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DEVOPS FOR FINANCIAL COMPANIES: A LITERATURE REVIEW

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ABSTRACT

The use of software has become an essential part of the business. In financial institutes, when it comes to exposing the client's financial capital, the need for better results expands proportionately. The objective of the present study was to identify the DevOps practices and tools by conducting a wide search in the literature, in order to find scientific evidence about the effectiveness of the DevOps movement. The search took place in the most relevant databases for research in software engineering. After applying the inclusion and exclusion criteria, we analyzed 26 articles published between 2014 and 2017. The results identified evidence in the use of practices and tools relevant to experiences in the deployment of DevOps in financial companies, as well as highlighting the communication given the integration of functions between the teams. However, there are few indexed studies on the bases listed that deal specifically with financial companies. In order to improve the proposed study, it is necessary to carry out more detailed studies on this subject in order to verify how the implementation of this movement is taking place in financial companies.

Keywords: Continuous Integration, DevOps, Infrastructure Automation, Software Quality.

1 INTRODUCTION

Over the past two decades, the use of software has become an essential part of the business. The choice of quality software includes, among other things, its ability to offer high performance, scalability and data security, and when it comes to exposing the client's financial capital, the need for better results expands proportionally.

The search for updates that positively benefit companies can be observed in various improvement initiatives. Since 2007, the software industry has been driving especially for a new concept of joint development and operation called DevOps.

The DevOps movement began in several places, but there are clues about the origins of the term that began in the year of 2008.

Patrick Debois, an independent and enthusiastic IT consultant, published an article in 2008 titled "Agile and Operations Infrastructure: How Infra-gile Are You?", In which he discussed how infrastructure could respond to constant changes, such as an agile methodology that, knowingly, responds quickly to the constant changes in the market (DEBOIS, 2008). At the same time, a mailing list called "agile-sysadmin" was created in Europe. The theme of agile infrastructure was widely explored, addressing how the operations team could work more responsibly to follow the development team.

The term DevOps was only popularized from a series of events entitled "DevOps Days", starting in 2009 in Belgium. In software engineering, this term has been used for the sharing of tasks and responsibilities, ranging from development to system deployment and support. A set of methods (such as automation, Infrastructure as a Code, auditing and monitoring in automated control panels) is used for developers and operations teams to streamline their communication and collaborate to build software (and services) quickly, reliable and better quality (HUTTERMANN, 2012; PERERA et al., 2016).

Due to natural conflicts between different groups (developers and operators), shared goals and incentives are difficult to achieve. Historically, when problems happen, the development team solves them through change. The operation team, in turn, seeks to minimize changes as they are focused on reducing system outages. In addition, it is the responsibility of developers to release the software more frequently, and operators to protect and stabilize the infrastructure. These are examples of incentive misalignments, as teams are rewarded for different behaviors. Solving this problem is the main focus of DevOps (LOGAN, 2014; HUTTERMANN, 2012).

Jabbari et al. (2016) considered DevOps a development method designed to integrate Development and Operations teams; emphasize communication,

collaboration, and continuous integration; share goals and incentives; automated deployment using a diverse set of practices and tools.

It is considered that no software process is better than the other since they must be selected, adapted and applied according to the needs of each project within the context of each organization (SWEBOK, 2004). However, in financial institutes, the needs are not limited to the adequacy of the teams and their conflicts of interest, but they emphasize security as a fundamental requirement since they work with sensitive data (RAHMAN and WILLIAMS, 2016).

According to Forsgren et al. (2017) report, made from a survey of over 3,200 IT professionals, was found that high-performance businesses, which have adopted the DevOps philosophy, managed to reduce by 21% the time spent on rework, and consequently increased by 44% the time invested in new features and codes. Other advantages were highlighted in this report, such as significant declines in flaws when compared to companies that did not use this practice; and with the increasingly automated delivery process, it has been possible to significantly reduce costs and reduce human failures.

