

# DevOps in Practice a Systematic Literature Review

Shahid Ali<sup>1</sup>, Hafsa Riasat<sup>2</sup>, Saleem Zubair<sup>3</sup>, Sabah Arif<sup>4</sup>

**Abstract**— IT firms are using agile methodologies to encourage speedy development and quality of software to release a quick IT solution to market. The DevOps process is a linking of IT solutions development and its operational management. One controversial matter has been whether DevOps professional career or firm-wide working culture. DevOps emerged as a new philosophy of thinking, its concepts and implementations are still cloudy, and doing its execution in routine is not well-versed. The conducted systematic literature review selects 15 out of 25 publications. Nowadays as the benefit of DevOps for enterprises increases, many researchers exploring the different dimensions of DevOps. In this review article, we noticed that all firms are confident about their skills and encountered some complications while implementing DevOps. The demand for DevOps realization amongst software development experts, therefore, enhances the necessity for a comprehensive study of its Implementation.

**Keywords**— DevOps, development, operations, agile, process

## INTRODUCTION

The best practices in agile methodologies resulted in the form of DevOps. DevOps fill the communication gap and the release process is automated from development to quality assurance and at the end to production with reliability [1]. The software industry is transforming from traditional to agile development as an outcome DevOps is getting popular among software organizations. In addition, agile methodology means rapid development and deployment. CI/CD Continuous Integration Development is the requirement of software firms [2]. How DevOps can benefit us, and the way organizations are implementing it for the development process. what costs are associated with the adoption of DevOps and their potential industry benefits. The communication gap and misunderstandings between different development teams are huge while business demands quick response [3]. The industry is facing challenges to implement DevOps. The managers' perspective relates to DevOps as how people and processes get affected and the developer's perspective is concerned with the development to the deployment process. The industry is gaining a grip on the technical aspect of DevOps and still

struggling with the collaboration among development and operational teams. Another technical feature microservices emerged relating to DevOps with some ifs and buts [4].

DevOps is getting popular among software companies due to its flexibility and clarification in responsibilities. Best practices of DevOps that can be used among all these firms have not been established [5]. The DevOps technique is used to produce the best quality products in the software development industry. DevOps is adopted in many organizations successfully and applied to the existing development methods [6]. Speed, frequency, and quality is boosted by DEVOPS in software development. Implementation of DEVOPS in firms will change their existing development habits and overcome the development and production time by automating the process. DEVOPS are providing benefits and challenges to the organization [7]. The DevOps is used to work in a novel way to improve software development and its operations as it is gaining engineering firms' attention [8].

DevOps can be explained as standard rules and their implementation aimed at improving cooperation and timely interaction between IT operations and the development teams. The benefit of adopting DevOps is frequent quality deployments with reliability. The major challenger to adopt DevOps was recruiting skilled staff and providing training to existing staff [9]. DevOps is the capability to keep the system in the operational state and having confidence in the deployment process. DevOps is the way to automate the process of development and deployment for cross-functional collaboration [10]. DevOps is a development lifestyle and its practice that intends to reduce the delays from development to production workflow [11]. It is not clear what the different characteristics of DevOps could be. In DevOps, the soft side aspect among people is explained by using the term culture [12]. The DevOps can be defined as a working relationship in different cross-functional development and IT operations teams to provide the updated software solution to market. DevOps has a lot of potentials to handle the cloud computing or virtualization environment and artificial intelligence trends [13].

The rest of the paper is structured as follows. The conducted literature review is described in Sect. 2. Section 3 presents and analyzes the results of the review. The service identification challenges are described in Sect. 4. The section 5 concludes the paper and forecasts future research.

