Industrial views on DevOps adoption before and after implementation: A qualitative comparison

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Abstract. DevOps is establishing itself as an important software development principle, pushing more organizations to adopt the trend for their projects. Several studies have investigated the benefits and challenges of DevOps adoption, but a comparison of practitioners who already use DevOps with those who are about to adopt is still missing. By comparing these two groups, we want to find possible differences in expectations for adopting DevOps and how planned adoption processes deviate from actual performed adoption processes. Moreover, seeing if the industrial assessments and understandings of DevOps shift as time passes is engaging. To close this gap, we conducted interviews about DevOps adoption with nine representatives of five companies. Our study includes subjects who use DevOps and those who plan to do so soon. We compare their assessments with each other and with the literature. Among other things, we find a high agreement between expected and actual benefits (which are also consistent with those reported in the literature) but a potential underestimation of cultural difficulties among subjects who plan to adopt DevOps. Furthermore, we find that customer expectations and demands are decisive factors in *why* and *how* DevOps is used.

Keywords: DevOps · Qualitative Study · Adoption

1 Introduction

DevOps is becoming an established paradigm for software development, deployment, and maintenance. There might be a hype around it – but studies on DevOps adoption consistently find certain benefits associated with its use like fast release cycles, high automation, and many more (see Sect. 2). Such studies, however, also report major challenges in the adoption process – from complex tooling with a steep learning curve to strong cultural changes for the involved persons. DevOps adoption is depicted as a complex and demanding process, which accords to anecdotal evidence and our own experience [2]. The literature seems to lack studies that compare the expectations of people about to adopt DevOps with the expectations and experiences of those already using it. By separating our participants into those two groups, we hope to better understand

how the adoption process of DevOps may differ from planned and reality. If there are deviations, what are these explicitly? Does DevOps fulfill the expected benefits? What are the reported and expected obstacles during the adoption process? How do the reasons for using DevOps differ between adopters and non-adopters? Furthermore, existing studies on DevOps adoption are often small and local and DevOps is expanding, which might lead to changes in its perception. All this suggests to further study the process of DevOps adoption. Understanding it better could help to devise tools that make it easier. For example, a better understanding of non-adopters suggested expectations and the adopters' actual learning could help develop tools that support the adoption process.

In this paper, we report on a small study we conducted about DevOps adoption. Our focus was on comparing the perspectives of adopters and non-adopters who are about to start using DevOps. The results presented in this paper are part of a larger interview series initially conducted to evaluate a tool for supporting the technology-choosing process for large-scale systems. The findings in this paper were not related to the overall study's intention but, from our perspective, are still relevant to the research on the DevOps adoption process. Therefore, we decided to report them in this paper. Concretely, we aim to answer the following research questions (RQs):

RQ1 How do the expectations of DevOps differ from reality?
  RQ1.1 How do expected benefits compare to experienced ones?
  RQ1.2 How do reasons for not adopting DevOps compare to experienced obstacles?
RQ2 Are the reasons for adopting DevOps in change?
  RQ2.1 What specific requirements do customers have in terms of the tools that have to be used?

For this, we performed interviews with 9 representatives from 5 different companies belonging to the two different groups. We find a realistic assessment of DevOps benefits, but our results also indicate that participants about to adopt might underrate the cultural challenges ahead of them. Furthermore, we find that using DevOps increasingly becomes a customer requirement – evidence that DevOps is on the march and a result we could not find in the literature so far.

Structure We describe related work in Section 2. In Section 3, we report our study, including methods (Section 3.1) and results (Section 3.2). Finally, we discuss and interpret our results in Section 4 and summarize our work and further research steps in Section 5.

2   Related Work

Several publications address different aspects of the DevOps adoption process from a technical or organizational perspective. From the organizational perspective, recent publications have examined different models to support the

adoption of DevOps [13,4]; others collect best practices for the adoption of DevOps [14,9,8].

Different qualitative studies investigate a wide range of questions about DevOps in the industry, such as practitioners' perceptions of its benefits and challenges [15,16,11,1], observation [7,17,5], improvement of the whole adoption process of DevOps [10], or detection critical success factors of DevOps [6]. There is also a quantitative case study, measuring the effects of DevOps adoption [12].