In this sense, the organizations that are considering the adoption of DevOps could also benefit from studies that identify works on this philosophy, which justifies the elaboration of the present study.

Considering the above problem, the objective of the present study was to identify the DevOps tools and practices already tried in financial institutions, carrying out an extensive search of the literature, in order to find scientific evidence about the effectiveness of the DevOps movement. The guiding question of the present study is: What DevOps practices and tools exist in the literature and are used in financial companies?

This article is structured as follows: Section 2 describes the methodology used, detailing the concepts most pertinent to the study. Section 3 the analysis of the results obtained. Finally, section 4 presents the final considerations and recommendations of this paper.

2 METHODOLOGY

2.1 Systematic Review of Literature

The systematic review is a methodology of scientific research that proposes to identify the studies on a subject in question, applying explicit and systematized methods of search, with the purpose of capturing, recognizing and synthesizing the scientific evidence. It consists of the following steps: definition of its purpose, guiding question, literature search after the definition of selection criteria, evaluation and analysis of data, and presentation of results. For this study, the results were analyzed

in order to provide conclusions and descriptions. This type of review can be an important resource in which information related to a given problem is collected, categorized, evaluated and synthesized (BIOLCHINI et al., 2005).

The main function of the systematic review in Software Engineering, according to Biolchini et al. (2005) and Kitchenham (2004), is to scientifically improve the validity of assertions that can be made in the field and hence the degree of reliability of the methods that are employed to develop technologies and support software processes.

Defining the research question structured in the format of the acronym PICO: Originally the PICO model was developed at McMaster University in the early 1990s as a strategy for a literature search for evidence. The Evidence-Based Practice (EBP) proposes that the problems that arise in teaching or research practice are decomposed and then organized through PICO (Patient, Intervention, Comparison and Outcomes), these four components are the fundamental elements for the question of research and the construction of the question for the bibliographical search of evidence (SANTOS *et al*., 2007).

Through the construction of these four elements, it was possible to perform a bibliographic search with greater evidence. In this study, the four elements were represented by:

What DevOps practices and tools exist in the literature and are used in financial companies?

(P – Define the population, context and / or problem situation): financial companies that use the DevOps philosophy;

(I – Intervention, indication or interest): identification of the DevOps practices and tools used;

(C – Standard procedure, comparison intervention): exploratory survey of evidence in the scientific and/or gray literature (The Fourth International Conference on Gray Literature (GL'99), held in Washington, USA in October 1999, defined gray literature as: "What is produced at all levels of government, institutes, academies, businesses and industry, in print and electronic format, but not controlled by scientific or commercial editors.") . ***Table 1*** shows the items that were the basis for a systematic review.

Table 1 - Articles for the Systematic Review

#	YEAR OF PUBLICATION	TITLE OF DOCUMENT	AUTHORS	ELECTRONIC BASE
1	2004	Procedures for performing systematic reviews http://www.ifs.tuwien.ac.at/~weippl/systemicReviewsSoftwareEngineering.pdf	KITCHENHAM	Google Scholar
2	2015	Um Panorama Sobre o Uso de Práticas DevOps nas Indústrias de Software https://repositorio.ufpe.br/handle/123456789/15989	BRAGA	Google Scholar (UFPE Repository)
3	2016	Evaluating the Impact of DevOps Practice in Sri Lankan Software Development Organizations https://ieeexplore.ieee.org/abstract/document/7829932/	PERERA, BANDARA, PERERA	IEEE Xplore

(O – Define desired or undesired outcomes): how the DevOps movement is deployed and organized by teams.

List of search sources: The selected scientific bases were chosen intentionally, based on the results of the study by ZHANG et al. (2011) in which the most relevant bases for research in software engineering were listed. We analyzed the available evidence in the literature of the following repositories:

1. ACM Digital Library;
2. IEEE Xplore Digital Library;
3. ScienceDirect;
4. Scopus;
5. Springer Link
6. Oasisbr;
7. Google / Google Scholar.

