How DevOps Practices Support Digital Transformation

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How DevOps Practices Support Digital Transformation

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ABSTRACT

Digital transformation is all about technology enabling and opening up new opportunities for businesses, societies, and governments to meet changing business and market requirements that would add values to the digital economy. Thus, to compete in the digital economy, companies must be able to manage software development in a rapidly and reliably fashion. To achieve this, they should apply powerful software development practices. Indeed, several software development practices are becoming popular, and one of these powerful practices used is DevOps. While digital transformation is well-established in research areas, the implications of software development practices on digital transformation are under-investigated. Taking this topic as a reference, this paper introduces how DevOps practices and culture facilities the digital transformation within organizations through a discussion of the DevOps core of principles, practices, and values that support digital transformation organizations in many aspects. Therefore, this paper is proposing DevOps practices and culture from two case studies. Then, it will illustrate how these practices support digital transformation organizations. The proposed DevOps practices and culture contribute significantly to the field of DevOps, as it would be useful to digital transformation organizations who have already adopted or are about to adopt DevOps.

Key words: Culture; DevOps; Digital Transformation; Software Development; IT projects; Practice.

1. INTRODUCTION

Nowadays, digital transformation became a common phenomenon in Information Systems (IS) research. Digital transformation aims to provide significant improvements in many governmental and business organizations, intending to empower customer engagement and rapid operations through adopting new digital technologies[1]. At a high level, digital transformation places changes in society and industries using digital technologies [2, 3].At the company level, they should find the best approaches and practices to innovate with these new technologies to improve the company's operational excellence [2].Therefore, most of the non-digital companies could stay competitive with other companies by gaining the benefits of both their current potential and the advantages presented by digital technologies. However, without obvious approaches and strategies to apply digital transformations, non-digital companies will be reacting to immediate opportunities rather than creating a long-term digital transformation strategic plan. It will be impossible to adopt technology without implementing a company's digital transformation strategy [2].

Unfortunately, the large majority of non-digital companies' profits still come from traditional business approaches [2].And to compete in the digital economy, companies should provide powerful, reliable techniques to access and extract important operational data. To achieve this, companies should develop a digital platform that obtains technology and business ability to ensure high performance and accuracy of the companies' procedures and operations [2].New research have participated in increasing the perception of certain perspectives on the digital transformation, such as the effects of digital transformation on information technology departments or units, where it is taken as an exemplary reference for digital innovation research. It is already subject to rigorous academic discussion within the Association for Information Systems (AIS) Senior Scholars "Basket of eight" leading IS journals ("Basket of eight") [4].Moreover, recent research has contributed to address how several digital technologies like cloud computing, predictive analytics, and the Internet of things support the digital transformation in organizations [5].

However, the technology side is not the only aspect of the digital transformation mystery that must be dissolved for companies to stay leadership in the digital world[6]. Meanwhile, there is a lack of published studies about the impact of software development practices and cultural values on information technology to facilitate digital transformation. In particular, DevOps, which is a combination of a collaboration of cultural and procedural practices that arise in the software development manufacture, with a goal to improve organizational information technology operations, decrease the cost of the software development lifecycle, and increase performance and quality through closing the gap between development teams and operations teams [7].The main aim of the current study is to explain how DevOps core of principles, practices, and values support and improve digital transformation in organizations or companies.

This paper provides the six following sections. First, review the role of digital transformation in the information technology unit, and in Section 2 to illustrate the gap that this paper fills. Then it will discuss the DevOps concept and practices in Section 3. The study design and the research questions in detail are presented in Section 4. After that, the paper provides DevOps adoption and benefits in the case study in Section 5. Finally, it answers the research questions in Section 6.

2. LITERATURE REVIEW

The review in this part aims to clarify the role of the digital transformation in the information technology departments or unit. As information technology plays a significant part in

digital transformation, it is not only wanted as a support function, but also must operate the current information technology unit in a cost-efficient and secure way and to improve itself simultaneously[8].

