Department of Information Science and Technology

DevOps Practices in Incident Management Process

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Resumo

O objetivo desta pesquisa é investigar como a cultura *DevOps* pode ser aplicada ao processo de gestão de incidentes e como pode melhorá-lo. Dada a abordagem exploratória para esta pesquisa, foi feito um caso de estudo. O objeto de estudo para esta pesquisa, foi uma equipa de gestão aplicacional em gestão de incidentes, onde um conjunto de 10 pessoas foi entrevistado. Esta equipa resolve incidentes e fornece o suporte necessário aos utilizadores de negócio, nas suas tarefas do dia a dia, utilizando práticas *DevOps*. Durante a elaboração deste caso de estudo, foi feita a triangulação de três métodos de recolha de dados: entrevistas semiestruturadas, análise documental e observação. Esta pesquisa fornece novas conclusões sobre uma possível relação entre práticas de *DevOps* e as fases do processo de gestão de incidentes, tal como o "porquê" e o "como" estas práticas podem ajudar o processo de gestão de incidentes. São apresentados resultados, como o tempo entre entregas, total de soluções de incidentes entregues a mais do que estava planeado e o número de entregas por mês, de forma a justificar como existiu uma melhoria de desempenho desta equipa após a implementação destas práticas.

As conclusões que são apresentadas nesta pesquisa trazem vantagens tanto para académicos devido à natureza exploratória deste estudo que estende o corpo de conhecimento científico. E também para profissionais, por demonstrar como aplicar estas práticas e os seus resultados após implementação. Direções para trabalho futuro são também apresentadas.

Palavras-Chave: DevOps, Gestão de Incidentes, Gestão Aplicacional, ITSM

Abstract

This research aims to investigate how DevOps culture can be applied in the incident management process to improve it. Given the exploratory approach of the research, it was performed a case study. For this case study an application management team was studied where a sample of 10 persons were interviewed. This team solves incidents and provides the necessary support to the users in their daily business tasks using DevOps practices. During this case study three data collection methods were used: semi structured interviews, document analysis and observation. This research provides novel findings about a possible relation between DevOps practices and incident management phases as well as on "why" and "how" can these practices help incident management. The results are supported by metrics, like time between releases, total of over delivered incidents solutions and releases per month, to justify how this team's performance have increased after the implementation of DevOps practices. The novelty of the findings brings advantages for academics, and due to the exploratory nature of this research, it extends the body of knowledge. It also provides contributions for practitioners, by showing how these practices can be applied and the result of the implementation of these practices. Directions of future work are also presented.

Keywords: DevOps, Incident Management, Application Management, ITSM

Publications

This section aims to present and detail the publications that were submitted/published along this research.

Table 1 — Publications

Conference/Journal	**Rank**	**Decision**
ISD	A	Accepted
IJISPM	Q2	Submitted

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Abbreviations

AM	–	Application Management
CI	–	Continuous Integration
CS	–	Case Study
IM	–	Incident Management
IT	–	Information Technology
ITIL	–	Information Technology Infrastructure Library
ITSM	–	IT Service Management
HPSM	–	HP Service Management
RQ	–	Research Question
TFS	–	Microsoft Team Foundation Server

Chapter 1 — Introduction

This chapter intends to frame this research as well as to introduce the motivation for conducting this research, along with its objectives, relevance and scope. The structure of the remaining document is also presented in this chapter.

1.1. Motivation and Scope

Organisations, since a few decades, have been changing their business management due to the constant competitive behaviour and new technologies, thus, organisations have begun to consider their core business proposition to provide services, changing the world economy to a service-based economy (Badinelli, Polese, Saviano, & Di Nauta, 2012). Services are considered interactive processes between customers and service providers where the customer benefits from the expertise of the service provider (Stokburger-Sauer, Scholl-Grissemann, Teichmann, & Wetzels, 2016). Thus, to measure the efficiency of services, the discipline of service management was created so organisations could understand how value can be created (Stokburger-Sauer et al., 2016; Verma, 2000).

To stay competitive, organisations, need to respond to the dynamic changes that markets require, to offer a better experience to their customers and to innovate with new services and products (Soni, 2016). Part of these dynamic changes are grounded on technologic advances. Therefore, organisations have been realising that the information technology (IT) is fundamental to their success (Park, Jung, Lee, & Jang, 2006). IT changes how organisations work, changing business processes, internal and external communication and most importantly, affects how organisations deliver their services to their customers (Alsolamy, Khan, & Khan, 2014).

Since organisations have started to see the importance of IT, they have begun to implement complex and dynamic IT systems to support their business processes (Jamous et al., 2017). Given the increasing dependence on IT and to support these business processes, organisations began using the term service (Cannon & Wheeldon, 2007). Thus, the concept of IT service started to grow. One of the most widely used definitions of an IT service is provided by Cannon and Wheeldon and can be seen in Table 2.

Table 2 — IT Service Definition

Concept	**Definition**
IT Service	*"A Service provided to one or more Customers by an IT Service provider. An IT Service is based on the use of Information Technology and supports the Customer's Business Processes."*(Cannon & Wheeldon, 2007, p. 377)

Due to both the expansion of IT services and changes in the world economy to a service-based economy, organisations have started to adopt IT Service (ITSM) (Nabais, Pinto, Cardoso, Cruz, & Cardoso, 2011). The ITSM is becoming an integral part of organisations (Mora, Gomez, O'Connor, Raisinghani, & Gelman, 2015), since it provides a set of activities to align, design, deliver, manage and improve how IT is used within an organisation (Wang, Song, Liu, Luo, & E, 2010).

Despite the existence of some IT frameworks to assist organisations in ITSM implementation, some organisations still struggle to understand the concept behind ITSM, how its processes are implemented (Remfert, 2017) and how to identify which process should be implemented first (Jamous et al., 2017). However, one of the most implemented processes of ITSM is the Incident Management (IM) process (Aguiar, Pereira, Vasconcelos, & Bianchi, 2018; Gacenga, Cater-Steel, Toleman, & Tan, 2011; Jäntti, 2011).

The Information Technology Infrastructure Library (ITIL) for example, which is one of the most used frameworks to implement ITSM (Aguiar et al., 2018; Rúben Pereira & Silva, 2011) is divided into 5 main documents (Service Strategy, Service Design, Service Operations, Service Transition and Continual Improvement) and includes the IM process as a core service operations process (J. Cao & Zhang, 2016). IT operations execute daily tasks to ensure the normal business operation and manage the IT infrastructure (Cannon & Wheeldon, 2007; J. Cao & Zhang, 2016).

The IM process focusses on restoring a service downtime as quickly as possible (Tan, Cater-steel, & Toleman, 2009; Yamami, Mansouri, Qbadou, & Illousamen, 2011) to avoid any impact to the business users in their daily activities (Ghrab, Ketata, Loukil, & Gargouri, 2016). Due to the competitiveness of the market, organisations want to provide a service of excellence to their customers, and one way to do it is to minimise the negative

impact of service interruption on businesses by implementing IM correctly to restore services promptly (Yun, Lan, & Han, 2017).

The prioritisation of incidents is usually calculated by the evaluation of the urgency and impact. However, this prioritisation is not always the most correct, which means that the priority will change (D. Wang, Zhan, & Shi, 2010). To deal with the constant change of requirements, agile methodologies, like SCRUM and Extreme Programming were created (Laukkarinen, Kuusinen, & Mikkonen, 2017).

The IM process resolution also has a lot of manual tasks and is time consuming (Gupta, Prasad, & Mohania, 2008). One of the premises of DevOps is to automate manual processes (Sharma & Coyne, 2014).

DevOps is a culture that tries to eliminate the lack of collaboration between development and operations teams (Mahanta, Pole, Adige, & Rajkumar, 2016) by teaming them up to promote cooperation, collaboration and communication (Guerriero, Ciavotta, Gibilisco, & Ardagna, 2016).

Building on the previous statements and context, this research has the following objective described in Table 3.

Table 3 — Research Objective

ID	**Objective**
O1	Explore the relationship between DevOps and the IM process and understand the impacts that DevOps adoption may cause on the IM process.

Given the objective O1, this research contributes to better understand the impacts that DevOps may cause on both practitioners and business users, which currently is seen as an unclear area (Kamuto & Langerman, 2017). More specifically, this research contributes by exploring the impact of DevOps adoption in the IM process.

The remaining document is organised as follows: the Theoretical Background section describes the main concepts that frame this research and helps readers understand these concepts and the author who contributed to them; in Related Work, the author examined DevOps case studies to confirm that none or few studies exist relating IM and DevOps domains; then, the Research Methodology identifies how the author will design and validate the case study methodology; subsequently, in the Case Study Protocol and

Conduct section, the author list all the data that will be needed to conduct the case study; next, the Analyse the Case Study Evidences section explains how the author will transform collected data for analysis; lastly, the author present a set of conclusions about all of the findings discovered during the analysis phase as well as explain why this research will be useful for academics and professionals.

Chapter 2 — Theoretical Background

This chapter introduces the main concepts covered in this research in addition to the primary contributions of the scientific community regarding the objective this research intends to explore. The topics that will be further described are ITSM and ITIL, IM and DevOps

2.1. ITSM and ITIL

ITSM frameworks have been adopted worldwide (Orta & Ruiz, 2018), focussing on delivering and supporting IT services that are adapted to particular business requirements (Qian Wang et al., 2010); thus, business and IT objectives should always be aligned to drive the organisation's success.

The idea behind ITSM is to utilise process-oriented solutions to improve IT efficiency (Scheuermann, Bruegge, Folmer, & Verclas, 2017), but other benefits have also been pointed out, such as improved quality of IT services and transparency of IT processes and the IT delivered to customers and business users (Hochstein, Tamm, & Brenner, 2005). This research follows the ITSM definition presented in Table 4.

Table 4 — ITSM Definition

Concept	**Definition**
ITSM	*"implementation and management of quality IT services that meet the needs of the business"* (Cannon & Wheeldon, 2007, p. 378)

Several frameworks have been created to help organisations to implement ITSM. Some of the most known frameworks are ITIL (Shahsavarani & Ji, 2011), CMMI (Richter, 2009), COBIT (Huygh, Haes, Joshi, & Grembergen, 2018), amongst others. ITIL seems to be one of the most adopted if not the most adopted one (Aguiar et al., 2018; Ayat, Sharifi, Sahibudin, & Ibrahim, 2009; Lahtela, Jäntti, & Kaukola, 2010; Latrache, Nfaoui, & Boumhidi, 2015; Rúben Pereira & Silva, 2011; Winniford, Conger, & Erickson-Harris, 2009). The adopted ITIL definition can be seen in Table 5.

Table 5 — ITIL Definition

Concept	**Definition**
ITIL	*"a set of practices for ITSM that focuses on aligning IT services with the needs of businesses*" (Li et al., 2014, p. 6)

ITIL is divided into 5 books focussing on the several areas of service management: service strategy, service design, service transition, service operation and continual service improvement (Yamami et al., 2011). By choosing ITIL as their ITSM frameworks, organisations can have benefits, like increased user and customer satisfaction, improved service availability, increased business profits and revenue and improved time-to-market for new products and services (Lucio-Nieto & Colomo-Palacios, 2012). Since ITIL has already been pointed out as the main IT framework that assists organisations in ITSM implementation (Ruben Pereira & Silva, 2012; Shahsavarani & Ji, 2011), it was already expected that part of its benefits would directly match the ITSM benefits.

2.2.Incident Management Process

Mentioned as one of the key pieces to support any IT system (Cusick & Ma, 2010) and one of the most implemented ITIL processes (Limanto et al., 2017), the IM process is composed of several activities (Table 6).

Table 6 — Incident Management Process Activities

Activity	**Description**
Incident Detection and Recording	Issues are found by health check monitors or by users.
Classification and Initial Support	Service Desk categorises the incident using standardised criteria and tries to solve the issue.
Investigation and Diagnosis	The responsible party will try to identify the root cause.
Resolution and recovery	Solutions will be taken to solve the incident.
Incident Closure	Incident is solved and is closed by the service desk.
Incident Monitor and Tracking	To get better performance some metrics are taken while the incident is not closed, to escalate the incident in time, if needed.

Source: Adapted from (C. Cao & Zhan, 2011)

The objective of this process is to solve incidents and restore services (Qing Wang et al., 2017) while minimising the impact on business activities and avoiding economic losses (Lou et al., 2013). This research adopts the IM process definition presented in Table 7.

Table 7 — IM Process Definition

Concept	**Definition**
IM Process	*"is the process through which IT support organisations manage to restore normal service operation after a service disruption"* (Bartolini, Salle, & Trastour, 2006, p. 1)

Since the organisations' main goal is to generate profit, economic losses must be avoided or mitigated as soon as possible.

An incident can be defined by the interruption of the organisation activity causing negative impacts, like the customers' confidence and financial and productivity loss (Latrache et al., 2015). To help solve these issues, the IM process can have three levels of support lines to help the users (Qian Wang et al., 2010). In Table 8 one can see the description of these three levels of support, adapted from (Cannon & Wheeldon, 2007).

Application management (AM) provides a holistic approach for software products from the requirement definition until the operation of the software, following the entire software life cycle: requirement define, design, build, deploy, operate and optimise (Hellerstein, 2008).

In ITIL framework, the AM is one of the specialist groups considered in the third support line (Table 8), which sometimes also plays the role of application development: "*In many cases the same team will be responsible for Application Developments as well as support* " (Cannon & Wheeldon, 2007, p. 264). Such statement indicates that the team that should operate applications and solve incidents can also develop new features for the application, bridging the gap between the IT operations and development that DevOps culture try to solve.

Table 8 — ITIL Service Operations Support Levels

Support Line	**Description**
1st Line of Support	This line of support is the service desk, which is main point of contact with the users when there are service disruptions and tries to help the users with less technical issues.
2nd Line of Support	A team with more technical capabilities than the service desk and with more time to allocate towards solving and diagnosing issues without telephone interruptions.
3rd Line of Support	Specialist support groups focussed on dealing with more deep-rooted incidents and/or new developments. In these support groups, we can find groups dedicated to network support, database support and AM teams.

