
4	14	1.48	925	Bouami,D., Bruggeman,W., Cunningham,B., Hu,J., Incalcaterra,J., Kaplan,A., Labro,E., Meara,J., Polanczyk,C., Sabharwal,S., Showalter,T., Tan,H., Van Den,A., Tollenaar,R.
5	11	1.16	936	Balakrishnan,R., Bozic,K., Burke,M., Fiocco,M., Hoozée,S., Kont,K., Niedzwiecki,D., Roodhooft,F., Shah,A., Siguenza,L., Steinberg,M.
6	5	0.53	941	Frank,S., Govaert,J., Mistry,B., Van Dijk,W., Wouters,M.
7	4	0.42	945	Guzman,A., Haas,D.,Laviana,A.,Thaker,N.
9	1	0.11	946	Feeley,T.
25	1	0.11	947	Kaplan,R.
Total	**947**	**100**		

Source: Author's elaboration.

Another interesting analysis is the relationship between authors working together or if the literature is fragmented regarding research groups. In this sense, Figure 2 shows the relationship between the authors who have published five or more articles. The size of the nodes represents the number of articles published by each author (van Eck and Waltman, 2017). Kaplan R stands out for his level of collaboration with other authors. He has published 25 articles that have been cited 1,365 times. He is the reference author in the literature on TDABC.

For this reason, he is in the middle of the figure. The nodes' color indicates each author's average year of publication. Then, it can be said that the collaborations are recent as they are pretty yellow.

Moreover, there are not many research groups in this literature. Mainly, we can identify five groups led by (1) Kaplan, (2) Burke, (3) Feeley, (4) Balakrishnan, and (5) Govaert (Figure 2).

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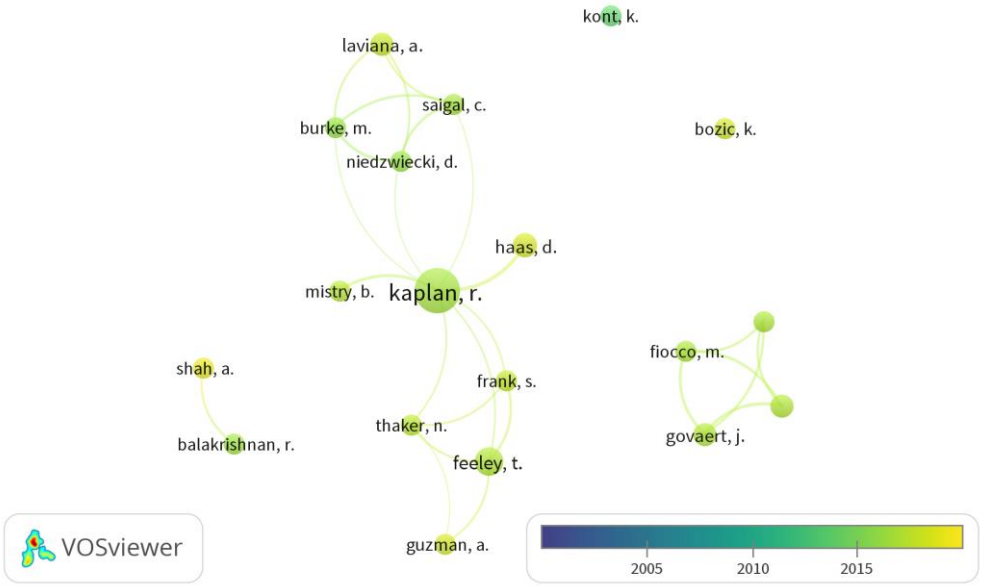

Finally, the affiliation is gathered to complete the research overview in terms of authors (Table III). In this sense, it only included the works of the 36 authors who have published four or more articles. Nevertheless, they add up to 203 of the 258 documents analyzed. These authors are academics from prestigious universities worldwide or authors who collaborate in health institutions.

