

**Transforming the software development environment through DevOps: A Case of a  
Software Development House in the Western Cape, South Africa**

by

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Master of ICT**

**in the Faculty of Informatics & Design  
at the Cape Peninsula University of Technology**

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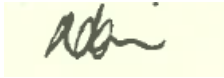
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12<sup>th</sup> November, 2023

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Date

## Abstract

DevOps presents itself as a new concept in ICT that experts are hailing as a viable approach for bridging the gap between operations and development in many software development houses today. Although DevOps is a new movement, little authoritative research has been conducted on the subject. However, in real-world situations, factors influencing firms to adopt and transform to DevOps and the expected outcomes have received little attention. This work presents an empirical study of Transforming the software development environment through DevOps: Case of a Software Development House in the Western Cape, South Africa. Furthermore, it offers the results of the findings of a selected case study on DevOps transformation in a software development house based in South Africa's Western Cape Province.

Research instruments used were a questionnaire and informal follow-up interviews to clarify some issues. It was hosted on Google Forms and was sent to participants in the primary roles responsible for DevOps transformation regarding ways of working; those included were the CEO, scrum master, developer, tester, product owner, and architect. Informal discussion to clarify and understand the concerns as they arose was also held as a follow-up to the questionnaire. The application of DevOps methods in this case study resulted in numerous advantages, including increased collaboration between operations and development teams, improved quality control, reduced waste in the delivery pipeline, a greater number of high-quality deployments and customer satisfaction. In addition, the researcher found out that this case study used Agile DevOps Transformational Model. Upon close interrogation of this model, the researcher discovered that it aligns well with the Kurt-Lewin model, which was used as a model in this study, especially phases of unfreezing, change and freeze.

The study delivered interesting results justifying the use of transformational models in the software development industry to move to DevOps maturity status. The Kurt-Lewin transformational model was the underlying model used by the company in the case study. The transformational model used Agile DevOps Transformational Model in the case study was consistent with the Kurt-Lewin model. Practical lessons from empirical data and findings unveiled in the agile transformational model will help current agile practitioners adopt DevOps and add value to the DevOps community and body of knowledge.

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## Acronyms and Abbreviations

CEO	Chief Executive Officer
CPUT	Cape Peninsula University of Technology
DevOps	Development and Operations
ICT	Information Communication Technology
MTTR	Mean Time to Recovery
SDH	Software Development House
VSM	Value Stream Mapping

# CHAPTER 1

## INTRODUCTION

### 1.1 Preamble

With ever-increasing competitiveness in the software market, businesses are paying close attention to smart ways of working and resource optimisation when developing and delivering software products for enterprises.

### 1.2 Introduction

This study revolves around the transformative impact of DevOps in a software development environment, with a specific focus on a Software Development House situated in the Western Cape, South Africa. DevOps, an amalgamation of development and operations practices, represents a paradigm shift in software development, aiming to enhance collaboration, automate processes, and expedite the delivery of high-quality software. The research delves into the specific case of the Software Development House in the Western Cape, investigating how the implementation of DevOps principles and practices influences the overall software development lifecycle. The study aims to analyse the challenges faced, benefits accrued, and the broader implications for the organization, shedding light on the intricate dynamics of adopting DevOps methodologies in a real-world software development context within the South African landscape.

### 1.3 Background to the Research Problem

The motivation for this study stems from the growing recognition of DevOps as a pivotal force in reshaping traditional software development practices. As organizations worldwide increasingly adopt DevOps methodologies to streamline their development and operations processes, there is a need for localized and context-specific investigations into its impact. The choice of a Software Development House in the Western Cape, South Africa, as the case study setting is motivated by the desire to understand how DevOps is implemented and adapted within a specific regional context. The literature reveals a global trend where companies are adopting DevOps to achieve faster delivery cycles, increased collaboration between development and operations teams, and improved overall software quality. However, there is a paucity of research that delves into the unique challenges and

opportunities presented by DevOps in the South African software development landscape. By exploring the experiences and outcomes of a Software Development House in the Western Cape, this study aims to contribute valuable insights that can inform both local and global discussions on the transformative potential of DevOps in software development environments. The goal of this research project was to identify factors that influence DevOps transformation in Software Development Houses. The term DevOps was derived by combining two words development and operations. DevOps is an Information Technology management paradigm or philosophy that attempts to speed up and improve software systems and service delivery to users (Ghantous & Gill, 2019). Software developers have embedded and adopted several ways of working, such as Agile, to enable quick sprints of incremental development of software. On the other hand, Operations departments have remained behind in their capability to deploy the outputs of the sprints quickly.