2.3.DevOps

When developing products and services, there exists a lack of communication between the development and operation teams that are responsible for delivering these products (Rong, Gu, Zhang, & Shao, 2017). The main gap between development and operations teams is the attitude toward changes: the development side embrace the changes as something they need to achieve, but on the other side, operations try to avoid the changes to not compromise the system stability (Hussaini, 2015). Besides the fear of change, there exists other problems: risky deployments; the blame-game, where the operations find the production issues and blame the developers for bad developments; and isolation, where developments from programmers, testers and quality assurance occur in silos, while the operations silo includes database administrators, systems administrators and operators (Wahaballa, Wahballa, Abdellatief, Xiong, & Qin, 2015). To face these problems between the development and operations teams, a new culture appeared, DevOps. This research follows the DevOps definition presented by Riungu-Kalliosaari (Table 9).

Table 9 — DevOps Definition

Concept	**Definition**
DevOps	*"a set of practices intended to reduce the time between committing a change to a system and the change being placed into normal production, while ensuring high quality"* (Riungu-Kalliosaari, Mäkinen, Lwakatare, Tiihonen, & Männistö, 2016, p. 2)

The last paragraph explains the origin of the term DevOps. The Dev is from Developers and Ops from operations, promoting the collaboration between this two teams sharing tasks and responsibilities while being empowered with full accountability of their service and its underlying technology stack, from development, to deployment and to support (Perera, Silva, & Perera, 2017). Besides collaboration. DevOps has another main concept, which is the automation to configure and manage deployment environments (Riungu-Kalliosaari et al., 2016).

Soni also says that the philosophy behind the DevOps concept is "*the faster you fail, the faster you recover*" (Soni, 2016, p. 1). This means that the faster the deployment of a solution including customers' feedback, the faster developers will be able to make the necessary improvements to enable a better customer experience.

Chapter 3 — Literature Review

Since this research aims to study the application of DevOps in the IM process, it is mandatory to search literature where it is possible to analyse the outcomes from DevOps applications and findings where DevOps was applied to the IM process. However, since DevOps is a recent culture (Mahanta et al., 2016), the author decided to study existing studies linking these two domains. To do that, the author performed a literature review.

A literature review is a selection of documentation regarding a certain topic that contains information, data, ideas and evidence to fulfil some certain aims or express certain views about the topic (Hart, 1998). For easier understanding of the peers, as well as to add more scientific rigor to our research, the author decided to follow the concept centric approach proposed by Webster and Watson (Webster & Watson, 2002).

To perform the literature review, the author has searched and consulted the following digital libraries: IEEExplore, ACM, Research Gate and the search engine Google Scholar was employed. Since this research focusses on IT service operation management, the author has also searched for interesting studies amongst the top journals regarding service management, ITSM and operation management domains. These journals were found by searching in Scimago, a scientific journal ranking website.

Moreover, this research took place between September 2017 and January 2018, but the author has maintained currency to date. The keywords used to perform this research were as follows: DevOps case studies; incident management; DevOps benefits; DevOps practices; DevOps; ITSM; IT service management; ITSM frameworks; and ITIL benefits. To select the articles for this research, the author tried to keep to relevant parameters, like the application domain, benefits, practical cases or researches and definitions.

In Section 3.1 the author presents the main findings regarding both DevOps practices and DevOps benefits/challenges. Then, Section 3.2 presents Tables 12 and 13 containing all the CSs found by the author where DevOps was applied to different contexts/domains. While Table 12 presents generic information about the CSs, Table 13 presents the results reported by each CS mapped with the corresponding benefits listed in Table 11. These two tables are expected to elucidate the existing related work on this area and related domains.

3.1.DevOps Practices, Benefits and Challenges

In this section, the author lists the main DevOps practices, benefits and challenges found amongst the literature. A recent study was published (Jabbari, bin Ali, Petersen, &

Tanveer, 2016) where the author synthesised the practices that DevOps practitioners have been applying so far (Table 10). Since author did not find a single DevOps practice that was not included in Jabbari et al.'s list, the author decided to use this list assuming it is the most complete collection of DevOps practices amongst the literature. Other studies referring to DevOps practices can be found amongst the literature (Punjabi & Bajaj, 2017; Sharma & Coyne, 2014; Soni, 2016; Stoneham et al., 2017) but not as complete as the one presented in Table 10.

The author also tried to reach an understanding of the real benefits and challenges of DevOps adoption by organisations. To achieve this, the author analysed the articles found in our literature review. The findings regarding DevOps benefits and challenges were summarised in Table 11.

In analysing Table 11 one can conclude that more benefits exist when compared with challenges. Thus, it is possible to understand each benefit/challenge in more detail:

- **Improved code quality, quality assurance and reliability** — Since the code is checked every time it is committed and moving forward on the pipeline, errors can be found earlier and are resolved in that moment, avoiding production errors (Riungu-Kalliosaari et al., 2016; Soni, 2016).
- **Better communication between Dev&Ops** — Accelerates the exchange of knowledge and experiences to capacitate both teams for the different tasks (Riungu-Kalliosaari et al., 2016).
- **Application stability** — DevOps allows a quick flow of changes to the production environment, while maintaining a high level of stability (Guerriero et al., 2016; Soni, 2016).
- **Visibility to the customer of the implemented features** — Due to the frequent releases and small bundles of features in each release, customers will be able to see a gradual growth of the application (Roche, 2013).

Table 10 — DevOps Practices

Practice name	**Description**
Shift Left	This practice refers to include operations as early as possible on the SDCL.
Continuous Planning	Business owners will see the growth of the application, so they can give feedback on whether the application is corresponding to their needs.
Continuous Integration (CI)	The developers will check in their code on the source control repository and integrate it with the code from other teams, allowing CI.
Feedback Loops between Dev and Ops	The goal of this practice is to get as much feedback as possible to perform the necessary corrections.
Automated Monitoring	Allows a better perception of the health of the system. This will allow continuous monitoring of the application
Prototyping Application	This will give a better idea of what requirements are needed for the application, reducing time on redesigned requirements.
Deployment Automation	These tools facilitate by managing the software components that need to be deployed and what middleware components and configurations need to be updated. This will allow continuous deployment.
Test Automation	Test automation will save some time by performing regression tests to be sure that older functionalities will not be impacted by new developments. This will also allow a continuous testing approach.
Infrastructure as Code	Allows the organisations to manage which environments need to be provisioned and configured to enable continuous delivery
Stakeholder Participation	The participation of stakeholders will provide more feedback to the DevOps teams.
Process Standardisation	By standardising the processes, they will be perfected over time by identifying errors and correcting them.
Change Management	Process for the efficient handling of IT changes

Source: Adapted from (Jabbari et al., 2016)

- **Continuous experimentation** — With DevOps businesses will be able implement and remove features to test ideas and to evaluate how their customers will react to software changes (Riungu-Kalliosaari et al., 2016; Soni, 2016).
- **Maximising competences** — Due to the exchange of knowledge between Dev and Ops both teams will be more capable, thus maximising their competences (Shahin, 2015).
- **Testing with real customers** — Due to the frequent releases, the teams will receive more feedback from the end users and therefore will be testing with real customers (Riungu-Kalliosaari et al., 2016).
- **Insufficient communication** — There can some reluctance to share information between different teams, which will impact the implementation of DevOps (Perera, Bandara, & Perera, 2017).
- **Deep-seated company culture** — DevOps requires the merging of new roles and some responsibilities can be shifted between roles. Usually, people do not like these changes due to the comfortability that they have with their responsibilities and roles (Riungu-Kalliosaari et al., 2016).
- **Industry constraints** — Different industries can have different constraints regarding what they hold, for example, in some industries the production access can be limited. This can be a challenge for DevOps. Usually Ops have access to production information unlike the Dev side, so the Ops work in a more restrict environment than Dev (Laukkarinen et al., 2017).
- **DevOps is unclear but also evolving** — It is hard to understand DevOps since just some of the practices can be applied and there is not just one way to implement them. They can be applied in different contexts and in different ways (Riungu-Kalliosaari et al., 2016).
- **Deployment automation for several technologies** — The deployment automation can be very complex when dealing with several technologies and multiple environments with different architectures and topologies (Mahanta et al., 2016).

The next section presents and details some CSs where DevOps was applied in practice. Their results and finding are also analysed.

Table 11 — DevOps Benefits and Challenges

	ID	Concepts	References	# of References
Benefits	B1	Improved code quality, quality assurance and reliability	(Erich, Amrit, & Daneva, 2014; Laukkarinen et al., 2017; Mahanta et al., 2016; Palihawadana et al., 2017; Perera, Bandara, et al., 2017; Riungu-Kalliosaari et al., 2016; Shahin, 2015; Soni, 2016)	8
	B2	Better communication	(Erich et al., 2014; Karapantelakis et al., 2016; Laukkarinen et al., 2017; Perera, Bandara, et al., 2017; Riungu-Kalliosaari et al., 2016; Soni, 2016)	6
	B3	Application stability	(Gottesheim, 2015; Guerriero et al., 2016; Mahanta et al., 2016; Roche, 2013; Soni, 2016)	5
	B4	Visibility to the customer of the implemented features	(Gottesheim, 2015; Riungu-Kalliosaari et al., 2016; Roche, 2013; Soni, 2016)	4
	B5	Continuous experimentation	(Erich et al., 2014; Mahanta et al., 2016; Riungu-Kalliosaari et al., 2016; Soni, 2016)	4
	B6	Maximising competences	(Riungu-Kalliosaari et al., 2016; Shahin, 2015)	2
	B7	Testing with real customers	(Riungu-Kalliosaari et al., 2016)	1
Challenges	C1	Insufficient communication	(Hussain, Clear, & MacDonell, 2017; Perera, Bandara, et al., 2017; Riungu-Kalliosaari et al., 2016)	3
	C2	Industry constraints	(Laukkarinen et al., 2017; Riungu-Kalliosaari et al., 2016; Sharma & Coyne, 2014)	3
	C3	Deep-seated company culture	(Riungu-Kalliosaari et al., 2016; Shahin, 2015)	2
	C4	DevOps is unclear but also Evolving	(Riungu-Kalliosaari et al., 2016)	1
	C5	Deployment automation for several Technologies	(Mahanta et al., 2016)	1

3.2.Related Work

This section intends to present and synthesise the related work. It describes the case studies found in the literature. The author aimed to identify the main practices that were applied to those case studies and understand which outcomes are related with those practices. The author also analysed the benefits behind those outcomes. At the end, it was possible to confirm that none of the case studies found was applied to the IM context.

For better comprehension, the author grouped the outcomes with a generic description of the outcome. An outcome can be written in a different way depending on its context but mean the same, so the author has grouped these outcomes by what they have understood from the meaning of the outcome. Table 13 shows the grouping that the author made for the outcomes.

As shown in Table 12, some scientific studies exist about DevOps application. By analysing Table 12 one can conclude that none of these researches aimed to study or elicit any conclusions/implications regarding the IM process.

Most of the cases studies have identified benefits on DevOps adoption. Only two case studies presented a possible challenge to DevOps adoption (CS.3 and CS.4). Nevertheless, both case studies also point to some benefits as the remaining case studies analysed. Like CS.4, CS.9 also investigates a very regulated industry; however, the author did not describe in which industry it is applied, contrary to CS.4, which concerns the health care industry. However, CS.9 presented benefits and no challenges on the adoption of DevOps culture.

The other case studies do not show any of the challenges that were presented in Table 11. Also, most of the case studies show two outcomes, which are “Breaking Down the Silos” and “Short release Cycles”. The author can relate this with the premises of DevOps, as stated in Section 2.3; the automation that DevOps propose will result in more releases and bridge the IT operations and the development teams, resulting in more communication, including communication with the business users.

To better understand the relation between benefits and DevOps practices adoption, Table 14 presents the information collected from the literature and what was reported in the analysed case studies (Tables 12 and 13).

Table 12 — Extant DevOps Case Studies in the Literature

ID	DevOps Practices Implemented	Reference (author, year)	Country (application)	Industry	Context
CS.1	Automated Tests; Automated Monitor; Feedback Loops; Process Standardisation	(Roche, 2013)	N/A	N/A	Application Development
CS.2	Continuous Integration; Automated Monitor; Deployment and test automation	(Soni, 2016)	India	Financial Industry - Insurance	
CS.3	Continuous Integration	(Laukkarinen et al., 2017)	Finland	Health	
CS.4	Continuous Integration; Test Automation; Shift-left; Infrastructure as Code	(Sharma & Coyne, 2014)	N/A	Software Development	
CS.5	Test Automation; Deployment Automation; Continuous Integration;	(Punjabi & Bajaj, 2017)	India	Software Development	
CS.6	Continuous Monitor; Deployment Automation	(Karapantelakis et al., 2016)	Sweden	Software Development	
CS.7	Continuous Integration; Test Automation; Deployment Automation	(Stoneham et al., 2016)	United States of America	Retail	
CS.8	Continuous Integration; Feedback Loops	(Stoneham et al., 2016)	United States of America	Government Agencies (Migrating Systems)	
CS.9	Continuous Integration; Infrastructure as Code	(Stoneham et al., 2016)	United States of America	N/A (Regulated)	
CS.10	Stakeholder Participation; Continuous Integration; Automated Monitors; Continuous Planning	(Stoneham et al., 2016)	United States of America	Large Consume	
CS.11	Continuous Integration; Test Automation; Feedback Loops; Stakeholder Participation	(Stoneham et al., 2016)	United States of America	N/A	
CS.12	Continuous Integration; Automated Tests	(Croker & Hering, 2016)	N/A	N/A	
CS.13	Continuous Integration; Deployment Automation; Test Automation; Automated Monitor	(Shivakumar, 2017)	India	N/A	

Table 13 — DevOps Case Studies Outcomes

Merged Outcome	**Outcome from Case Studies**
Breaking down the Silos	- Merging of Tasks (Dev team perform ops tasks and vice versa); - DevOps is not just about the practices but also about the culture. DevOps tries to bridge the gap between the developers and operators, making them see that they have the same final purpose: providing the best service for the business; - Both developers and operators were enthusiastic about working together (breaking down the silos): - Breaking down the silos; - Implementation of a full stack team; - Breaking down the silos between developers, operators, testers and functional teams; - Business can change their priorities without any pushback from the development teams;
Short Release Cycles	- Faster and more frequent deployments - Automated tasks like deployment and testing allow a continuous delivery, creating more releases with smaller chunks of code/functionalities. - With these smaller and more frequent releases, the developers can incorporate the business feedback faster. - The author, after applying the DevOps practices, have found a reduction in the time between deployments (which enables more releases) and the deployments were faster. - The retailer switched their legacy systems by online channels, embracing the CI and delivery, which resulted in more releases. - Faster time to market
Application Availability	- Automated monitors were implemented to check the system health, pre, during and after deployments. - Increase in availability (70%) - Reduction of defects (80%)
CI brings quality	CI brings quality.
Industry Constraints	Industry constraints;
Improved Security with Resiliency	Improved security with resiliency;
High Scalability	The websites made were able to auto scale elastically to support high traffic.