In turn, it is observed that the TDABC cost system is being studied and implemented mainly by American academics from the Harvard Business School, University of Texas, and University of California. They were followed by those from the United Kingdom (Universidad de Oxford, University of Liverpool, and Faculty of Public Health and Policy, London School). This result could be expected due to the US health system being private to a greater extent, and it is highly controlled in processes and costs (Niñerola et al., 2021).

Table III. Main Authors by Institution and Country of Affiliation

Articles	*Authors*	*Fx*	*Affiliation*	*Country*
25	1	25	Harvard Business School	USA
9	1	3. 4	Harvard Business School	USA
7	4	62	Harvard Business School, University of California, University of Texas.	USA
6	5	92	University of Texas, Anderson Cancer Center, Harvard Business School, Department of Surgery Leiden University.	USA, United Kingdom
5	11	147	The University of Iowa, University of Texas, University of California, Leiden University, Ghent University, Tallinn University, David Geffen School of Medicine at UCLA, Katholieke Universiteit Leuven, Children's Hospital of Philadelphia, University of Cuenca.	USA, Belgium, Estonia, Ecuador
4	14	203	University Mohamed, Ghent University, University of Minnesota, University of Texas, David Geffen School of Medicine at UCLA, University of North Carolina, Boston Children's Hospital, Federal University of Rio Grande do Sul, Imperial College NHS Trust, University of Virginia, Leiden University, KU Leuven.	USA, Belgium, Brazil, United Kingdom, Morocco
Total	**36**			

Source: Author's elaboration.

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Journals Analysis

The 258 articles in the study are published in 169 scientific journals of different categories. This section analyzes the journals regarding citations, quartile, h-index, and country.

Table IV shows the overview of all journals in the database concerning citations received and quartile. It is observed that 82% of the journals are from the first or second quartile in its category. Only 30 journals are from quartiles 3 and 4. From this information, it can be deduced that the articles about TDABC are published in high-impact journals.

Table IV. Citations And Quartiles of Journals That Published On TDABC

Fx Documents	*Journals*	*%*	*Articles*	*Citations*	*Q1*	*Q2*	*Q3*	*Q4*
1	125	73.96	125	1 416	60	38	17	10
2	22	13.02	44	1 400	14	6	0	2
3	11	6.51	33	599	9	2	0	0
4	5	2.96	20	359	3	2	0	0
5	2	1.18	10	57	1	0	1	0
6	2	1.18	12	111	1	1	0	0
7	2	1.18	14	377	2	0	0	0
Total	**169**	**100**	**258**	**4 319**	**90**	**49**	**18**	**12**
%	**100**				**53**	**29**	**11**	**7**

Source: Author's elaboration.

Only twenty-two journals have published three or more articles on TDABC (with a maximum of 7 articles published by two journals: Clinical Orthopedics and Related Research, and Journal of Oncology Practice) (Table V). These numbers represent 13% of the total publications of the database. Therefore, there is not a specialized group of journals that publish TDABC research. On the contrary, it is published in different journals in different fields of specialization, not only accounting and management.

In addition, another important aspect to consider is the h-Index of those journals. The h-Index indicates scientific works' visibility, production, and impact (Miró and Burbano, 2013). In this sense, the group of journals analyzed has a high h-index, with 332 as the maximum. Ten of these 22 journals have a h-index greater than 100. Quartiles and h-index have been taken from the SCImago web portal Journal Rank (SJR) for 2020.

Table V. Quartile And H-Index of Journals That Published At Least Three Articles About TDABC.

Country	*Journal*	*Articles*	*Citations*	*Quartile*	*h-index*
USA	Clinical orthopedics and related research	7	301	Q1	204
USA	Journal of oncology practice	7	76	Q1	60
USA	Brachytherapy	6	85	Q2	49
UK	Bmj open	6	26	Q1	103
USA	Journal of healthcare management	5	12	Q3	48
UK	Journal of the American college of radiology	5	45	Q1	59
UK	Healthcare	4	89	Q2	36
UK	Int . journal of productivity and quality management	4	40	Q2	26
USA	Journal of arthroplasty	4	77	Q1	135

