

Improving healthcare performance through Activity-Based Costing and Time-Driven Activity-Based Costing

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Abstract

Improving healthcare performance has become a need for resource optimisation in a field where they are scarce. Activity-Based Costing (ABC) has been applied for more than 30 years to allocate costs and provide information for decision-making. This paper seeks to review previous literature in the health field that analysed this cost system and its new version, TDABC (Time-Driven Activity-Based Costing). Five hundred ninety articles published from 1989 to 2019 were retrieved from Scopus and Medline. The review includes descriptive, relational and content analyses. Results show that the interest in applying these cost systems is growing, especially in journals focusing on the financial aspects of health, policy and planning, and radiology. However, there is a difference in the application of ABC and TDABC. ABC is more related to efficiency and more used in laboratories. In contrast, TDABC is primarily used in hospitals and addressing the value of health rather than cost-effectiveness. On the other hand, the findings suggest that TDABC present greater opportunities for publication compared with ABC. Its progression is higher and gets more citations. The current article

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contributes to broadening the field's vision and encourages authors for further research.

KEYWORDS

Activity-Based Costing, cost determination, health, Time-Driven Activity-Based Costing, value-based health care

1 | INTRODUCTION

According to Kaplan and Porter,¹ health care's biggest problem is not insurance or politics. It's that we measure the wrong things in the wrong way. There is a need for studying health systems' performance and measurement as people are most prone to pay for value rather than for volume.² More expensive care is not necessarily better care. Thus, appropriate cost systems are needed, especially in emerging and developing countries where the performance of health systems is a crucial topic given the scarcity of financial resources.^{3,4} For this reason, the concept of value in this context is noteworthy. As far as value is commonly defined from an economic point of view as the benefit achieved for the money spent,⁵ it can only be determined considering their associated costs.

To quantify the services provided by healthcare, different cost systems for allocation of resources have been used: traditional charge systems, relative value unit (RVU) costing, ratio-of-cost-to charges (RCC), Diagnosis-Related Group (DRG), Activity-Based Costing (ABC) or Time-Driven Activity-Based Costing (TDABC), among others.⁶⁻⁸ This review focused on ABC and TDABC. It has been found that these systems improve resource allocation and provide more accurate cost information in complex environments with resources focusing on skills and implicit knowledge like health care services.^{9,10} Moreover, some authors believe that TDABC is the most practical approach for measuring value in the field.²

ABC was born due to the business changing environment and providing useful information for decision-making.¹¹ Specifically, it could be said that Cooper and Kaplan created the system for obtaining a more accurate cost of products.^{12,13} Traditional cost accounting, which mainly uses one single cost driver, such as direct labour or output volume, to allocate the overhead costs, could not give an accurate cost for properly running the business. In this sense, the more significant difference between ABC and other systems is the allocation of indirect costs. In this system, the cost allocation is based on the activities required to obtain the product. Therefore, ABC focuses on measuring the cost and performance of activities based on three basic premises: products require activities, activities consume resources and resources cost money.¹³ ABC systems have been proved to be more valuable than traditional cost accounting systems.^{14,15} According to Cooper and Kaplan,¹⁰ ABC helps managers understand precisely where to take actions to drive profits.

On the other hand, despite the method's benefits, it is not exempt from criticism.¹⁴⁻¹⁶ Some critiques are related to its methodology. There are difficulties in defining the activities accurately as some processes require very extensive development, sometimes challenging to understand, and costly.^{16,17} Moreover, other authors found that ABC adoptions are occasionally unsuccessful due to implementation problems.^{18,19} Consequently, not all companies found ABC useful for decision-making²⁰ or considered it appropriate for guiding their actions.²¹

These concerns make this system not universally accepted and explain its low adoption rate. For this reason, Kaplan, one of the leading promoters of ABC, alongside Anderson, proposed an evolution of this method to gain in simplicity and usefulness,¹⁴ developing the TDABC.

The fundamental difference between the two systems is that ABC uses many cost drivers, while the TDABC only uses time as a cost generator. TDABC demands fewer resources by requiring only two key parameters: the capacity cost rate (CCR) and the time necessary to perform activities. The CCR is the cost of capacity-supplying resources divided by those resources' practical capacity.²² Moreover, in this system, time equations are used to capture activities'

complexity. They reflect how order and activity characteristics cause processing times to vary. According to Kaplan and Anderson,¹⁵ the key insight is that although transactions can quickly become complicated, managers can usually identify what makes them problematic. Moreover, the variables that affect most such activities can often be precisely specified and are typically already recorded in a company's information systems. Then, the implementation is more manageable and objective than in the ABC.