Table 14 — DevOps Outcomes and Benefits

CS ID	Outcome	Benefit/Challenge ID (Section 3.1)
CS.1	Breaking down the silos	B2; B6
	Short release cycles	B3; B4
CS.2	Short release cycles	B1; B3; B4
	Application availability	B3
CS.3	CI brings quality	B1
	Industry constraints	C2
CS.4	Short release cycles	B1; B3; B5
	Industry constraints	C2
	Breaking down the silos	B2
CS.5	Short release cycles	B4; B5
CS.6	Short release cycles	B3
	Application availability	B3
CS.7	Breaking down the silos	B2
	Short release cycles	B1; B3
CS.8	Short release cycles	B1
	Breaking down the silos	B2; B6
	High scalability	B3
CS.9	Application availability	B1; B3
CS.10	Breaking down the silos	B2
	Short release cycles	B1
CS.11	Breaking down the silos	B2
	Short release cycles	B5
CS.12	Short release cycles	B5
	Improved security with resiliency	B1
CS.13	Short release cycles	B1; B5

Analysing Table 14 above, the following conclusions can be drawn. The improvements in code quality and reliability are present in DevOps in nine CSs (69%), respectively. The objective of DevOps is to deliver fast of high quality, and our literature review confirms it in practice. Better communication was only matched with “Breaking

down the Silos"; however, this was found in seven of 13 case studies, which also represents more than 50% of the sample of case studies. Application stability was also found nine times in the case studies. This shows that DevOps culture works. The final objective of each software project is to deliver with quality, but it is also important to deliver stable software. Having developers and operators working together monitoring the application stability brings great results, building confidence between the IT and business teams.

Table 15 — Outcome vs Benefit

	B1	**B2**	**B3**	**B4**	**B5**	**B6**	**C2**	**Total**
Breaking down the silos		*7*				*2*		*9*
Short release cycles	*6*		*5*	*2*	*5*			***18***
Application availability	*1*		*2*					*3*
CI brings quality	*1*							*1*
Industry constraints			*1*				*2*	*3*
Improved security with resiliency	*1*							*1*
High scalability			*1*					*1*
Total	***9***	*7*	***9***	*2*	*5*	*2*	*2*	

Analysing Table 15, it was in the "Short Release Cycles" where the author could see more benefits. Having short release cycles bring a lot of benefits for the software. Since the developers and operators deal with smaller chunks of code, it is easier to maintain, test and deploy. This also allows the business to see their application grow step by step and be able to provide feedback to include in a possible next release, creating a user engagement between the application and the business users.

As far as the author could find, the application of DevOps culture on the IM process remains an unstudied field. Therefore, grounded on the motivation presented in the Introduction section, this research intends to provide more insights about the possible application of DevOps culture on the IM process. At the end of this research, the author proposes to answer the research questions (RQ) presented in Chapter 4, Table 16. Since no researches exist about the application of DevOps on the IM process, it is possible to conclude that this research is exploratory.

Chapter 4 — Research Methodology

Since the research in the domain of DevOps application in the IM process is in its very early stages, as stated on the previous section, the nature of this research is exploratory rather than hypothesis testing. Exploratory research is meant to start a study on a determined phenomenon observed, where there are no prior (or few) works (Zaidah, 2007). Zaidah (2007, p. 1), argues that "a case study enables to the researcher to examine the data within a specific context". Moreover, a CS is built around a question (Thomas, 2016), which in this case is, "How do DevOps affect professionals working on the Incident Management Process"? For a better synthesis of this research, the author detailed the main question in several research questions that can be found in Table 16, later in this chapter. Thomas (2016) argues that this question is the subject of the CS, but the CS also should be defined on its purpose, approach and process. Moreover, the subject may lead to three different types of CSs: special or outlier (when the researcher tries to study a phenomenon out of the norm), a key case (when the researcher is studying a phenomenon that happens a lot), and a local knowledge case (where the researcher is investigating something that is familiar to him) (Thomas, 2016). This CS is classified as a local knowledge case since the researchers of this study work on a team that applies DevOps practices and use the IM process. More information regarding this team can be found in Section 4.2.

Yin (2009) argues that questions like "what" are exploratory since the purpose is to develop propositions for further inquiry, which fits the questions that were previously stated. A CS also has "how" and "why" questions, where the researcher does not have control over the variables, which suits this research (Perry, Sim, & Easterbrook, 2004).

We decided to formulate a set of research questions that this research intends to answer. A research question (RQ) concentrates on an uncertainty that the researcher wants to investigate and solve (Stephen et al., 2007). As advised by Abbas Tashakkory and John Creswell (2007), the author also used RQs as a way to shape the design of our investigation. In Table 16 one can see the RQs this research proposes to further investigate and answer.

Table 16 — Research Questions

Research Question ID	**Description**	**Section where answered**
RQ1	What DevOps practices can be used in each phase of IM?	6.1.1; 6.2; 6.3;
RQ1.1	How can these practices be applied?	6.1.1; 6.2; 6.3;
RQ1.2	Why should these practices be applied?	6.1.1; 6.2; 6.3;
RQ2	What are the benefits of using DevOps practices in IM?	6.1.2
RQ3	What are the challenges of using DevOps practices in IM?	6.1.3
RQ4	How do DevOps improve the resolution of incidents?	6.1.4

Exploratory research often builds on secondary research, such as reviewing available literature and/or data, or qualitative approaches, such as informal discussions with consumers, employees, management or competitors, and more formal approaches through in-depth interviews, focus groups, projective methods, case studies or pilot studies (Kuruzovich, Bassellier, & Sambamurthy, 2012).

Perry (2004) also argues that case studies are a powerful method for exploratory researches because they try to understand and explain the phenomenon or construct theory. Thomas (2016) asserts that the researchers should explain or explore a phenomenon, which leads to the following purposes: intrinsic, instrumental, evaluative, explanatory and exploratory. Since the objective of this research is to understand the impacts of a phenomenon, one can conclude that the purpose of this research is exploratory. For this approach, Thomas also suggests the following: testing a theory, building a theory, drawing a picture, descriptive, interpretative, experimental (Thomas, 2016). As previously stated, no literature was found investigating the relationship between DevOps and Incident Management; therefore, the purpose of this research is to build theory.

Some author provide insights about the structure of a CS (Tellis, 1997). Table 17 presents the approach suggested by Yin (1994), which will be followed in this research.

Table 17 — Case Studies Stages

Stage	Stage Description
Design the Case Study Protocol	This stage is composed of two minor stages, which are determining the required skills, where Yin suggests that the researchers should be good listeners, able to interpret the responses and develop and review the protocol for extensive reading about the topic to create some draft questions.
Conduct the Case Study	Preparation of the data collection, distribution of the surveys and conducting interviews.
Analyse Case Study Evidences	An analytical strategy should be employed to evaluate the data gathered in the previous stages of the research.
Develop Conclusions	Develop conclusions regarding the data analysis made on the previous stages to establish a bridge between the researcher and the user to explain the benefits or problems found during the research.

Source: Adapted from (Tellis, 1997)

Researchers can adopt either a single-case or a multiple-case approach. A single-case approach should be adopted when the event that is supposed to be studied is limited by a single occurrence, or the study will only target a single unit of analysis (Yin, 2009; Zaidah, 2007), which is appropriate for exploratory research. The multiple-case studies are used on real life events, where numerous, easy to replicate sources of evidence exist (Zaidah, 2007).

Since this research focusses on the analysis of a single team, which will be a single unit of analysis as described by Yin (2009), the author argue that this research follows a single CS approach.

For a better understanding on how this research maps with Thomas' framework, to build a CS, Figure 1 describes the different classifications of our research according to Thomas' framework and guidelines.

Thomas (2016) also says that time is important. The author defines three timeframes:

- Retrospective — where the studied phenomenon happened in the past;
- Snapshot — where the study happens on a timeframe;
- Diachronic — where the study shows a change over time;

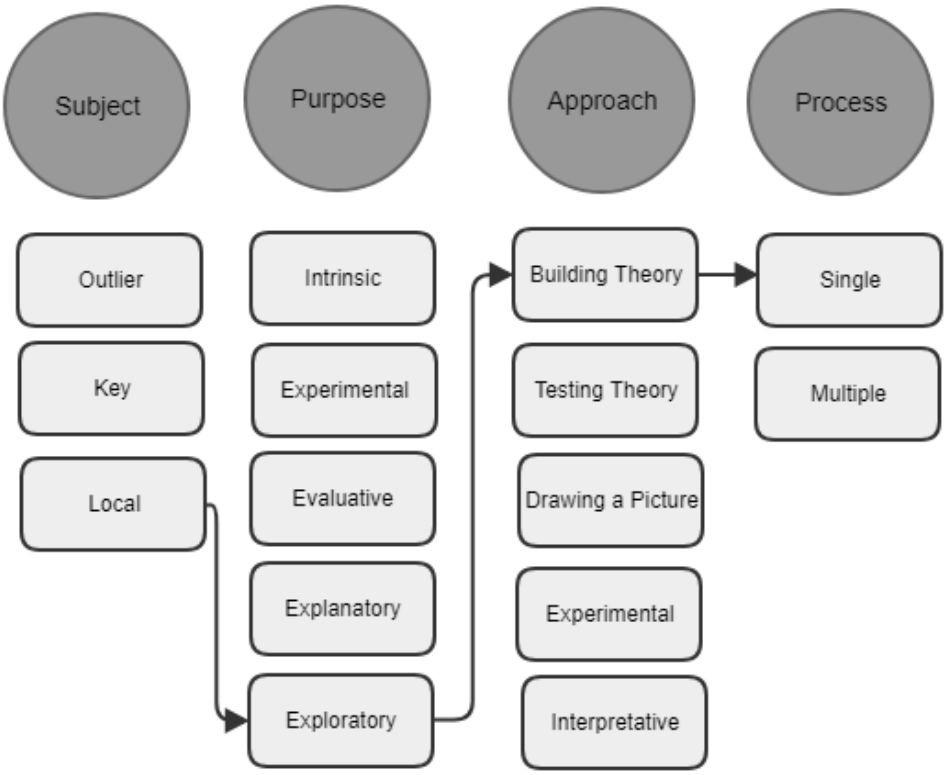

Figure 1 — Path for the CS, adapted from (Thomas, 2016)

Since this research intends to study the possible influence of DevOps practices on the IM process phases grounded on the experience (past) of a single team, this study is about the impact of practices that were implemented in the past; therefore, it must be considered a retrospective CS.

Since this is a retrospective CS, the main data collection procedures are document analysis and also interviews of who experienced the study phenomenon (Thomas, 2016).

According to Thomas (2016), case studies are about seeing different behaviours from different angles, so many author advise the triangulation of several data collection methods (Modell, 2005; Tellis, 1997). Therefore, to answer our RQs (Table 16), the author will use triangulation between the following research methods: semi-structured interviews, document analysis and observation.

To sum up, the performed CS will follow a single, retrospective CS approach, and the triangulation of methods (semi-structured interviews, data analysis and observation) will be used to enrich the research findings.

In the following sub-sections, the author will explain how this research maps the CS stages proposed by Telis (1997) and Yin (2009) presented in Table 17. Subsequently, to

demonstrate the validity of our CS, the author use the CS validity test proposed by Yin (2009) to demonstrate our research rigor and relevance.

According to Thomas (2016), a CS should adhere to the following structure presented in Figure 2.

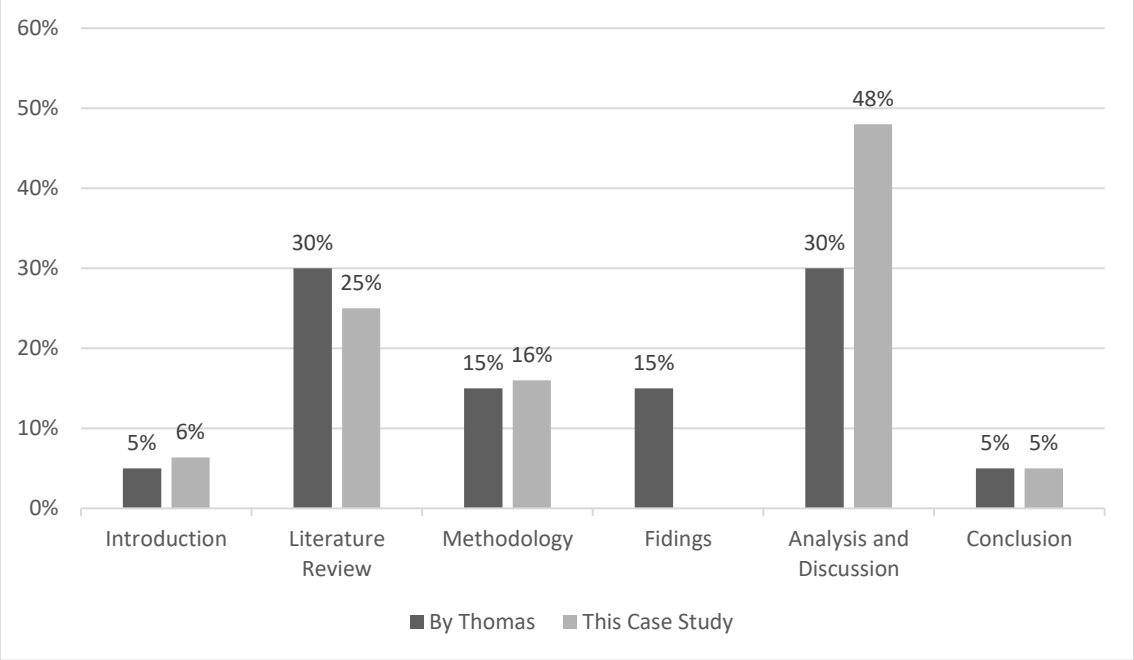

Figure 2 — CS Structure Dimension

By looking at Figure 2, it is possible to conclude that this CS is following the CS structure proposed by Thomas (2016), with small differences between some CS stages. In this CS the findings are discussed together with the analysis and discussion, which is why the findings for this CS are 0% while analysis and discussion is 48%. According to Thomas's proposal, it should be 45%, which is not much different than the result of this CS.