Keywords: The following English-language descriptors, derived from the IEEE Taxonomy, version 1.0, from 2017 (IEEE, 2017) were used: "DevOps", "Implementation", "Operation" or "Operations", "Practice" or "Practices", "Tool" or "Tools", and "Financial Management". In Portuguese, the descriptors "DevOps", "*Implementação*", "*Operação*" or "*Operações*", "*Prática*" or "*Práticas*", "*Ferramenta*" or "*Ferramentas*", and "*Gerenciamento Financeiro*" were used. The logical operators "AND" and "OR" were used to combine the keywords.

Search Strings: In general terms, the following search strings were applied, which were later adapted to each search source:

- English: "DevOps" AND "Implementation" AND (("Operation" OR "Operations") OR ("Practice" OR "Practices") OR "Tool" OR "Tools") OR "Financial Management".

- Portuguese: “DevOps” AND “Implantação” AND ((“Operação” OR “Operações”) OR (“Prática” OR “Práticas”) OR (“Ferramenta” OR “Ferramentas”)) OR “Gerenciamento Financeiro”.

Criteria for inclusion and exclusion of articles: The inclusion or exclusion criteria in a systematic review limit the selection of papers based on relevant evaluations according to the research objective. ***Table 2*** presents the criteria that have been established for this review:

Table 2 – Inclusion and Exclusion Criteria

INCLUSION CRITERIA	EXCLUSION CRITERIA
a) Works published and available in full on the web in electronic format;	a) Articles that clearly do not address research questions;
b) Studies that present some proposal, experiment or application of the DevOps movement;	b) Repeated articles (in more than one search source) had only their first occurrence considered;
c) English and/or Portuguese language;	c) Duplicate articles have only their most recent or most complete version considered, except in cases where there is additional information;
d) Types of study: articles monographs, master’s dissertations, doctoral theses, and books;	d) Framed studies such as abstracts, keynote speeches, courses, tutorials, workshops and the like;
e) Temporal clipping from Jan/2009 to Dec/2017. The initial year coincides with the popularization of the term DevOps, which began in 2009 in Belgium through conferences called “DevOps Days”.	

Strategy Definition for Studies Selection: According to the keywords, specific strings were created for each source cited and later applied to obtain the initial list of articles. The next step was to select them, with the reading of titles, keywords, summary, and application of the inclusion/exclusion criteria.

Selection Step Definition: The works recovered from the bases were documented in specific tables and presented for each source in the conduction stage. The abstracts were evaluated through the inclusion/exclusion criteria, defining the list of articles that should be evaluated in their entirety.

Eligibility Stage Definition: The eligibility stage consisted of an evaluation of the articles selected in the previous phase, and exhaustive reading of the material in full, looking for evidence in the results and discussions of the authors that met the proposed objective. If so, the articles were included, as described in the review flowchart (***Figure 1***).

Final Inclusion Step Definition: Subsequently, the following information was extracted from the articles included: the title of the document, authors, source and year of publication (of indexed productions). Finally, a list of relevant studies for the review was created.

Results Summarization Strategy: With the obtained results, the practices or tools used were highlighted, describing the critical analyzes prepared by the reviewer: qualitative and quantitative analyses, with respect to the works researched and considerations about the results observed in the selected papers.