There are not many previous reviews addressing the cost of health care with those methods despite being widely used. Stefano et al.²³ highlight that the application of ABC in health is restricted by areas or departments of a health organisation and, in the same line, most of the reviews carried out in the field have this scope. They are centred on a specific health area like surgery,²⁴ obstetrics,²⁵ oncology⁹ or traumatology.²⁶ These reviews focus mainly on how the different methods (including ABC or TDABC) have measured a specific aspect within the study area,^{9,25} the variations in the use of the cost method itself to conclude that it lacks standardisation,²⁶ or the comparison of the cost-effectiveness between different techniques.²⁵

To the authors' best knowledge, the few general reviews on ABC and TDABC²³ or reviews that address cost issues on health care²⁷ do not analyse properly and extensively both systems in the field. The only reference we found, published in Health Policy, includes only the TDABC²⁸ and examines 25 papers until 2015, representing a small sample.

Therefore, this paper aims at conducting a comprehensive review of the literature that has addressed cost issues using ABC or TDABC in health. More concretely, the objectives are, on the one hand, to determine the use of ABC and TDABC over time, where the studies have been published, and their motivations. On the other, to identify differences between the systems in terms of practical applications and bibliometric variables.

This review is structured as follows: after a brief of both systems and their use in healthcare developed in the introduction, the methodology is explained in Section 2, results (descriptive, relational, and conceptual) are presented in Section 3, discussion in Section 4 and, finally, conclusions and future research is summarised in Section 5.

2 | METHODOLOGY

We use a bibliometric methodology for analysing the scientific literature that addresses the ABC and TDABC systems application in the healthcare area. Bibliometric is the use of statistical methods to analyse books, articles, and other publications.²⁹ It usually considers the author's research areas, publication sources, the citation network and the paper content, among other items.³⁰

2.1 | Research design

We undertook the literature review following the PRISMA statement.³¹ We identify the relevant studies using the terms "activity-based costing" OR "activity-based cost" and health, in the title, abstract or topic, and keywords.

As shown in Figure 1, articles should be included in one of the following databases, usually used to conduct literature reviews in the health field³²: Medline or Scopus. Medline is the world's most popularly used database in health sciences. On the other hand, Scopus, offered by Elsevier, is multidisciplinary, covering Life Sciences, Social Sciences, Physical Sciences, and Health Sciences. The criteria for selecting studies were: articles published in peer-reviewed journals, written in English, and until 2019.

It should be highlighted that 539 articles in Medline were included and 544 in Scopus. In total, the review consists of 590 not overlapped documents. Using both databases, we increase the review's comprehensiveness and coverage. In this sense, we calculated the traditional overlap suggested by Gluck,³³ and there is a 69% similarity between the papers of ABC and TDABC found in the two databases. In other words, a 31% separation, which is what we have gained using both.