---

<sup>1-2-3-4</sup>Superior University Lahore

Country : Pakistan

Email: msse-s21-003@superior.edu.pk

## LITERATURE REVIEW

- Ramtin Jabbari et al. states that DevOps is used to work in a novel way to improve software development and its operations as it is gaining engineering firms' attention. Moreover, no details are available regarding DevOps concepts and there is no consensus among practitioners and developers [8].
- Pulasthi Perera Roshali Silva and Indika Perera state that best practices in agile methodologies resulted in the form of DevOps. DevOps fill the communication gap and the release process is automated from development to quality assurance and at the end to production with reliability [1].
- F. M. A. Erich et al. states that DevOps is the term that covers the underlying technologies of agile development. In addition, agile methodologies are used to increase software development. DevOps further increases the processing pace [14].
- Jessica Díaz, Rubén Almaraz, Jennifer Pérez, and Juan Garbajosa states DevOps is a development style and solution to organizations that are using agile development methodologies for rapid development. In addition, how DevOps can benefit us, and the way organizations are implementing it for the development process. Jessica Díaz et al. conducted interviews with industry experts to provide material to professionals and researchers to clear the concepts of DevOps, their benefits, and implementation in the development process. Moreover, what costs are associated with the adoption of DevOps and their potential industry benefits [3].
- Mali Senapathi and others described DevOps can be explained as standard rules and their implementation aimed at improving cooperation and timely interaction between IT operations and the development teams. The software industry has an aptitude towards DevOps adoption, this article describes indicators that influence DevOps implementation [9].
- Mary Sánchez-Gordón and Ricardo Colomo-Palacios describe those timelines and quality of software affecting the software development process. In addition, to overcome the problem DevOps is an alternative solution. Moreover, the main goal of DevOps is to automate the development process by increasing frequency, enhancing quality, and increasing deployment speed with reliability. In addition, several researchers indicate the fact that DevOps is a shift in development culture [12].
- Pratibha Jha and Rizwan Khan state DevOps can be explained as conceptual studies of the development and integration of systems. software firms are facing challenges to maintain quality and collaboration among teams. In addition, DevOps is a new approach to fill the gap and enhance communication and fast deployment process. Moreover, in this paper, DevOps is explored as a set of guidelines and tools to implement them to achieve the objective of fast development and speedy deployments because of CI and CD [15].
- Lucy Ellen Lwakatare et al. discussed that DevOps is the capability to keep the system in the operational state and having confidence in the deployment process. DevOps is the way to automate the process of development and deployment for cross-functional collaboration. The implementation or adoption of the DevOps role is not an easy task because it will impact the company's technical and cultural behavior [10].
- Welder Pinheiro Luz et al. explained DevOps is a development lifestyle and its practice that intends to reduce the delays from development to production workflow. As DevOps interest is growing, the existing research has sought to elaborate and categorize DevOps concepts. However, due to limited knowledge about professionals' understanding of successful paths to DevOps [11].
- Rachel A. Kaczka Jennings and Gerald Gannod explained the DevOps-related courses for students to meet software industry needs and overcome the deficiency of DevOps skills [2].
- Leonardo Leite et al. states that DevOps is used in different organizational departments for automation of the development process with reliability. In addition, DevOps understanding, and different automated tools explored in this context. Moreover, the industry is facing challenges to implement DevOps. In addition, managers' perspective relates to DevOps as how people and processes get affected and the developer's perspective is concerned with the development to the deployment process [4].
- Rütz, Martin states that DevOps can be defined as a working relationship in different cross-functional development and IT operations teams to provide the updated software solution to market. In addition, hundreds of publications were reviewed and out of them, only 58 were selected to conduct the research paper. Moreover, due to DevOps popularity and the market's interest in DevOps resulting in the form of publications has been increased [13].
- Alok Mishra and others state DEVOPS is used to tackle the quality pressure during software development. Speed, frequency, and quality is boosted by DEVOPS in software development. Researchers showed interest in DEVOPS, but little work is done on software quality enhancement impacted by using DEVOPS. Author, in this research focused on the different features of DEVOPS to enhance the software quality assurance [7].
- Ruth W. Macarthy et al. states DevOps is getting popular among software companies due to its flexibility and clarification in responsibilities. Moreover, deployment is increasing due to rapid changes in software due to this a reliable mechanism is mandatory to cater collaboration among different software development teams. In addition, communication among teams and ownership of tasks is

- the core feature of DEVOPS to establish the success [5].
- Monika Gasparaite, Kristina Naudziunaite, and Saulius Ragaisis state that the DevOps technique is used to produce the best quality products in the software development industry. In addition, DevOps is adopted in many organizations successfully and applied to the existing development methods. Moreover, DevOps is gaining momentum and popularity in the industry but still lacks good models to follow as a standard [6].