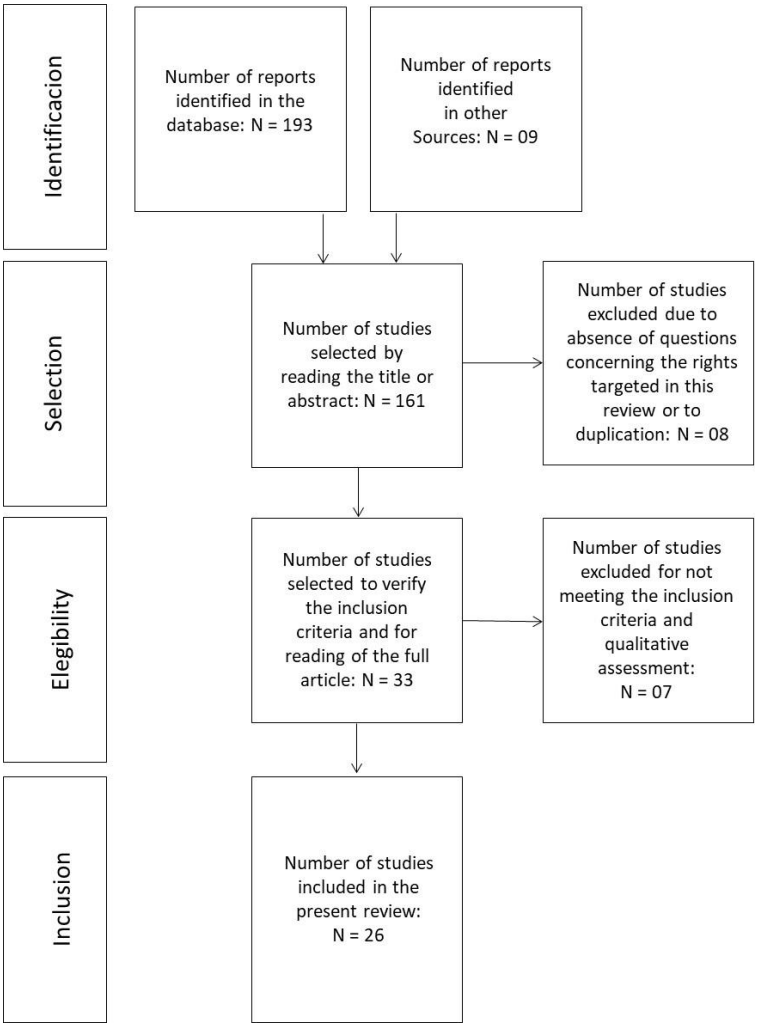
2.2 Conducting the Review

After the search strings were applied, 194 studies were identified. The next step was to select them, excluding 161 articles that did not meet the proposed objective, remaining 33 articles for the next stage.

The eligibility step consisted of a qualitative evaluation of the 33 articles selected, which included an exhaustive reading of the material as described in the review flowchart (***Figure 1***), totaling 26 references.

Subsequently, the following information was extracted from the 26 articles included: the title of the document, authors, source and year of publication (of indexed productions). Finally, a list of relevant studies for the review was created.

Figure 1 – Systematic Review Flowchart



As an example of identification and selection of articles, the following is for IEEE Xplore data source.

String used: "DevOps" AND "Implementation" AND (("Operation" OR "Operations") OR ("Practice" OR "Practices") OR "Tool" OR "Tools") OR "Financial Management".

Fields searched: Abstract

Period considered: 2009 to 2017.

Table 3 – Articles extracted from IEEE Xplore source

ID	YEAR	TITLE	AUTHORS
1	2006	Enhancing Service Quality Through Integrated Services Marketing	A. Maritz
2	2007	Enhancing Service Quality Through Integrated Services Marketing	A. Maritz
3	2007	Setting the standards in the human performance simulator	H. Strahley; L. DeRue; J. Titus
4	2009	Design and implementation of a location awareness system for field police work	Duansheng Chen; Yongquan Du; Yibao Zhang
5	2009	CHANGEMINER: A solution for discovering IT change templates from past execution traces	Cordeiro *et al.*
6	2011	Implementation of the management of an Optical Distribution Network in a Geographic Information System	Kuo *et al.*
7	2012	Data consolidation solution for internal security needs	K. H. Prasad; S. Soni; T. A. Faruquie; L. V. Subramaniam
8	2012	Antecedents and Consequences of New Product Development Practices and Software Tools: An Exploratory Study	G. R. Heim; D. N. Mallick; X. Peng
9	2013	Operations modeling in the Iceland hydro dominated power system	E. Benedikt Hreinsson
10	2013	A customized modeling and Simulation Tool for port and airport evacuation and recovery: An integrated tool for enhancing preparedness and response	P. A. Belella; B. Rooney
11	2013	Designing supply chain analysis tool using SCOR model (Case study in palm oil refinery)	F. Lestari; K. Ismail; A. B. A. Hamid; W. Sutopo
12	2014	Standards-Based DevOps Automation and Integration Using TOSCA	Wettinger *et al.*
13	2014	Twelve years of Live Substation Work at Powerlink Queensland Australia	J. P. Jouglard
14	2015	An integrated model of Kano and quality function deployment for evaluation of lean production tools in assembly environment	A. Azizi; D. O. Aikhuele
15	2016	Design and implementation of bank financial business automation testing framework based on QTP	X. Xie; Z. Yang; J. Yu; W. Zhang