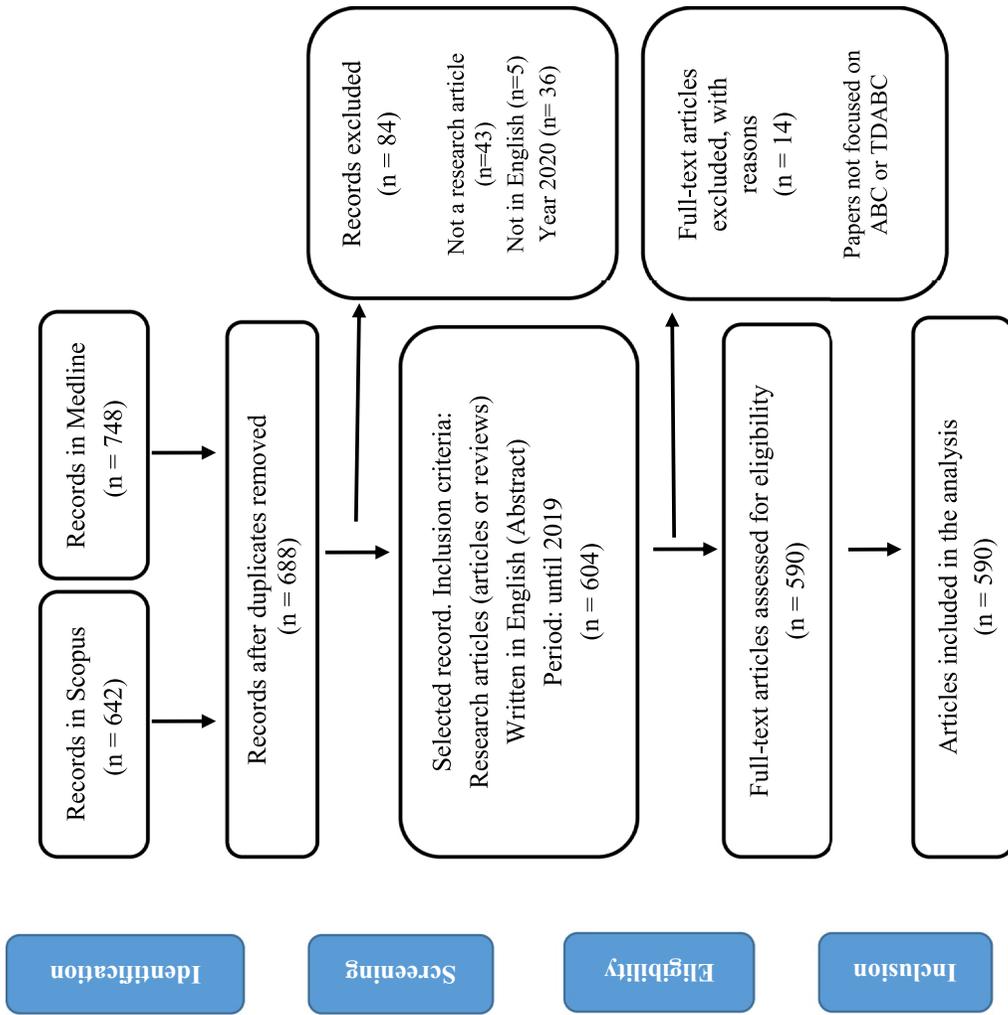


FIGURE 1 PRISMA (search conducted on 30 June 2020)

$$\% \text{ Traditional overlap} = 100 \times \left(\frac{|\text{Scopus} \cap \text{Medline}|}{|\text{Scopus} \cup \text{Medline}|} \right) \quad (1)$$

$$\% \text{ Traditional overlap} = 100 \times \left(\frac{407}{590} \right) = 69\% \quad (2)$$

2.2 | Data processing

An initial homogenisation step was carried out before starting with data analysis to improve the results' consistency. We disambiguated the authors' names, journal names, and keywords. As data was retrieved from two different databases, some words were exhibited in different formats.

To process the data, Excel and VOSviewer were used. Nees Jan van Eck and Ludo Waltman developed VOSviewer in 2010 at Leiden University (The Netherlands).³⁴ It is bibliometric mapping software that allows obtaining a broad overview of the literature's structure on a particular topic of interest, and it is a widely used tool.³⁵

2.3 | Data analysis

Three analyses were carried out in the review using different software and methodologies. For the descriptive analysis (Section 3.1), we used excel statistical functions and graphics. On the other hand, the relational analysis of keywords (Section 3.2) was performed using the software mentioned above, VOSviewer. Visualising and classifying keywords give insights about topic thematic subfields.

Finally, for studying the motivations and main goals of the papers of the database, we use content analysis (Section 3.3). Codes (objectives) were defined during the data analysis after reading the title, abstract, and in some articles, the full text. Therefore, they derived from the content rather than from literature or theory. Subsequently, they were grouped into 17 categories following the similarities with those proposed by Innes et al.³⁶ and Kuo and C. Hang.³⁷

Two of the authors were independently working on the open coding process to identify the objectives. Afterwards, they were analysed by the three authors to discard duplications, discuss discrepancies, and ensure the consistency and validity of their classification.

3 | RESULTS

This section is divided into three sub-sections. The first sub-section provides the descriptive analysis results, drawing a broader picture of bibliometric aspects of ABC and TDABC research on healthcare. The second sub-section shows the development of the thematic analysis considering the keywords. And finally, the third sub-section provides the results of the content analysis, including more in-depth information about the purposes of the papers analysed.

3.1 | Bibliometric descriptive analysis

The analysis includes 590 articles. It should be highlighted that 441 used ABC as a cost system, and 142 addressed the study's objective through TDABC. Only seven papers combine both cost methods. On the other hand, the TDABC system is more recent than ABC, so it is expected to accumulate fewer documents.

The evolution of publications in the healthcare field using ABC and TDABC has notably increased in the last years (Figure 2). Although the ABC method has already turned 30 years old, 50% of the publications have been from 2013.