## METHODOLOGY

To undertake DevOps in practice review, which is the purpose of this report, we performed an SLR according to the methods suggested by Kitchen Ham and Charters [16]. This approach consists of arranging, executing, and reporting phases in which there are many stages in each process. It consists of three levels/steps.

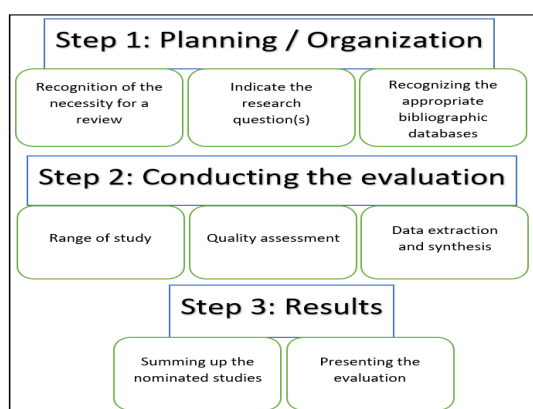


Fig 1: SLR steps and events

### Planning / Organization

As mentioned in the above overview, the preparation process began by defining the need for this analysis, as well as setting the targets to be reached. We determined the key goal of the analysis in this process and carried out the following tasks that clarified each move in detail.

#### 1) Recognition of the necessity for a review

We identified in Step 1 that there was no SLR in DevOps in practices especially. This SLR aims to explain and summarize the current DevOps approaches in practice and facts. Determining that DevOps is important. Any of this is useful for future studies. Therefore, due to the findings of the previous tests, we calculated the need to execute an SLR.

#### 2) Indicate the research question(s)

The overarching goal of this SLR is to identify and review studies relating to DevOps and their different features conducted between 2016 - 2020. To attain a more accurate and systematic view of this subject, the foremost objective was divided into succeeding research issues. This analysis needs to keep the door open for potential updates.

To achieve the objective of this analysis, three key questions were described as follows:

**RQ1:** What is DevOps according to literature?

**RQ2:** What are the benefits and problems of implementing DevOps?

### 3) Recognizing the appropriate bibliographic databases

The available digital libraries were scanned for the appropriate papers as per the research questions: Google Scholar, Science Direct, IEEEExplore Digital Library, ACM, and Springer. The foremost motive for choosing these digital reference libraries was they accumulate studies associated with the fields of computer science and technology; they index articles from numerous publication channels like journals, conferences, books, and workshops. In this article, the explorations were narrow to articles published in the 2016 - 2020 journal and conference proceedings.

### Conducting the evaluation

The massive coverage can be generated by the search string, but it is a fair scale. Consequently, the keywords matching the study questions were extracted for the fortitude of the search string, and the synonyms linked to the main terms were identified. To merge alternative meanings, the Boolean OR was used and the Boolean AND was used to connect the key pieces. The entire search string collection was planned as follows:

((“DevOps” AND “ DevOps in Practices”) OR “ DevOps Benefits”) OR (“DevOps Models” AND “ DevOps Best Practices”) OR (“DevOps Adoption” AND “Automation”) OR (“DevOps Features” AND “Continuous Integration”) OR (“Continuous Deployment” AND “DevOps Culture”).

#### 1) Range of study

We revised the paper’s abstract, introduction, and conclusion/finish. We picked those that were written in English among the papers received and that fulfilled minimally one of the following measures:

- Studies should elaborate on DevOps and features.
- Papers that compile DevOps models.
- Reports discuss DevOps and its benefits.