4.1.Designing the Case Study Protocol

As described in Table 17 on this stage, it is required to determine the necessary skills to conduct the CS and develop a protocol where an extensive reading about the topic should be done, to create some draft questions. Tellis (1997) uses Yin as an example arguing that researchers should be good listeners and have a good interpretation of the responses.

In this research, the most required skill is to have a good knowledge of software engineering (SE) and IM process; thus, the author can interpret the results and know what to ask to the target audience.

For the CS protocol, the author performed an extensive literature review about IM process and DevOps to reach a deep understanding about these domains and how they have been applied so far. To support the interviews, a questionnaire was built to guide the author during the performed CS.

4.2.Conducting the Case Study

On this stage, the author performed interviews to collect practitioners' opinions and experience about the implementation of DevOps practices and their impact for the project and for themselves as IT professionals.

Since our RQs aim to explore what or how DevOps practices influence the work of professionals in the IM process, the author used semi-structured interviews. This type of interview is used when one needs to gather more detailed information by giving the interviewees the liberty to express their opinions (Miles & Gilbert, 2005). To accomplish the triangulation goal, other techniques for data collection were also used, such as data extraction from performance reports and direct observation.

The interviews will be performed with members and ex-members of a maintenance team of a big corporation. This team works on an AM workstream, analysing and developing the solution for production incidents. All the team members work for the same corporation, and they work on the same project as consultants. The client is a Danish organisation that operates in the financial sector. By following the process, the root cause analysis and solution of incidents should not be placed in IM process, but in Problem Management (Cannon & Wheeldon, 2007). However, the IM process implemented by the client of this team, requires performing this root cause analysis and solution on the IM process. This team also uses several software's in their daily tasks: HP Service Management (HPSM) to manage incidents and changes; Microsoft Team Foundation Server (TFS) as a code repository and to perform CI; Jenkins for building changes and packages of the code checked in TFS; SonarQube to validate the code quality; Artifactory to save the packages that are built on Jenkins; and CA LISA to perform the installation of packages. Additionally, this team works at three different sites at the same time (2 offices in Portugal and one office in Denmark), so communication is very important for their success. This team supports the business users in their daily work by helping them when they face some errors with the application, sometimes proving workarounds and making some extractions for business reports. The team also supports the development teams. The dev teams usually present the solutions of the new features to members of the

AM team, so weaknesses can be identified before going to production, to improve the quality of the delivery. Also, the AM team is required to help to define the requirements and performance metrics. Generically, observation is used to analyse the "before and after" of the behaviour of a certain phenomenon after some change (Yin, 2009). However, since the practices were already implemented by the team, it is not possible to verify this change of behaviour in the first place. Thus, the author will use the observation to validate the findings that were gathered during the interviews.

Observation can be seen as structured or unstructured (Thomas, 2016). Structured observation occurs when the researcher systematically looks for particular kinds of behaviours, while unstructured observation happens when the researcher informally observes important details of what is happening (Thomas, 2016). Unstructured observation may also be called participant observation, where the researcher is also a participant. The kind of observation that should be used in this research is unstructured observation, since the observation will only be used to validate some of the results of the interviews, such as taking notes. We also analysed some performance reports on team performance discrepancies that this team produced weekly to present to business users.

4.3.Analysing the Case Study Evidences

Following the case study comes analysis. The author analysed the data that was collected from the semi-structured interviews and from the questionnaires. Furthermore, all the data from performance documentation provided from the team under study was also analysed as well as from direct observation.

4.4.Developing Conclusions

This stage must describe all the main findings regarding the data previously collected and analysed. The author will condense all the quantitative (reports) and qualitative (observation and interviews) data collected from practitioners, documentation and observation. More information can be seen in Section 4.2.

4.5.Case Study Validity

Yin (2009) proposes four tests to validate the reliability of a CS. Such tests are described in detail in the following sections.

4.5.1. Construct Validity

This test aims to develop the necessary operational sets of measures to justify the study. Yin (2009) also suggests two steps that can help to build construct validity:

- Select the specific types of changes that are to be studied;
- Demonstrate that the selected measures of these changes do indeed reflect the specific types of changes that have been selected.

This test defines a concept through a set of attributes to make it measurable through empirical observations (Baškarada, 2014); this makes it easier for future researchers to follow this CS. Yin (2009) also suggests three strategies to build construct validity:

- Multiple sources of evidence;
- Having key informants to review the CS report;
- Maintaining chain of evidence.

4.5.2. Internal Validity

Yin says that internal validity should be used for explanatory case studies, since on explanatory case studies the investigator is trying to determine if one cause leads to a certain event. This type of validity is not applied to exploratory case studies where it is supposed to build new theory (Yin, 2009).

4.5.3. External Validity

This test validates if the problem of the research is general and if does not only apply to the CS regarding the research (Yin, 2009), which is usually a problem for single case studies. Therefore, it is recommended to make use of theory (Tellis, 1997) like it is used in this research in the Theoretical Background and Related Work sections. This is important for the research design to help the researchers find the right way to conduct their research (Yin, 2009).

4.5.4. Reliability

The reliability test defends that if a future researcher follows the same steps and procedures that are used on the current research, she or he will reach the same results (Yin, 2009). To achieve this test with success, this research possesses a lot of documentation to support any procedure or steps that were done to justify its results.

4.5.5. Our Case Study Validity

The validity tests presented at the previous sections are also linked with the stages of the case studies. More details can be viewed in Table 18.

Table 18 — Case Study Validation Tests with Case Study Stages

Test	Stage	Validation for this research
Construct Validity	Conducting the Case Study	Multiple sources were consulted to elicit information regarding the CS. The author analysed some reports and performed semi-structured interviews. Also, in this research the changes to be studied are the changes that DevOps practices adoption may cause during IM process operation.
Internal Validity	Not applied to exploratory case studies	Yin (2009) states that this test should not be applied to exploratory case studies. Since this CS is exploratory, we did not address this test.
External Validity	Designing the Case Study Protocol	The author has analysed the literature (Section 3) and have not found any research about DevOps application in the IM process. Therefore, it proves the novelty of this research and the relevance of our findings for the body of knowledge. This research proves that the relation between DevOps and IM exist; therefore, it can be considered a pioneer on the subject.
Reliability	Designing the Case Study Protocol and Conducting the Case Study	A path was created during all the research showing how the researchers have led their investigation, so future researchers can proceed with the investigation and get similar results. Yin (2009) and Thomas (2016) guidelines were adopted throughout the performed CS and respective report.

Source: adapted from (Yin, 2009)

With Table 18 it is possible to analyse that this CS has passed every test that should be applied to an exploratory CS, making it a reliable CS.

Chapter 5 — Case Study Protocol and Conduct

Since our RQs aim to explore what or how DevOps practices influence the work of professionals in the IM process, the author used semi-structured interviews. This type of interview is used when one needs to gather more detailed information by giving the interviewees the liberty to express their opinions (Miles & Gilbert, 2005). To accomplish the triangulation goal, other techniques for data collection were also used, such as data extraction from performance reports and direct observation.

At the end of the CS, the author was able to interview 10 members of the studied team. The details about each interviewee are listed in Table 19.

Table 19 — Interviewee Details

Interviewee	**Position**	**Experience (years)**	**Experience in IT (years)**	**Experience in IM (years)**	**Projects in IM**	**Date of joining the team**
A	*Developer*	*3.5*	*3.5*	*3.5*	*2*	*06/15*
B	*Developer*	*3.5*	*3.5*	*3.5*	*2*	*11/14*
C	*Senior Developer*	*4*	*4*	*4*	*3*	*06/15*
D	*Developer*	*2.5*	*2.5*	*2.5*	*1*	*01/16*
E	*Team Leader*	*7*	*7*	*7*	*3*	*07/13*
F	*Team Leader*	*10*	*10*	*10*	*3*	*03/14*
G	*Developer*	*3*	*3*	*1*	*1*	*11/16*
H	*Manager*	*13*	*13*	*10*	*3*	*09/17*
I	*Developer*	*1.5*	*1.5*	*1.5*	*1.5*	*05/17*
J	*Team Leader*	*6*	*6*	*5*	*4*	*01/15*
Average		*5.4*	*5.4*	*5.4*	*2.35*	

The average experience of the team is about 5 years. Moreover, most of the interviewees have been involved in more than one IM project, allowing us to retrieve a range of ideas on best practices

Chapter 6 — Analyse the Case Study Evidences

6.1. Semi-Structured Interview Data Analysis

On the questionnaire, the author asked some basic questions about DevOps, like what practices the interviewee knows about and what they apply or had applied on previous/current projects. When enquiring about the practices already applied, the author made a scale from 1 to 3, where 1 meant *didn't apply*, 2 meant *partially applied* and 3 meant *fully applied*. One should assume partial implementation as a practice that is incomplete or could not be implemented in the entire context it was expected to work. For example, for deployment automation, a developer cannot use the deployment automation tool for production deployments while a team leader has permission to do it.

Table 20 shows the results for these two questions. From Table 20 one can see that the interviewees have considerable knowledge about the existence of DevOps practices. From the 12 practices described in Section 3.1, Shift-left and Infrastructure as Code were the only practices that the interviewees had no prior knowledge of. Furthermore, from Table 20 one can conclude that the most known practices are being fully or partially applied. The author also noted that there appears to exist a relation between the experience of the interviewee and the practices implemented. For example, the deployment automation practice is fully applied by interviewees E, B and F, while the others only applied it partially. The CI is being fully applied by most of the team, likely because it is an intuitive and easy practice to employ due to the existence of tools that allow this practice, like Jenkins.

6.1.1. Incident Management Phases vs DevOps Practices (RQ1)

Given the practical experience and knowledge of the interviewees, the author placed an item on the questionnaire to better understand where each DevOps practice can be applied in each IM process phase as shown in Table 21. The author focussed on where the main idea is in each interviewee's answers (grey cells on Table 21), why (Wx on Table 21) and how (Hx on Table 21) the practices can help on each IM phase. The grey cells are coded by three tones which go from a lighter to a darker grey, where one or two matches are identified with the lighter grey tone, three matches are the medium grey tone, and greater than three matches are the darker grey tone.

Table 20 — Practices Known vs Fully and Partially Applied

	Continuous Planning	**Feedback Loops between Dev & O**	**Continuous Integration**	**Deployment Automation**	**Test Automation**	**Change Management**	**Automated Monitoring**	**Prototyping Application**	**Stakeholder Participation**	**Process Standardisation**	**Shift Left**	**Infrastructure as Code**	**Total**	**Percentage**
Practices Known														
A			●	●	●	●	●						*5/12*	*42%*
B		●	●	●	●	●	●	●	●	●			*9/12*	*75%*
C	●	●	●	●	●	●							*6/12*	*50%*
D	●		●	●	●	●		●	●	●			*8/12*	*67%*
E	●	●	●	●	●	●	●	●	●	●			*10/12*	*83%*
F	●	●	●	●	●	●	●	●	●	●			*10/12*	*83%*
G	●		●				●						*3/12*	*25%*
H	●		●	●	●	●	●		●	●			*8/12*	*67%*
I	●	●	●		●	●	●	●		●			8/12	67%
J		●	●	●	●	●	●	●	●				8/12	67%
Total	*7*	*6*	*10*	*8*	*9*	*9*	*8*	*6*	*6*	*6*	*0*	*0*		
Practices Fully vs Partially Applied														
A			●	◖	◖	●	◖						*5/12*	*42%*
B		●	●	●	◖	●	◖	◖		●			*8/12*	*67%*
C	◖	◖	●	◖	◖								*5/12*	*42%*
D	●		●	◖		◖			●				*5/12*	*42%*
E	●	●	●	●	◖	●	◖		●				*8/12*	*67%*
F	◖	◖	●	●	◖	●	◖		◖	◖			*6/12*	*50%*
G	◖		◖				◖						*1.5/12*	*12%*
H	●		◖	◖		●			◖	●			*4.5/12*	*37.5%*
I	●		●			●				●			*4/12*	*33.3%*
J		◖		●		●	◖	●	◖				*4.5/12*	*37.5*
Total	*5.5*	*3.5*	*8*	*6*	*2.5*	*7.5*	*3*	*1.5*	*3.4*	*3.5*	*0*	*0*		

From Table 21 one can see that the only practice where the interviewees did not find any possible correlation was the Shift-left. The interviewees' lack of knowledge on the corresponding practice is a possible reason for such a finding. Regarding all the other practices, the interviewees engaged in one or more IM phases.

Table 22 lists interviewees' opinions on why organisations would benefit by applying DevOps culture on IM process and how one could achieve such benefits. The collected information answers the RQ1 by describing the relation between DevOps practices and IM process phases in more detail, grounded on the experience of the AM team under study. Such mapping is a step forward in this subject. The qualitative data present in Table 22 give us interesting and novel qualitative information to answer RQ 1.1 and RQ 1.2. This table show arguments from the interviewees to justify why and how DevOps practices may be applied on each IM process phase.

Each practice matches an average of approximately three IM phases, which indicates that the practices are, in fact, compatible with the IM process. Moreover, there are 2.3 matches for each grey cell 2.3 which shows that on average, two different interviewees have identified a match between the practice and the IM phase.

The practices with more matches in different IM phases were "Process Standardisation" and "Test Automation" matching four different IM phases. Since IM is a process it makes sense that teams who apply this process will try to make a standard for each phase, so it can be easier for everyone on the team to follow it. The Test Automation framework is used to ensure that the testing of new functionalities and incident fixes have the desired quality, ensuring that everything works appropriately. But these tests can be applied to different contexts according to the interviewees (Table 22). This explains why these tests are not only related to the "Resolution and Recovery" phase where the solutions are being taken and tested.