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USA	Journal of bone and joint surgery - series a	4	79	Q1	260
USA	Journal of management accounting research	4	74	Q1	23
UK	Bone and joint journal	3	11	Q1	181
USA	Accounting horizons	3	49	Q1	74
Ireland	Health policy	3	258	Q1	92
USA	International journal of radiation oncology biology physics	3	35	Q1	248
UK	Journal of academic librarianship	3	46	Q1	58
UK	Journal of oral and maxillofacial surgery	3	41	Q2	121
USA	Journal of pediatric orthopedics	3	26	Q1	96
UK	Journal of pediatric surgery	3	33	Q1	126
USA	Laryngoscope	3	14	Q1	148
USA	Plos one	3	48	Q1	332
UK	Qualitative research in accounting and management	3	38	Q2	26
Others	Less than 3 articles	169	2 816		
Total		258	4 319		

Source: Author's elaboration.

On the other hand, USA is in first place in the number of journals (75) and citations received (2,830) (Table VI). The citation data is double compared to the country in the second position. Although 60 journals belong to the United Kingdom, they received 1,059 citations. Overall, these two countries received 90% of the total citations, highlighting the importance of the American and British journals in cost research.

The remaining 34 journals belong to 16 countries and received 10% of the citations. Moreover, it is important to highlight that almost 7% of these citations correspond only to Irish journals.

Table VI. Country Of Origin of The Scientific Journals and Citations Received

Country	***Journals***	***Citations***	***%***
USA	75	2 830	65.52
United Kingdom	60	1 059	24.52
Brazil	5	19	0.44
Germany	4	13	0.30
Australia	3	17	0.39
Canada	3	41	0.95
Spain	3	18	0.42
Ireland	3	298	6.90
Swiss	3	14	0.32
India	2	6	0.14
Croatia	1	0	0.00
Ghana	1	0	0.00
Lithuania	1	3	0.07
Portugal	1	1	0.02
Romania	1	0	0.00
South Africa	1	0	0.00

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Turkey	1	0	0.00
Ukraine	1	0	0.00
Total	**169**	**4 319**	**100**

Source: Author's elaboration.

Finally, regarding the journals' research scope, 65% are related to healthcare, 17% of the journals focus on business management (accounting, economics, and finance), and 18% are distributed in other research domains such as engineering, manufacturing, library services, information and communication systems, environment and multidisciplinary.

Study Method

For the analysis of the method used in each article, the articles were classified into five study methods, adapting the classification proposed by Sánchez-Rebull et al., (2023) (Table VII).

Table VII. Articles According to The Used Methodology by Year

Year	*Theoretical basis*	*Case study*	*Literature review*	*Simulation model*	*Quantitative study*	Total	%
2 004	1	0	0	0	0	1	0.39
2 006	0	1	0	0	0	1	0.39
2 007	0	1	0	0	0	1	0.39
2 008	0	2	0	1	0	3	1.16
2 009	0	1	0	0	0	1	0.39
2 010	0	5	0	0	0	5	1.94
2 011	1	3	0	0	0	4	1.55
2 012	0	3	0	3	0	6	2.33
2 013	0	8	2	0	0	10	3.88
2 014	0	13	1	0	0	14	5.43
2 015	0	19	1	0	0	20	7.75
2 016	0	43	0	0	1	44	17.05
2 017	0	29	2	2	1	34	13.18
2 018	0	38	2	2	0	42	16.28
2 019	0	39	2	2	0	43	16.67
2 020	0	27	2	0	0	29	11.24
Total (%)	**2 (0.8%)**	**232 (89.9%)**	**12 (4.6%)**	**10 (3.9%)**	**2 (0.8%)**	**258 (100%)**	

Source: Author's elaboration

The study of the TDABC as in any field of research focuses on method theoretical and exploratory and then moves more toward quantitative studies. Only el 0.8% the articles contain the theoretical bases for implementing the TDABC, its contribution has been fundamental. Between 2006 and 2009, 6 articles were published, it began to be implemented in the library and logistics operations sector. It was not until 2009 that the application of the method study case to the health sector.