A question was raised to examine if the digital transformation is distinct from other information technology-enabled transformation?[6].To examine this question, researchers investigated the proofs given in information technology-enabled transformation literature against the proofs given in digital transformation studies to compare them, then they referred to four properties of digital transformation during the decomposition process. After these comparisons, it led to a result that digital transformation work as an evolution of technology-enabled transformation [6].

Consequently, most of the studies showed great emphasis on the necessity of a new digital information technology (IT) department or unit. And because companies still have traditional IT with current resources, the IT unit in several companies is performing in a longer development life cycle and in a slow manner, as it develops major core systems, which are inflexible to modify or change[9].Thus, the collaboration between digital IT and traditional IT arises to form a new concept which is "bimodal IT" or "two-speed IT", which is the new "digital IT" unit that leads companies to be moreaware, and easily and rapidly implementing its IT simultaneously with its IT-enabled deliverables[9].

2.1 Bimodal IT

Numerous studies exist on the topics "bimodal IT" or "two-speed IT" as an established new IT model that enables digital transformation. In addition, three reasons were illustrated on why companies decide to adopt bimodal IT [10].With the increasing need for a level of IT that classical IT capabilities are originally not prepared or designed to operate, these reasons are the needs for IT agility, IT explorative capabilities, and structural alignment with the business[10].These needs are required by the business for more efficient support to the digital transformation. Additionally, the powerful and faster-growing companies demand to create more digital business solutions.

As a reaction to the previous reasons, several academic studies explained various bimodal IT aspects. For example, it has been introduced that bimodal IT has many roles, which could be one of four themes[6].The first theme focuses on automation and reduces human labor to gain better capacity and performance[6].The second is to inform-up. This means providing information to top management[6].Thirdly, the information-down description includes spreading information to employees of the company [6].It seems that the second and third categories have the same goals which are improvingin decision-making, coordination, and collaboration. The fourth theme is to transform and redefine business processes and the model of the company, to change current abilities, and gain new abilities [6].The use of the four themes affects three fields, which are financial markets, customer experience, and healthcare [6].In the first two fields, a major change has already happened as operations, networks, and market structures, wherein the healthcare field is just starting [6].

Moreover, different types of bimodal IT are explained in other studies[11, 12].One study identified five different types of bimodal IT as the result of a qualitative empirical study on the bimodal IT adoption in nine organizations. The five different types are bimodal IT, agile IT, traditional IT with agile IT outsourcing, bimodal sourcing IT, and traditional IT with bimodal development processes [11].The order of the five different types is established on the degree of transformation the traditional IT companies demand in order to create the appropriate bimodal IT type [11].In addition, the DevOps methodology is introduced for "Agile IT" and "Bimodal IT" to align traditional and agile IT. On the other hand ,the IT functions were defined into two categories[12]. Category 1 focuses on allowing the IT function to provide continuous IT deliverables to the companies [12].Category 2 focuses on encouraging companies to faster react to business market pressure and lead to more digital innovation [12].

Through the collaboration of these two categories, the study identified three different archetypes of bimodal IT. These are adoption category 2 entirely outside of the current IT unit, splitting the structure of the IT function into two categories, and project-by-project category selection [12].Companies adopting these categories are capable to implement one archetype and later modify to another archetype as an effect of changing requirements and the experience with the past archetype [12].

2.2 Utilizing Bimodal IT

In order to utilize the capabilities of bimodal IT, companies have to handle major changes, considering both changes to the IT functions and business processes. Thus, implantation or adopting bimodal IT is illustrated in several studies[13, 14].The development is characterized by creating micro services elements for software development, and also standardized hardware components which are easy to increase in scalability by utilizing "Lego blocks" which are linked into a cloud structure, and all projects are characterized by agile methods [13].In another study, digital companies structure required the next elements to achieve the operation, which are two-speed architecture, zero downtime, real-time data analytics, easy process configuration, product factory, automated scaling of IT platforms, and secure architecture [14].