The practices that matched fewer IM phases were as follows: "Automated Monitor", matching 2 different IM phases; "Prototyping Application", matching one phase; and "Deployment Automation", matching two different phases. Regarding the "Automated Monitor" practice, half of the interviewees placed a match on the Monitor phase, as they have found that this practice is helpful to determining how the incident was really solved. However, there was one interviewee who matched the Detection phase, justifying that the automated monitor might find issues that were never identified. Prototyping Application was only matched with "Resolution and Recovery" but it was matched by three different interviewees, which is almost half of the interviewees. For Deployment Automation, it

was found in “Resolution and Recovery” and “Closure”. The purpose of this practice is to speed up the delivery of the code in several environments. Therefore, it will speed up the closure of the incident and its resolution.

Table 21 — IM Phases Where DevOps Practices Can be Applied

	Detection and Recording	**Classification and Initial Support**	**Investigation and Diagnosis**	**Resolution and Recovery**	**Closure**	**Monitor and Tracking**
Shift-Left						
Continuous Planning	2 W1, H1	3 W2, H1, H2	1 W3, H1			
Feedback Loops Between Dev and Ops			3 W4, H3			
Continuous Integration			3 W5, H4	4 W6, H4		1 W7, H5
Automated Monitoring	1 W8, H6					5 W9, H6
Prototyping Application				3 W10, H7		
Deployment Automation				2 W11, H8	3 W12, H8	
Test Automation	1 W13, H9		1 W14, H10	2 W15, H10		1 W16, H10
Infrastructure as Code			3 W17, H11			
Stakeholder Participation	4 W18, H12	3 W19, H13	4 W20, H12			
Process Standardisation	2 W21, H13, H14	2 W22, H15	2 W23, H16	1 W24, H16		
Change Management				1 W25, H17	5 W26, H18, H19	1 W27, H20

Table 22 — Feedback from Interviewees

Why	
W1	*"Continuous planning helps the business to know what needs to be fixed and the negative impact that it is causing."* *"It's important to register and centralise incidents to identify the ones that affect multiple users' ability to execute daily work."*
W3	*"Feedback provided while planning and selecting the next priorities will help in the investigation."*
W5	*"All the code will be easily merged, facilitating its diagnosis."* *"With CI it is possible to keep track of the changed code, which will be easier to find the person who changed it (given that person is still working for the company) to know why the code was changed that way, since that person could have different thinking on how the functionality should work."* *"Having all the code integrated on the last version and ready to be deployed in any environment may help with replicating incidents, avoiding misalignments between lower environments and production environment."*
W8	*"Automated monitors are useful to check the health of the system detecting incidents."*
W9	*"Constant monitoring of the system to find if the incident was solved"* *"Helps to find issues and to guarantee that the fixes are working"* *"The automated monitor will check if the system is ok; this way will also monitor if the fix for the incident was successful."*
How	
H2	*"By perform quick analysis of the issue reported and affected portfolio"*
H3	*"Promote Knowledge Transfer sessions"* *"Consider inviting operations for discussions when analysing incidents"* *"Having more sessions between Dev and Operations"*
H19	*"By requesting action requests/changes to responsible teams"*
H20	*"By planning in advance future releases in the system"*

Table 23 — Discussion on Interviewees' Feedback

Wx, Hx	**Practice**	**IM Phase**	**Comments**
W2, H1, H2	Continuous Planning	Classification and Initial support	The quotes for this practice show that the interviewees are greatly concerned with the prioritisation of their tasks. Their objective is to help the firm's client's, but they need to know what the most critical tasks are, so there can be better alignment between the AM team and the business. Two of the quotes shown talk about this prioritisation, while one of the quotes cites their concern on collecting feedback from the customer to provide the initial support. This may be achieved by having meetings with the business and regularly reviewing the incidents backlog.
W4, H3	Feedback Loops between Dev and Ops	Investigation and Diagnosis	Here the interviewees have focussed on feedback and knowledge sharing between Dev and Ops teams, bringing better cohesion between both teams and quality to the final solution to deliver to the business.
W5, W6, H5	CI	Investigation and Diagnosis; Resolution and Recovery	For both matches, the interviewees have mentioned the importance of the integration and alignment of the code. Having the last code version installed on lower environments will help with diagnosing the root cause of incidents, thus, accelerating resolutions. It was interesting to see that the same "why" can benefit two different IM phases using the same "how" (H4).
W8, W9, H6	Automated Monitor	Detection and Recording; Monitor and Tracking	Even though W7 only had one match, the author found quite curious how all the interviewees had focussed their answers on the Monitor and Tracking phase, creating the match W8. On W8 the interviewees showed that their concern was to use the Automated Monitor to check the system health and if their fixes had indeed solved the incident. While in W7 the only interviewee had justified his choice by using the Automated Monitor to find new incidents. To achieve this, the interviewees suggest implementing some automatic dashboards or scripts to produce reports related with system health.
W10, H7	Prototyping Application	Resolution and Recovery	The interviewees have commented this match by showing the result to the business. It looks like this team thinks this practice will lead to a better alignment between them and the business.

W11, W12, H8	Deployment Automation	Resolution and Recovery; Closure	Automation deployment is another example where it is possible to see that a practice can be applied for different contexts. The interviewees who found that Deployment Automation is useful for Resolution and Recovery have said that it can be used to deploy fixes for different environments quickly, so the users can approve the fixes. While the interviewees who have matched the Deployment automation with the Closure phase have justified this by saying that the move accelerates incident closure due to the time saving that this practice brings to the team.
W17, H11	Infrastructure as Code	Investigation and Diagnosis	In their answers, the interviewees have shown some concern regarding the readiness of their environments. None of them have ever applied this practice, but they seem to be intrigued while discussing this practice with the author, showing interest in applying it later. The interviewees suggested using cloud environments, which provide better tools for implementation.
W18, W19, W20, H12, H13	Stakeholder Participation	Detection and Recording; Classification and Initial Support; Investigation and Diagnosis	Analysing the quotes from the interviewees, it is possible to conclude that they depend a lot on the business to succeed in their work. The major need that they require from the business is feedback. Without feedback to obtain answers on how to replicate the issues or to get the correct prioritisation for the incidents, they will not be able to solve the incidents as quickly. To achieve this, the interviewees recommend planning meetings with the business users to discuss the incidents impacts.
W26, H18	Change Management	Closure	The interviewees believe that this practice will facilitate the closure of the incident by guaranteeing the quality requirements that are needed to do the deployments in production. By guaranteeing the quality of the delivery, they can confirm that the incident was correctly solved, contributing to the closure of the incident. There is a need to implement this process very carefully, so it can guarantee the quality required for the deliveries.

To analyse the quantitative data provided in Table 22, the author opted to concentrate on the most quoted matches (equal or greater than three) from Table 21. Table 22 is just a sample of the interviewees' answers, and the full table can be analysed in Appendix C. Also, the author analysed some matches that seems contradictory between the interviewees, which makes a relevant discussion (presented in Table 23) on how the DevOps practices might help the IM process phases.

From Table 23, it is possible to conclude that all the IM phases were approached regarding the matching with DevOps practices. This reinforces the idea that DevOps practices can help in several phases of the IM process.

6.1.2. DevOps Benefits (RQ2)

To find the benefits that the DevOps practices brought to this team, the author have asked the interviewees, "Why have you started to apply this practice?" to determine its benefits as viewed by the participants. The answers are visible in the table provided in Appendix D and serve as the answer to RQ2. In this table we show the number of matches and some quotes from the interviewees citing their justifications.

Analysing Appendix D, the author tried to identify keywords that could translate into generic benefits of each practice. The keywords identified by the author were the following: feedback, mitigate, impact, alignment and quality. By looking at Appendix D, these words are largely used by the interviewees in several practices. For better understanding, the author highlighted these keywords on the quote's column of Appendix D.

In analysing the table provided in Appendix D, it is possible to find that there is a relationship between these keywords and the practices, which enabled the author to investigate the benefit behind that practice. One can find these relationships in Figure 3.

Based on Figure 3 and Appendix D, the author was able to elicit and synthesise the benefits described by the interviewees for each practice, as shown in Table 24.

After analysing Table 24, the author summed up the benefits of DevOps adoption in the IM process, raising 5 major concepts, which where possible to map with the benefits identified in the literature review (Section 3.1). This can be seen in Table 25.

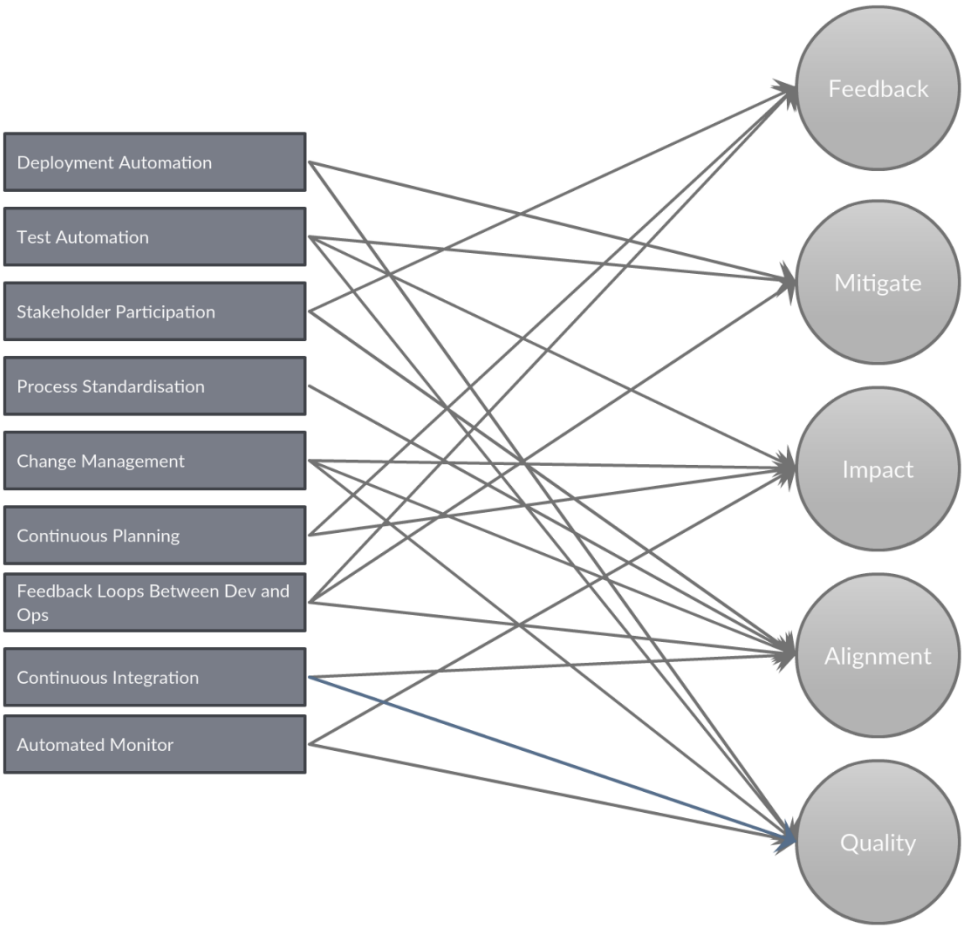

Figure 3 — Practices Vs Keywords

6.1.3. DevOps Challenges (RQ3)

To determine the DevOps challenges, the author asked, "How was the adoption of these practices?" This question was rated from 1 to 5, meaning "Very Hard", "Hard", "Neutral", "Easy" and "Very Easy". The interviewees were given the opportunity to justify their answers. By doing so, it was possible to collect their opinion about the challenges of adopting each DevOps practice. In Table 26, one can find the interviewees' answers to this question in a condensed format; the full set of answers can be seen in Appendix A. The columns in the table list the different ratings that the interviewees could choose (with respective comments) and the practices on the rows, creating a matrix. One of the columns presents the sum of the interviewees' ratings so the reader can have an idea of which practices are easier or harder to adopt. Not all the interviewees had participated in implementing the practice in question. So, the sums of the ratings can be different from practice to practice.

Table 24 — Keyword Conclusions About the Benefits

Practice	**Key Words**	**Conclusion**
Continuous Planning	Feedback Impact	With this practice development teams, together with business, can plan the next steps based on the feedback and the impact of the incidents on the business, contributing to business satisfaction and business engagement with the development teams.
Feedback Loops between Dev and Ops	Feedback Impact Alignment	All the teams can bring their feedback to the table regarding the new developments, reducing the impacts to the business. This practice also guarantees an alignment between the developers and operators, where they can learn from each other, contributing to the quality of software delivery and engagement between developers and operators and maximising competences.
CI	Alignment Quality	This practice will bring alignment between the developments, contributing to the quality of software deliveries and engagement between teams.
Automated Monitoring	Impact Quality	The Automated Monitor is essential to guaranteeing a fast response to the recent issues, minimising their impact and guaranteeing the quality of the fixes from the AM team, which contributes to software quality.
Deployment Automation	Mitigate Quality	Deployment Automation is a key practice to mitigate human error, ensuring better quality software delivery.
Test Automation	Mitigate Impact Quality	Regression tests can be performed automatically, mitigating human error, which will result in less impact on existing functionalities. This will bring more quality to the software solution that was developed.
Stakeholder Participation	Feedback Alignment	Feedback from all the stakeholders is the key to the success of any application, leading to engagement between stakeholders.
Process Standardisation	Alignment	The standardisation of processes will lead to alignment between all individuals and later between teams, which will guarantee that everyone will work the same way, leading to quality developments.
Change Management	Impact Alignment Quality	The change management process measures the impacts of the software change, where all the involved teams will need to be aligned to ensure the quality required for the software.

Table 25 — Conclusions About the Benefits

Benefits	**LR**	**CS**
Quality	B1 B3	The participants identified quality of the software delivery in several topics. The quality of software delivery is key for every development team. The quality of the software delivery should not be measured when the software is delivered but during all stages until delivery: meaning, requirement gathering, designing, building, testing. If the quality is improved in all phases, the software delivery quality will be higher.
Engagement	B2 B4	The engagement of all the stakeholders on the application is a key success factor for the application. Everyone, this means business users, developers, operators, managers, etc., need to be on the same page; otherwise, the success of the application will not be maximised.
Value	Not found in the LR	The objective of every project is to bring value to the business. From the quotes of the interviewees, they are very focussed on getting the feedback from the business and to provide their feedback to businesses to improve them. They know that the business is depending on the applications and since they are responsible for maintaining these applications, they not only try to fix them but also to improve them and avoid possible issues. They implement practices that help them to find the issues quickly to minimise impacts and even find them before the issues happen.
Integrity	Not found in the LR	The interviewees are currently maintaining an application that currently is not finished. The development teams are currently working and adding more functionalities to the application. This requires substantial integration between these two workstreams.
Personnel development	B6	The concept behind DevOps is to join Operators and Developers. Joining these 2 workstreams will make them share knowledge between them, which will create more capable professionals who are able to work for these 2 workstreams.