This finding suggests a growing need to know and assess more precisely the costs and performance in healthcare. On the other hand, the TDABC method is gaining ground on its predecessor, and its numbers are already equal in just a few years. It is, therefore, foreseeable that the TDABC will surpass the ABC in terms of research interest soon. This fact is a consequence of the greater simplicity during the TDABC implementation process, making professionals choose this cost system instead of its precursor.

Figure 2 also exhibits a relevant fact related to authorship. As can be seen, the largest number of documents have collaborations (joint authorship), that is, the papers are written together by academics and professionals of the sector. Mainly, this trend occurs in the last years, coinciding with the booming literature in the field. There are two possible explanations. On the one hand, the complexity of the method may require a person specialised in its application. Therefore, this person, usually an accountant or someone involved in management functions, works with health professionals or academics. And on the other hand, it has been seen in other reviews³⁸ that the medical field encourages collaboration between medical professionals and scholars, especially in university hospitals.

Regarding the journals where the studies are published, we identified 382 journals with just one paper published addressing cost issues through the ABC or TDABC system. Besides, if we look for two documents, this number down to 90 (23.5%) and 48 if we ask for three published papers, that is, 12.5%. Only 26 journals have published four documents and, Table 1 shows the journals considering the threshold of five published articles. As can be seen, all of them are journals related to health and not accounting. Moreover, it is noteworthy to say that they mainly focus on the financial aspects of health, policy and planning, and radiology.

Finally, authors from universities, hospitals, or other United States organisations contribute with 45.8% of the database. They also authored most of the most cited articles. In this country, there has always been an urgent need to improve the health system's efficiency, not only at the quality level of health but also at its cost to compare health outcomes and costs. It should be noticed that the United States does not have a universal healthcare program, unlike most of the other developed countries and, although they are the ones that most spend on healthcare,⁴⁰ they do not have the best system, and they are not the most efficient.⁴¹ Italian authors represent 7.1% of the papers, and the British authored 5.9%. Other countries are below 5%.

3.2 | Thematic and relational analysis

The thematic analysis emphasises identifying, analysing, and interpreting patterns of meaning (or 'themes') within qualitative data. This review uses the most repeated keywords as themes to see the structure of the field studied. Keywords reflect the authors' beliefs about their articles' subject content fields genuinely⁴²; therefore, they can capture what the article is about or what it is related to. On the other hand, seeing how these themes are connected, we can identify groups of similar works (clusters) that may be of interest to the same group of researchers. To do so, we use the software VOSviewer as it allows us to organise and visualise the occurrence of keywords and the relationships between them.

The result of the most important keywords is displayed in Figure 3. The threshold by default in the software is five, so we include the keywords that appeared at least five times (36 keywords). The nodes and words' sizes represent the keywords' occurrences, that is, a bigger node means that the keyword is more repeated in the database, so it is more significant within the field studied. Moreover, the distance between two nodes reflects the strength of the relationship between them and the line's thick, the times they appear together.⁴³

The most important keywords were Activity-Based Costing (129 occurrences), cost analysis (79 occurrences), cost (69 occurrences), Time-Driven Activity-Based Costing (57 occurrences) and cost-effectiveness (44 occurrences).

ABC is the most repeated keyword. We found 441 articles that applied it as a cost system, but only 129 mention it as a keyword. That is, only 30% of the authors put the cost system used in the paper's characterisation. On the contrary, this percentage increases for TDABC. If our database is made up of 141 articles and 57 uses it as a keyword, it means that 40% of the TDABC papers do so. The difference between these percentages among systems shows that