16	2016	Being a DevOps Developer	Spinellis
17	2016	Evaluating the Impact of DevOps Practice in Sri Lankan Software Development Organizations	Perera, Bandara, Perera
18	2017	Condition based maintenance of machine tools: Vibration monitoring of spindle units	A. Rastegari; A. Archenti; M. Mobin
19	2017	Tool support for traceability management of software artifacts with DevOps practices	Palihawadana *et al.*
20	2017	The High-Frequency Coastal Radar Network Operated by Puertos del Estado (Spain): Roadmap to a Fully Operational Implementation	Lorente *et al.*
21	2017	IT troubleshooting with drift analysis in the DevOps era	Meng *et al.*
22	2017	Reinforcing DevOps approach with security and risk management: An experience of implementing it in a data center of a Mexican organization	Díaz, Muñoz
23	2017	Towards a Full-Stack DevOps Environment (Platform-as-a-Service) for Cloud-Hosted Applications	Li, Zhang, Liu

Table 4 – List of IEEE Xplore source articles with Inclusion and Exclusion status.

Article	Inclusion criteria met	Exclusion criteria met	Status
1	(a)(c)(d)	(b)(d)	Excluded
2	(a)(c)(d)	(b)(d)	Excluded
3	(a)(c)(d)	(a)	Excluded
4	(a)(c)(d)	(a)	Excluded
5	(a)(c)(d)	(a)	Excluded
6	(a)(c)(d)	(a)	Excluded
7	(a)(c)(d)	(a)	Excluded
8	(a)(c)(d)	(a)(b)	Excluded
9	(a)(c)(d)	(a)	Excluded
10	(a)(c)(d)	(a)(b)	Excluded
11	(a)(c)(d)	(a)(b)	Excluded
12	(a)(c)(d)	(a)(b)	Excluded
13	(a)(c)(d)	(a)	Excluded
14	(a)(c)(d)	(a)	Excluded
15	(a)(c)(d)	(a)	Excluded
16	(a)(b)(c)(d)(e)		Included
17	(a)(b)(c)(d)(e)		Included
18	(a)(c)(d)(e)	(a)(b)	Excluded
19	(a)(b)(c)(d)(e)	(a)	Excluded
20	(a)(c)(d)(e)	(a)	Excluded
21	(a)(b)(c)(d)(e)		Included
22	(a)(b)(c)(d)(e)		Included
23	(a)(b)(c)(d)(e)		Included

Other article IDs and selections of the sources cited in this work are in the master dissertation of Figueiredo (2018).

3 RESULTS

Table 5 contains the 26 studies of the indexed and gray literature that were selected after applying the inclusion and exclusion criteria. In this selection, only articles were found starting in 2014.

