DOI: https://doi.org/10.14210/alcance.v31n2(mai/ago).85-102
ISSN - 1983-716X

TIME-DRIVEN ACTIVITY-BASED COSTING (TDABC) IN HIGHER EDUCATION INSTITUTIONS: A SYSTEMATIC REVIEW OF THE LITERATURE

TIME-DRIVEN ACTIVITY-BASED COSTING (TDABC) EM INSTITUIÇÕES DE ENSINO SUPERIOR: UMA REVISÃO SISTEMÁTICA DA LITERATURA

¿ TIME-DRIVEN ACTIVITY-BASED COSTING (TDABC) EN INSTITUCIONES DE EDUCACIÓN SUPERIOR: UNA REVISIÓN SISTEMÁTICA DE LA LITERATURA

ABSTRACT

Dilemma: The implementation of cost systems in Higher Education Institutions (HEIs) is a complex task, which requires a simplified methodology, in which the costs for implementing and updating the model are not greater than the benefits generated. In this context, the TDABC costing method appears as an alternative to be evaluated, which is why this study offers a synthesis of the steps, benefits and limitations identified in its implementation in HEIs.

Objective: To identify procedures, benefits and limitations observed in the adoption of the TDABC costing method in HEIs, in studies published between 2012 and 2022.

Methodology: This is a systematic review of the literature, with a qualitative-descriptive approach, carried out in the databases DOAJ, Scopus, Brazilian Costs Congress and AB-Custos Magazine, covering the period from 2012 to 2022, in which 379 documents were identified, which After the classification process, 17 articles were selected for synthesis.

Results: During the investigated period, a growing interest in the TDABC method was observed, increasing from 6 studies in 2012 to 36 in 2022. Its application occurred in the most diverse segments, with a predominance of 58.87% in the health area. Regarding studies applied in HEIs, it was observed that 47.10% of the studies were carried out in libraries. The selected studies indicated that TDABC, despite the time required for process mapping and execution time measurement, provides simplicity in implementation, and assists managers in understanding cost behaviors, enabling benchmarking between processes and optimization of resource consumption.

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Submitted in: 01/22/2024
Accepted in: 06/06/2024

How to cite: de Oliveira, E. D., Pereira, E. N., Cescon, J. A., & Lima, N. C (2024). Time-driven activity-based costing (tdabc) in higher education institutions: a systematic review of the literature. *Revista Alcance (online)*, 31(2), 85-102 Doi: https://doi.org/10.14210/alcance.v31n2(mai/ago).85-102

OPEN ACCESS

INDEXED BY redalyc.org

DOI: https://doi.org/10.14210/alcance.v31n2(mai/ago).85-102

Limitations/Implications: The use of only four sources for article collection, as well as the focus on applied research in Higher Education Institutions, constituted a limitation of the study. This impacted the number of articles selected for synthesis, representing only 4.49% of the initially collected documents, thus restricting the potential scope of the investigation regarding the use of the TDABC method in the educational sector more broadly.

Originality/value: The study stands out by focusing on the identification of procedures employed for the implementation of the TDABC method in Higher Education Institutions. Additionally, it provides an overview of the results obtained from the application of the method, supporting the feasibility analysis of its adoption by public agencies, especially Brazilian Higher Education Institutions, at an opportune moment, considering the issuance of NBC TSP 34/2021.

Keywords: Systematic review. Cost System. Costing Method. TD-ABC. Higher Education Institutions.

RESUMO

Dilema: A implementação de sistemas de custos em Instituições de Ensino Superior (IES) é uma tarefa complexa, que requer metodologia simplificada, em que os custos para implantação e atualização do modelo não sejam superiores aos benefícios gerados. Nesse contexto, o método de custeio TDABC surge como alternativa a ser avaliada, razão pela qual este estudo oferece uma síntese das etapas, benefícios e limitações identificadas na sua implementação em Instituições de Ensino Superior (IES).

Objetivo educacional: Identificar procedimentos, benefícios e limitações observados na adoção do método de custeio TDABC em IES, nos estudos publicados no período de 2012 a 2022.

Metodologia: Trata-se de uma revisão sistemática da literatura, com abordagem qualitativa-descritiva, realizada nas bases DOAJ, *Scopus*, Congresso Brasileiro de Custos e Revista ABCustos, compreendendo o período de 2012 a 2022, nas quais foram identificados 379 documentos, dos quais, após o percurso classificatório, foram selecionados 17 artigos para síntese.

Resultados: No período investigado, observou-se o crescente interesse no método TDABC, que passou de seis estudos, em 2012 para 36, em 2022. Sua aplicação se deu nos mais diversos segmentos, com predominância de 58,87% na área de saúde. Em relação aos estudos aplicados em IES, observou-se que 47,10% foram realizados em bibliotecas. Os estudos selecionados indicaram que o TDABC, apesar do tempo necessário para o mapeamento dos processos e medição dos tempos de execução, proporciona simplicidade na implementação e auxilia os gestores na compreensão dos comportamentos dos custos, possibilitando a realização de *benchmarking* entre processos e a otimização do consumo dos recursos disponíveis.

Limitações/implicações da pesquisa: A utilização de apenas quatro fontes para coleta de artigos, bem como o foco em pesquisas aplicadas em Instituições de Ensino Superior, configurou-se como uma limitação deste estudo. Isso implicou na quantidade de artigos selecionados para síntese, representando somente 4,49% dos documentos inicialmente coletados, restringindo, dessa forma, o potencial alcance da investigação em relação à utilização do método TDABC no segmento educacional de forma ampla.

Originalidade/valor: O estudo se diferencia por focar na identificação dos procedimentos empregados para a implementação do método TDABC em Instituições de Ensino Superior. Além disso, fornece um panorama dos resultados obtidos a partir da aplicação do método, subsidiando a análise de viabilidade da sua adoção pelos órgãos públicos, especialmente Instituições de Ensino superior brasileiras, em momento oportuno, tendo em vista a edição da NBC TSP 34/2021.

Palavras-chave: Revisão Sistemática. Método de Custeio. Sistema de Custos. TD-ABC. Instituições de Ensino Superior.

RESUMEN

Dilema: La implementación de sistemas de costos en las Instituciones de Educación Superior (IES) es una tarea compleja, que requiere de una metodología simplificada, en la que los costos de

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implementación y actualización del modelo no sean mayores que los beneficios generados. En este contexto, el método de costeo TDABC aparece como una alternativa a ser evaluada, por lo que este estudio ofrece una síntesis de los pasos, beneficios y limitaciones identificados en su implementación en las IES.

Objetivo: Identificar procedimientos, beneficios y limitaciones observados en la adopción del método de costeo TDABC en las IES, en estudios publicados entre 2012 y 2022.