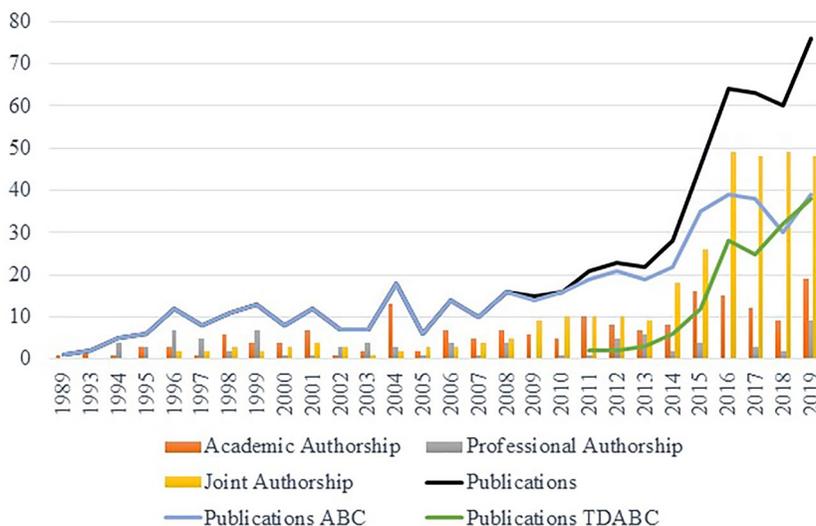


FIGURE 2 Publication trend

authors using TDABC value identify the cost system when characterising the paper. The system is itself an important highlight of the article. On the other hand, it could also be that being a newer method, the authors currently pay more attention to the keywords used or add more than before.

TABLE 1 Most productive journals

| Journal ^a | Articles | Citations | Country |
|-------------------------------------|----------|-----------|-----------------|
| <i>Healthc Fin Manag</i> | 11 | 212 | United States |
| <i>BMJ Open</i> | 8 | 34 | United Kingdom |
| <i>Brachytherapy</i> | 7 | 71 | United States |
| <i>Eval Program Plan</i> | 7 | 75 | United Kingdom |
| <i>J Health Care Fin</i> | 7 | 90 | United States |
| <i>J Healthc Manag</i> | 7 | 110 | United States |
| <i>Acta Hospitalia</i> | 6 | 2 | Belgium |
| <i>BMC Health Serv Res</i> | 6 | 83 | United Kingdom |
| <i>Health Policy</i> | 6 | 213 | Ireland |
| <i>Health Policy Plan</i> | 6 | 133 | United Kingdom |
| <i>J Med Syst</i> | 6 | 95 | United States |
| <i>PLoS One</i> | 6 | 31 | United States |
| <i>Radiother Oncol</i> | 6 | 100 | The Netherlands |
| <i>Transfusion</i> | 6 | 597 | United Kingdom |
| <i>Clin Orthop Relat Res</i> | 5 | 78 | United States |
| <i>Eur Radiol</i> | 5 | 85 | Germany |
| <i>Int J Radiat Oncol Biol Phys</i> | 5 | 166 | The Netherlands |
| <i>J Pediatr Orthop</i> | 5 | 27 | United States |
| <i>Radiol Med</i> | 5 | 72 | Italy |

^aJournal Abbreviation Database (ISO4).³⁹

The association strength method was chosen to normalise data and divide the keywords into clusters.⁴⁴ Each cluster with a different colour permits the visualisation and analysis of the set of items that are similar according to the method chosen. The program reveals four clusters (Table 2) that grouped the papers into different subtopics by methodology, objectives, or scope.

In this sense, Cluster #1 includes the TDABC papers and, as can be seen, they are related to value-based health care. Cluster #2 refers to articles using keywords specifically about costs management, such as cost allocation or cost control. It suggests that they are empirical papers focused on cost determination, presumably in hospitals, as the word 'hospital' also appears in the cluster as a keyword. ABC method is included in Cluster #3, and it is related to efficiency. Moreover, some papers of this cluster focus on laboratory cost analysis suggesting that ABC is further used than TDABC in laboratories. Finally, there is a subgroup of literature in the database that addresses the cost of cancer. These papers are included in Cluster #4, along with cost-effectiveness and economic evaluation of cancer therapies.

ABC and TDABC are different cost systems, and the objectives pursued are not the same. This distinction is evidenced through the performed cluster analysis. For this reason, in the next section, we analysed them separately regarding their content, tracking the main objectives identified in the papers devoted to the different cost systems.

3.3 | Content analysis

The differences in the objectives pursued by ABC and TDABC could be determined through the goals described in the papers. For this reason, a conventional content analysis was conducted according to Hsieh and Shannon⁴⁵ to identify the main objectives of the papers. In the methodological section, we have already explained the analysis stages, codification of objectives or purposes, and assignment to each category.

Table 3 points out the main objectives found as the result of the content analysis of the 590 papers that composed the database. It should be noted that one document can have more than one purpose. As can be seen, in both methods, the 'cost determination' is the main objective, 88.2% of the ABC papers and 81.7% of TDABC.

Regarding the motivations for knowing the cost in healthcare using ABC, they mainly focused on the need for 'identifying procedure costing' (83 papers), addressing 'cost-effectiveness of products or processes' (48 papers) and the 'comparison with reimbursement rate' (44 papers). To a lesser extent (7.5% of the papers), they are also concerned about 'cost-saving', 'decision making' and 'identifying the components of cost'.