To implement the idea efficiently and introduce a continuous learning process, different implantation approaches would be used [15].Software-as-a-service is a tool that helps implement and deploy software or services in an easy manner. Software-as-a-service removes operation and maintenance obstacles by leaving them to the service provider[15].The software-as-a-service structure is represented major number of "micro-apps" which can be combined together to develop software and are is easily scalable if needed[15].Whereas the platform-as-a-service is another tool that helps to implement and test applications efficiently in the operating environment, then deploy them rapidly and swiftly[15].Platform-as-a-service usually is used if a required application is not offered by the software-as-a-service model[15].Scrum or DevOps are other approaches that significantly raise agility and speed in the development environment of new products and services[15].Another way to implement bimodal IT is to

become an observer in the IT industry to be aware of the recent data of IT and adopt it efficiently, or also to request partners to generate new IT solutions, such as in the NPM museums case study [16].The NPM museums case study introduces obvious proof that the sensing–seizing–transforming process offers critical support for companies in implementing new IT solutions [16].

Achieving digital transformation is not all about providing new technologies; it is also about creating a digital team that assists and makes a change in the IT department. Thus, the researcher discusses the digital transformation from the aspect of the digital project team instead of digital transformation technologies and approaches [17].Four main team cultures were identified as necessary to enable digital transformation, which are an iterative target, talented organization, continuous learning process, and a diverse skills team composition [17].

3. DevOps CONCEPT AND PRACTICES

DevOps is a common technical term. It mainly developed to cope with the gap between developers and operations[7].DevOps improves the communications between developers and operations teams [7],resulting in faster deliverables of software or services and continuously learning from customers[18].This study focuses on how a DevOps approach would assist companies in the digital transformation from a view of speeding up the process of developing new products or services. Thus, this section first describes the fundamentals of the DevOps concepts and practices.

DevOps goals and values behave similarly to Agile, but with a powerful focus on team culture. DevOps refers to movement, practices, culture, tools, and the philosophy of the software development process with a cross-functional collaboration between software developers and IT operations team[18].The goal is to speed up the development and deployment process of the quality and resilience of software, system, or service[19]where visibility and transparency are the main attributes to achieve collaboration [20].DevOps collaboration requires many prerequisites. Those prerequisites include team members respect for each other, collective ownership, an obligation to shared values and goals,and use of the same application process and tools. Two significant factors of DevOps are cycle time and lead time. Cycle time is a period of time that began at the start of the implementation up until the first income is received [20].Lead time is the period of time that began from an input request to the software or service until the fulfillment of that request [20].

DevOps practices are essentially about decreasing the risk of software deployment and gaining fast feedback by using a collection of techniques and tools, which is known as continuous delivery. Typically, the software user stories can be developed and deployed into production in one or two days [21].DevOps practices usually split into two categories, collaboration practices between project team members, and procedural practices that are mostly automated[18].In the procedural practices, the entire software process is automated from requirementchange requests to the change that is deployed to customers. In the deployment mechanism, DevOps adopt an automation environment to minimize the contribution of the development team with the operation team in the manual involvement and facilitating learning[18].To facilitate the automatic deployment of software changes, continuous integration (CI), server, and virtual machine (VM) are incorporated in a cloud-based system in several cases. Different deployment strategies can be used to automate the deployment mechanism; great examples are blue-green and rolling upgrade, that guarantees the iterative and reliability of software deployment[18].In addition, two attributes developers and operations should consider when choosing the deployment approach are monitoring and security [18].

Software development organizations utilize DevOps to solve several problems, such as the concernof software change consequences. DevOps eliminates the fear of changes because once the software is delivered, stakeholders might tend to be afraid of any software change as changes take a long time to be affected [19].Also, DevOps mitigate the risk of the deployment process. In those cases not practicing DevOps, developers and operators might not be completely confident regarding the operability of the developed software to work properly in the real environment; this would be a result of several factors including the existence of the isolated environment between developers and operators[19].DevOps tends to solve this issue, where it cooperates with both the development team and operation team in the implementation process. For instance, programmers, testers, and the Quality Assurance unit (QA) from the development team would work closely with database, system, and network administrators, and operators from the operations team [19].