Metodología: Se trata de una revisión sistemática de la literatura, con enfoque cualitativo-descriptivo, realizada en las bases de datos DOAJ, Scopus, Congreso Brasileño de Costos y Revista ABCustos, abarcando el período de 2012 a 2022, en la que se identificaron 379 documentos, que Luego del proceso de clasificación, se seleccionaron 17 artículos para su síntesis.

Resultados: En el período investigado, se observó un creciente interés en el método TDABC, que pasó de 6 estudios en 2012 a 36 en 2022. Su aplicación se dio en los más diversos segmentos, con predominancia del 58,87% en el área de salud. En cuanto a los estudios aplicados en IES, se observó que el 47,10% de los estudios se realizaron en bibliotecas. Los estudios seleccionados indicaron que el TDABC, a pesar del tiempo necesario para el mapeo de procesos y la medición de los tiempos de ejecución, proporciona simplicidad en la implementación y ayuda a los gerentes a comprender el comportamiento de los costos, permitiendo la realización de benchmarking entre procesos y la optimización del consumo de recursos disponibles.

Limitaciones/Implicaciones: La utilización de solo cuatro fuentes para la recolección de artículos, así como el enfoque en investigaciones aplicadas en Instituciones de Educación Superior, se configuró como una limitación de este estudio. Esto implicó en la cantidad de artículos seleccionados para síntesis, representando solo el 4,49% de los documentos inicialmente recolectados, restringiendo, de esa forma, el potencial alcance de la investigación en relación con la utilización del método TDABC en el segmento educativo de forma amplia.

Originalidad/valor: El estudio se diferencia por enfocarse en la identificación de los procedimientos empleados para la implementación del método TDABC en Instituciones de Educación Superior. Además, proporciona un panorama de los resultados obtenidos a partir de la aplicación del método, subsidiando el análisis de viabilidad de su adopción por los organismos públicos, especialmente las Instituciones de Educación Superior brasileñas, en el momento oportuno, teniendo en cuenta la emisión de la NBC TSP 34/2021.

Palabras clave: Revisión Sistemática. Método de Costeo. Sistema de Costos. TD-ABC. Instituciones de Educación Superior.

INTRODUCTION

At the end of the 20th century, a movement emerged in various countries called New Public Management (NPM), introduced in Brazil as Nova Gestão Pública (NGP), to make the state function better and cost less for citizens by incorporating management tools that have proven successful in the private sector (Denhardt & Denhardt, 2000; Marques, 2020). Among these tools, cost accounting stands out for its role in determining results and measuring the competitiveness of government actions (Pigatto, Holanda, Moreira & Carvalho, 2010).

Since the enactment of Federal Law No. 4,320/1964, according to Carvalho, Oliveira, and Barbosa (2022), financial control and cost management standards have been implemented, establishing a legal framework aimed at promoting better management of public resources. More recently, the Brazilian Accounting Standard NBC TSP 34/2021 has been highlighted, establishing the guidelines to be observed in implementing cost systems (CFC, 2021). However, despite the State's efforts, according to Messias, Ferreira, and Soutes (2018), the adoption of strategic cost management by Brazilian public agencies is still in its "embryonic stage."

Among these public agencies are the Federal Higher Education Institutions, classified by Marinho, Resende, and Façanha (1997) as complex organizations, which makes efficiency evaluation a difficult task, but very relevant, not only for managers but also for society, which wants to know if the resources generate some benefit for them (Magalhães, Silveira, Abrantes, Ferreira & Wakin,

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2010). Thus, to assist in this task, the National Treasury Secretariat published the Manual of the Cost Management Process of the Federal Government, which, among other guidelines, recommends the evaluation of the use of Activity-Based Costing (ABC) (STN, 2022).

According to Kaplan and Anderson (2007), ABC emerged in the 1980s, but after the growing adoption of the model, limitations related to large-scale application were observed, due to the excessive cost of its maintenance. Because of this difficulty, and aiming to simplify the method, the time-driven ABC, called Time-Driven Activity-Based Costing (TDABC), was presented in 2004, which uses the execution time of activities as the only cost driver (Kaplan & Anderson, 2004).

To investigate the adoption of the TDABC method since its inception, Sigüenza-Guzmán et al., (2013) conducted an extensive systematic literature review. This review identified 36 studies published between 2004 and 2012, which analyzed TDABC in various segments, such as health, logistics, hospitality, industry, and non-profit services. Among these studies, only 6 implemented the method in universities. Therefore, this research makes it possible to update the panorama of the application of TDABC in universities, with an emphasis on observing the procedures used, which differentiates it from other studies.

Thus, considering that the implementation of cost systems in Higher Education Institutions (HEIs) is a complex task, that requires a simplified costing methodology, in which the efforts for its implementation and update should not be greater than the benefits provided by the information generated, the research question emerges: **What are the procedures performed, benefits and limitations observed in the application of TDABC in higher education institutions?**

This research is justified insofar as it provides an overview of the studies and results obtained in the application of TDABC, supporting the analysis of the feasibility of its adoption by public agencies, especially Brazilian HEIs, at an opportune moment, due to the issuance of NBC TSP 34/2021, which made the adoption of cost systems mandatory from January 2024. In addition, the study contributes to the academic discussion on costing methodologies.

The article is organized into five sections, including this introduction. The second section corresponds to the theoretical framework of the TDABC method, which addresses the concepts, parameters, and steps for its implementation. The third section presents the methodological procedures adopted for the collection in the periodical databases and the selection of studies for synthesis, presented in section 4. Finally, section 5 presents the conclusion of the article and the gap identified for future research.

THEORETICAL FRAMEWORK

The TDABC method, according to Carvalho, Oliveira, and Nascimento (2020), was developed by Kaplan and Anderson (2004) to address problems and disadvantages identified in the initially developed model known as Activity Based Costing (ABC), which was gradually abandoned by companies.

The TDABC differs from the previous model mainly by simplifying implementation, as it requires only two parameters: (i) the cost of supplying resource capacity, which corresponds to the cost of all resources provided to a department or process, such as personnel resources, supervision, space, equipment, etc.; and (ii) practical capacity, which corresponds to the time that employees are available to perform activities, excluding breaks, meetings, etc. (Kaplan & Anderson, 2007).

Practical capacity can be determined in two ways: through the arbitrary approach, where 80% for labor activities and 85% for machine operations of theoretical capacity can be considered, or through the analytical approach, where explicit amounts of idle time obtained from productivity history are subtracted (Kaplan & Anderson, 2007). Once these two parameters are defined, the cost of supplying resource capacity is divided by practical capacity to obtain the Capacity Cost Rate (CCR), which then allocates indirect costs to cost objects based on the time spent on their production (Wernke, 2019).

Time estimates can be obtained through various methods such as direct observation or interviews, and should be expressed in time units, typically minutes, which allows them to be rea-

DOI: https://doi.org/10.14210/alcance.v31n2(mai/ago).85-102

dily observed and validated. Like practical capacity, precision is not critical, and estimates can be approximate, as TDABC aims to be approximately right rather than exactly wrong (Kaplan & Anderson, 2007).