The author will start by defining DevOps. What is DevOps? "DevOps is the professional and cultural movement that stresses communication, collaboration, integration, and automation to improve the flow of work between software developers and IT operations professionals." The definition was given by (Kim et al., 2016).

DevOps tries to continuously improve the way of working by eliminating the existing silos between IT teams and introducing a product-specific strategy that focuses on automation and tooling to improve the manual tasks of deploying and testing software (Syed, 2018). DevOps requires organisational cultural transformational initiatives and benefits from using tools to implement its many techniques and approaches (Díaz et al., 2021). DevOps tries to reduce the time to software delivery or Go-live, enabling IT teams to deliver their software incrementally and rapidly deploy software into production, enabling organisations to achieve value for money (Guseila, Bratu and Moraru, 2019).

DevOps's primary aim is to enable a software development lifecycle using agile by employing continuous development techniques, including delivery, continuous deployment, and continuous microservices (Khan, 2020). The terms DevOps transformation and embedding are gaining tremendous appetite in the industry since DevOps focuses on continuous delivery of business value. Gruver and Mouser (2015) report that most organisations are struggling to survive because organisations are failing to respond

timeously to changes in the marketplace fast enough to realise business value, leading to business organisations getting frustrated.

Despite its rising adoption rate, there is a dearth of empirical data on the implementation of DevOps (Senapathi, Buchan & Osman, 2018). The current theory, except for a few case studies, offers minimal insights into the practical implementation and best practices of DevOps and their related usefulness in continuous software development (Senapathi, Buchan & Osman, 2018). According to various surveys (Research and Assessment 2018; Webteam 2018), DevOps has grown in importance in major software-intensive businesses whose success depends on the effectiveness of their development and operations, according to Díaz et al., (2021). However, since this movement is still in its infancy, more empirical data regarding the motivations behind organisations' adoption of DevOps and the advantages they expect to reap from doing so is required, in addition to looking at the examples of large, well-established businesses (Díaz et al., 2021).

#### **1.4 Research Problem**

The research problem is structured as follows:

##### **What is the problem?**

The problem driving this study is the need for a clearer understanding of specific factors that influence the transformational migration to DevOps by SDH and how to transform from traditional ways of working to new ways of working as embedded in DevOps. The drivers for change are the major compelling reasons why companies and software houses are embracing DevOps transformational agendas to quickly realize business value (Guseila, Bratu & Moraru, 2019).

##### **Why is it a problem?**

The rapid changes in technology and society, brings about increasing competitive pressure on organizations to deliver business value quickly. The real problem can be summarized as the lack of oversight to timely respond to technological advancement and changes. Companies and organization not adapting to technological changes risk being left behind and can quickly become insolvent. Empirical examples are that of Kodak and Nokia, who

failed to move with the advancement in digital technologic and ended up folding (Zimmer, 2021) . This is compounded by the emergence of cloud technology which has had an enormous impact on IT and contributes to increasing demand from business partners, stakeholders and customers for speed, flexibility, and innovation. In order to realize benefits from DevOps a transformation agenda is needed (Sharma, 2017).

### **What are the consequences of the problem?**

Transformation to DevOps and embedding DevOps in organizations brings about value creation and addition which enables competitiveness and sustainability of organization in the business (Ravichandran, Taylor & Waterhouse, 2016). The consequences of not adopting and embedding DevOps leads to lack of value creation and innovation initiatives. The other consequence is that it extremely becomes difficulty for organizations to deliver their strategic plans without embracing new ways of working and best practices (AlQershi, 2021).

DevOps creates value to Companies and organizations and therefore those entities not adopting and embedding technological best practices like DevOps risk being out of date on a technological and methodological level which may lead to reduction in their business competitiveness and consequently lose market share. This situation may consequently lead the company to becoming insolvent. The consequences of not embracing best practices have a negative impact and moreover companies using old technologies are victims of losing their customer bases, and this usually leads to bankruptcy. Companies like Kodak and Nokia are living examples of what can happen when technological oversight is ignored and not embraced.