The investigator conducted a manual check of the search string results and found that advanced settings such as IEEEExplore were required for some of the online databases. The researcher wants to apply to the search string alternate terms and phrases.

The requirements for inclusion and omission for this SLR are based on study questions. As this SLR is based on the test case prioritization methodology, it is important to identify inclusion and exclusion requirements to choose only appropriate documents. As follows, the inclusion conditions

are:

- In English, all articles must be written.
- From 2016 to 2020, all articles must be written.
- All records must concentrate on DevOps, and its manifestations.
- Before being considered for the next step, each of the papers is screened into exclusion criteria. For this SLR, the exclusion requirements are as follows:
  - Articles that have not been written in English.
  - Duplicate areas of science.
  - Papers that comprehend only opinion pieces, perspectives, studies on development, or partial findings.
  - Articles with fewer than three pages.
  - Papers that do not report any scientific analysis in their study.

**2) Quality assessment**

Quality testing is typically designed to evaluate appropriate and impartial research. Therefore, to refine our search results and ascertain the relevance and rigorousness of the applicant papers, we determined more or less of the quality assessment metrics. As follows, the questionnaires for quality evaluation are based on other SLRs. Are the research’s objectives and priorities explicitly stated?

- Is the research pattern specified? yes/no/partial
- Have the researcher(s) properly taken the process of data collection? yes/no/partial
- Did the researcher(s) have adequate evidence to confirm their outcomes and conclusions? yes/no/partial
- Does the experiment require comparing other techniques? yes/no

**3) Data extraction and synthesis**

A data extraction procedure was introduced to satisfy the research questions to gather the appropriate data from the chosen documents.

**RQ1:** What is DevOps according to literature?

**RQ2:** What are the benefits and problems of implementing DevOps?

To synthesize the collected data and to address the study questions, various techniques were active. A narrative synthesis approach was used entirely to address research questions. In addition, based on research concerns, visualization techniques were applied.

**Results**

**1) Summing up the nominated studies**

The investigator classified 180 papers using the specified search words from the first stage of the search process. Just 150 were theoretically important, after screening titles and abstracts. Any of the articles were filtered before being approved for the synthesis of evidence for comparison to inclusion and exclusion criteria. Irrelevant experiments and repeat studies have been removed at this point. If the titles and

abstracts were not adequate to categorize the paper applicable to the research field or not, the researchers read the full papers. Finally, to provide answers to the formulated study questions, 15 studies were chosen.

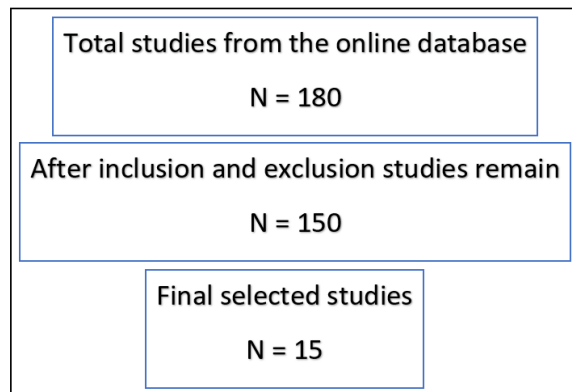


Fig 2: Studies inclusion and exclusion

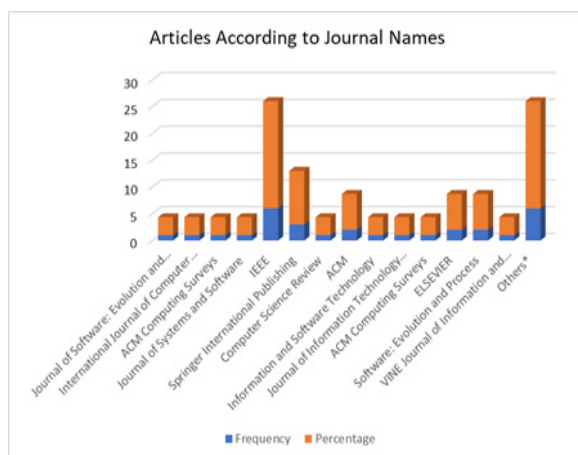


Fig 3: Division of articles according to journal names

The selected literature shows that in recent years the newer publication are exploring the DevOps in literature and this trend is continuously growing as market is adopting DevOps.