The method also allows for adjustments of allocated costs to a specific process or activity due to variations in demands, through the formulation of time equations, which involves including additional time to perform a task based on its specificities, termed multiple time drivers (Kaplan & Anderson, 2007; Everaert, Bruggeman, Sarens, Anderson & Levant, 2008; Cescon, Antunes Júnior, Brunozi Júnior & Besen, 2015).

For implementation, Everaert et al. (2008) synthesized the method in six steps: (i) identifying resource groups (departments); (ii) estimating the total cost of each resource group; (iii) estimating the practical capacity of each resource group (available working hours); (iv) calculating the Capacity Cost Rate (CCR), obtained by dividing the total cost of the resource group by practical capacity; (v) determining the time estimate for each activity; and (vi) multiplying the CCR by the time estimate for each activity.

Given the benefits of TDABC presented by Kaplan and Anderson (2007), Sigüenza-Guzmán et al. (2013) analyzed 36 studies that applied the method. This analysis revealed that TDABC provides most of the majority advantages by the authors, such as ease of implementation, versatility, and modularity resulting from the adoption of time equations, as well as the ability to simulate scenarios considering impact in terms of costs.

However, difficulties were identified in measuring times, especially for non-continuous and unpredictable activities, due to the degree of subjectivity and the tendency of employees to overestimate them. Additionally, the satisfactory formulation of time equations requires a considerable amount of robust and reliable data to achieve an acceptable level of accuracy. Based on this information, Sigüenza-Guzmán et al. (2013) considered the application of tdabc more appropriate for repetitive and routine activities.

After presenting the concepts, limitations, and steps for implementing TDABC, below are presented is the methodological path for conducting this Systematic Literature Review.

METHODOLOGICAL PROCEDURES

According to Kitchenham (2004), a Systematic Literature Review (SLR) is a way to identify, evaluate, and interpret the available and relevant research for a research question, thematic area, or phenomenon of interest. For Donato and Donato (2019), the SLR should be comprehensive and conducted through explicit research methods.

Thus, the present research aims to synthesize the procedures, benefits, and limitations of adopting TDABC in HEIs based on primary studies, classifying itself as bibliographic research in terms of procedures, using a qualitative approach, and as descriptive in terms of objectives (Gil, 2022).

For its development, a Systematic Review Protocol was elaborated, in which the databases, inclusion and exclusion criteria, quality assessment questions, and the research objective were defined: to identify the procedures, benefits, and limitations observed in the adoption of the TDABC costing method in HEIs in studies published between 2012 and 2022. To achieve the established objective, keywords were defined, resulting in the search string ("TDABC" or "TD ABC" or "TD-ABC" or "TIME DRIVEN ABC" or "TIME-DRIVEN ABC"), applied in titles, keywords, and abstracts, along with filters to select peer-reviewed articles published between 2012 and 2022, in English, Portuguese, or Spanish.

Considering the concentration of studies related to TDABC, the research was conducted in the international indexing databases Directory of Open Access Journals (DOAJ) and SCOPUS. Additionally, since the interest of this review is to contribute to the discussion of costing methods in Brazilian HEIs, the proceedings of the Brazilian Cost Congress and the ABCustos Journal were also included (Boina, Avelar, Souza, & Ohayon, 2016; Carvalho et al., 2020; Cabral, Neto & Souza, 2022).

Data collection was conducted between June 9 and June 20, 2023, adapting the search criteria to the characteristics of each database's mechanisms, as detailed below:

a) DOAJ: the 'articles' option was selected, applying the search string to Title, Abstract, and Keywords, yielding 32, 103, and 41 do-

DOI: https://doi.org/10.14210/alcance.v31n2(mai/ago).85-102

cuments, respectively, totaling 176 documents. After excluding 73 duplicates, 103 documents remained.

b) Scopus: the search string and filters 'article', 'English', 'Portuguese', and 'Spanish' were applied, resulting in the collection of 211 documents.

c) ABCustos Journal: the search terms from the string were individually entered in the 'Search' option, resulting in 39 documents. After excluding duplicates, 32 remained. Subsequently, a detailed search was conducted in volumes 7 to 17, but no additional articles were found.

d) Brazilian Cost Congress: the search was conducted for the terms from the string in the titles, abstracts, and keywords of editions XIX to XXIX, resulting in the identification of 36 studies, of which 30 remained after excluding duplicates.

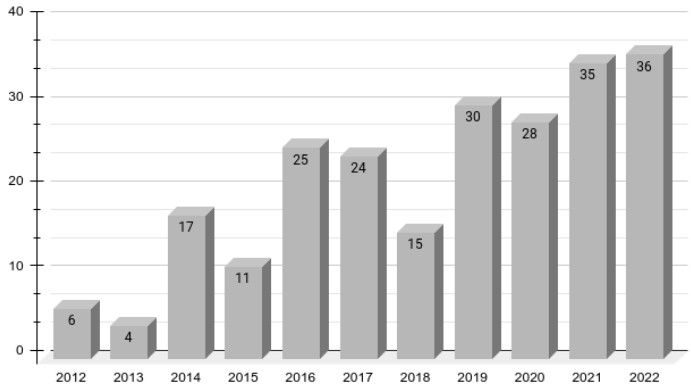
Therefore, 376 documents were identified, corresponding to Sample A, and their metadata was converted to BibTeX and exported to the Parsifal software, where 57 duplicates were excluded. Subsequently, the titles, abstracts, and keywords of the remaining 319 documents were read aiming to classify them on the explicit observation of the inclusion or exclusion criteria defined in the protocol.

In this classification stage, it was necessary to read eight studies in full, as the information in the title, abstract, and keywords was insufficient for classification. After excluding one more duplicate article, 318 documents remained, corresponding to Sample B.

Concurrently with the reading of titles, abstracts, and keywords, 29 articles unrelated to the TDABC costing method were excluded; 8 in undesired languages; 2 journal editorials; and 48 theoretical studies. After these exclusions, Sample C was generated, consisting of 231 documents, among which 144 were published between 2018 and 2022, concentrating 62.34% of the production, as shown in Figure **1.**

Figure 1

Production of studies per year

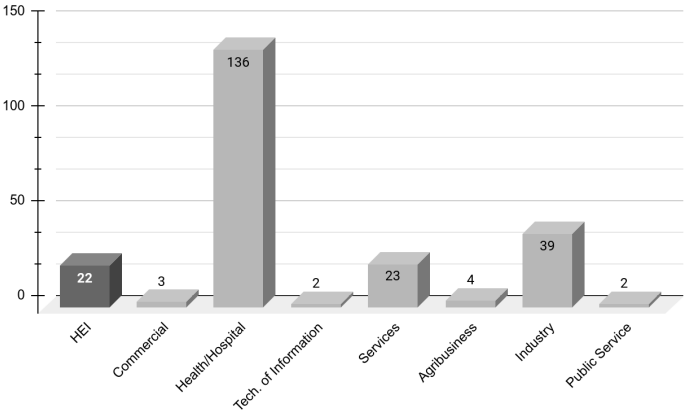


Source: research data.