Table 26 — DevOps Challenges in Each Practice

Practices	Rates						Comments
	1	**2**	**3**	**4**	**5**	**Average**	
Continuous Planning		3	1	2		2.8	*"It was hard to define which ceremonies should be part of this practice."*
Feedback Loops Between Dev and Ops	1		2	1		2.75	*"Challenges due to busy agendas and different time zones between Dev and Ops"*
Continuous Integration			2	4	2	4	*"Easy to implement with the correct tools. Also, easy to understand its benefit."* *"Easy process to use"*
Automated Monitoring	1		2			2.3	*"Requires some time to build these monitors and know what should be monitored"*
Deployment Automation		2	3	1	1	3.1	*"The automated deployment was complex to use due to the team's lack of knowledge of the tools."*
Test Automation	1	1	2			2.25	*"Hard to configure and to maintain due to the continuous delivery"*
Stakeholder Participation	2		3			1.6	*"Lack of engagement from the stakeholders to participate in some decision processes"*
Process Standardisation		1	1	1		3	*"The project management encourages this since it will reduce the mistakes during the process execution."*
Change Management		1	2	4		3.4	*"On the change management process, there are a lot of people involved. The communication between all these people is not easy."*

Regarding the challenges, the author has reviewed the answers from the interviewees and take the main idea from their comments to obtain the challenge. For this analysis the author only considered the practices where the average was less than three, since three in the questionnaire means neutral.

From Table 27 it is possible to find that the interviewees have only found challenges on implementing five of the 10 practices that they currently apply. The main challenges found were as follows: time spent on documentation, culture, communication, maintenance and the technical challenge of implementing the respective practice. Similar to the previous section, the author mapped the findings of section 3.1 and the challenges the interviewees identified.

Table 27 — Conclusions About the Challenges

Practice	Average	Challenge
Continuous Planning	2.8	The challenge for this practice was the time spent to build the support documentation for the required meetings.
Feedback Loops between Dev and Ops	2.75	The interviewees felt some lack of will from the Ops side to break down the silos; also, the combination between agendas of different time zones was a challenge.
Automated Monitoring	2.3	It requires time to build these monitors, and the management does not see much value on implementing them since it will take some time to maintain these monitors due new releases.
Test Automation	2.25	The interviewees have stated this practice is hard to incorporate in their system and to maintain due to new releases.
Stakeholder Participation	1.16	The interviewees stated there are challenges due to the technical/functional language that can lead to a lack of interest from stakeholders. Also, some stakeholders do not want to be included in the decision-making process since they do not want to have to be accountable if something goes wrong.

Table 28 — Challenges Crosscheck between LR and CS

Concepts	**LR (Section 3.1)**	**CS**
Technical Challenges	C5	The interviewees have stated they have found some challenges while implementing the Automated Monitor and Test Automation. The automated monitor needs to be aligned with the current solution that is in production; since the DevOps culture promotes a fast delivery life cycle, it is hard for the Automated Monitor to keep up with these changes. Regarding Test Automation, these tools are hard to configure, which makes this AM team spend a lot of time just to configure/reconfigure the tool.
Culture	C2 C3	The interviewees stated the fear of the stakeholders to take accountability for their decisions, which may be related with deep-seated company culture. It is common to have a deep-seated company culture in the financial sector, like the company where these interviewees provide their services.
Communication	C1	The interviewees also stated the reluctance of the Ops to provide feedback on the sections of "Feedback between Dev and Ops". This may be related with the insufficient communication challenge since the Ops side does not want to communicate with the developer.
Time Spending	Not found on the LR	The interviewees have stated they need to spend a lot of time on preparing meetings and all the documentation that is required for these meetings.

In Table 28 the author identifies four concepts and some challenges. Comparing the results from the LR in section 3.1 with the results of the interviewees, it is possible to see that for Technical Challenges the interviewees have stated the difficulty of maintaining the monitors updated to observe the current solution. The Automated Monitors are both important for the developers of the AM team and for the Ops team. This results in a new challenge for the DevOps: since DevOps promotes a quick delivery life cycle, it will be possible to deliver with more frequency, not giving enough time to maintain the monitors. Unless, maintaining the monitors should be a task for the developers when they make new developments that could affect these monitors. Regarding the time consumption, all the other author never found that time was an issue. However, based on the interviewees they lost ample time producing the necessary documentation to support the agile meetings, resulting also in a new challenge.

6.1.4. Team Performance (RQ4)

To evaluate if the team performance was improved due to the implementation of the DevOps practices, the author placed a question on the questionnaire where the interviewees could rate from 1 to 3, 1 meaning did not improve while 3 means improved; a box was also provided for comments to justify why a practice had or had not improved. Again, an abridged version appears in Table 29, while the full table can be found in Appendix B.

Analysing Table 29, it is possible to conclude that most of the practices that the interviewees have in place, have improved their work. All the practices have an average greater than two, except for Test Automation, where the final average was 2. From the interviewees' point of view, the test automation practice can be a good practice to improve their work, since they can apply this practice to execute regression tests, which usually takes a lot of time. However, when a test is marked as failed on this tool, it takes a lot of time to check why the test was marked as failed; moreover, some of the failed tests are false positives, which may lead to wasted time.

Table 29 — Team Performance

Practices	Rate			Average	Comments
	1	2	3		
Shift-left					
Continuous Planning			6	3	*"It helps the team to define objectives and keep their focus on the tasks."*
Feedback Loops between Dev and Ops		2	2	2.5	*"It helps to prevent issues, but it takes a lot of time in meetings."* *"Due to a better relationship between Dev and Ops, errors may be found earlier and even avoided."*
Continuous Integration			8	3	*"It will ensure the code merge, avoiding placing effort on merging activities";* *"It prevents errors in merging and facilitates the alignment between teams."*
Automated Monitoring			3	3	*"Reduces time on monitoring activities"*
Deployment Automation		2	5	2.71	*"Reduces time on deployment activities so there are no worries on creating manual packages"*
Test Automation		4		2	*"Even when automated tests are made, we always need to perform unit and integrated tests."*
Stakeholder Participation		1	3	2.75	*"It can improve the performance if all the stakeholders that are involved on the discussion are interested on the topic"*
Process Standardisation	1		2	2.33	*"It requires a lot of time and efforts to define the processes."*
Change Management	1	2	3	2.33	*"It wastes some time to ensure that the right participants are doing their tasks."*

The author wants to highlight the practices “CI”, “Automated Monitoring” and “Continuous Planning”. These three practices got an average of three, which was the maximum rate for this question. For the CI the interviewees focussed their answers on saving time since they have reduced their merge activities and the human error of these activities. When working with other teams, the code merging activities can be very time consuming, as no one wants to make an error on others’ code. Regarding continuous planning, have focussed on having a defined scope for their tasks. As previously said on other sections, this team seems to have problems on working within priorities. This practice will allow a continuous scope of activities, so the interviewees do not need to be changing all their tasks from day by day. The interviewees for the Automated Monitor, focussed on how it saves time. The Automated Monitors will create reports or a dashboard, so this team can check the health status of the system and react on time if something goes wrong.

For the remaining practices, the interviewees talked about other topics, like maximising competences (feedback between dev and ops), saving time (deployment automation), the importance of the business of taking decisions (stakeholder participation), making an easier process for everyone to follow (process standardisation) and achieving quality (Change Management).

One can conclude that these interviewees are concerned about the improvement of their work. It is possible to analyse that they consider that these practices improve their work, since most of the practices that they implement got an average of greater than two (neutral). They have focussed their improvement of performance on the time saving and on the quality of the deliver. They seem to be satisfied with the time that has been reduced on support and routine tasks, so they can be focussed on the problems that their business users face every day. Also, they look concerned with the quality of their deliveries and this was also a main focus on their answers when asking about their performance increase.

Based on the previous statements, it is possible to conclude that DevOps practices may improve the IM process by reducing the time to reach its resolution.

6.2. Report Analysis

The author had the opportunity to analyse two kinds of reports from this team. One produced at the end of each sprint to evaluate what needs to be changed and the second are weekly performance reports to highlight key issues that were the focus of the

AM team for that week. By analysing these reports, the author intended to cross-check information from the interviews feedback.

The author has analysed all the reports produced between March 2016 and June 2018, Overall, 18 sprint reports (major releases) and 115 weekly reports were analysed. The analysis of the documentation was useful to bring consensus on the information collected from the interviewees. It is possible to see these findings in Table 30.

6.3. Direct Observation Analysis

As previously stated before, the author have chosen to perform a unstructured observation, which may also be called by participant observation (Thomas, 2016). Unfortunately, it wasn't possible to observe how the implementation of the practices affected the interviewees behaviour, therefore, the observation will just be used to validate the answers and finding from the other data collection methods. As per Thomas (2016), this, reinforces the definition of this case study when is stated in Chapter 4 as a retrospective CS. This meets up with the definition of Thomas (2016) when describing that for the participant observation it will just be taken notes of certain behaviours of what is happening. In Table 31 it's possible to analyse the finding within its source and if it can be confirmed by observations. Table 30, it's a sum up of all the findings, the complete table can be found at Appendix E.

Analysing Table 31 it is possible to see that the author was able to find 19 findings from the two data collection methods, semi structured interviews and report analysis. This table is a sum up of the information that is stated in Appendix E. From these 19 only 10 findings were not able to be confirmed by the observation, due to not having a baseline to compare the before and after, which was really needed for that finding, and some for some of them is not possible to confirm by observation. About 52% of the findings were able to be confirmed by the observation method, a value that the author considers acceptable to be considered as credible method for this research. It is also possible to see that some of the finding can be found in both Semi Structure Interviews and report analysis, but the validation of the triangulation between data collection methods will be discussed on the next section.

Table 30 — Report Analysis

Type of Report	Report findings	Interviewees Cross-check	Metrics			
			Detail	**Baseline**	**Evolution**	**Δ% to baseline**
Sprints	In a former report, AM team evidences the lack of engagement of the business on providing feedback and help on the analysis of the incidents. While on the last one, business engagement is already pointed as something positive.	W15 H9	N/A	N/A	N/A	N/A
	On the most recent reports, the AM team evidences how important could be implement automated deployments during the test phase of the sprint, optimising the tests of the users.	W8	Time to deploy a bugfix	48h	2h	-95%
	Changes to scope were also mentioned on these reports. Due to the continuous planning, business users could change the incidents' solutions scope to be delivered on that sprint. The users can prioritise these incidents by their impact, having them solved more quickly.	W1 W2	N/A	N/A	N/A	N/A
	There is no record of the AM team not delivering any incident solution where was compromised to deliver.	N/A	N/A	N/A	N/A	N/A
	Before of the implementation of the Continuous Planning and other agile practices, the AM team didn't have any evidence of over deliver incidents solutions that weren't planned on the plan of the release. After the implementation of those practices the team was able to show "Out of Sprint" scope that was being delivered on the release (an average of 10,1 incidents per release)	N/A	Over delivered incident solutions	0 Incidents	10.1 Incidents	+100%
	The AM describe that the Business wasn't interest on showing up on the sprint planning ceremonies, which result on a lot of changes on the sprint scope. After they started to show, the sprint scope started to have less changes, and the changes that were made was a well-defined agreement between the AM team and the business.	Appendix B, Continuous Planning quotes	Number of attendees from the business side	1 Attendee	5 Attendees	+500%
	Before the implementation of the CI and automated deployments, all the environments were misaligned, which impacts a lot the acceptance tests	W5	N/A	N/A	N/A	N/A

	environment. After the implementation of these practices the environments come more stable and aligned					
	On the first, the AM team realises on how the agile ceremonies for the continuous planning consumes time. However, they don't see this as an issue anymore since they have made standard documents	N/A	Time to prepare documentation for ceremonies	4 Days	1,5 Days	-267%
	Stakeholder Participation – The AM team misses the expertise of some areas on the continuous planning meetings. After some time, they don't see this as a problem anymore	Appendix B, Stakeholder Participation description	From the 5 attendees before mentioned, it is at least one representative of each application module.	0 Attendees	1 Attendee	+100%
Performance Reports	The AM team could implement biweekly releases with only hotfixes for the most critical incidents (identified after the sprint planning and due to the complexness weren't able to include on the sprint). Such biweekly releases exist due to the deployment automation and CI performed by the team. Having a good integration of the software allow to have several tracks of development without having merge errors. Also, the deployment automation saves developers' time, so they can focus on solving the incidents	W4 W5 W9 H6 H9	Number of Releases per month	1 Release per month	3 Releases per month	+200%
	These reports also evidence the existence of some problems on the production infrastructure. The AM team have implemented these monitors to have a reactive posture in case that something wasn't right. On these reports is stated that the issues were found in time, minimising the impact for the business users.	W6	Average of infrastructure problems per month	3 Problems per month	0,5 Problems per month	-83.33%

Table 31 — Findings

ID	Main Findings	Source	Confirmed by Observation?
F.1	Shift-left wasn't considered by the Interviewees	Semi Structured Interviews	Yes
F.2	Each DevOps practice matches at least in an average of 3 IM phases (50% of the IM phases)	Semi Structured Interviews	No
F.3	All the IM phases have at least a match	Semi Structured Interviews	No
F.4	Automated Monitor, Prototyping application and Deployment automation matched less phases since they can only be applied to reduced contexts	Semi Structured Interviews	Yes
F.5	CI helps on the incident analysis and resolution	Semi Structured Interviews / Performance Reports	Yes
F.6	Prototyping Application helps to understand the business needs	Semi Structured Interviews	Yes
F.7	Infrastructure as Code may help on the readiness of the environments	Semi Structured Interviews	No
F.8	Stakeholder Participation may help on Detection and Recording, Classification and Initial Support, Investigation and Diagnosis	Semi Structured Interviews	Yes
F.9	Change Management is related with Closure IM phase	Semi Structured Interviews	Yes
F.10	There was found several benefits after applying the DevOps Practices: Quality; Engagement; Value; Integrity; Personal Development	Semi Structure Interviews	No
F.11	There was possible find the following challenges when implementing the DevOps practices: Technical Challenges; Culture; Communication; Time Spending	Semi Structured Interviews	No
F.12	All the practices improved the performance except test automation	Semi Structured Interviews	No
F.13	CI and Deployment Automation saves time	Semi Structure Interviews / Performance Reports	Yes
F.14	With continuous planning is possible to have a well-defined scope, and in case of have changes to the scope, it could be aligned between business and team management	Semi Structure interviews / Sprint Reports	Yes
F.15	While discussing the performance improvement of the team it was referred: Time saving; Maximising competences;	Semi Structured Interviews	No
F.16	Regarding the performance it was also mentioned an increase of quality	Semi Structured Interviews	No
F.17	More releases	Performance Reports	Yes
F.18	More Performance (overdeliver)	Sprint Reports	Yes
F.19	Infrastructure problems	Performance Reports	No

6.4. Data Analysis Synthesis

On this section author will compare the findings that were described on the previous sections 6.1, 6.2, 6.3 and 6.4, to validate the data collection methods triangulation, as can be seen in Table 32.