Table 5 – Selected studies according to year of publication, title, authors and electronic base

#	YEAR OF PUBLICATION	TITLE OF DOCUMENT	AUTHORS	ELECTRONIC BASE
1	2014	A Mapping Study on Cooperation between Information System Development and Operations https://link.springer.com/chapter/10.1007/978-3-319-13835-0_21	ERICH, AMRIT, DANEVA	Springer Link
2	2014	Your data is your dogfood: DevOps in the astronomical observatory https://www.researchgate.net/publication/264241006_Your_data_is_your_dogfood_DevOps_in_the_astronomical_observatory	ECONOMOU, HOBLITT, NORRIS	Scopus
3	2015	An introduction to Docker for reproducible research https://dl.acm.org/citation.cfm?id=2723882	BOETTIGER	ACM Digital Library
4	2015	Including Performance Benchmarks into Continuous Integration to Enable DevOps https://dl.acm.org/citation.cfm?id=2735416	WALLER, EHMKE, WILHELM	ACM Digital Library
5	2015	Um Panorama Sobre o Uso de Práticas DevOps nas Indústrias de Software https://repositorio.ufpe.br/handle/123456789/15989	BRAGA	Google Scholar (Repositório UFPE)
6	2015	Performance-oriented DevOps: A Research Agenda https://arxiv.org/abs/1508.04752	BRUNNER T *et al.*	Scopus
7	2016	Asserting Reliable Convergence for Configuration Management Scripts https://dl.acm.org/citation.cfm?id=2984000	HANAPPI, HUMMER, DUSTDAR	ACM Digital Library
8	2016	Characterizing DevOps by Hearing Multiple Voices https://dl.acm.org/citation.cfm?id=2973845	FRANÇA, JERONIMO JUNIOR, TRAVASSOS	ACM Digital Library

#	YEAR OF PUBLICATION	TITLE OF DOCUMENT	AUTHORS	ELECTRONIC BASE
9	2016	What is DevOps? A Systematic Mapping Study on Definitions and Practices https://dl.acm.org/citation.cfm?id=2962707&dl=ACM&coll=DL	JABBARI *et al.*	ACM Digital Library
10	2016	Being a DevOps Developer https://ieeexplore.ieee.org/document/7458759/	SPINELLIS	IEEE Xplore
11	2016	Evaluating the Impact of DevOps Practice in Sri Lankan Software Development Organizations https://ieeexplore.ieee.org/document/7829932/	PERERA, BANDARA, PERERA	IEEE Xplore
12	2016	DevOps: Making It Easy to Do the Right Thing https://www.scopus.com/record/display.uri?eid=2-s2.0-84968747438&origin=resultslist	CALLANAN, SPILLANE	Scopus
13	2016	A Context Model and Policies Management Framework for Reconfigurable-by design Distributed Applications https://www.sciencedirect.com/science/article/pii/S1877050916321044	GOUVAS *et al.*	Science Direct
14	2016	Streamlining DevOps automation for Cloud applications using TOSCA as standardized metamodel https://www.sciencedirect.com/science/article/pii/S0167739X15002496	WETTINGER *et al.*	Science Direct
15	2016	DevOps Technologies for Tomorrow http://oasisbr.ibict.br/vufind/Record/RCAP_d0546ff554e8caabbcd648aef7f811bd	BARROS	Oasisbr
16	2016	Towards DevOps: Practices and Patterns from the Portuguese Startup Scene http://oasisbr.ibict.br/vufind/Record/RCAP_e91cc5cf836f9d40cbbfd77f4249e23c	TEIXEIRA	Oasisbr
17	2016	Why DevOps? Top 5 benefits for financial businesses https://www.quali.com/blog/why-devops-top-5-benefits-for-financial-businesses/	ASHLOCK	Google
18	2016	DevOps: Stepping out of the IT Shadows https://www.finextra.com/blogposting/12721/devops-stepping-out-of-the-it-shadows	DONOVAN	Google
19	2016	Software security in DevOps: synthesizing practitioners' perceptions and practices https://dl.acm.org/citation.cfm?id=2896946	RAHMAN, WILLIAMS	ACM Digital Library
20	2017	IT troubleshooting with drift analysis in the DevOps era https://ieeexplore.ieee.org/document/7877287/	MENG *et al.*	IEEE Xplore