## **1.5 Research Aim, Questions and Objectives**

The aim of this research is to comprehensively examine the impact of DevOps on the software development environment within a specific regional context, namely a Software Development House in the Western Cape, South Africa.

From the above research problem and aim, the following research questions (RQs) have been developed:

RQ1: What are the enablers and drivers of DevOps?

RQ2: What are the value stream mapping elements of pre-DevOps transitions?

RQ3: How does DevOps transformation impact on SDH ways of working and productivity?

RQ4: What change management models are currently being used in DevOps transformation?

RQ5: How can DevOps transform the software development processes to assist in making SDH agile entities?

**The research objectives (ROs) which align with the RQs are as follows:**

RO1: To identify the enablers and drivers of DevOps transition for SDH

RO2: To critically assess the need for value stream mapping in pre-DevOps transition in SDH

RO3: To determine the impact for adopting and embedding DevOps

RO4: To benchmark DevOps transformation model with known change management models

RO5: To develop a set of recommendations towards using DevOps in software development processes to transform SDHs into agile entities.

## **1.6 Thesis Outline**

The remaining content of this thesis is organised as follows:

**Chapter One:** Introduction and thesis layout. This chapter also explains the need for DevOps research to improve software development quality and effectiveness. It also highlights the research questions addressed in the study.

**Chapter Two:** DevOps is defined in chapter two, which includes a summary of previous work and an outline of the current research need for DevOps.

**Chapter Three:** The Research Method undertaken in this study is described in this chapter along with the literature review.

**Chapter Four:** In this chapter, the case study is described. The study's qualitative and quantitative outcomes based on the questionnaire are also analysed. Respondent Analysis is provided per the questionnaire for both open-ended and closed-ended questions grouped according to the research questions.

**Chapter Five:** A discussion of findings is reported in chapter five and a comparison to known change management models.

**Chapter Six:** Finally, chapter six discusses the contribution, future works, recommendations, and conclusion.

## 1.7 Chapter Summary

Chapter One of this thesis has been presented as an Introduction chapter. Its primary purpose is to introduce the research problem, research questions, and the significance of the study.

In this chapter, the author begins by providing an overview of the research topic and explaining its importance by describing the current state of knowledge on DevOps and identifying problems in the existing research.

The author then presents the research problem and questions that the study seeks to address.

Finally, the author concludes the chapter by summarizing the main points and outlining the structure of the rest of the thesis. This involved providing a brief overview of each chapter and explaining how they contribute to the overall research project.



## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

The literature review section aims to present empirical studies from available recent literature that would guide this study by addressing the research questions. The researcher discusses transformational change management models, including Lewin's model, which will be used as a benchmark in the proposed study.

Literature offers many different definitions and characteristics for the term DevOps. Although nearly all sources agree that DevOps presents itself as a synthesis of Development and Operation, it is not enough to explain what DevOps exactly is (Banica et al., 2017).

Patrick Debois and Andrew Shafer coined the phrase "DevOps" in 2008 (Davis & Daniels, 2016). They were concerned about Agile's flaws and sought to come up with a better solution. The concept gradually gained traction, and following the DevOps Days conference in Belgium in 2009, it had become quite a catchphrase (McCarthy et al., 2015). DevOps is a development methodology that uses a collection of development processes to close the gap between development and operations. It emphasises communication and collaboration, continuous integration, quality assurance, and delivery with automated deployment. DevOps is defined in more detail by other sources as the people, processes, and technology needed to link development and execution.

#### **2.2 An Overview of DevOps**

DevOps normally requires a cultural shift or change in an organisation. DevOps aims to shorten the time between development and deployment by allowing IT teams to rapidly evolve products in short bursts and put them into production. It also eliminates waste in the delivery and deployment pipeline. DevOps is a set of concepts that encourages close collaboration and information exchange between development and operations teams (Senapathi, Buchan & Osman, 2018). Throughout the whole software development, deployment, and operations life cycle, the strategy mainly depends on maximal automation (Syed, 2018).

DevOps aims to improve development and operations alignment, efficiency, quality, and productivity (Luz, Pinto & Bonifácio, 2019a). DevOps's guiding concepts are culture, measurement, collaboration, and automation (Perera, Silva & Perera, 2017). Continuous Integration, Continuous Testing, Continuous Delivery, Continuous Deployment, and Continuous Monitoring are the primary components of DevOps (Shahin, Ali Babar & Zhu, 2017). In the realm of DevOps, these components have allowed us to adopt the phrase Continuous Everything. Continuous Integration refers to automated planning, design, development, unit testing, and code integration. For example, the test cases are automated and run as soon as the code is merged and delivered to the quality assurance environment under the Continuous Testing paradigm (Gupta, Kapur & Kumar, 2017).