4. RESEARCH METHODOLOGY

The previous Sections 2 and 3 revealed some fundamental research areas regarding the role of digital transformation in the information technology unit and the background of the DevOps concepts and practices. Although the investigated sources regard the implementation or adoption of the bimodal IT model to serve digital transformation how software development practices such as DevOps in bimodal IT serve digital transformation has not been reached. This gap affects the motivation of digital transformation companies to implement DevOps approaches for the IT department. Developing a clear relation of how DevOps practices support digital transformation with a case study is the main purpose of this paper. This section describes procedures taken for establishing this study. The following subjects are discussed in subsections; case selection, the interview design, data gathering, and the interview data analysis.

4.1 Case selection and the interview design

The paper is driven by a multiple-case study method, which was selected to examine the DevOps culture and practices during several aspects of digital transformation in a real world. Moreover, the case study method fits the aims of this paper, which is to present how DevOps implementation and benefits support digital transformation. Multiple cases mean that three development teams that adopted a DevOps culture and practices were examined. The two research questions used to lead this paper were:

- First research question: What are the perceived benefits of DevOps practices that support digital transformation?
- Second research question: What are DevOps common practices in the digital transformation company?

Case selection A previous study does not identify how DevOps affects digital transformation. Based on this, this study selected digital transformation organizations or companies that help other organizations to digitalize, and also had successfully adopted DevOps. The part that had been examined and analyzed was a development team implementing several and different services or applications for customers or employees in the organizations. The selected two cases are identified in the tables with letters A and B, which are development teams from; A) a government sector (municipality) B) a private IT company.

Design of the interview The design of the interview offered advantages for this paper, which is to obviously request an answer for each question. The interview contains open-ended questions that were split into two categories: development practices andimpacts of DevOps.The list of all interview questions is in Appendix A. The interview questions were sent by email to interviewees that represent the company before the interview and the company background information was requested.

4.2 Data gathering

Most data were gathered through interviews with one employee from each case. Table 1 summarizes the roles and responsibilities of interviewees from each case. The interviews, structured with open-ended questions, allow interviewees to add additional discussion when answering the questions. The first case interview was done face-to-face, where the second interview was done via Google Duo. Each interview took, on average, one or two hours.

Table 1: interviewees in cases

Case	Interviewees	Responsibilities
A	Developer	Working on developing software tasks and software testing process
B	CTO (Chief Technical Officer)	Monitor and manage the IT development team

4.3 The interview data analysis

The data was analyzed by the cross-case synthesis method [22].which is a method that has been used to help to make a comparison of differences in the evidence, processes, and information by using tables to support and assist the comparison of the cases, which are used to extract results from the cases [22].The method is mainly presented as a synthesis method for a multi-case study, where here it is used across just two case studies. The method contains three main procedures; decrease and summarize data, data presentation, and illustrate and verify the conclusion[22].The three main procedures are repeated through the analysis process until they reach the final result [22].The first step, which is decreasing and summarizing data is to provide items of information in the cases to cluster and present them into a table [22].In this study, Table 2 shows the first step, the initial set of the items used to cluster the interview transcripts. Subsequently, the second and third steps illustrate the next sections.

Table 2: Items used to cluster the cases.