#	YEAR OF PUBLICATION	TITLE OF DOCUMENT	AUTHORS	ELECTRONIC BASE
21	2017	Reinforcing DevOps approach with security and risk management: An experience of implementing it in a data center of a Mexican organization https://ieeexplore.ieee.org/document/8169957/	DÍAZ, MUÑOZ	IEEE Xplore
22	2017	Towards a Full-Stack DevOps Environment (Platform-as-a-Service) for Cloud-Hosted Applications https://ieeexplore.ieee.org/document/7830891/	LI, ZHANG, LIU	IEEE Xplore
23	2017	Proposta de Modelo para Avaliação da Maturidade DevOps: Estudo de Caso em Empresas de Grande Porte http://oasisbr.ibict.br/vufind/Record/PUC_SP-1_e05405691fb9a433e29a51017747f4b8	LEVITA	Oasisbr
24	2017	DevOps for Financial Services – KeyBank's Story https://blog.xebialabs.com/2017/11/21/devops-for-financial-services-keybanks-story/	CLEVESY	Google
25	2017	3 Tips for Transitioning to DevOps in Financial Services https://blog.xebialabs.com/2017/11/07/3-tips-for-transitioning-to-devops-in-financial-services/	LAURIA	Google
26	2017	Influência das práticas do DevOps nos processos de gestão de TI conforme o modelo COBIT 5 http://navus.sc.senac.br/index.php/navus/article/view/584/3D	FERNANDES *et al.*	Google Scholar (Navus)

In order to analyze the results, the articles were compared and grouped by content similarity, and two analytical categories were constructed to meet the proposed goal: DevOps Practices, DevOps Tools.

It is observed in ***Table 6*** the number of publications selected in the electronic databases versus the year of publication.

Table 6 – Publications distributes by electronic bases and year of publication

BASES	YEAR OF PUBLICATION				
	2014	2015	2016	2017	Total
ACM Digital Library	0	2	4	0	6
IEEE Xplore	0	0	2	3	5
Scopus	1	1	1	0	3
ScienceDirect	0	0	2	0	2
Springer Link	1	0	0	0	1
Google Scholar	0	1	0	1	2
Oasisbr	0	0	2	1	3
Google	0	0	2	2	4
TOTAL	2	4	13	7	**26**

As to the origin of the material raised in the indexed literature, ***Table 7*** contains their quantities and percentages, as well as the language of their publication. Qualitative, quantitative, and mixed studies were found. The articles were about DevOps movement practices and tools.

Table 7 – Origin of material collected in the literature

Origin of Material	Quantity	Percentage
ACM Digital Library	6	23%
IEEE Xplorer Digital Library	5	19%
Scopus	3	12%
ScienceDirect	2	8%
Springer Link	1	4%
Google Scholar	2	8%
Oasisbr	3	12%
Google	4	15%
Language		
English	23	88%
Portuguese	3	12%

3.1. DevOps Practices

The focus of the practices found in the present review was to improve collaboration between the teams, as well as quality assurance and software delivery.

The analysis of the studies showed that the studies of Fernandes *et al*. (2017), Rahman and Williams (2016), Economou *et al*. (2014), Jabbari *et al*. (2016), Callanan

et al. (2016), Gouvas *et al*. (2016), Waller *et al*. (2015), Hanappi *et al*. (2016), Bruno (2017), Clevesy (2017), Barros (2016) and Teixeira (2016) evidenced the main DevOps practices for its implementation, which served as the basis for the definition of the propositions used in this study. ***Table 8*** contains a summary of these practices.