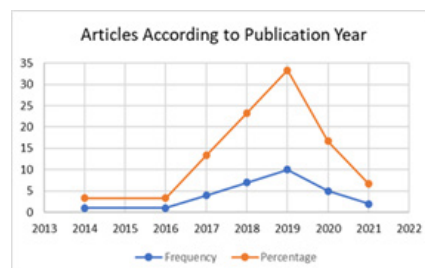


Fig 4: Distribution of articles according to publication year

The selected literature reveals that two or more than two author worked on the research, the possible reason is that DevOps term is a combination of agile development methodologies and software integration team.



Fig 5: Division of articles according to authorship pattern

The division of selected literature by sector reflects that DevOps is a very popular term in software industry and due to its hype literature is exploring the dimensions of DevOps in literature and also defining the different elements of DevOps and moving towards a standard.

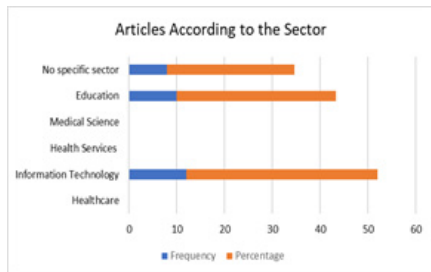


Fig 6: Division of articles according to the sector

The selected literature also reveals that as United States of America is leading the information and technology industry so the highest publications on DevOps are done in United States as shown in the figure below.

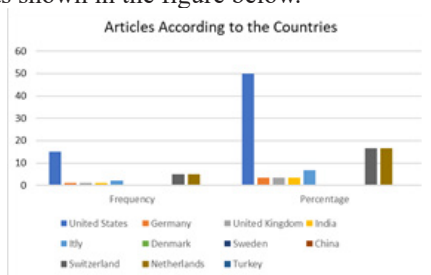


Fig 7: Division of articles according to the countries

Furthermore, the selected literature explored that researchers are mostly using qualitative method in research so that they analyze the market situation more accurately and provide solid guidelines and solutions to the software industry.



Fig 8: Division of articles according to type of research

The selected literature reveals that most of the research is on secondary data very few researchers are working on primary data. In addition, the literature showed that industry is reluctant to provide data for research due to these limitations researchers rely on secondary data.

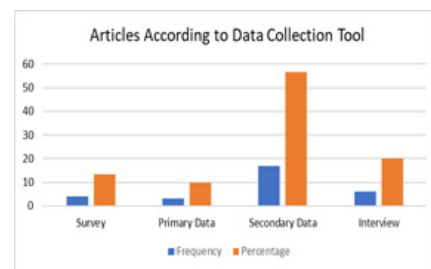


Fig 9: .Division of articles according to data collection tool

## 2) Presenting the evaluation

**RQ1:** What is DevOps according to literature?

The chosen literature presents many diverse explanations and characteristics for the word DevOps. Although approximately all sources reach agreement on the statement that DevOps is a blend of Development and Operation. it isn't adequate to explain what DevOps precisely is. Many journals define DevOps as a process of principles which enables interaction and discussion between development and operational team. Some focus on linking the difference amongst the two teams, others say that it is a development method or software distribution technique. A few define DevOps as programmed continuous deployment, integration, or quality assurance enhancement.

This implies that DevOps have different viewpoints which look like to polarize but all attempts wind up in the linking of development and operations.