Item	Description
Organization	Organizational size, development team roles, product or service, and end-users.
Procedural practices	DevOps procedural practices reflected by the development team during the deliverable development life cycle
Collaborations culture	DevOps collaborations culture reflected by the development team during the release life cycle
Benefits	General benefits observed from DevOps
Operation	DevOps impacts on an organization operation
Invention	DevOps impacts on creativity and invention in a digital transformation organization
Customer	DevOps impacts on customer engagement in a digital transformation organization
Analysis	DevOps impacts on the collection and analysis of data used in an organization
Challenges	DevOps drawbacks and challenges

5. DevOps ADOPTION AND BENEFITS IN THE CASE STUDY

The adoption and benefits of DevOps practices in each development team was explored in the flowing cases:

    A. A government sector (municipality).
    B. A private IT company.

Those cases were presented in the following lines of this section, where DevOps practices were discussed in two categories. These categories are DevOps collaboration culture and DevOps procedural practices. In addition, the discussion included brief information regarding development team customers, previous software, and customers and end-users. A brief description of the cases is given in Table 3.

Table 3: Brief description of the cases.

Aspect	Case A	Case B
Organization type and size	government organization, 40,000+ employees	business company, five development teams.
Software	websites, web-based services, and web application	web applications, platform solutions, and mobile applications
Customer and End-users	citizens of Jeddah and employees of the organization	other non-digital companies
Development team and size	web development team, 6 members; team leaders, analyst, and 4 developers	the development team 15, 5 members designer, analyst, and 3 programmers.
Tools	Bootstrap, Google inspector, GitHub, Saltstack, and Telerik Fiddler.	
Programming languages	php, C++, jQuery, and JavaScript	C#, asb.net, Java, and Swift
Release cycle time	one week	14 days
Deployment frequency	several times to production during the cycle time	at the end of the release cycle

5.1 Case A – web development team of the municipality

The municipality web development team mainly provides digital solutions for the other municipality departments and visitors to the municipality official website. The solutions are mainly provided as web-based services and web-based applications. The digital solutions provided by the team to serve other municipality departments facilitate business processes. Direct Dialing Service (DDS) is an example of the web-based application that was developed by the team to help visitors to lodge inquiries regarding the various services provided by the municipality.

5.1.1 DevOps collaborations culture

The DevOps collaborations culture is presented in the way that the team works together during the release cycle time, which was one week. The development team consisted of four developers, a system analyst, and team leader. Each project is required by another department, where the project's features and requirements are specified by that department. At the beginning of each week, the team members meet, where they divide the project requirements into tasks, prioritized them, and assign a deadline for each one. Then, the team members pick tasks based on their skills and knowledge. During the weekdays, the team members use a spreadsheet to inform the team leader and the team members regarding the status of each task. Each task can be assigned a status as done, under processing, in queue, delayed, or canceled. At the end of each week, an end of the week meeting is conducted between team members to review the progress of the week. The meetings achieve collective ownership and commitment of the shared goals and values,while the spreadsheet achieves visibility and transparency. All the previous attributes are core components to employee DevOps collaborations culture.

5.1.2 DevOps procedural practices

The way the development team in develops and deploys deliverables reflects DevOps procedural practices. The procedural practices of rapid releases of new software or services seem rich as the development team releases multiple project deliverables during the release cycle time[20].The deliverables may be released daily or at the end of the release cycle time. Subsequently, the development team gains faster feedback from end-users that would help in mitigating several risks, such as working on incorrect requirements.

Each deliverable goes through the entire agile development life cycle. In this case, development life cycle steps are design, build, test, and deployment. DevOps practices eliminate the fear of change. During the development life cycle, all steps are interweaved. This gives the project leader the opportunity to review each step to increase the likelihood of having the right decision of approving or deciding to go back to the previous step. That gives the ability to change the project requirements easily, for example, adding new features, change user scenarios, or change the design.

In the first step, the design phase, one team member assigned an employee a Bootstrap tool, which is an open-source toolkit for developing a quick prototype in HTML, CSS, and JS programming languages with a responsive grid system, extensive prebuilt components, and powerful plugins built on jQuery[1].