DevOps has developed as a critical addition to Agile development to facilitate frequent and continuous product delivery (Buchalceková & Doležel, 2019). However, the most crucial human skill, such as people, expertise and experience, is required for Agile-DevOps transformation to DevOps at a broad scale for business agility (Ghantous & Gill, 2019). As a result, academic education and professional training are critical for effective Agile-DevOps transformation to DevOps (Ghantous & Gill, 2019).

DevOps enable an agile software development lifecycle by utilising continuous development techniques, including continuous delivery, deployment, and microservices (Khan, 2020). Other developments in this context include a rise in the use of mobile platforms and technologies on which this software runs, as well as a rise in the server-side (such as Software-as-a-Service) or direct-to-consumer distribution of software over the internet (Senapathi, Buchan & Osman, 2018). Furthermore, these software development strategies encourage quick and short software delivery cycles in the fast-paced, constantly-changing Internet environment (Dileepkumar & Mathew, 2021). DevOps has therefore been well embraced in the software engineering community and has garnered much attention in practitioner literature, as seen by the annual "state of DevOps" reports (Senapathi, Buchan & Osman, 2018).

The above definitions show that DevOps has a variety of opinions that appear to be polarised. However, the varied opinions arrive at the same destination: connecting Development and Operations (Fitzgerald & Stol, 2017). This also entails a move to a variety of sectors in information technology. For example, SecDevOps and DevSecOps are terms

used interchangeably to describe security in DevOps. Thus, security teams work with development and operational teams to show the entire process from conception to production in both cases (Mohan & Othmane, 2016). Another example is the DevOps perspective from Project Management, which involves the project management team as part of the DevOps process.

Recent studies show that despite its growing popularity, there is a lack of empirical data on the actual application of DevOps (Senapathi, Buchan & Osman, 2018). Moreover, except for a few case studies, there is not much information in the current literature about how DevOps supports continuous software development (Senapathi, Buchan & Osman, 2018). Nevertheless, most forward-looking companies are adopting and embedding Cloud technologies. The drivers, as reported by (Guseila, Bratu & Moraru, 2019) and (Ionescu & Andronie, 2021), are:

- Global supply: the increased pressure of international market competition on rates, skills, and knowledge of local IT delivery options.
- Workforce automation: The industry trend to fully automate repetitive work.
- Digitally disruptive competition: The influence of the first three drivers on the speed at which an existing organisation can go to market and realise business value. Hence there is an opportunity to fully understand the critical factors and drivers of change impacting IT and business value delivery. Díaz et al. (2021) also report that according to several surveys (Research and Assessment, 2018; Webteam, 2018), DevOps has become more critical in large software-intensive companies whose success is based on the efficiency of their development and operations. However, because this movement is new, more empirical information regarding the factors that push organisations to adopt DevOps and the benefits they hope to achieve when embracing DevOps culture is needed (Díaz et al., 2021).The researcher looked at the previous studies to see what the issues were. Below are the findings from the literature.

## 2.3 Similar Studies

DevOps has not been extensively examined previously, as evidenced by the lack of a unified definition of DevOps in the literature. Erich, Amrit and Daneva (2017) undertake an in-depth literature assessment that reveals the lack of work in the field of DevOps. The researchers launched a systematic investigation into DevOps, analysing 26 of 139 papers on the topic and found that DevOps has not yet been extensively explored. They claimed that the prior DevOps study had been of poor quality and that the industry lacked a complete process or approach. The paper claims that DevOps is like agile software development and that businesses should implement DevOps concepts for better quality and quicker turnaround. Various authors have already described the core ideas, objectives, guidelines, elements, and benefits of DevOps.

Other writers have compared DevOps and other approaches such as Agile and waterfall. In the study, the researcher considered Agile, lean and waterfall as best practices and necessary components of DevOps. Smeds, Nybom and Porres (2015) interrogated 13 people in a software firm using DevOps to investigate the fundamental attributes of DevOps and what seems to be the challenges to DevOps transformation . This study was done in Turku, Finland. As a result, the researchers could provide insights into common impediments encountered in the transformation process of DevOps transformation . Their findings also concluded that DevOps transformation requires overcoming cultural and organisational-specific impediments.