Besides quantifying papers devoted to each objective, it is interesting to see its evolution over time. Looking at Figure 4 (in dark blue), we can conclude that applying ABC in healthcare started to help in 'decision making' and at the beginning was 'comparing with traditional costing systems'. Those papers are before 1990. Later on, will appear the 'cost-saving' motivation, the 'overhead cost allocation', or the 'cost variation' analysis objective.

Nowadays, none of the objectives is losing interest, as seen in the last year of a paper published addressing each objective (MAX), but the average can reveal some trends. The average year for a category refers to the mean of the category's papers concerning the year of publication, not what year were more papers published. Therefore, a lower average category means that more papers were published in the first years of the study. The introduction of the concept of 'value' on ABC is really new. The five papers that included this approach combined with ABC are from 2018. The results also show that the 'ABC adoption factors', related to papers detailing the motivations for using the system also have a high average, which means that its publication is recent. In these papers, the reasons for changing the cost system, the antecedents, and impediments are discussed. On the contrary, the 'cost variation' is not a hot objective anymore.

On the other hand, one of the main objectives of TDABC is 'time identification', 38% of the papers literally said that in its abstract. Moreover, documents using this cost system also care about value-based healthcare rather than merely focused on efficiency, reimbursement rate or cost allocation, according to Table 3. Besides, the evolution of the papers' objectives using TDABC is shown in Figure 4 in orange.

TABLE 2 Cluster analysis

| Cluster | Color | Items | Keywords | Topic |
|---------|--------|-------|--|--------------------|
| #1 | Red | 11 | Accounting; brachytherapy; economic analysis; health care; healthcare value; health economics; hospital costs; outcomes; time-driven activity-based costing; value; value-based healthcare | Value and TDABC |
| #2 | Green | 9 | Cost allocation; cost control; economics; health care costs; hospital; management; medical; process analysis; quality improvement | Cost management |
| #3 | Blue | 8 | Activity-based costing; activity-based management; cost; cost drivers; costing; economic burden; efficiency; laboratory | Efficiency and ABC |
| #4 | Yellow | 8 | Breast cancer; cervical cancer; cost analysis; cost-effectiveness; economic evaluation; implementation; primary care; radiotherapy | Cost of cancer |

TABLE 3 The objective of the papers

| | Objective category | ABC | % of ABC sample (441 docs) | TDABC | % of TDABC sample (142 docs) |
|-----|---|-----|----------------------------|-------|------------------------------|
| #1 | Determine costs | 389 | 88.2% | 116 | 81.7% |
| #2 | Decision making | 33 | 7.5% | 10 | 7.0% |
| #3 | Cost savings | 33 | 7.5% | 37 | 26.1% |
| #4 | Procedure costing | 83 | 18.8% | 37 | 26.1% |
| #5 | Comparison with traditional cost system | 22 | 5.0% | 6 | 4.2% |
| #6 | Cost components | 33 | 7.5% | 27 | 19.0% |
| #7 | Time identification | 9 | 2.0% | 54 | 38.0% |
| #8 | Cost-effectiveness | 48 | 10.9% | 10 | 7.0% |
| #9 | Profitability | 9 | 2.0% | 3 | 2.1% |
| #10 | Overhead costs allocation | 13 | 2.9% | 1 | 0.7% |
| #11 | Comparison with reimbursement rate | 44 | 10.0% | 14 | 9.9% |
| #12 | ABC adoption factors | 8 | 1.8% | 1 | 0.7% |
| #13 | Pricing | 7 | 1.6% | 1 | 0.7% |
| #14 | Value | 5 | 1.1% | 25 | 17.6% |
| #15 | Cost variation | 12 | 2.7% | 5 | 3.5% |
| #16 | Quality improvement | 15 | 3.4% | 8 | 5.6% |
| #17 | Cost control | 6 | 1.4% | 2 | 1.4% |

Abbreviations: ABC, Activity-Based Costing; TDABC, Time-Driven Activity-Based Costing.

It's been 2 years without one article of TDABC focusing on the 'comparison with traditional cost system' or 'profitability' and 'cost variation' as the main goals of the system. Instead, 'identifying cost components' represents the highest average and recent publications. 'ABC adoption factors' and 'pricing' objectives were not considered relevant as they were addressed just in one paper in 2019. For this reason, they are at the top of the figure. What is clear is that 'cost determination', 'time identification' and 'value' represent the principal motivations of the application of TDABC in healthcare.