Additionally, during this stage, the studies were classified based on the activities conducted by the organizations, resulting in the quantities shown in Figure 2.

Figure 2

Articles classified by the application area of TDABC



Source: research data.

Based on this classification, 209 studies in which TDABC was not implemented in HEI environments were excluded, leaving 22 studies subject to full reading where quality criteria were applied, as shown in Table 1, to establish a hierarchy based on minimum requirements justifying inclusion in the SLR (Kitchenham, 2004).

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Table 1

Criteria for evaluating the quality of studies

Evaluation Criteria	Evaluation
1. Does the study deal with the application of TDABC in Brazilian organizations?	**Yes: Grade = 1;** **Partially: Grade = 0.5;** **No: Grade= 0.** Note: The maximum possible grade is 7. Studies scoring above 2 will be selected for synthesis.
2. Does the study clearly present the procedures adopted for implementing TDABC?	
3. Does the study report the adaptations employed in the TDABC method for its implementation?	
4. Does the study present the difficulties encountered in implementing TDABC?	
5. Does the study present the benefits and/or results obtained with the adoption of TDABC?	
6. Does the study identify its limitations and/or limitations of the TDABC method regarding the studied object?	
7. Does the study compare or draw any relationships between the results of TDABC and other costing methods?	

Source: Prepared by the authors (2023).

At this stage, 1 incomplete study, 1 with restricted access, 1 in an undesired language, and 1 duplicate were excluded. Additionally, 2 studies cited in the selected articles were incorporated, and 1 study replaced the excluded incomplete article.

This incomplete article refers to the study by Bezerra (2018). Considering its relevance to this systematic review, a query was made in the researcher's Lattes Curriculum, obtaining the complete article of said study, which was included in the analyzed database (Bezerra & Oliveira, 2019).

After completing reading and applying the evaluation score, exclusively related to the study's adherence to the objectives of the systematic review, 4 articles scoring equal to or lower than 2 were excluded, leaving 17 selected for synthesis, corresponding to Sample D, as listed in Table 2.

Table 2

Articles selected for synthesis

Articles	Grade
Custeio Baseado em Atividades e Tempo (TDABC): um estudo em uma Instituição de Ensino Superior do sul do estado de Santa Catarina (Mazzuco, Wronski, & Zonatto, 2017).	7,0
Custeio Baseado em Atividade e Tempo-TDABC: estudo de caso em uma instituição de ensino superior particular (Rodrigues, Silva, & Araújo, 2014).	7,0
TDABC to Determine the Cost of Retirement Procedures: Applied at Universidade Federal do Rio Grande do Norte (Bezerra & Oliveira, 2019).	6,0
TDABC na Mensuração de Custos dos Processos Seletivos Realizados pela COMPERVE/UFRN (Carvalho, Oliveira, & Barbosa, 2022).	5,0
Value Improvement by Assessing IR Care via Time-Driven Activity-Based Costing (Masthoff, Schneider, Schindler, Heindel, Köhler, Schlüchtermann, & Wildgruber, 2021).	5,0
Dissecting Costs of CT Study: Application of TDABC (Time-driven Activity-based Costing) in a Tertiary Academic Center (Anzai, Heilbrun, Haas, Boi, Moshre, Minoshima, Kaplan, & Lee, 2017).	4,5
Modelo de costeo basado en tiempo invertido por actividad para servicios tecnológicos en Instituciones de Educación Superior: Un estudio de caso (Valdivieso-Donoso, Ayabaca, & Sigüenza-Guzmán, 2020).	4,0
Time-Driven Activity-Based Costing Systems for Cataloguing Processes: A case study (Sigüenza-Guzmán, Van den Abbeele, & Cattrysse, 2014b).	4,0
Using Time-Driven Activity-Based Costing to Identify Best Practices in Academic Libraries (Siguenza-Guzman, Auquilla, Van den Abbeele, & Cattrysse, 2016).	4,0
Using Time-Driven Activity-Based Costing to Improve the Managerial Activities of Academic Libraries (Kissa, Stavropoulos, Karagiorgou, & Tsanaktsidou, 2019).	4,0
Using Time-Driven Activity-Based Costing to Support Library Management Decisions: A case study for lending and returning processes (Sigüenza-Guzmán, Van den Abbeele, Vandewalle, Verhaaren, & Cattrysse, 2014a).	4,0
Endoscopic versus open carpal tunnel release: a detailed analysis using time-driven activity-based costing at an academic medical center (Koehler, Balakrishnan, Lawler, & Shah, 2019).	3,5
How much does it cost to catalog a document? A case study in estonian university libraries (Kont, 2015b).	3,0
If Time and Money Matters: EBook Program Challenges in Tallinn University of Technology Library (Kont, 2021).	3,0
Sistema de Custo Baseado na Metodologia do Custeio TDABC: Uma experiência em uma entidade de apoio (Rodrigues & Pinho, 2017).	3,0
To Buy or to Borrow? Evaluating the Cost of an eBook in TalTech library (Kont, 2020).	3,0
What do Acquisition Activities Really Cost? A case study in Estonian university libraries (Kont, 2015a).	3,0

Source: Prepared by the authors (2023).

Finally, Figure 3 illustrates the synthesis of the selection process through a flowchart based on the PRISMA method.