Table 8 – Summary of DevOps practices, according to reference found

REFERENCES	PRACTICES
Bruno (2017) Clevesy (2017) Ashlock (2017) Donovan (2017) Barros (2016) Teixeira (2016) Rahman e Williams (2016) Jabbari *et al.* (2016) Spinellis (2016) Sharma (2014)	Use of automation (performance monitoring, feedback, dashboards, deployment, testing) and service virtualization.
Gouvas *et al.* (2016) Waller *et al.* (2015)	Microservices for automation of software quality assurance.
Bruno (2017) Jabbari *et al.* (2016) Clevesy (2017) Fernandes *et al.* (2017) Sharma (2014)	Planning, Integration and continuous monitoring.
Jabbari *et al.* (2016) Clevesy (2017)	Continuous and automated testing.
Bruno (2017) Jabbari *et al.* (2016) Hanappi *et al.* (2016)	Configuration/change management.
Bruno (2017) Teixeira (2016) Barros (2016) Fernandes *et al.* (2017)	Infrastructure as a Code (IAAC).
Bruno (2017) Rahman e Williams (2016) Díaz e Muñoz (2017)	Risk analysis and safety training for the development and operation team.
Economou *et al.* (2014)	"*Eat your own dogfood*" – software tools developed by the developers should be used internally by them, rather than being used only by the operations team or the users themselves.
Jabbari *et al.* (2016) Rahman e Williams (2016) Díaz e Muñoz (2017) Callanan *et al.* (2016) Spinellis (2016) Sharma (2014)	Collaboration between different departments of the company to review and validate the system.

3.2 Tools

In addition to the cultural and organizational changes required for DevOps, tools are also needed to implement end-to-end automation in deployment processes (LAURIA, 2017). Of the 26 articles selected in the systematic review, seven brought evidence about the use and diversity of useful tools to DevOps. ***Table 9*** presents a summary of the tools listed in the selected articles versus practices that can use the mentioned tools.

Table 9 – Practices summary x DevOps Tools

Practices	Related Tools
Code control and Versioning	Git, GitHub, GitLab, Team Foundation Server, Subversion
Containerization	Docker
Configuration Management	Chef, Docker, Powershell, Puppet
Continuous Delivery	Jenkins, Puppet, UrbanCode Deploy
Continuous Integration	Jenkins, Codeship, Team Foundation Server
Build Automation	Apache Maven, Gradle, Jenkins, UrbanCode Build
Continuous Testing	Appium, Cucumber, Jira, Jmeter, Load Impact, Night Watch
Monitoring	Kibana, New Relic, Splunk, Zabbix
Collaborative Development	Confluence, Jira, Slack, Team Foundation Server, Trello
Issues Management	Bugzilla, CA Service Desk, Jira, MantisBT
Continuous Planning	IBM DevOps Services, Jira, Rational Team Concert
Knowledge Sharing	Sharepoint
Database	DB2, MongoDB

4 CONCLUSIONS

In general terms, this review presented the studies in international databases and gray literature, considering the practices and tools of deployment of the DevOps movement. The results of the included studies identified evidence of relevant practices and tools for experiments in the deployment of DevOps and were essential to answer the research question: What DevOps practices and tools exist in the literature and are used in financial companies?

In the literature, there are studies that have identified DevOps practices in software development companies with promising results, such as the Perera *et al*. (2016) in companies in Sri Lanka, and the work of Braga (2015) in Brazilian companies. However, the studies indexed in the bases listed for this study dealing specifically with financial companies are scarce.

It was also observed conceptual differences in the view of the authors, specifically related to what DevOps is and how it should be handled (ERICH *et al.*, 2014; JABBARI *et al.*, 2016; BRUNNERT *et al.*, 2015; FRANCE *et al*., 2016).

In presenting the concepts and practices of the DevOps movement, there was a movement to encourage the participation of teams; encouragement of the responsibility of employees, given the integration of functions, as well as improved communication between them. Changes that improved the quality of software products and allowed significant improvements for companies.

In order to improve the proposed study, it is also necessary to conduct future researches to address:

- The use of DevOps in financial companies, in order to verify how the DevOps movement is deployed by the teams, and to draw parallels between the results of this study with that verified within the institutions.
- The use of the DevOps movement in other industries, such as consulting firms, public, and pharmaceutical, in order to know the practices and tools present in different organizations.

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