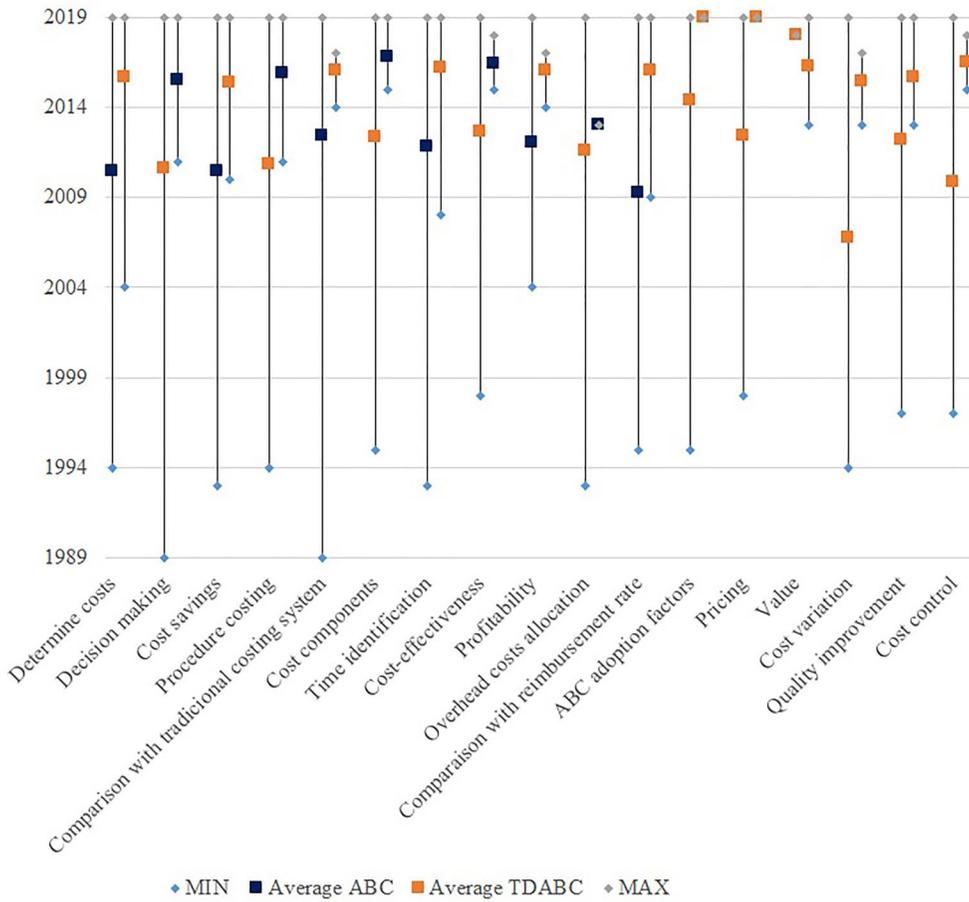


FIGURE 4 Activity-Based Costing and Time-Driven Activity-Based Costing objectives evolution

4 | DISCUSSION

The present review covering 31 years (1989–2019), is the broadest literature review on ABC and TDABC systems in health care. It highlights that applying these cost systems has been more relevant in specific health areas or departments. According to Mariotto et al.⁴⁶ cancer care, in particular, contributes to a substantial and growing percentage of healthcare expenditures. The development of new treatments represent opportunities for oncology patients to live better and longer but maintaining high-quality care is expensive. For this reason, a lot of research is conducted to improve cost-efficiency and incentivises optimisation of resources.^{47–49}

On the other hand, radiology plays an essential role in health, whether in diagnostic or interventional aspects. It allows the detection of anomalies and obtaining the necessary information to establish the appropriate strategy and treatment in each case. Typically, it tends to be overcrowded with too many patients scheduled for the same time slot and, unnecessary studies, and repeated studies all represent waste due to overstressing.⁵⁰ Moreover, the material and machinery used are costly. All these factors led to many cost-efficiency studies.^{51–55}

In our study, the fourth cluster of keyword analysis on cancer cost and journals specialising in radiology pointed out this fact. It is clear that oncology and radiology departments have paid more attention to both cost systems, and they have had more implementation, according to the papers analysed. Definitely, cost-effectiveness in these areas is

more critical as they are departments with high costs and fewer resources. Then, it is more needed to accurately know the reimbursement rate and a more reliable cost system.

