

A Mapping Study on Cooperation between Information System Development and Operations

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Abstract. DevOps is a conceptual framework for reintegrating development and operations of Information Systems. We performed a Systematic Mapping Study to explore DevOps. 26 articles out of 139 were selected, studied and summarized. Based on this a concept table was constructed. We discovered that DevOps has not been adequately studied in scientific literature. There is relatively little research available on DevOps and the studies are often of low quality. We also found that DevOps is supported by a culture of collaboration, automation, measurement, information sharing and web service usage. DevOps benefits IS development and operations performance. It also has positive effects on web service development and quality assurance performance. Finally, our mapping study suggests that more research is needed to quantify these effects.

1 Introduction

Many organizations which develop and use Information Systems (IS) make a structural division of their IS departments. A popular one is separating IS development and operations. Some practitioners argue that this division has a negative impact. DevOps is a conceptual framework which aims at benefiting IS development by reintegrating development and operations in various ways.

In this paper we try to find empirical evidence that DevOps does indeed benefit IS development. To accomplish this we have performed a systematic mapping study, asking the following main research question: "How does DevOps influence IS development and operations performance?"

2 Research Method

We performed a systematic mapping study [5]. We started our search with the search term *DevOps*. Based on our preliminary findings we also added the search terms "*Continuous Delivery*" AND *Software*; and "*development and operations*" AND *software*. We applied the search terms to the databases of Scopus, Web of Science, IEEE Xplore and ACM Digital Library. The first author selected the articles and discussed them with the co-authors. Papers considered for the review were (1) published in 2007 and onward; (2) related to problems found in

the intersection of software development and software operations; and (3) mainly considering IS. Because we did not closely study the potential biases authors of the studies might have, and which validity instruments were used, we present our work in progress as a mapping study instead of an SLR.

3 Results

We selected 14 journal articles, 10 conference proceedings and 2 industry reports out of 139 articles found. From the journal articles, 10 originated from special issues on DevOps from the Cutter IT Journal. Summaries of the papers as well as their related concepts can be found online [2]. Following the concept mapping approach [6], we labeled each article based on their primary concerns. This produced the following labels (and the amount of articles labeled as such):

- Culture of collaboration (9): Articles concerning the cultural changes required to reintegrate development and operations.
- Automation (9): Articles describing how the SDLC can be automated, covering both development and operations.
- Measurement (4): Articles describing how measurements can be introduced which cover both development and operations.
- Sharing (5): Articles describing how information sharing between development and operations can be increased and improved.
- Services (4): Articles describing how DevOps supports service development and is supported by existing services.
- Quality assurance (5): Articles describing what role quality assurance plays in a DevOps initiative.
- Structures and standards (8): Article describing how DevOps can be integrated into existing processes and works together with standards.

Regarding study quality, we have classified each study according to the Study Design Hierarchy for Software Engineering [4, p. 13]. We have classified 20 articles to be in the lowest level (5, evidence being limited to expert opinion), 5 articles to be in level 4 (evidence from (quasi-)randomized experiments in an artificial setting or case series) and one article to be in level 3 (in this case a multi-arm study considering a focus group and two cases).

4 Discussion

Until now development and operations have mostly been studied as two different fields. We believe our research shows that there is some merit in studying the combination of both. This is because in industry, many organizations are reintegrating development and operations. We understand that academic research should not primarily be swayed by trends in industry, which are often the subject of hype. But at the same time, academic research should support industry developments by finding evidence which supports or rejects the value proposition of commercial offerings that match the respective market developments.

Our survey of the academic literature available on DevOps shows that there is some interest in DevOps from an academic perspective in three ways: DevOps is considered as (i) the subject of discussion, (ii) a supporting factor of some other subject (iii) a factor supported by some other subject. Yet, we consider the study design quality of the discovered literature to be low.

A problem frequently discovered in the literature is the lack of a concrete shared definition of DevOps. While we have defined it as a conceptual framework, some authors see DevOps as a job description and others see it a skill set. Research could benefit from a clarification by creating a DevOps taxonomy [1]. A good starting point for a taxonomy is the CAMS framework [3]. We suggest that DevOps research can be classified using an extended version of this framework, including the concepts of services, quality assurance and structures & standards.

We believe the different views of DevOps require us to look at DevOps from multiple perspectives. This allows us to unite the conflicting definitions of DevOps under separate names, such as DevOps as a role in the SDLC process, DevOps as a skill set and DevOps as a conceptual framework for supporting IS development and operations.

We hope that by writing this article we have contributed towards creating more awareness and some initial understanding of DevOps.

5 Limitations

One must consider two primary limitations of mapping studies. First, possible selection bias. This bias is reduced significantly, as no author has prior publications in the area nor collaborations with authors of the included 26 papers. Also, our inclusion of English-only papers might mean that we missed out relevant studies in other languages actively exploring DevOps. This could not be avoided since English was the only feasible common language for our team. Second, it is possible that we collectively categorized a paper in a wrong way. The categorization was reviewed by another senior researcher, minimizing this threat's risk.

We think our research is in particular vulnerable to two biases, the argument from authority bias and the publication bias. Most articles selected in the review are based on expert opinion. While we have no reason to doubt these opinions, one should be aware that experts can be wrong. When one blindly follows expert opinion, one is vulnerable to the argument from authority bias. That is why expert opinion should be backed up with other sources of evidence. In our research we have found little evidence of DevOps having a positive effect on IS development besides expert opinion. The research is also vulnerable to publication bias, which means there is a tendency to publish only positive results. Hence, there might be organizations which struggle with DevOps and might have abandoned it, yet nothing is published regarding this. We control for these biases by being aware of them and regularly reflecting on the risks they pose.

We have limited our research to IS development and operations. This limitation follows from our belief that this is the biggest class of systems using structured software development processes, such as agile software development.

Our limitation to academic search engines hides a lot of potential sources of state-of-the-art material on DevOps research and development. DevOps is a concept born in the field, the primary venue for research and development of the DevOps concept are professional conferences and blogs. But professional conferences are hosted in native languages in countries all over the world, making it hard to extract useful information about them. Also, getting a complete overview of which authors have blogged about DevOps is nearly impossible. We have decided to offer a complete study over a smaller population, rather than offer a possibly incomplete study over a larger population. This paper still represents the state-of-the-art of academic DevOps research. We recommend future research to focus on the gap between professional research and development regarding DevOps and the academic research on the topic.

6 Conclusions

We now return to the main research question, which asked how DevOps influences IS development and operations performance. We have discovered that this influence is generated by practices which are considered part of DevOps, as well as how DevOps supports the development of web services and the process of quality assurance. DevOps itself is both supported by structures and standards, as well as allows the realization of structures and standards which are considered beneficial for IS development and operations.

The arguments of DevOps proponents that development and operations could benefit from more integration are quite compelling, yet lack very strong evidence. We suggest further research is needed to discover whether DevOps actually increases IS development and operations performance.

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