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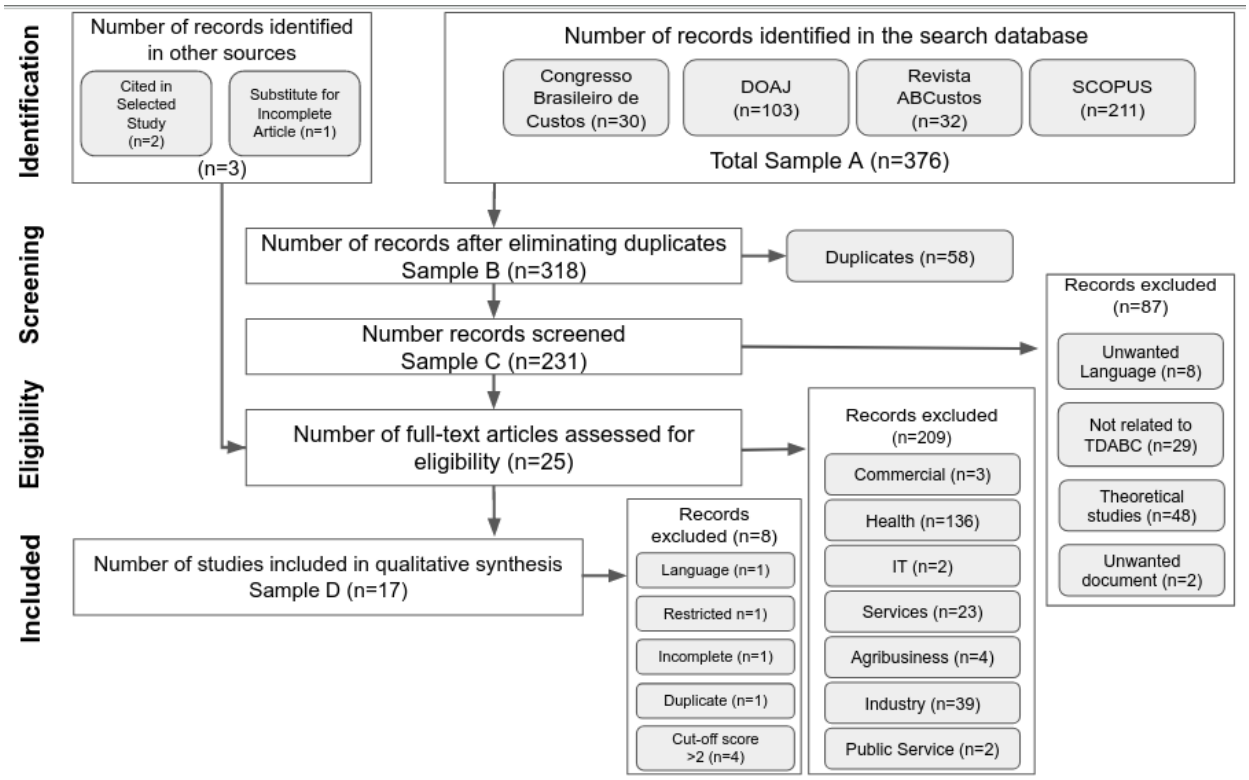
Figure 3

Flowchart of article selection based on the PRISMA method.



Source: Developed by the authors based on Galvão, Pansani, and Harrad (2015).

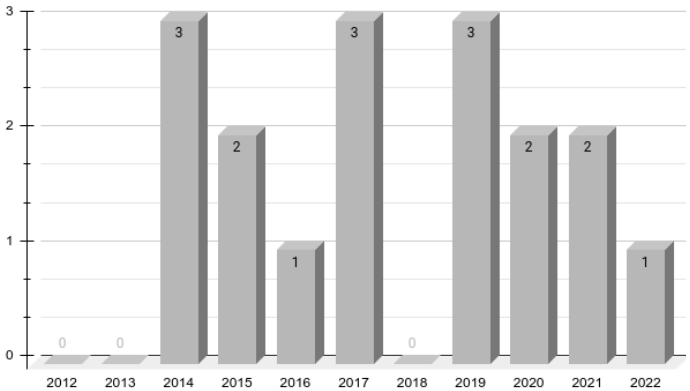
The results obtained with data extraction, established in the planning of this RSL, corresponding to the articles in Sample D are discussed in the next section.

ANALYSIS AND PRESENTATION OF RESULTS

According to Kitchenham (2004), data synthesis involves grouping and summarizing the results identified in the primary studies accepted for the review, structured to highlight their similarities and differences, and may include a descriptive and quantitative summary. Thus, the journey of this SLR resulted in the selection of 17 studies, which were published within the period shown in Figure 4.

Figure 4

Production of selected studies per year



Source: research data.

These studies were grouped based on the activity or environment of the Higher Education Institutions where TDABC was applied, forming the categories presented in Figure 5.

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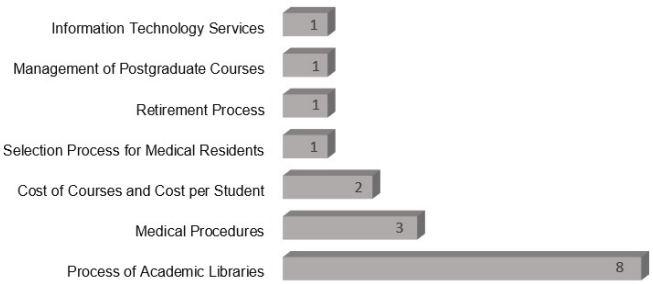
Figure 5

Application of TDABC in Higher Education Institutions.



Source: research data.

Based on these categories, the benefits and limitations of the TDABC costing method, as well as the procedures adopted for its implementation are presented below.

Process of Academic Libraries

A RSL revelou oito estudos aplicados em bibliotThe systematic literature review revealed 8 studies that applied TDABC in university libraries, representing 47.1% of the selected studies.

Sigüenza-Guzmán et al., (2014a) studied TDABC in supporting managerial decisions in the loan and return processes, while Sigüenza-Guzmán et al., (2014b) implemented TDABC for detailing the cataloging process. Both studies were conducted at the Arenberg Campus Library of KU Leuven in Belgium. The study by Sigüenza-Guzmán et al., (2016) tested TDABC as a benchmarking tool to identify best practices between two academic libraries in Belgium.

In these three studies, TDABC was implemented using the six steps proposed by Everaert et al. (2008):

I. identified the main activities and prepared flowcharts through interviews.

II. estimated the total cost of each group of resources.

III. estimated the practical capacity, considering the arbitrary approach, assuming 80% of the theoretical capacity of labor and 85% of the productive capacity of machines.

IV. calculated the Capacity Cost Rate.

V. estimated the time through direct observation and stopwatch use, from which they developed time equations corresponding to the sum of times for each activity, and

VI. determined the process cost by multiplying the unit cost of each resource group by the duration of the activity.

Sigüenza-Guzmán et al. (2014a) observed that the more precise the time measurement and detailed the workflows, the better the results and analyses will be, however, they warn that the greater detail, the longer it will take to implement the method.

Nevertheless, they concluded that TDABC provides significant benefits, such as the ability to identify non-value-added activities, conduct benchmarking for performance improvement, and support decision-making for the development of new services. Therefore, it proves useful for cost analysis in a simple, precise, and easily understandable manner (Sigüenza-Guzmán et al., 2014a).

Sigüenza-Guzmán et al. (2014b) confirm the benefits identified by Sigüenza-Guzmán et al. (2014a) and add that TDABC offers the possibility to perform "what-if" analyses to simulate potential scenarios. This allows decision-making regarding task delegation and grouping activities for batch processing during specific periods to optimize labor availability.

In the study by Sigüenza-Guzmán et al. (2016), TDABC enabled the identification of best practices between two libraries, highlighting that both could benefit mutually from learning from each other for performance improvement. However, the authors noted that besides the time-consuming process of mapping and time estimation, direct observation caused discomfort among some employees during routine tasks, resulting in resistance and delaying data collection.