For the purposes of this paper, we extracted the following from the above cited literature: (1) reasons to adopt DevOps; (2) benefits experienced through DevOps; (3) challenges of DevOps adoption; and (4) implemented DevOps practices. In each case, we present our summary without any particular order. Regarding reasons (1) we extracted: Fast release cycles, high grade of automation, reducing technical debts, improving communication, feedback loops, availability, and observability. Regarding benefits (2) we found: Improved software quality, fast release cycles, high grade of automation, improved scalability, and reduced costs. Mentioned challenges (3) are: Scepticism of developers, scepticism of management, missing knowledge, complex technology stack, teams need to be reorganized, steep learning curves for adopters, and security concerns through cloud usage. Finally, implemented practices (4) consist of: Source control, CI/CD pipelines, culture shifts with team reorganization, usage of cloud from hyperscaler, continuous monitoring.

While some of the cited studies accompany DevOps adoption processes, i.e., are longitudinal, we could not find a comparison of the views of practitioners that already use DevOps with those of practitioners wanting to use DevOps (but not doing so, yet).

3   A qualitative study on DevOps adoption

In order to answer our questions about the possibly changing reasons for the use of DevOps and the different expectations of future users, we conducted a qualitative study, which we present in this section.

3.1   Methodology

We interviewed participants to compare their views on DevOps adoption before and after implementation. In the first group, participants had not adopted DevOps but concretely planned to do so for a near-term project, but did not concretely name a time-based process for their planned adoption. Participants in the second group should be actively using DevOps for their projects. We recruited the participants from the first author's network and ensured that the resulting participants were distributed among multiple companies across Germany. We used a mix of structured and semi-structured interviews for our qualitative study. The questions were predefined in a fixed order, but the participants could answer freely. The first author performed the interviews online (individually with each participant) and recorded them with Microsoft Teams. Microsoft Teams also

created the initial transcript of the interviews. Afterward, we refined the transcripts by hand to improve their readability. During the first screening of the interview results, we decided to clarify our findings through follow-up questions. These were sent and answered by e-mail. During the data collection phase, we extracted the core statements from the participants' answers using the refined transcripts and compiled them into a spreadsheet. The refined transcripts were in German, so the data extraction and compiling into the spreadsheet were also done in German.

For the sake of transparency, the transcripts of the interviews, as well as our data collection files, are available at Zenodo [3]. All files were automatically translated from German to English using DeepL. As previously mentioned, the presented study is part of a bigger interview study. Therefore, the transcript may appear short, but the full interviews were longer.

3.2   Results

We interviewed nine participants from five companies in Germany, which consist of software development service providers and consulting firms. Participants from the same company were interviewed regarding different projects. Four of the nine participants want to use DevOps in their projects in the near future (Group 1 (**G1**)), and five are already using it (Group 2 (**G2**)). Table 1 provides an overview of our interview partners and their assignment to study groups. Table 2 provides the results of our interviews with G1 (about to use DevOps)

Table 1. Overview of survey participants

Participant ID	Company ID	Industry Sector	Position	Group
P1	C1	Heat Industry	Software Engineer	2
P2	C1	Heat Industry	Software Engineer	2
P3	C2	Energy Economics	Software Engineer	2
P4	C3	Energy Economics	Software Engineer	1
P5	C4	SAP	Technical Consultant	1
P6	C4	SAP	Technical Consultant	1
P7	C5	Multiple	Cloud Solution Architect	2
P8	C5	Multiple	Cloud Engineer	2
P9	C5	Multiple	Lead DevOps Engineer	1

and Table 3 the ones for G2 (already using). We asked participants from G1 the following questions. **Q1**: Why do you want to use DevOps in your project? **Q2**: Are there any reasons why you did not use it earlier? **Q3**: Were there any obstacles beforehand that prevented you from applying DevOps? We also asked participants from G2 about their reasons for adopting DevOps and experienced obstacles but additionally asked for their assessment of the experience. The questions are as follows. **Q4**: Why did you use DevOps for your project? **Q5**: Was the

introduction worthwhile? **Q6**: Are there any reasons that might prompt you to migrate back? **Q7**: Have you encountered any obstacles during the introduction of DevOps?