Furthermore, according to software practitioners, the researcher defined DevOps and detailed DevOps methodologies. Arising from those mentioned above, the researcher carefully included questions on DevOps leadership traits, styles, and types necessary for successful DevOps transformation in this study. In this study, the researcher sought to understand the leadership style essential to champion DevOps in an organisation as a change agent for successful DevOps transformation.

DevOps was used to get good results in organisations which focussed on quality and execution techniques during DevOps implementation, according to Patwardhan et al., (2016). The study was conducted internally within a software company in Sweden. Continuous Integration, Continuous Testing, Continuous Deployment, and Continuous

Monitoring are crucial DevOps elements and have received much attention in the past. In this study, the researcher was cognisant of the above components of DevOps and went further to include questions in the questionnaire on software performance metrics, e.g., Low Deployment frequency, Lead time for changes, MTTR and Change failure rate.

Lwakatare et al., (2016) used three interactions from one case study and multi-vocal literature. The study was conducted in Finland. Their empirical findings provided a further dimension of insights about DevOps, concluding that it is not just a phenomenon of change of mindset but includes patterns identified explicitly by practitioners. They discussed trends in the five areas of DevOps: culture, automation, monitoring, and measurement. Additionally, they noted that DevOps transformation is more prevalent among businesses that offer internet services. This is true because most software development houses use test, development, and production environment instances from the cloud; hence it was also the researcher's considered view that the respondents in this case study had 24/7 access to the internet.

In a qualitative multiple-case study, Riungu-Kalliosaari et al., (2016) spoke with representatives from three Finnish software development companies to learn how industry professionals assess the advantages of DevOps approaches in their organisations and how they perceive DevOps transformation challenges. Their findings validated several benefits attributed to the transformation of DevOps, and at the same time, they also highlighted some challenges faced when adopting DevOps.

Erich, Amrit and Daneva (2017) conducted an exploratory study on six businesses to describe what DevOps is and to look at the impact of using DevOps, how DevOps is applied, and what supportive factors are available. The study was conducted in various countries. Four of these organisations are based in The Netherlands, one organisation is based in the United States, and one is based in the United Kingdom. These studies helped provide the researcher with lessons learnt so that the researcher did not duplicate research already undertaken.

The researcher still needed to gather new data to ensure that the research findings were up to date. In order to identify the problems, bottlenecks, and obstacles a large firm face when

implementing DevOps, Kuusinen et al., (2018) conducted a case study at a significant Danish software corporation.

Senapathi, Buchan, and Osman (2018) used an exploratory case study to examine the main justifications for adopting DevOps, engineering competencies, and technology enablers, as well as the advantages and challenges associated with doing so in a New Zealand product development company.

This study examines why companies embrace a DevOps culture for the first time, but only in one large finance/insurance company. The definition and understanding of the necessity for creating an automated delivery pipeline and cross-functional organisational structures, which were essential to delivering the promised value of DevOps, were among their research results. Luz, Pinto and Bonifácio (2019a) conducted 15 scenarios of effective DevOps transformation in organisations using grounded theory to develop a model. The study was conducted at a Brazilian government institution. The major thrust of their research work was to prove that collaboration is essential in order to transform to DevOps successfully.

Leite et al., (2019) released a comprehensive study of DevOps ideas and problems. This study was conducted in Brazil. They assessed practical consequences for engineers, managers, and researchers using an approach influenced by systematic literature review and grounded theory. The DevOps transformation model used in the case study was consistent with the current best practices in the industry. Their findings highlighted the two most important pillars of DevOps: automation and the human side of team collaboration.

Díaz et al., (2021) did an empirical study in Madrid, Spain, which sought to improve evidence and assist practitioners in better understanding of issues causing DevOps shift. They utilised empirical evidence to determine and report that the significant challenge motivating software firms to embrace DevOps is that software delivery takes too long, necessitating the development of innovative software delivery methods. Their studies have also shown that implementing a DevOps culture and cooperation in software development reduces software development time, resulting in a faster production release time, contributing to higher software quality and, finally, enhancing customer satisfaction.