Kont (2015a) estimated the costs of the acquisition process, while in another study, Kont (2015b) determined the cost of the cataloging process. Both studies were conducted at the library of Tallinn University of Technology (TalTech) and the Estonian Academy of Music and Theatre Library. Subsequently, Kont evaluated the acquisition and lending costs of e-books and compared the acquisition and cataloging costs of e-books with those of printed books. Both studies were conducted at TalTech University Library in Estonia (Kont, 2020, 2021).

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For the application of TDABC in these 4 studies, 5 steps were performed, differing quantitatively from the six steps proposed by Everaert et al. (2008) only in that the identification of Capacity Cost Rate and the calculation of practical capacity were grouped into a single step.

Regarding the procedures, there were differences compared to the studies by Sigüenza-Guzmán et al. (2014a, 2014b, 2016) in the following stages: identification of activities, by adding documentary analysis; in cost estimation, by considering only direct costs; in the definition of practical capacity, using an analytical approach considering the days effective of the operational of the libraries, deducting holidays, and assuming 22% of time spent on non-productive activities, without detailing how this percentage was obtained; and in time estimation of activities, obtained through questionnaires administered to employees who were encouraged to use stopwatches for data collection through self-observation.

Kont (2015a, 2015b, 2020) emphasizes that documenting workflows and estimating the duration of activities can be time-consuming and uncomfortable for the observed team, corroborating Sigüenza-Guzmán et al. (2014, 2016).

On the other hand, Kont (2015a, 2015b, 2020, 2021) argues that, unlike other methods, TDABC already considers aspects that affect the efficiency and performance of employees, such as rest periods, breaks, arrivals, departures, and non-work-related activities. He also emphasizes that the TDABC method is simple and easy to understand, allowing it to be tested and implemented by managers in individual departments or processes.

Finally, Kont (2015a, 2015b, 2020, 2021) concludes that the TDABC method seems to be one of the best tools for refining and understanding the cost behavior of university libraries, this is because it allows the evaluation of processes with many activities and complex drivers, providing accurate information, identifying activities without added value, and suggesting ways to reduce time consumption without compromising the quality of work.

The study by Kissa et al. (2019) applied TDABC to improve managerial activities related to borrowing, renewal, and return at the University of Macedonia Library (UoM) in Greece. They used the 6-step model by Everaert et al. (2008), following the same procedures and parameters as the studies by Sigüenza-Guzmán et al. (2014a, 2014b, 2016).

Kissa et al., (2019) corrobora a avaliação de Kont (2015a e 2015b) e Sigüenza-Guzmán et al., (2014a, 2016), quanto ao fato que a coleta de tempos por observação é mais demorada e desconfortável para a equipe, por outro lado, os dados obtidos são mais confiáveis, levando a resultados mais precisos. Dessa forma, para evitar que a equipe seja reativa, os autores destacam a importância de se explicar os objetivos da pesquisa, o que torna os funcionários mais receptivos, assim como sugerem Sigüenza-Guzmán et al., (2016).

Kissa et al. (2019) agrees with the assessment of Kont (2015a and 2015b) and Sigüenza-Guzmán et al., (2014a, 2016), that estimating time through observation is more time-consuming and uncomfortable for the team, however, the data obtained is more reliable and representative, leading to more precise results. To prevent the team from being reactive, the authors emphasize the importance of explaining the research objectives, and making the staff more receptive, as also suggested by Sigüenza-Guzmán et al., (2016).

The results of the study by Kissa et al., (2019) demonstrated that TDABC is an excellent method for mapping library activities, being easily and cost-effectively adjusted to changes in the internal and external environment, and helps managers save time, reduce costs, optimize activities, and understand the causes of costs, allowing the elimination of non-value-added activities.

Medical Procedures in University Hospitals

Initially, it's important to highlight the predominant implementation of TDABC for determining costs in medical procedures, as shown in Figure 2. Among the 209 excluded articles, 136 had this purpose, accounting for 65.07% of that total. However, among the selected studies, 3 were identified as being applied in academic hospital settings, representing 17.6% of the total.

In the study by Anzai et al. (2017), TDABC was applied to assess the costs of performing a

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computed tomography scan in an academic radiology department. The implementation of the method followed these steps:

I. mapped the processes, identified the professionals involved in the procedure, the duration, clinical resources, and the frequency percentage of each type of intervention through direct observation and extraction of hours from the unit's information system, and

II. obtained from the financial administrator the Capacity Cost Rate, calculated by dividing the cost of capacity provided by the practical capacity of the resources provided. An arbitrary approach of 80% to 85% was used for personnel, while the capacity of spaces and equipment was obtained by dividing by the productive availability time, without applying an idleness percentage.

Anzai et al. (2017) noted that process mapping and data collection for time estimation required considerable effort, recommending that the more automated these steps are, the easier the measurements will be. They concluded that TDABC enables optimization of healthcare resource allocation, leading to improved performance of involved professionals and patient care. The authors further explained that once Capacity Cost Rates are determined, they can be applied to other activities as well.

Koehler et al. (2019) determined the costs of an outpatient procedure through two clinical interventions to identify cost factors, compare them, and inform improvement opportunities at an academic medical center. The implementation involved five stages:

I. mapped the processes through direct observation and interviews.

II. estimated the time in two ways, through real-time direct observation using stopwatches, and from data extracted from the electronic medical records.

III. calculated the Capacity Cost Rate for personnel by considering total personnel expenses divided by practical capacity. For doctors, practical capacity was derived from the electronic medical record, while for other professionals, an arbitrary approach of 80% of theoretical capacity was used.

IV. calculated the Capacity Cost Rate for equipment by considering replacement costs based on annual depreciation value, allocated according to the proportion of usage time. For surgical rooms and other indirect costs, the Capacity Cost Rate was directed based on the time taken for procedures, and

V. determined the total costs by multiplying the Capacity Cost Rate by the execution time of each activity.

Koehler et al. (2019) identified that TDABC is more challenging to apply in complex processes with significant procedural variation due to the need to measure the costs of secondary activities. They justified that adopting time measurement through direct observation aimed to avoid bias. According to the authors, the granularity of information generated by TDABC provides concrete opportunities to reduce costs, improve procedures, and optimize resources by identifying main cost factors and highlighting the functional opportunity cost for non-productive time spent.

Masthoff et al. (2021) determined the costs in radiology at a university hospital, differing from the implementation conducted by Koehler et al. (2019) by incorporating stages for defining medical conditions and identifying activities, not considering indirect costs, and estimating time through interviews. Although both studies estimated practical capacity using an arbitrary approach, Masthoff et al. (2021) considered 80% of theoretical capacity for both personnel and equipment.

Masthoff et al., (2021) also observed that using interviews to estimate time makes data collection and updating easier, but it is subject to bias, confirming the assessment by Koehler et al., (2019). They found greater accuracy for short and standardized stages, consistent with previous studies on the human capacity for time estimation, which becomes less precise with increased variation and duration of the estimated period (Yarmey, 2000, cited in Masthoff et al., 2021).