**RQ2:** What are the benefits and problems of implementing DevOps?

Adoption of DevOps, comes with a slew of advantages. Devops was perceived as encouraging cross-departmental collaboration, which improved communication and employee satisfaction. Continuous releases make it possible to take a more experimental approach and get feedback more quickly.

It also facilitates quick deployments and seamless transitions. Its software development cycle is shorter. It aids in the development of our culture and the delivery of software. DevOps also reduces human labor and automates processes. It also has the advantage of improving operational support, resulting in faster patches and more stable software. Defect discovery at an early stage leads to high-quality software development. Increased client satisfaction and improved customer experience. CI and CD also aid in the improvement of quality and the reduction of time from months to hours.

Communication arrangements that stifle cross departmental collaboration are among the obstacles, as is replacing with the cultural shift. DevOps may possibly not be suitable for all sectors. A Few of the technological barriers mentioned were the disparities in development and production environments. With the introduction of new tools, your team will demand to be trained on in what manner to utilize them, along with guarantee that they meet security requirements and are well integrated with existing infrastructure. There is, therefore, a learning curve. Devops give the impression of a difficult concept to grasp, but it works effectively. Change is also reached with opposition. Your company's old infrastructure may cause it to fall behind its competition. Using newer micro services architectures to replace older applications and infrastructure allows for faster development and innovation. The complexity of this transformation is a difficulty. In DevOps, there are also challenges with tool selection. Adapting well defined processes to make them more efficient.

#### DISCUSSION

The performed organized literature evaluation gives a comprehensive sketch of the word DevOps. The increasing quantity of publications highlights the value of DevOps in a digital world. IT solutions decide about business success and businesses look for solutions to comply with the increasing demand of customized IT solutions. DevOps cover all the relevant dimensions of IT firms company culture, process automation, quality measurement and information sharing. The firm's culture is often linked and connected with teamwork. Furthermore, the sense on culture is human based and automation deals with tools and processes, which is the practical thing. In small-scale organization staff is located physically in one place and due to a less standardized delivery process, a more intensive communication happens. The liking of the proper tools in the very environment with the right resources is the key to fit DevOps. Nevertheless, many corporations plan to put up DevOps in their organization because the greater throughput provides lot of benefits, reduce release time, automate practices, and greater client satisfaction. But the DevOps adaption procedure in many organizations encompasses many challenges on a technical and human level. Apart from the challenge to adapt DevOps in a big organization, to implement the DevOps is a tricky thing. The research doesn't provide a model or solution, how to cater the

different ideas of development teams and the operational teams. That's the situation where management can play a vital role.

#### CONCLUSION AND FUTURE WORK

The literature review indicates the increasing significance of DevOps appearing in many organizations in the digital transformation course. The literature focuses on tools, practices, and the lack of standards. In conjunction with this, the literature doesn't offer a suitable framework or procedure to adapt DevOps to an active IT ecosystem in enterprises. Particularly big firms work hard to adapt DevOps to their present software development departments to deliver their clients groundbreaking software products. Some research deal with resemblances of various software development principles and try to incorporate DevOps in specific frameworks. But this isn't enough to defeat the mentioned difficulties as a big enterprise. That's why an additional research is required. Furthermore, new techniques like cloud computing alongside artificial intelligence in blend with DevOps are not explained in a detailed way. But the significance of DevOps in blend with cloud-based web applications grows and digital titans like Amazon has already a functioning DevOps environment.