Table 32 — Data Analysis Synthesis

Research Question	**Finding**	**I[1]**	**R[2]**	**O[3]**	**S[4]**
RQ.1	F.1	X		X	6.1.1.
RQ.1	F.2	X			6.1.1.
RQ.1	F.3	X			6.1.1.
RQ.1	F.4	X		X	6.1.1.
RQ.1	F.5	X	X	X	6.1.1 / 6.2.
RQ.1	F.6	X		X	6.1.1.
RQ.1	F.7	X			6.1.1.
RQ.1	F.8	X		X	6.1.1.
RQ.1	F.9	X		X	6.1.1.
RQ.2	F.10	X			6.1.2. / 6.2
RQ.3	F.11	X			6.1.3.
RQ.2; RQ.4	F.12	X			6.1.2. / 6.1.4.
RQ.2; RQ.4	F.13	X	X	X	6.1.2. / 6.1.4.
RQ.2	F.14	X	X	X	6.1.2.
RQ.2	F.15	X			6.1.2. / 6.1.4.
RQ.4	F.16	X			6.1.4.
RQ.2	F.17		X	X	6.2.
RQ.2	F.18		X	X	6.2.
RQ.4	F.19		X		6.2.

[1] Semi Structured Interview
[2] Report Analysis
[3] Observation
[4] Section Where this Finding is Described

Chapter 7 — Conclusions

This research brought contributions for the academic and scientific community by exploring an area that wasn't explored so far, improving the body of knowledge and establishing new baselines for further investigation.

This research contains a set of data collected from the interviews that were made to IT professionals that apply DevOps practices while they work with the IM process and solve incidents and collected from performance documentation provided by this team. With these interviews and documentation, it's possible to conclude that these practices can help to increase AM team performance as well as the engagement with business users by making them involved with the solutions that are provided by the AM team, when diagnosing and solving the incidents.

Due to the automation practices like testing and deployment, the interviewees also pointed that they could perform more emergency changes, contributing to the health of the application and to solve the incidents that cause more impact faster. They have also shared, that they would like to fully apply some of the practices like test automation, automated monitoring and infrastructure as code because they understand that by applying this, they would have more benefits. Most of the practices were implemented by request of the AM team's client, however some of them, like Feedback Loops Between Dev and Ops and Process Standardisation, were practices that are encouraged to be practiced by the team management, due to the performance improvement that these practices can bring. Also, due to the Feedback Loops, the AM team could expose some concerns regarding the new developments, contributing to the quality of the new developments and prevent future issues on the application.

In general, the interviewees are happy to apply these practices due to the agility of DevOps and the involvement of all the stakeholders, they feel their work has more impact and it's recognised by all the organisation.

To conclude, all the RQs that this research proposed to answer, were answered. RQ1, about which DevOps practices may be applied on the IM process, why and how, was mainly answered by the answers that the interviewees gave on the interviews. According to the interviewees all the DevOps practices may be used on the several phases of the IM process, except for Shift-left, which is considered a limitation for this research. Regarding RQ2, which is about the benefits of DevOps practices, there was found several benefits for each practice and benefits on a general way. Also, there was identified some

benefits that weren't found on the LR, like Value and Integrity. For RQ3, some challenges were also found like on the LR, but on this research it was also possible to find some more challenged that didn't exist on the current body of knowledge, like Time Spending. Regarding RQ4, which is about on how DevOps may improve the incidents resolution, it was possible to see that the practices will reduce time on several manual tasks, this way improving how the IM process behaves.

This research also provides some contributions for the professionals and practitioners. In the absence of studies exploring the relation between DevOps and ITSM (IM and AM team), this research brings new insights on why and how an AM team should adopt DevOps practices. Benefits of the practices are also mentioned on this research, as well as the adoption challenges, so the professionals and practitioners can see some of the results that can happen when they apply these practices. There is also showed how these practices can improve the IM process.

7.1. Research Limitations

This research also has some limitations. This research is grounded on the knowledge of a single team and other perspectives may exist. An example of this limitation is that no member of this team knows about the Shift-Left practice. So, this research lacks any conclusions regarding its impact on the IM process.

7.2. Proposal for Future Work

Future work may pass by interview the remaining workers to refine the results of this research. Plus, further researchers may also investigate how the DevOps practices may be applied in other ITIL processes. This is a goal that the author intends to pursue in a near future, for instance for Problem Management process. Also, as future work the author proposes the exploration of more challenges regarding the DevOps implementation, since that are more researchers exploring the benefits.

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Appendixes

Appendix A

Practices	Rates						Comments
	1	2	3	4	5	Average	
Continuous Planning		3	1	2		2.8	*"It was hard to define which ceremonies should be part of this practice"* *"The major challenge of this practice was the definition of dates to book the meetings"* *"The attendees from the business couldn't realise of the benefits of these meetings, so, they came reluctant to the implementation of this practice"* *"There was a lot of effort to create the template documentation for support for these ceremonies"*
Feedback Loops Between Dev and Ops	1		2	1		2.75	*"We felt a lot of lack of engagement from the Ops teams to participate in on our meetings. Maybe due to the different consultant teams between the Development teams and Ops team. After showing this to the client responsible, the Ops, started to accept to attend the meetings and we were able to seem more engagement from their side"* *"Challenges due to busy agendas and different time zones between Dev and Ops"*
Continuous Integration			2	4	2	4	*"Easy to implement with the correct tools. Also, easy to understand its benefit"* *"Easy process to be used"*
Automated Monitoring	1		2			2.3	*"Hard to maintain due the continuous delivery"*

							"Lack of interest from the project management. The project management is focussed in fixing incidents and doesn't want to waste the time of their resources in maintain these automated monitors" *"Requires some time to build these monitors and know what should be monitored"*
Deployment Automation		2	3	1	1	3.1	*"The automated deployment was complex to use due to the lack of knowledge of the team about the tools"* *"It was hard to use due to the lack of the debugging tools to find why the deployment fails"* *"The use is hard due to the lack of knowledge on how to configure this kind of tools, but easy to use"*
Test Automation	1	1	2			2.25	*"It is hard to configure the tools to the system"* *"Hard to configure and to maintain due to the continuous delivery"*
Stakeholder Participation	2		3			1.6	*"Lack of engagement from the stakeholders to participate in some decision processes"* *"There are some challenges to break the barrier between the technical and functional language. In these meetings it is needed some stakeholders that can make this bridge"*
Process Standardisation		1	1	1		3	*"The project management encourages to do this, since it will reduce the mistakes on the process execution"* *"It takes a lot of time to achieve the perfection on the process. Every time that someone makes a mistake on the process, it needs to be redesigned"*
Change Management		1	2	4		3.4	*"On the change management process there are a lot of people involved. The communication between all these people is not easy."*

Appendix B

Practices	Rate			Average	Comments
	1	2	3		
Shift-left					
Continuous Planning			6	3	*"Creates more interaction between the development teams and the business, creating better relationships"* *"With continuous planning we are able to take care of the incidents already discussed with the business, saving time on the analysis"* *"With continuous planning it will be possible to always have scope to deliver on next releases, which will leave to the decrease of incidents"* *"It will guarantee that the delivery will be what the business has requested, avoiding wastes of time to code the functionality over again"* *"It helps the team to define objectives and keep their focus on the tasks"* *"With this practice, we can have a well-defined scope from the business, so we were able to keep our focus on the scope that was defined"*
Feedback Loops Between Dev and Ops		2	2	2.5	*"It helps to prevent issues, but it takes a lot of time on meetings"* *"Due to a better relationship between Dev and Ops, errors may be found earlier and even avoid"* *"The team will have a broader knowledge, where the team members will be more autonomous"*

					"The knowledge transfer sessions that exists between Dev and Ops will be very benefit for both sides, but bit takes a lot of time from the attendees from performing their tasks"
Continuous Integration			8	3	*"It will ensure the code merge, avoiding having effort on merging activities";* *"Prevent errors on merging and facilitates the alignment between teams"* *"Guarantee the code integration saving time from merging activities"* *"Saves time on merging activities with other teams, avoiding errors of overwritten code"* *"Avoids errors and wasting time on merging activities"* *"It facilitates the code versioning, avoiding mistakes on merging"* *"It allows to have updated environments and ready to work"* *"Our productivity was increased due to the reducing of the merging tasks that we do before"*
Automated Monitoring			3	3	*"Reduces time on monitoring activities"* *"Saves time"* *"Saves time on performing manual monitors that were being done, and allows to find errors and react on time"*
Deployment Automation		2	5	2.71	*"Reduces time on deployment activities and there are no worries on creating manual packages"* *"Reduces the human error and ensure the correct deployment"* *"When it goes fine it can save a lot of time, but when it goes wrong it may result on a big amount of time to understand why"* *"It improves the deployment process, mitigating the human error"* *"Saves time but it can be painful to analyse in case of errors"*

					"Allows better release management in terms of time consumed by the deployments" *"We spent a lot of time on supporting the deployments, but with this practice, we almost don't spend any of our time on supporting these tasks"*
Test Automation		4		2	*"Even when automated tests are made, we are always needed to perform unit and integrated tests"* *"It may have false positives and when this happens, the developers waste a lot of time to find the false error"* *"Tests will be executed faster, but in case of false positives it may result on a big waste of time"* *"Even this practice was in place, our process also includes unit testing, so the developer also needs to take time to perform these tests"*
Stakeholder Participation		1	3	2.75	*"Helps to understand the business needs"* *"It can improve the performance if all the stakeholders that are involved on the discussion are interested on the topic"* *"Having business present while fixing a functionality it will give us the right path to follow, instead of trying to fix something which can lead to another error"* *"The participation of all the stakeholders is important because the accountability of the decisions can be distributed. So, every time that we need to have a decision from the business, we don't need to be reduced a small amount of points of contact."*
Process Standardisation	1		2	2.33	*"It makes the development process easier since the process will be the same for everyone"* *"It requires a lot of time and efforts to define the processes "*

					"The standard processes make the team to work on the same way for all the processes, there the space for errors will be reduced over the time."
Change Management	1	2	3	2.33	*"It's essential, but we lose a lot of time on requesting to the other participants on the change process to do their tasks"* *"It wastes some time to ensure that the right participants are doing their tasks"* *"All the participants need to be careful on their tasks and do them with the maximum of attention"* *"Guarantees that all the changes follow the a restrict quality control, contributing to the quality of our delivery"* *"It guarantees that all the quality procedures have been done, to avoid errors"* *"The change management process will guarantee that our deliver will follow all the quality standards that are imposed by our client. However, the change management process that we follow today, takes some time since that are required a lot of participants to act, which also impact our timings."*

Appendix C

Why	
W1	*"Continuous planning helps the business to know what needs to be fixed and the negative impact that is causing."* *"It's important to register and centralise incidents to identify the ones that affect multiple users to execute daily work"*
W2	*"During the planning, business will show their needs and will expose the next priorities."* *"Feedback from the client will help on establishing a correct classification providing an initial support"* *"The correct incident classification in terms of severity and priority allow to better select mandatory incidents"*
W3	*"Feedback provided while planning and selecting the next priorities will elk on the investigation"*
W4	*"By providing feedback from both teams with different perspectives, the issues can be found and analysed easily."* *"Both teams will have different approaches on how to solve the issues generating brainstorms and a better cohesion"* *"Sharing knowledge will maximise the capabilities for both teams, contributing for a faster analysis"*
W5	*"All the code will be easily merged, facilitating its diagnosis"* *"With CI it is possible to keep a track of the changed code, which will be easier to find the person who change it (in case that person is still working at the company) to know why the code was changed on that way, since that person could have different thinking on how the functionality should work."* *"Having all the code integrated on the last version and ready to be deployed in any environment may help on replicating incidents, avoiding misalignments between lower environments and production environment"*
W6	*"By always working on the last version of the code will help to find the resolutions"* *"Resolution of the code will be easier, and the code may not be smashed"* *"By using the latest code version, we will be working on the last software version, finding the resolution faster"* *"Since all the integrated code is easier to evaluate the impacts of the resolution, thereby accelerating the resolution"*
W7	*"It allows to detect any problems originated by teams" parallel developments"*
W8	*"Automated monitors are useful to check the health of the system detecting incidents"*
W9	*"Constant monitoring of the system to find if the incident was solved"*

	"Helps to find issues and to guarantee that the fixes are working" *"Automated monitoring will save time for everyone and find issues in production"* *"Can help on checking the system health and if the incidents were indeed fixed"* *"The automated monitor will check if the system is ok; this way it will also monitor if the fix for the incident was successful"*
W10	*"It will show a proposal of the solution and final behaviour, so the business can accept it faster"* *"It will guarantee that the solution is what the business is expecting"* *"By having a prototype of the fix of the functionality, we can show the result to the users, so they can approve the resolution or tell us what is supposed to be the final result."*
W11	*"Automated deployments will allow more deployments for several test environments, accelerating the user tests to approve the resolutions"* *"The deployment automation may help on the resolution, accelerating the fixes deployment for other environments, finding issues that those fixes may cause in production"*
W12	*"Incidents may be closed faster since more deployment windows are available"* *"Due to the time saving there will be more deployments, which will give the possibility to install hotfixes more often"* *"To allow deploying release and related incidents/change requests without manual process it will help on the closure of the incident"*
W13	*"Reduce the manual tests performed to the build solution and application stability."*
W14	*"If we receive an incident that we guess could fail on an automatic test, we can run that test and check where it fails, giving an idea of where the issue can be found"*
W15	*"By knowing the final result, it's possible to design the automatic test, saving time, instead of doing the manual test; therefore, the resolution will be found earlier"* *"Automated tests to perform integrated tests to check if the resolution doesn't impact other functionalities"*
W16	*"By executing automated tests, we can find if the incidents are fixed or not"*
W17	*"Environments can be easily provisioned to have all the needed components"* *"It will help to have environments ready for the analysis of incidents"* *"This practice will help with having the environments work for the necessities of the developers, helping to analyse the incidents"*
W18	*"Communicating with the stakeholders will aid in understanding the real impacts and issues that one incident is causing"*