Therefore, for more extensive and varied interventions, Masthoff et al., (2021) recommend collecting times through observation and using a stopwatch. However, they caution that aspects of labor legislation that may restrict the use of this method should be considered, as well as the

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considerable increase in time and effort required to implement TDABC.

Cost of Courses and Cost per Student

Rodrigues et al., (2014) evaluated TDABC in determining the cost of a course and the cost per student, comparing the results with the absorption costing method used by the institution. In turn, Mazzuco et al., (2017) used this study by Rodrigues et al., (2014) as a reference to conduct a similar study with the same objectives.

In both cases, the authors point out that the absence of cost separation by the department and the lack of control over the number of activities performed in HEIs prevented the determination of specific Capacity Cost Rates for the units. Therefore, they determined the Total Capacity Cost Rate, obtained by dividing the Total Provided Capacity Cost by the Total Practical Capacity of Resources Provided, both representing the total value of the institutions. Thus, the authors implemented the method in 8 steps:

I. identified the departments and operational processes through the analysis of internal regulations, organizational charts, and semi-structured interviews.

II. identified the activities and estimated the execution time by administering questionnaires.

III. calculated the Total Capacity Cost Rate, obtained by dividing the Total Cost of Capacity Supplied by the Total Practical Capacity of Resources Supplied, considering an arbitrary approach of 22 days per month and 6.5 hours per day.

IV. calculated the Total Cost of Activities by multiplying the Total Capacity Cost Rate by the estimated time taken to perform each activity.

V. identified the number of students per class and calculated the relative percentage of the total number for the institution.

VI. allocated the indirect costs of the courses by applying the relative percentage.

VII. determined the Total Cost of the courses by adding the direct costs to the indirect costs, and

VIII. calculated the cost per class/course and student by dividing the Total Cost by the number of students.

Rodrigues et al. (2014) observed that the method retains a certain degree of subjectivity, particularly regarding the allocation of services provided by professionals who perform multiple functions. They recommend the joint adoption of TDABC and absorption costing to better assess idle capacity. Mazzuco et al. (2017) pointed out that the interview stage for estimating the time spent was complex and highlighted that time estimation based on employees' perceptions is subject to bias.

Despite the limitations of the HEI, the adapted TDABC yielded positive results, allowing for comparison with the absorption costing method, and confirming that TDABC allocates resources less arbitrarily (Rodrigues et al., 2014). Thus, the authors further asserted that TDABC is applicable in HEIs, as these organizations possess the characteristics for which the method is recommended, such as diverse services, growth in indirect costs, need for new technologies, and high competitiveness, among others.

The results obtained by Mazzuco et al., (2017) corroborate the findings of Rodrigues et al., (2014), demonstrating that the method is suitable for managing HEIs, mainly because costs are allocated based on the hours spent on each course, providing greater accuracy compared to absorption costing. On the other hand, they highlight the risk of bias in time estimation based on employees' perceptions.

Management of Postgraduate Courses

Rodrigues and Pinho's (2017) research aimed to identify the benefits of TDABC for managing a postgraduate course. Initially, interview scripts were developed for managers of each department to identify activities and estimate time spent, along with gathering cost information. Following this survey, six stages were conducted:

(I) identified the departments and mapped out the activities involved in the offering, delivery, and completion of a postgraduate course.

(II) allocated direct costs and indirect costs, proportionally directed based on the number

DOI: https://doi.org/10.14210/alcance.v31n2(mai/ago).85-102

of employees.

(III) estimated theoretical capacity and calculated practical capacity, obtained through an arbitrary estimation of 80% of theoretical capacity.

(IV) calculated the Capacity Cost Rate.

(V) estimated the time spent, based on the indications of the sector managers, and

(VI) calculated the monthly cost of the process by adding up the estimated time of the activities and multiplying it by the Capacity Cost Rate.

Rodrigues and Pinho (2017) stated that TDABC determined costs simply and clearly, confirming its applicability in service delivery, providing relevant information that allows revenue projection, and ensures the achievement of strategic objectives. Additionally, it facilitated the analysis of activities aimed at resizing or eliminating those that do not add value to the processes.

Retirement Process

Bezerra and Oliveira (2019) assessed the cost of the retirement process in a Federal Higher Education Institution, aiming to identify factors influencing cost increases and thereby contribute to enhancing management and controlling public expenditures. In this study, the following steps were carried out:

I. analyzed the flow of retirement processes and identified the types and departments involved.

II. identified the activities performed and estimated the average execution time through interviews.

III. calculated the direct costs.

IV. calculated practical capacity using an analytical approach, considering the average salary of employees and deducting from the total of 365 days in a year, 52 Saturdays, 52 Sundays, approximately 19 holidays, and 30 days of vacation per employee, resulting in 211 days, that was multiplied by 8 hours per day, without applying an idleness rate.

V. calculated the Capacity Cost Rate.

VI. They estimated the indirect cost of electricity, considering the department's occupied area in square meters and allocating it based on operating time, and

VII. calculated the total cost by summing up the direct and indirect costs.

Bezerra and Oliveira (2019) highlighted that TDABC is useful for cost allocation in Federal Institutes of Higher Education due to its practicality, enabling the generation of management reports for various aspects of the process. However, they noted that the lack of cost information per unit prevented the general cost calculation of the retirement process.

Information Technology Services

Valdivieso-Donoso et al. (2020) determined the costs of information technology (IT) services provided at a public university in Ecuador.

For implementation, the six steps proposed by Everaert et al. (2008) were utilized, similar to the studies by Sigüenza-Guzman et al. (2014a, 2014b, 2016) and Kissa et al. (2019). However, there was a difference in data collection for time estimation, which was conducted through interviews, and there was no mention of process mapping for flow analysis. The authors did not consider indirect costs, deeming them irrelevant to the analyzed process.

According to Valdivieso-Donoso et al. (2020), TDABC allowed for the observation of the financial burden generated by each user of IT services, identifying the value that should be considered in the event of outsourcing services, or even the number of financial resources needed to cover self-financed programs or offerings. Furthermore, TDABC enabled process improvement in terms of time, frequency, and costs, optimizing and making efficient use of resources, especially those related to personnel costs.

Medical Residency Selection Process

Carvalho et al. (2022) measured the costs of the selection process conducted by the Permanent Contest Core associated with a Federal Institute of Higher Education. To apply TDABC, the authors adopted the following steps:

I. mapped the activities involved in service provision and estimated the execution times

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through interviews.

II. calculated the costs of capacity provided for indirect costs, which included expenses for scholarships, personnel, cleaning, and depreciation.

III. calculated practical capacity using an arbitrary approach, considering 80% of theoretical capacity.

IV. calculated the Capacity Cost Rate for indirect costs.

V. calculated the direct costs, and

VI. obtained the process cost by summing the direct and indirect costs.

Carvalho et al. (2022) encountered difficulties in measuring electricity costs and noted subjectivity in time estimation obtained through interviews, which aligns with the findings of Mazzuco et al. (2017). Despite these challenges, they considered the TDABC method suitable for generating cost information for both service providers and public administration. In their view, TDABC can be used in conjunction with standard costing, where TDABC would account for actual costs incurred, while standard costing sets the target for an ideal cost to be achieved.