#### REFERENCES

- [1] P. Perera, R. Silva, and I. Perera, "Improve software quality through practicing DevOps," in 2017 Seventeenth International Conference on Advances in ICT for Emerging Regions (ICTer), Colombo, Sep. 2017, pp. 1–6. doi: 10.1109/ICTER.2017.8257807.
- [2] R. A. K. Jennings and G. Gannod, "DevOps - Preparing Students for Professional Practice," in 2019 IEEE Frontiers in Education Conference (FIE), Covington, KY, USA, Oct. 2019, pp. 1–5. doi: 10.1109/FIE43999.2019.9028598.
- [3] J. Díaz, R. Almaraz, J. Pérez, and J. Garbajosa, "DevOps in practice: an exploratory case study," in Proceedings of the 19th International Conference on Agile Software Development: Companion, Porto Portugal, May 2018, pp. 1–3. doi: 10.1145/3234152.3234199.
- [4] L. Leite, C. Rocha, F. Kon, D. Milojicic, and P. Meirelles, "A Survey of DevOps Concepts and Challenges," *ACM Comput. Surv.*, vol. 52, no. 6, pp. 1–35, Jan. 2020, doi: 10.1145/3359981.
- [5] R. W. Macarthy and J. M. Bass, "An Empirical Taxonomy of DevOps in Practice," in 2020 46th Euromicro Conference on Software Engineering and Advanced Applications (SEAA), Portoroz, Slovenia, Aug. 2020, pp. 221–228. doi: 10.1109/SEAA51224.2020.00046.

- [6] M. Gasparaite, K. Naudziunaite, and S. Ragaisis, "Systematic Literature Review of DevOps Models," in *Quality of Information and Communications Technology*, vol. 1266, M. Shepperd, F. Brito e Abreu, A. Rodrigues da Silva, and R. Pérez-Castillo, Eds. Cham: Springer International Publishing, 2020, pp. 184–198. doi: 10.1007/978-3-030-58793-2\_15.
- [7] A. Mishra and Z. Otaiwi, "DevOps and software quality: A systematic mapping," *Computer Science Review*, vol. 38, p. 100308, Nov. 2020, doi: 10.1016/j.cosrev.2020.100308.
- [8] R. Jabbari, N. bin Ali, K. Petersen, and B. Tanveer, "What is DevOps?: A Systematic Mapping Study on Definitions and Practices," in *Proceedings of the Scientific Workshop Proceedings of XP2016, Edinburgh Scotland UK, May 2016*, pp. 1–11. doi: 10.1145/2962695.2962707.
- [9] M. Senapathi, J. Buchan, and H. Osman, "DevOps Capabilities, Practices, and Challenges: Insights from a Case Study," in *Proceedings of the 22nd International Conference on Evaluation and Assessment in Software Engineering 2018, Christchurch New Zealand, Jun. 2018*, pp. 57–67. doi: 10.1145/3210459.3210465.
- [10] L. E. Lwakatare et al., "DevOps in practice: A multiple case study of five companies," *Information and Software Technology*, vol. 114, pp. 217–230, Oct. 2019, doi: 10.1016/j.infsof.2019.06.010.
- [11] W. P. Luz, G. Pinto, and R. Bonifácio, "Adopting DevOps in the real world: A theory, a model, and a case study," *Journal of Systems and Software*, vol. 157, p. 110384, Nov. 2019, doi: 10.1016/j.jss.2019.07.083.
- [12] M. Sánchez-Gordón and R. Colomo-Palacios, "Characterizing DevOps Culture: A Systematic Literature Review," in *Software Process Improvement and Capability Determination*, vol. 918, I. Stamelos, R. V. O'Connor, T. Rout, and A. Dorling, Eds. Cham: Springer International Publishing, 2018, pp. 3–15. doi: 10.1007/978-3-030-00623-5\_1.
- [13] F. Wedel, "DEVOPS: A SYSTEMATIC LITERATURE REVIEW," p. 16, 2019.
- [14] F. M. A. Erich, C. Amrit, and M. Daneva, "A qualitative study of DevOps usage in practice," *J Softw Evol Proc*, vol. 29, no. 6, Jun. 2017, doi: 10.1002/smr.1885.
- [15] P. Jha and R. Khan, "A Review Paper on DevOps: Beginning and More To Know," *IJCA*, vol. 180, no. 48, pp. 16–20, Jun. 2018, doi: 10.5120/ijca2018917253.
- [16] B. Kitchenham and S. Charters, "Guidelines for performing Systematic Literature Reviews in Software Engineering." 2007.