	"Will help the business to understand how the functionalities are working and create incidents if needed" *"By discussing with the business, we can understand if the functionalities are correctly implemented and if there is a misalignment, an incident should be created"* *"Helps understand what the real requirement was and what was implemented"*
W19	*"By providing feedback to the business, they can categorise the incidents correctly"* *"We can help the business to evaluate the impact of an issue, so it can have a better prioritisation"* *"Due to the stakeholder participation, it is possible to have an initial support in order to help the business in order to understand if there is an issue or not."*
W20	*"By evolving all the stakeholders, including technical stakeholders, not only the business, it may help on the investigation phase by contributing with other knowledge areas"* *"Business users may help replicate the issues facilitating the analysis"* *"The functional knowledge of the business may be a great plus on investigating the root cause of the incidents"* *"Having businesses participate in the investigation and diagnosis will help to find the root cause for the incidents and finding if the software is working as it was designed. From this we might get two different conclusions: there is no issue and there was an error from the user when interpreting the result of the functionality, or a Change Request may be raised to change the functionality design"*
W21	*"Having standardised processes on how to report incidents will help the users to report incidents properly"* *"In order to report incidents with necessary detail to allow identify the root cause"*
W22	*"Implement processes to evaluate impacts in order to have a better prioritisation"* *"Having processes to define priorities"*
W23	*"Having procedures to report incidents properly will help on the diagnosing the incidents"* *"Implementing processes on how to replicate certain behaviours may help on diagnosing the incidents"*
W24	*"Standard processes may help on the incident resolution facilitating what should be done to progress with the solution that was made while diagnosing the incident"*
W25	*"Important to detect any undesired effect in the system due to implemented changes."*
W26	*"Helps with guaranteeing process to deliver a change into production"* *"Manages all the process of the change reducing the impacts that may cause"*

	"By being a rigid process, it certifies that the change is in condition to go to production" *"This process will evaluate the required change to fix the incident, minimising the impact that may cause on the application health"* *"Production/lower environments application changes and incident closure should follow defined process/rules"*
W27	*"It allows to collect better environment interventions and allocate resources for implementing them"*
How	
H1	*"Promote planning meetings with the business"* *"Use the Agile ceremonies: Spring Planning, Sprint Retrospective and Sprint Review. Even if the goal of retrospective and review is not planning, it will help to understand the status of the application and the remaining incidents that need to be fixed; therefore, it needs to be prioritised"* *"Regular meetings with the business"* *"Promoting business meetings and discussing the priority incidents to be addressed in following releases"*
H2	*"By perform quick analysis of the issue reported and affected portfolio"*
H3	*"Promote knowledge transfer sessions"* *"Consider inviting operations for discussions when analysing incidents"* *"Having more sessions between Dev and Operations"*
H4	*"Having tools to enable this"* *"TFS and Jenkins are good tools to do this"* *"Having tools that facilitate this integration"* *"The Version Control Software should be able to integrate with a build software"* *"Tools should be used to enable this, like TFS and Jenkins"*
H5	*"By updating main source code repository and refreshing lower environments"*
H6	*"Scripts that can be executed and produce reports"* *"Having tools that trigger alerts when something is wrong with the system"* *"Having dashboards that are automatically refreshed in time to time to detect something wrong with the system"* *"Having reports that are generated automatically are very useful to evaluate the system health"*

	"Scripts that are executed everyday generating reports checking the system health"
H7	*"Having environments that are not used to analyse incidents but just to install the solutions, so the users can see the final results"* *"Having environments with similar data as production so the users can test the solutions"* *"Lower environments with production data"*
H8	*"Having tools that can deploy the changes without user action"* *"Tools to enable the automatic deployment for several environments"* *"Tools that deploy changes that are needed"* *"By implementing automation process and reducing human error"*
H9	*"Executing regression tests and programming specific tests scenarios"*
H10	*"Having a tool that allow us to provide the final result so that the tool can follow several flows in order to reach that result"* *"Having testing tools that can test several modules of the application at the same time"* *"Having tools where we can insert break points in order to check the flow of the test"* *"Test tools that can make the tests based on final outputs provided by the business to check if the functionality is working as it is supposed to, confirming that the incident was solved"*
H11	*"Using cloud environments"* *"Cloud environments are an enabler for this"* *"Having scripts and tools that can configure the environments quickly"*
H12	*"Have regular meetings with technical and functional stakeholder to discuss the health of the system so it can help on diagnosing issues and finding new issues"* *"Involving business on the incident analysis and asking them questions when we find something that looks wrong"* *"By booking meetings to discuss the incident status and ask for help to replicate"* *"Book regular meetings to provide statuses of the most urgent incidents. This way business will participate in case of any doubt that we may have"*
H13	*"By trying to get involved with the business to help"* *"Having prioritisation meetings with the business"* *"Due to the stakeholder participation, it is possible to have an initial support in order to help the business to understand if there is an issue or not."*

	"Prioritisation meetings are needed where the root cause of the incidents is explained and how is impacting the application, in order to have better prioritisation"
H14	*"Having a report document template that the business should use when reporting incidents"* *"By defining templates to report mandatory information and this way facilitate root cause identification"*
H15	*"Create an incident prioritisation matrix comparing impacts vs affected people"* *"Having templates with the parameters that should be considered when prioritising incidents"*
H16	*"Include steps to reproduce when reporting incidents"* *"Setting the steps to reproduce the incidents"* *"Document all the process since the investigation until having the change in production, so everybody can follow the same process"*
H17	*"Validating the outputs and implementing rollback tasks if needed"*
H18	*"Have a checklist to check if the change is following the right path"* *"Follow the process step-by-step in order to reduce the impacts"* *"Define the correct path that this process should follow or consider having a software that already has this kind of process"* *"Have the process well defined. However, due to the changes of other processes or teams, this process may need to be redefined. It is needed to adapt this process to all other changes around on the company"*
H19	*"By requesting action requests/changes to responsible teams"*
H20	*"By planning in advance future releases in the system"*

Appendix D

Practice	**# of Matches**	**Quotes**
Continuous Planning	6	*"To receive **feedback** from the client as soon as possible in order to enhance incident management / resolution if required"* *"Showing the progress of developments to the business to check if a re-plan is needed."* *"Plan in medium-long time to guarantee a continuous delivery"* *"There were implemented some meetings to re-prioritise the incidents in case of need"* *"Due to the changes of requirements due to the developments"* *"Meetings are made to consider the most critical incidents on the pipeline to be solved"*
Feedback Loops between Dev and Ops	4	*"To **mitigate** errors on deployment activities and enhance recovery activities"* *"To guarantee a better **alignment** between teams"* *"Getting **feedback** from other teams"* *"There are knowledge transfer sessions between the Dev's and the Ops where the dev's share their new developments; so, the ops could share their concerns on how these developments may **impact** the software."*
Continuous Integration	8	*"To facilitate the process of having teams working simultaneous on the same application"* *"It helps the development since the developers will always work on the latest software version"* *"Developing the most recent code version allows us to find the errors easily"* *"To keep the integrity to decrease the amount of errors to ensure the **quality** of the software"* *"Due to the increase of deliveries by all the teams it's needed to have all the code integrated to avoid that the code gets overwritten and guarantees the **alignment** between teams"*

		"To guarantee all the integration of the software between teams, to avoid merge issues" *"Allows the team to work on the latest code version, avoiding merge issues"* *"Allows the integration of the most recent code in lower environments, guaranteeing that the team is working on an environment with the most recent code"*
Automated Monitoring	5	*"To monitor system health"* *"It verifies the system health before, during and after the deployments"* *"Saves time and finds new issues"* *"Saves time and find issues introduced by new software deliveries or middleware issues, ensuring **quality**"* *"Finds issues in preliminary stages causing less **impact** to businesses"*
Deployment Automation	6	*"**Mitigates** human error and the process becomes standard"* *"Saves time for the developers by deploying their changes to test environments"* *"Saves time and makes a standard process that everyone will follow"* *"Helps on the deployment reducing human error"* *"**Mitigates** the human error"* *"Saves time and **mitigates** human error"*
Test Automation	5	*"**Mitigates** the risk of breaking existing functionalities"* *"So, the regression tests can be done in a more severe way"* *"More **quality** on testing"* *"Guarantees a rigid regression test plan verifying that the new developments will not result in new errors on the software"* *"Regression tests are made to guarantee the **quality** of the solution"*
Stakeholder Participation	3	*"Provides continuous **feedback** of the existing processes"* *"Helps on understanding the needs of the business"*

		"Helps to guarantee that everything is delivered as intended" *"Guarantees that the stakeholders are aware of the status of the application, to know what the most critical issues that need to be solved"*
Process Standardisation	3	*"Defining rules to be followed by everyone"* *"Guarantees that everyone will follow the same process"* *"Implementing standard processes will make sure that everyone will follow the same process, reducing errors"*
Change Management	6	*"To guarantee **quality** on the Software Delivery"* *"To be sure that **quality** control process is made to register the software changes"* *"To guarantee that the code change follows all the defined steps of the **quality** control process"* *"This process helps minimise the **impact** of the change"* *"Process that follows all the code change to ensure that will not cause other issues and guarantees that the problem will be solved"* *"All the deployments are address by following the same rules"*

Appendix E

ID	Main Findings	Source	Confirmed by Observation?	Comments
F.1	Shift-left was not considered by the Interviewees	Semi Structured Interviews	Yes	This team usually does not evolve the Ops since the beginning of the software development cycle. Only when it is just really needed.
F.2	Each DevOps practice matches at least in an average of 3 IM phases (50% of the IM phases)	Semi Structured Interviews	No	By observing the interviewees behaviour, it is not possible to see in which phases they apply each practice. Only by looking at documentation.
F.3	All the IM phases have at least a match	Semi Structured Interviews	No	By observing the interviewees behaviour, it is not possible to see in which phase of the IM process the practice is being applied.
F.4	Automated Monitor, Prototyping application and Deployment automation matched fewer phases since they can only be applied to reduced contexts	Semi Structured Interviews	Yes	These practices are applied in reduced scenarios by the AM team.

F.5	CI helps on the incident analysis and resolution	Semi Structured Interviews / Performance Reports	Yes	Sometimes, there were some situations where the team could not replicate the issue reported by the business user. After performing the integration of the most recent code to a lower environment, it was possible to replicate the issue like in production. The environment alignment is also discussed in the report analysis.
F.6	Prototyping Application helps to understand the business needs	Semi Structured Interviews	Yes	It was possible to see that the business was satisfied with seeing some demos before deployment, so they can check the behaviour after the new code.
F.7	Infrastructure as Code may help ensure the readiness of the environments	Semi Structured Interviews	No	Since this team doesn't apply infrastructure as code, it was not possible to observe
F.8	Stakeholder Participation may help on Detection and Recording, Classification and Initial Support, Investigation and Diagnosis	Semi Structured Interviews	Yes	It was possible to see that the AM team often looks for the business when they find issues, expresses the need to prioritise them and needs help with the investigation. However, it is not possible to confirm in which phase the AM team is.
F.9	Change Management is related with Closure IM phase	Semi Structured Interviews	Yes	It was possible to confirm that the Change Management is related with the closure of the incident. An incident that requires code fix needs to be related with a Change,

				and the incident will only be closed once the change is approved by the several quality controls
F.10	Several benefits were uncovered after applying the DevOps Practices: Quality; Engagement; Value; Integrity; Personal Development	Semi Structure Interviews	No	Since the author could not follow the implementation of the practices, it is not possible to analyse if there are benefits after implementation. However, the increase of engagement is also referred to in the analysis
F.11	It was possible find the following challenges when implementing the DevOps practices: Technical Challenges; Culture; Communication; Time Spending	Semi Structured Interviews	No	Since the author could not follow the implementation of the practices, it is not possible to analyse if there are benefits after implementation. Time resources are also discussed in the report, saying that over time, this problem subsides.
F.12	All the practices improved the performance except test automation	Semi Structured Interviews	No	Since the author could not follow the implementation of the practices, it is not possible to analyse if there are benefits after implementation.

F.13	CI and Deployment Automation saves time	Semi Structure Interviews / Performance Reports	Yes	There is possible to see that this team saves a lot of time when performing continuous merges using CI where the human error is reduced. This also applies for Deployment Automation
F.14	With continuous planning it is possible to have a well-defined scope, and in case of making changes to the scope, it could be aligned between business and team management	Semi Structure interviews / Sprint Reports	Yes	In some meetings it was possible to see that the business users wanted to change the scope of the releases a few times, since the plan is made on a continuous way, it was possible to align and change the scope. This is also mentioned that the scope was changed several times during the sprints, on the reports.
F.15	While discussing the performance improvement of the team it was referred to as Time saving; Maximising competences;	Semi Structured Interviews	No	Even that the author does not have a baseline to compare times for time saving, the author recognises that applying some of the practice reduces time due to all the manual work that was performed before. Regarding the maximising of competences, it was possible to see that some of the developers do not have any knowledge of the database/environment maintenance, as they are now able to make analysis on the database/environment issues by themselves.

F.16	Regarding the performance it was also mentioned an increase of quality	Semi Structured Interviews	No	There is no baseline to consider before and after the quality that is delivered by this team.
F.17	More releases	Performance Reports	Yes	It was possible to see this team have several releases per month
F.18	More Performance (overdeliver)	Sprint Reports	Yes	By looking at the scope delivered incident solutions by this team, was possible to check that they are able to deliver a lot of out of sprint incidents.
F.19	Infrastructure problems	Performance Reports	No	Even not having a baseline to compare the before and after, it is possible to analyse that this team doesn’t handle so much infrastructure issues.