CONCLUSIONS

Considering that HEIs are complex organizations characterized by multiple inputs, outputs, missions, and objectives (Marinho et al., 1997), where the implementation of cost systems is challenging (Cordeiro & Alves, 2016), and that the information generated by the system should provide benefits that outweigh the costs of implementation (Azevedo et al., 2017), TDABC emerges as an alternative that should be analyzed.

TDABC was introduced by Kaplan and Anderson (2007) as a practical and accurate option for cost estimation, due to its straightforward implementation that requires only two parameters: the cost of providing resource capacity and the practical capacity of resources. Through these parameters, a single cost driver is established, known as the capacity cost rate.

Thus, the current systematic review of the literature identified the procedures conducted, benefits, and limitations observed in the implementation of TDABC in HEIs, following a methodological itinerary that initially collected 379 documents, from which 17 articles were selected for synthesis.

Among the selected studies, it is notable that TDABC is predominantly applied in academic libraries, followed by medical procedures in university hospitals, cost calculation of courses, and cost per student. On the other hand, there was only one study identified for each of the following applications: cost estimation of IT services, management of graduate courses, selection process for medical residents, and retirement process.

The implementation employed in five studies followed the six steps proposed by Everaert et al. (2008). The remaining studies, while some included or excluded certain steps due to data availability or specific research objectives, essentially used similar procedures. The main variations observed among the studies were related to data collection methods for time estimation and determination of practical capacity.

Regarding the estimation of activity execution time, the studies employed the following techniques:

- The application of interviews or questionnaires was adopted in 11 studies, representing 65.71% of the total: Kont (2015a, 2015b, 2020, 2021); Masthoff et al., (2021); Rodrigues et al., (2014); Mazzuco et al., (2017); Rodrigues e Pinho (2017); Bezerra and Oliveira (2019), Valdivieso-Donoso et al., (2020); and Carvalho et al., (2022); and
- Direct observation was adopted in 6 studies, corresponding to 35.29% of the total. Sigüenza-Guzmán et al., (2014a, 2014b, 2016); Kissa et al., (2019); Anzai et al., (2017); and Koehler et al., (2019).

Collecting task execution time through direct observation is a more time-consuming and potentially uncomfortable technique for the monitored team during work. However, it offers higher precision and reliability in results, reducing the risk of bias (Kont, 2015a, 2015b; Sigüenza-Guzmán et al., 2014a; Kissa et al., 2019; Koehler et al., 2019).

On the other hand, time estimation throu-

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gh interviews makes data collection and updates easier but is subject to bias due to subjectivity (Kont, 2015a, 2015b; Mazzuco et al., 2017; Carvalho et al., 2022) being more suitable for shorter and standardized activities, given that for longer and more varied activities, it resulted in inaccurate estimates (Masthoff et al., 2021).

Regarding the calculation of Practical Capacity, the studies applied the following approaches:

- The arbitrary approach was used in 12 studies, representing 70.59% of the total: Sigüenza-Guzmán et al., (2014a, 2014b, 2016); Kissa et al., 2019; Anzai et al., (2017); Koehler et al., (2019); Masthoff et al., (2021); Rodrigues et al., (2014); Mazzuco et al., (2017); Rodrigues e Pinho (2017); Valdivieso-Donoso et al., (2020); and Carvalho et al., (2022); and
- The analytical approach was applied in 5 studies, corresponding to 29.41% of the total: Kont (2015a, 2015b, 2020, 2021); and Bezerra and Oliveira (2019).

Regarding limitations, Koehler et al. (2019) evaluated that TDABC is more challenging to apply in complex processes with variations in procedures, due to the need to measure costs of secondary activities. Similarly, Rodrigues et al. (2014) and Mazzuco et al. (2017) encountered difficulties in developing time equations due to unavailable data such as time spent, and quantity of activities performed in the organization studied. Likewise, Bezerra and Oliveira (2019) and Carvalho et al. (2022) found that lack of information prevented them from determining the general cost of the processes studied.

Regarding the benefits, TDABC provided valuable insights such as identifying non-value-added activities, enabling optimization of labor, and facilitating benchmarking across different scenarios, offering decision-making support in a simplified, accurate, and easily understandable manner (Sigüenza-Guzman et al., 2014a, 2014b).

According to Kont (2015a, 2015b, 2020, 2021), TDABC appears to be one of the best tools for understanding cost behavior. For Kissa et al. (2019), it is an excellent method for mapping activities, helping managers save time and thereby reduce costs, besides being flexible, allowing for quick and inexpensive adjustments in response to changes in the organizational environment.

Koehler et al. (2019) highlight that TDABC provides concrete opportunities to reduce costs and improve procedures by demonstrating the functional opportunity cost for non-productive time. Mazzuco et al. (2017) confirm the efficiency of the method in HEIs, leading to appropriate management, especially because costs are allocated based on hours spent, supporting the findings of Rodrigues et al. (2014) and Rodrigues and Pinho (2017). Furthermore, Bezerra and Oliveira (2019) and Carvalho et al. (2022) justify this applicability due to the practicality in cost allocation, enabling the generation of valuable managerial information for public administration control.

As observed, all studies corroborate positive aspects of TDABC highlighted by Kaplan and Anderson (2007), such as simplification for implementation and updates, the capability to reveal the costs of activities and the time spent on them, and providing relevant information for decision-making. Therefore, there is a need to focus on parameterization and method dynamization over time, incorporating technological innovations like artificial intelligence and mobile phones to enhance these outcomes.

Based on this set of information, the present Systematic Literature Review updates the landscape of TDABC application in HEIs, with emphasis on the procedures employed. This allows managers, particularly in public institutions, to assess the feasibility of implementing the method in compliance with NBC TSP 34, which mandates the adoption of cost systems starting January 2024.

Despite the contributions and positive aspects observed in the selected studies, it is important to note that the use of only four sources for article collection, as well as the focus on research applied in Higher Education Institutions (HEIs), constituted a limitation of this study. This resulted in a limited number of articles selected for synthesis, representing only 4.49% of the initially collected documents, thereby restricting the potential scope of the investigation regarding the use of TDABC in the educational sector more broadly.

In this perspective, for future research like this, it is suggested to broaden the research focus to the educational sector to provide a comprehensive view of TDABC application in this segment. Another research gap identified in this study is the limited detail of the data and criteria used to determine Practical Capacity through the analytical approach, as well as the cost-benefit analysis of this approach compared to the arbitrary approach. Finally, with the same objective, investigating the differences between measuring activity execution times using the direct observation method versus the interview method is recommended.

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