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2024
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From 2013 to 2020 most research is conducted mainly through case studies (89.9%). Tibor et al. (2017) state that researching TDABC under the case study methodology is essential to more accurately understand the influence of the methodology in the cost allocation and estimation process.

On the other hand, analyzing the economic area of the application of TDABC, it is observed that 75% focused on the healthcare area, while 25% remaining was on other activities such as manufacturing, commerce, construction, and services: hotel services, library, and information and technology.

The authors agree on the concern to quantify the value of process improvements in terms of costs, time, and personnel resources (French et al., 2016; Ostadi et al., 2019). The TDABC approach is novel in calculating capacity cost rates (Au and Rudmik, 2013; Kaplan et al., 2015; Kaplan and Witkowski, 2014). On the other hand, they estimate that improves the distribution of the cost and highlight that it effectively works with other business management tools (Öker and Özyapc, 2013; Vogl, 2013).

Due to the results' relevance in healthcare, it was considered to study which department implements TDABC in more detail. (Table VIII).

Table VIII. Articles about TDABC – Health Areas

Healthcare	Articles	%
Arthroplasty	18	10,17%
Cancer surgery	21	11,86%
Cardiovascular Treatment	6	3,39%
Emergency department	8	4,52%
Medical process	12	6,78%
Mental healthcare	6	3,39%
Obstetrics and Gynaecology	7	3,95%
Orthopaedics	5	2,82%
Pediatrics	11	6,21%
Pharmaceutical services	6	3,39%
Radiation therapy	14	7,91%
Surgical procedure	20	11,30%
Urology	6	3,39%
Other	37	20,90%
Total	**177**	**100,00%**

Source: Author's elaboration.

In this sense, 39 areas were identified, including 177 published articles. The health areas where more than five implementations were carried out are gathered

Relational Analysis: Trend of The Co-Occurrence of Keywords

The keywords that appeared together in a paper, i.e., co-occurrence, are analyzed in this subsection (Figure 3). In this sense, the papers in the database include 431 keywords. These keywords used by the authors for characterizing their work serve to identify subthemes and trends in a field of research.

A threshold of three repetitions was set to find relevant information. Then, 43 keywords fulfilled this requirement and were analyzed using VOSviewer.

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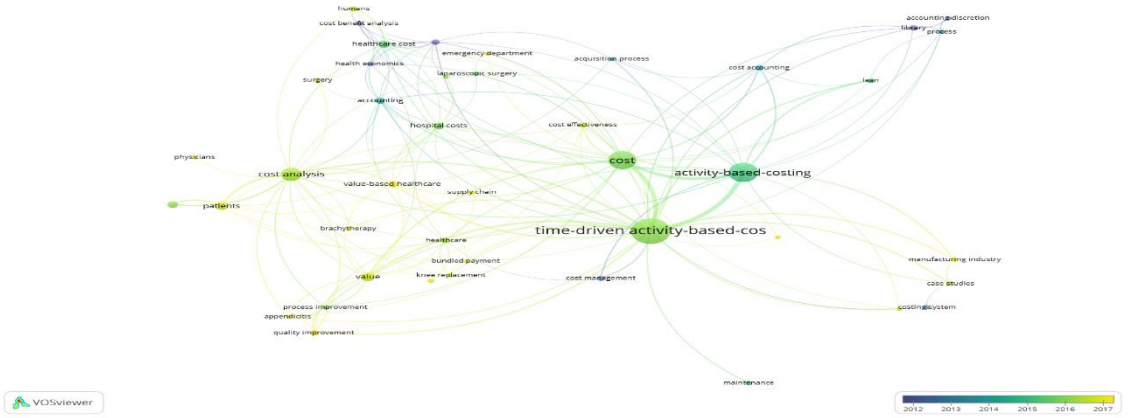

Figure 3 shows the importance of each keyword (size of its node) and their relationships (lines). Each link means they have appeared together in some document (van Eck and Waltman, 2017). On the other hand, the color shows the average year in which that keyword has appeared in different publications. In this way, nodes in yellow such as "patients", "quality improvement", "value-based healthcare" and treatments such as "brachytherapy", "knee replacement", and "appendicitis" have been used more frequently in recent years. At the same time, words like "cost control", "accounting", "cost management" and "cost benefits analysis" marked in blue mainly appeared at the beginning of the analyzed period. Therefore, it is suggested that nowadays, TDABC focuses on improving quality and patient satisfaction rather than cost control.