Then, developers were assigned to tasks in the developing phase. To enhance collaboration between team members, two developers could be working together on the same task during this phase based on the task requirements and deadline. In this phase, developers were assigned to tasks, such as developing front-end, back-end or database code, by using and sharing the following tools:

[1]a. Mark Otto, "Bootstrap", *Getbootstrap.com*, 2019. [Online]. Available: https://getbootstrap.com/. [Accessed: 01- Dec- 2019]

- DevTools, which is a set of web developer tools built directly into Internet browser[2].

- GitHub, which is a version control system that allows developers to keep software versions and the modifications in a central repository, which assists developers to easily collaborate and keep track of code modification[3].

- Saltstack, a distributed remote execution system used to execute commands and query data on remote nodes, either individually or by arbitrary selection criteria[4].

The previous tools help developers in automating the building process and develop a better website, faster.

The testing phase is done in two steps. First, developers test each other's code in a local environment until the code is well structured, and programmers are not allowed to test his/her own code. Secondly, the team leader and programmers test the deliverable by using the Telerik Fiddler to perform security tests and performance tests, which is a special-purpose proxy server for debugging web traffic from applications like browsers[5]. Finally, in the deployment phase, release software or service operates by the team leader and attended by all team members to ensure visibility between the team members.

5.2 Case B – development team in the private IT company

The main purpose of the IT company is to help digitalize other companies by introducing digital business solutions to their customers as web applications, platform solutions, and mobile applications. The digital business solutions have been developed by the company such as customer management systems, hotel booking systems, and property management systems. The company has five development teams and this case studies one development team of the company. The team consists of five members; a system designer, a system analyst, and three programmers.

5.2.1 DevOps collaborations culture

The development team reflects DevOps collaborations culture during the release cycle time. In this case, the release cycle duration is two weeks. The release cycle starts with the team meeting with a customer to identify project requirements. Then the system analyst is responsible for establishinga requirements specification and prioritizing it based on customer preference. The team meets at the beginning of the release cycle time to divide project requirements into tasks, prioritize, and organize the tasks among them based on each member's knowledge and skills. Moreover, the team conducts a weekly-based meeting to identify the accomplished and incomplete tasks. Technically, they use Azure Boards, an online board that allows combination drag-and-drop sprint planning and flexible work item tracking with comprehensive traceability to plan, track, and discuss each other's performance in the agile method way[6]. Both regular meetings and use of the Azure Boards tool support DevOps collaborations culture as they allowed the sharing of values, goals, and knowledge.

5.2.2 DevOps procedural practices

The DevOps procedural practices are introduced in the development life cycle. The development life cycle in this case is design, develop, test, and deployment. The development team focused on automating the development of life cycle phases through the adoption of many tools, as it supports the team to gain faster release and feedback, as well as to mitigate the risk of the software or service deployment.

In consideration of automating most of the life cycle phases, the development team adopts various tools in each phase. In the first phase, the development team employs the following tools in the development phase;

- Visual Studio, an application developing platform to write code, debug, test and collaborate efficiently[7].
- Android studio, an application developing platform for building applications on every type of Android device[8].
- Xcode, an application developing platform for building applications on IOS operating system[9].
- GitHub

In the test phase, they use the following tools;

- Test Studio, a platform that helps to quickly and easily craft automated tests, integrate them in your CI/CD

[2]"Chrome DevTools | Tools for Web Developers | Google Developers", *Google Developers*, 2019. [Online]. Available: https://developers.google.com/web/tools/chrome-devtools. [Accessed: 01- Dec- 2019]

[3]"Build software better, together", *GitHub*, 2019. [Online]. Available: https://github.com/. [Accessed: 01- Dec- 2019]

[4]"Introduction to Salt", *Docs.saltstack.com*, 2019. [Online]. Available: https://docs.saltstack.com/en/latest/topics/. [Accessed: 01- Dec- 2019]

[5]"Fiddler - Free Web Debugging Proxy - Telerik", *Telerik.com*, 2019. [Online]. Available: https://www.telerik.com/fiddler?_ga=2.259859722.182694 8199.1575106071-513017264.1573560085. [Accessed: 01- Dec- 2019]