Regarding reasons for adoption (Q1, Q4), G1 (about to adopt) named time savings through automation (P5, P6, P9), outside pressure (P4), and expected improved communication within the team (P6). G2 (already using) also mentioned automation (P3, P8) and, similarly to outside pressure, the industry trend to use DevOps (P7), and additionally the customer requirement (P1, P2, P8), or necessity by high project complexity (P1).

Table 2. Interview results for Group 1 (about to adopt)

Question	Answers	Participant
Q1	Pressure from outside, we have to move with the times	P4
	Automation and the associated time savings through pipelines	P5, P6, P9
	We hope to improve communication within the team	P6
Q2	Time-consuming migration due to the age of the project	P4, P5
	We do not have the needed knowledge in our team	P5, P6
	It was not a requirement of our client	P4, P9
Q3	Our client has not defined DevOps as a requirement	P4, P5, P9
	We do not have the needed knowledge in our team	P6

Asked for their reasons to not adopt DevOps earlier and the obstacles that hold them back in the past (Q2 and Q3), participants from G1 (about to use DevOps) reported that they do not yet use DevOps because it hadn't been required by the client before (P4, P5, P9), because of the complex migration process (P4, P5), and because of missing knowledge (P5, P6). Regarding the actually experienced obstacles (Q7), G2 (already using) reported the lack of knowledge and personnel and the steep learning curve (P1, P3, P7, P8), conflicts, where individual persons had to be convinced of the benefits of using DevOps (P3, P7, P8), and missing insight into the customer's pipeline (P1). However, a single participant reported not having experienced any real obstacles (P2).

Regarding the assessment, G2 (already using) unequivocally agrees that the adoption of DevOps was worthwhile (Q6) and lists advantages like the rescue of the project (P1, P2), time savings (P3, P8), better resilience, observability, and team/client communication (P7) when answering Q5.

Surprised by how frequently the adoption of DevOps was mentioned as a customer requirement, we asked participants in both study groups in follow-up emails which technologies had been explicitly specified by the customer in their project (**Q8**) and which technologies they had explicitly been free to choose (**Q9**). They reported the following tools and technologies as specified by their customers: CI/CD with GitLab, GitHub or Jenkins (P1, P2, P6, P9), Jira (P2, P6), Grafana (P1, P6), Docker and Visual Studio Code (P6), managed Kuber-

Table 3. Interview results for Group 2 (adopters)

Question	Answers	Participant
Q4	It was a requirement of our client, they want it because of the automation possibilities	P1, P2, P8
	Without DevOps, the project cannot be built due to its complexity	P1
	We have saved time through a high degree of automation	P3, P8
	The general industry is moving to DevOps, so we followed the trend	P7
Q5	Yes, without DevOps we could no longer develop the project	P1, P2
	Yes, the time saving factor is huge	P3, P8
	Yes, our benefits are better resilience, observability, and team/client communication	P7
Q6	No, the drawbacks of losing the benefits are too critical	P1, P2, P3, P7, P8
Q7	No direct obstacles; we see the overhead of DevOps as the prize to pay	P2
	No insight into the customer's pipeline	P1
	Lack of knowledge/trained personnel; steep learning curve	P1, P3, P7, P8
	Needed to convince individual persons of the benefits of DevOps	P3, P7, P8

netes from AWS, GCP or Azure (P7, P9), Nexus (P1, P2), and Confluence, Gradle, SonarQube and Firebase (P2). For the tools they were free to choose, they stated the following: they were only free to specify the development workflow (P6), they could only choose the communication channel (P1, P2), they got a list of authorized cloud services (P7, P9), they could choose the programming language and frameworks as long these do not affect the infrastructure as code system (P9).

4   Key findings

In this section, we interpret the obtained results to answer our research questions.

4.1   The cultural aspect of DevOps still seems to be underestimated

In our study, the technical reasons of G1 (about to use DevOps) for starting to adopt DevOps are congruent with the reasons and the experienced benefits reported by G2 (already using), namely expected benefits by automation and improved communication. In contrast, the reasons reported by G1 (about to use DevOps) to not adopt earlier are not entirely congruent with the actually experienced obstacles reported by G2 (already using). Missing knowledge and high costs are reported by both groups. However, the adopters reported additional non-technical issues – in particular, conflicts in convincing individual persons of the benefits of DevOps have been reported by 3 of 5 subjects of G2 (already using).