The cost system analyzed, "Time-driven Activity-based-costing", appears set in green as it has been used regularly throughout the period. It maintains a strong relationship with the words "cost", "cost analysis" and "activity-based cost", as the thicker line remarks.

Content Analysis: TDABC Objectives

The last analysis performed in this literature review is the content analysis to identify the objectives or motivations pursued in each article. It should be noted that some articles include more than one objective. Therefore, the number of papers analyzed does not coincide with the number of objectives found. Was applied The classification and structure process used by Niñerola et al. (2021).

Fifty-seven objectives were identified (Annex1). The objective "determine costs" had the highest frequency, given that 172 articles pursued this objective. After, "time identification" with 68 appearances and "procedure costing" 58 times represented the primary motivation for implementing TDABC. Other highly repeated objectives were "cost savings" (57 times), "cost components" (43), "value" (24), and "decision making" (24). All these results show that the determination, application, management, and control of costs are the fundamental basis of TDABC.

The influence of the health field in the TDABC literature also becomes evident when we identify these objectives. The designing of process maps also improves patients' care (Kawamoto et al., 2013).

Finally, other objectives have less presence, but they stand highlighting that TDABC is not merely seen as a cost-control tool but is also a cost-valuable system for improving quality and decision-making. After the papers' objective identification, they were grouped into 12 categories to understand better the motivations for using TDABC (Niñerola et al., 2021) (See Appendix 1 for more detail). the objective "Stocks valuation" in the first place, followed by "Cost reduction, cost management, and cost control" and "Time reduction and time management". These are the most important motivations addressed in TDABC literature. Approximately 83% of the objectives have been grouped in these three categories.

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Conclusions

The TDABC system, was emerged due to criticism from its predecessor ABC, is a widely implemented methodology in different economic segments, highlighting its contribution to the health field (Anderson and Sedatole, 2013; Dalci et al., 2010). costs must be managed to optimize capacity and eliminate non-value-generating activities (Adıgüzel and Floros, 2020), and provides transparent cost information and is easier to implement than ABC (Campanale et al., 2014; Everaert et al., 2008).

This work's main contribution is providing an overview of the state-of-art of the TDABC cost system, some impact journals have been identified that can be possible outlets for new papers about this literature. It can be a starting point for researchers who want to learn and deep TDABC. The use of three different and relevant databases Scopus, WOS, and MEDLINE-PubMed constitutes a significant contribution. In addition, this study represents an extension of previous reviews since it covers the period 2004 to 2020, that is, 17 years of TDABC literature.

La versatilidad del TDABC ha permitido que esta metodología de costos sea ampliamente implementada en diferentes actividades económicas, situación que se refleja en la relación entre las palabras clave. Anteriormente, TDABC, ABC y los costos estaban frecuentemente interrelacionados, destacando la comparación entre métodos y la necesidad de controlar los costos. Sin embargo, hoy en día, otras palabras clave frecuentes que aparecen en nuevas publicaciones como pacientes, atención sanitaria o costes hospitalarios reflejan que el sector sanitario ha adoptado el TDABC.

Another relevant finding is the quality of the scientific journals interested in publishing TDABC papers mainly related to the health area, which generally has higher levels of impact than accounting journals. Most of those journals are from developed and avant-garde countries.

Regarding the motivations for implementing TDABC, from the content analysis, it can be deduced that cost determination is the main aim of this research. However, other aspects have been valued, such as the efficiency of reducing time or avoiding unnecessary activities.

Finally, it would be interesting for future research to apply the methodology to different contexts in regions and economic environments as the research is highly concentrated.

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