[6]"Azure Boards | Microsoft Azure", *Azure.microsoft.com*, 2019. [Online]. Available: https://azure.microsoft.com/en-us/services/devops/boards/. [Accessed: 01- Dec- 2019]

[7]"Visual Studio 2019 | Download for free", *Visual Studio*, 2019. [Online]. Available: https://visualstudio.microsoft.com/vs/. [Accessed: 01- Dec- 2019]

[8]"Android Studio Preview | Android Developers", *Android Developers*, 2019. [Online]. Available: https://developer.android.com/studio/preview. [Accessed: 01- Dec- 2019]

[9]"Xcode - Resources - Apple Developer", *Apple Developer*, 2019. [Online]. Available: https://developer.apple.com/xcode/resources/. [Accessed: 01- Dec- 2019]

environment following an agile workflow, find defects earlier, and ship a better-quality software product[10].

- Azure Test Plans, a software testing platform that executes tests across desktop or web apps and compares the actual outcome with the expected outcome[11].

The team tends to perform multiple test levels in this phase, including acceptance test, stress test, and load test. However, in the test phase, the programmers are divided into two teams and test each other's work.

Eventually, in the deployment phase, the release decision is made by the project manager. If the project manager approves the release, the team uses four cloud-based servers and the Azure Pipelines tool, which is a tool used to continuously build, test, and deploy software to any platform and cloud[12]. This phase is operating through three steps, which are backup, configuration, and deployment.

6. RESULTS

This section answers the two research questions mentioned in Section 4 by presenting the benefits of using DevOps practices to enable digital transformation. The results were concluded based on Section 5 and the item information used to cluster interview answers in Table 2.

6.1 First research question: What are the perceived benefits of DevOps practices that support digital transformation?

The explanation of the adoption of a DevOps collaborations culture and procedural practices in each case in the previous Section 5 with interviewees' answers for the second category (impacts of DevOps) aid to extract DevOps impacts in a digital transformation organization. The result showed that DevOps impacts introduced significant benefits at various aspects of the digital transformation organization. Table 4 presents a summary of DevOps benefits in aspects of the digital transformation organization.

The way teams work together, and the automation of most phases in the release life cycle, have several impacts on a digital transformation organization's operation. In Case A the interviewees mention that DevOps produces more reliable software to operate, as there is more than one review on the software code during the build and testing phases. Both Cases A and B confirmed the faster

production and incremental development in the operating environment as a result of DevOps practice. Consequently, rapid productions introduced a high level of invention and creativity to digital transformations. Also, according to interviewees in Case A, the DevOps culture allows team members to be more creative, as it encourages each member to absorb more awareness of deliverables requirements.

Table 4: Benefits of DevOps practices.

Aspect	Benefits
Operation	incremental development, faster production, and reliable software
Invention	more production and creativity of team development
Customer	more customer engagement through digital transformation platforms
Analysis	support collection and analysis of end-user data in a digital transformation organization
Team	improve users skills experience and knowledge

Digital transformation organizations are always looking for customer engagement. Both cases supported that DevOps practices increase customer engagement. In Case A, as they are a public sector who targets citizens, the interviewees mentioned that as "the more and faster development team adds new features, more citizens visit the website or in the web application." Moreover, DevOps rapid releases support digital transformation on the collection and analysis of data used by the development organization. As in Case A, it helps to make fast, precise decisions in the organizations by developing software to collect and analyze citizens' information. According to interviewees in Case B, the team always asks for end-users clustering information from their customer companies, where DevOps rapid releases support the team to achieve that.

In general, both cases were agreed with the believe that DevOps culture enhances development teams progress, as it allows them to share knowledge and skills. A Case A developer stated that "I get more experience from the team, I learn a lot on testing, data analysis and how important it is that the code should be well-structured because my co-workers advise me if there is an error in the code. Users will never visit the website again if the user thinks it is unreliable." In Case B, the CEO mentions that he and the project manager always make sure the whole team shares most skill and knowledge to improve the team skills.