After reviewing the above empirical research findings by several researchers in DevOps, the researcher decided to study further the factors influencing DevOps transformation with a

specific focus on SDH in South Africa's Western Cape Province. The approach to address some open questions raised by the previous research was to supply additional empirical information on research subjects like value stream mapping and change management models. These are currently being used in DevOps transformation and are key DevOps performance factors influencing the transformation of DevOps while also surfacing as the main roadblocks to DevOps transformation.

## **2.4 DevOps Transformation**

DevOps implementation in an organisation is influenced by several factors (Leite et al., 2019). After reviewing several studies conducted by previous academics, the researcher discovered the following factors from the literature that impact DevOps deployment. These include Infrastructure as a Code, Continuous Feedback, Daily Check-ins, Iterative Development, Code Maintainability, System Monitoring, Test Early and Often, Automated Code Review, Automated Testing, Automated Deployment, Automated Tools to Monitor, Infrastructure as a Code, Involvement of Operations in Development (OpsinDev), Test Early and Often, and Involvement of Development in Operations (DevinOps) (Leite et al., 2019).

## **2.5 Enablers and Drivers of DevOps**

DevOps enablers may take many forms and cover a wide range of topics (Leite et al., 2019). John Willis and Damon Edward, DevOps practitioners, offer the CAMS paradigm to organise DevOps enablers (Caprarelli, Di Nitto & Tamburri, 2019). CAMS stand for Culture, Automation, Measurement and sharing. They are referred to as DevOps' four essential dimensions (Perera, Silva & Perera, 2017). DevOps enablers are a group of engineering process skills supported by cultural and technological enablers (Senapathi, Buchan & Osman, 2018).

Enablers provide for a flexible, adaptive, and efficient working environment, whereas capabilities outline the operations that an organisation should be able to perform (Luz, Pinto & Bonifácio, 2019b). DevOps competency enablers, cultural enablers, and technology enablers are the three main components of this concept. The competence enablers are supported by cultural and technical enablers (Senapathi, Buchan & Osman, 2018). Table 2.2 below highlights the enablers of DevOps.

Table 2.1 DevOps Enablers

Capabilities Enablers	Technological Enablers
Continuous development and being Collaborative	Build automation
Integrating and testing continuously	Test automation
Continuous deployment and release	Deployment automation
Infrastructure optimisation and continuous monitoring	Monitoring automation
feedback and constant user behaviour monitoring	Recovery automation
Without delay, recover from service failure	Infrastructure automation
Constant Monitoring	Configuration management for infrastructure and code
	Automation meant for metrics

Source: Smeds, Nybom & Porres, 2015

DevOps has competence enablers (i.e., planning, development, testing, and deployment) that encompass the fundamental activities of software development that are continuously



carried out in response to input from other activities. New features, for example, may be released as soon as they have been fully integrated and tested using the continuous deployment feature (Chen, 2017). However, this necessitates using technical solutions like test automation and good communication between development and deployment teams. In addition, infrastructure monitoring and user behaviour monitoring are capabilities that give information on the functioning of the service's infrastructure and how and when users interact with it (Chen, 2017).

By automating tasks, technology enablers boost DevOps capabilities (Senapathi, Buchan & Osman, 2018). Automation makes continuous delivery and deployment easier by giving all changes to a system a single path to production, whether it is code, infrastructure, or configuration management settings, where customised programs or scripts configure and monitor the service architecture (Khan, 2020).

The cultural enablers are the behaviours that DevOps teams must exhibit to develop DevOps capabilities positively. They stress the need for broad cooperation, low-effort communication, shared goals, continuous experimentation and learning, and collective accountability (Smeds, Nybom & Porres, 2015).

This may be costly and time-consuming if the product organisation is converted to a DevOps one. Nonetheless, many quickly developing companies justify their investment in DevOps by stating that the expected advantages of the transformation outweigh the cost of work and change required to get started (Díaz et al., 2021).

Figure 2.1 visually depicts the projected advantages, or drivers, that encourage DevOps transformation . There are three types of drivers: strategic, tactical, and operational (Senapathi, Buchan & Osman, 2018).