It is not surprising that the United States is the leader in publications. It happens in this field and many others. They have a long scientific tradition and prestigious universities where it is conducted much research with high quality. Above all, what makes many health studies undertaken, including cost studies, is the kind of national health system they have. Insurance companies, private clinics, hospitals, and other organisations in the sector put much effort into knowing the cost of their products, services, and processes. This casuistry has been reflected in an extensive literature on case studies in medical organisations, especially in North America, and also by authors from American universities.

Results give prominence to the difference between the objective pursued by both cost systems. This is one of the main contributions of this paper. While the ABC was more focused on cost allocation and seeking efficiency, TDABC was concerned about health value. Currently, the paradigm is shifting towards a system more based on the value of health care. So, the TDABC addresses the costs from this point of view, as shown in keyword analysis and content analysis. The keyword 'TDABC' was in the same cluster that the 'value' and the percentage of papers with the value as an objective were higher in this cost system than within the ABC papers. In this regards, some papers in previous literature remark the opportunities to enhance the quality of care and outcomes while reducing costs demonstrating the power of TDABC to improve value.^{2,56} Etges et al.⁵⁷ state that TDABC could be a strategy to help in the transition from fee-for-service to value-based systems through its capability to contribute to cost savings. For example, optimizing the care trajectory and identifying care benchmarks can facilitate health system improvement opportunities.

Hence, in health care where costs are continually raising the application of cost systems that helps managers and practitioners to better understand the cost of care will contribute to the redesign of procedures and services to make them more efficient.

5 | CONCLUSIONS AND FUTURE RESEARCH

ABC and TDABC systems reviewed in this article have served to improve the cost identification, control, and efficiency in healthcare. TDABC is the evolution, or rather, the simplification of the ABC. As a matter of fact, one of the originators of the ABC, Kaplan, is the creator of the second method. He has even criticised the ABC in numerous papers, advocating for the use of the TDABC.

The literature on TDABC and its applications have grown tremendously in recent times, and it has more impact in academia, with publications more cited. These findings have some implications for practitioners, researchers and policy-makers. From the authors' point of view, researchers should focus their research on TDABC. At the practitioners' level, it has been proved that TDABC overcomes some ABC criticisms by simplifying the implementation process. Therefore, its use can help organisations control and better allocate costs without the complexity of developing the ABC structure. At the academic level, in terms of the number of citations, the impact of the research using this cost system in health is higher, according to the most cited papers. Researchers should consider exploring the opportunities of using the TDABC since many times to obtain funds or projects, the impact of the research is measured, and the TDABC has more impact and potential growth. Currently, there is much talk about the value of health rather than cost. In this sense, according to our study, the TDABC is more related to this concept of value. Policy makers should promote the use of these cost systems that provide more accurate results for decision-making.

We can outline some research opportunities in the field. Besides papers detailing its implementation, authors should consider carrying out more comparative studies between this system and other previous costing systems. Moreover, the use of only one type of cost driver, time in TDABC, can also benefit the development of comparative studies among similar departments, products or services. We encourage authors to conduct this type of research in order to help organisations establish efficiency standards that could be taken as goals to be achieved. Finally, we want to emphasise the importance of sharing the results of the application of cost systems, their effectiveness, successes and even failures to improve further the knowledge in health systems' performance and measurement.

Despite the review contributions, it also has some limitations. The search was conducted in a limited number of databases. We included two important ones, but others, such as Google Scholar, would increase coverage. On the other hand, VOSviewer establishes the number of five as a threshold for representing the data by default. Therefore, we missed some information for visualising the dataset more clearly. We could modify this number, but a large number of keywords would make the figure unreadable. These limitations can be opportunities for future research.

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CONSENT FOR PUBLICATION

All authors of this manuscript have consented to publish this work

CONFLICT OF INTERESTS

It is to specifically state that 'No Competing interests are at stake and there is No Conflict of Interest' with other people or organizations that could inappropriately influence or bias the content of the paper.

ETHICS STATEMENT

The manuscript has been submitted with full responsibility, following the due ethical procedure, and there is no duplicate publication, fraud or plagiarism. All authors have seen and approved the manuscript and have contributed significantly to the paper.

AUTHOR CONTRIBUTIONS

All the authors designed the research. Angels Niñerola and Maria-Victòria Sánchez-Rebull collected the data. Angels Niñerola and Ana-Beatriz Hernández-Lara performed the analysis of data. Finally, the paper is written by Angels Niñerola, Ana-Beatriz Hernández-Lara and Maria-Victòria Sánchez-Rebull. All the authors read and approved the final manuscript.

DATA AVAILABILITY STATEMENT

There are no restrictions to data and materials used in this manuscript.

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