6.2 Second research question: What are DevOps common practices in the digital transformation company?

The Cases A and B adopt many DevOps practices as discussed in Section 5. After studying both cases, comparisons between the Cases A and B DevOps practices are presented in Table 5 to find the common practices. Table 5 demonstrates that DevOps practices considered under two categories, collaboration culture and procedural practices, prove that common practices in both cases are the collaborations between the development team and the automation of most the development life cycle phases.

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[10]"Continuously Ensure High Level of Software Quality - Telerik Test Studio", *Telerik.com*, 2019. [Online]. Available:
https://www.telerik.com/teststudio/features/continuous-delivery. [Accessed: 01- Dec- 2019]
[11]"Azure Test Plans | Microsoft Azure", *Azure.microsoft.com*, 2019. [Online]. Available:
https://azure.microsoft.com/en-us/services/devops/test-plans/. [Accessed: 01- Dec- 2019]
[12]"Azure Pipelines | Microsoft Azure", *Azure.microsoft.com*, 2019. [Online]. Available:
https://azure.microsoft.com/en-us/services/devops/pipelines/. [Accessed: 01- Dec- 2019]

Table 5 : DevOps practices in cases

DevOps categories	Practices	Case A	Case B
collaboration culture	automated dashboards		✓
	self-organized development team	✓	✓
	share goals and values	✓	✓
	share knowledge and skills	✓	✓
procedural practices	continuous deliverable	✓	✓
	continuous integration	✓	✓
	automation development	✓	✓
	automation test		✓
	automation deployment	✓	✓

However, there is a slight difference between the practices in the two cases. In Case A the development team just used a spreadsheet to track, organize, and share work between them, which is not an effective approach to achieve visibility and transparency in the team. In contrast, the Case, B development team used a web-based automated dashboard tool to track, organize, and share work between them, which is a more efficient and effective way than a spreadsheet to achieve visibility and transparency in the team. Moreover, in Case A the testing phase development team wrote a test script and performed it manually to check the expected outcome. This can be difficult to perform and take a long time, as it's a repetitive task, wherein Case B the automation test been used to test and compare the actual outcome with the expected outcome in a rapid and softly approach.

DevOps practices help a lot in closing the gap between the operation and development team but, according to Case B, there is still a challenge faced by the DevOps team which is the differentiation in understanding project requirements between business analysts and developers.

7. CONCLUSION AND FUTURE WORK

The main purpose of this paper is to examine the DevOps values, collaboration culture, and producer practices in supporting the establishment and improvement of digital transformations in organizations. Throughout two case studies that implement the DevOps concepts in a development team, where both cases are related to digital transformations, either it helped other companies to digitalize or the company was going through the digitalization phase itself. The two cases were examined through interviews that emphasize two aspects in each case; development practices and impacts of DevOps. The collected data were analyzed and presented in two themes. These themes are collaboration culture and producer practices. The cases introduced information regarding DevOps practices, which have been analyzed by using a cross-case synthesis method to create a correlation between the impacts of DevOps practices and the digital transformation. The correlation between DevOps and digital transformation would generate several benefits of

DevOps that assist digital transformations in various aspects. The extracted benefits of DevOps have been divided into five groups. Each group supports a specific aspect of digital transformation companies. The aspects that were affected by DevOps in digital transformation companies are the company operation, invention of team development, customer engagement, analysis and collecting of end-user data, and team skills and experience. Moreover, through the process of analyzing the two cases' data, this study discovered the most adopted practices through these cases, which are the collaborations between the development team and the automation of most of the development life cycle phases. Therefore, the result of this paper is a recommendation to motivate digital transformation companies to implement the DevOps concept by providing pieces of evidence that adopting DevOps enhances digital transformations. The future work of this paper will extend to discover more DevOps practices that can support further major aspects of a digital transformation organization and to build a DevOps practices framework, which will be an essential guide for a development team in digital transformation companies.

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