Answering RQs 2.1, we interpret these findings as indicating that adopting DevOps is associated with benefits that adopters know about and can realistically expect to experience. The strong focus on potential technical obstacles in the reasons of G1 (about to use DevOps) to not adopt DevOps earlier might indicate that industrial representatives still underestimate the complexity of the

cultural shift needed to adopt DevOps. This is surprising as this issue is well-reported in the literature on DevOps adoption (see Sect. 2).

4.2   DevOps as a requirement of the customers

As seen in Sect. 2, important reasons for adopting DevOps and benefits experienced by that that have been reported in the literature include increased automation and improved communication. We also find this in our study but detect an important new trend that, to the best of our knowledge, has not been reported in the literature so far: In our study, 3 of 5 participants from G2 (already using) mention an explicit customer requirement as one of the reasons for adoption. While no participant from G1 ((about to use DevOps)) answers this when directly asked for reasons (Q1), 3 of 4 mention a missing customer requirement as reason for not adopting earlier (Q2 and Q3). This shows that also their adoption is accompanied by a now raised customer requirement. Additionally, in both groups outside pressure resp. a wish to be part of the trend is mentioned.

   When examining the *concrete customer requirements* from our follow-up questions to understand their understanding of DevOps, we see that the tools requested and specified by the customers are congruent with the DevOps practices described by the literature and cover the DevOps cycle (consisting of planning, coding, building, testing, releasing, deploying, operating, and monitoring). Specifically, tools for source control with the ability to define CI/CD pipelines like GitLab or Github (P1, P2, P6, P9), containerization and Cloud Provider Platforms with Kubernetes (P6, P7, P9), for agile methods like Jira and Confluence (P2, P6), and monitoring like Grafana (P6) are mentioned.

   To summarize and answer RQ 2, the reasons for adopting DevOps are shifting as, beyond technical reasons, customer requirements are becoming a critical reason for not only *why* but also *how* to adopt (including stringent requirements on tooling). In that, for both the adopters of DevOps and the clients who desire DevOps in their projects, the primary association with DevOps seems to be a high grade of automation through CI/CD pipelines and deployment in a containerized/cloud platform environment. While further research is needed to substantiate that claim, we interpret these results cautiously as showing increasing acceptance of DevOps and maybe even indicating a move to more modern software development practices in German industry.

4.3   Threats to validity

The main threats to the *external validity* of our study are the small sample size, the recruiting method for our subjects, and the study method being interviews, where the obtained results represent opinions and viewpoints. To tackle these threats, we tried to recruit our subjects as heterogenous as was possible to us, having representatives from different companies working in different branches, and ensuring that participants from the same company work at least in different projects. The main threat to *internal validity* is that the first author individually performed the interviews and data extraction, increasing the threat of bias and

misinterpretation. To mitigate this threat, all three authors together discussed examples for data extraction and the whole interpretation of the obtained data. Furthermore, as the participants were recruited from the first author's network, social desirability could have led to untrustworthy answers during the interviews. However, this threat was mitigated through the design of the questions by directly asking about negative aspects.

5   Conclusion

This paper presents the results of a qualitative study, which involved standardized interviews with nine participants from five different companies across Germany, belonging to two different groups: participants about to start adopting DevOps and participants already using it. The key findings of our work are: i) Expectations for and experiences of DevOps benefits nearly overlap in both groups. However, it might be possible that the non-adopters underestimate the cultural challenges of DevOps ahead of them. ii) Besides the benefits of DevOps, the primary reason the interviewed participants use DevOps is the requirement of their clients. iii) Industrial practitioners perceive DevOps as associated with a high degree of automation through CI/CD pipelines and deployment in a cloud environment. Nevertheless, we still have open questions that need further investigation. Why is there a noticeable gap between expected and experienced challenges? How can the stated challenges be mitigated without adding more complexity? We will conduct further investigations to close these gaps.

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