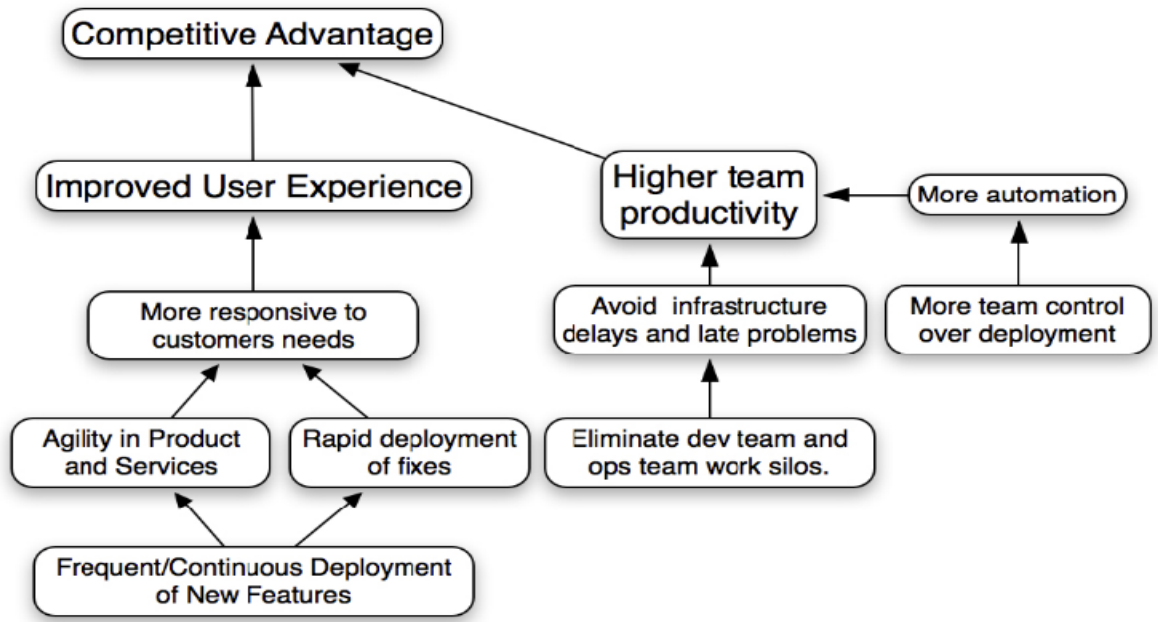


FIGURE 2.1: PROJECTED ADVANTAGES OR DRIVERS THAT ENCOURAGE DEVOPS

Source: Senapathi, Buchan & Osman, 2018

To understand the DevOps enablers and Drivers, the researcher used the research instruments to collect empirical data from experienced practising software development engineers from selected software development houses. The research instrument used in this study was the questionnaire based on open and closed-ended questions.

## 2.6 Constraints to DevOps Transformation.

TABLE 2.2: CONSTRAINTS TO DEVOPS TRANSFORMATION

DevOps Constraint	Description
No clear definition and goals for adopting DevOps	Ambiguity can cause confusion and make it difficult to take the steps necessary to achieve the goals.
Organisational Structure.	The structure of an organisation may have an impact on communication, decision making and common goals.
Geographical distribution.	Communication cannot be done in person, and owing to different time zones, reaching someone may be challenging.
Some customers may not be interested in DevOps.	Customers may demand specific processes and procedures, such as lengthy testing periods or stringent deployment procedures.
The environments used for development and testing are not the same as those used in production.	There is a chance that software will not be fully validated before going into production. Collaboration and shared working practices may also be affected.

There are several different production environments.	Continuous delivery may be hampered by a potential obstruction. It becomes difficult to automate and have uniform tools and processes.
Tiredness is a popular buzzword.	In practice, what will be done may not differ from what has already been done. Therefore, resisting change mindset.
Developers may have to do additional work as a result of DevOps.	Overburdening developers with additional tasks can lead to reluctance to participate in new collaborations and similar endeavours.
DevOps necessitates both development and operations expertise.	Not able to effectively manage both development and operations. The belief that it is best to concentrate on one subject might lead to a lack of openness to communicating and collaborating.

Source: Smeds, Nybom & Porres, 2015

The successful transformation to a DevOps culture and practices can be challenging and may encounter various constraints and obstacles. Table 2.2 illustrates a summary of some common constraints to DevOps transformation.

## 2.7 The Practice of Value Stream Mapping

Value Stream Mapping (VSM), according to Keyte and Locher (2017), intends to empower users to discover administrative and service waste. They will also be able to determine where the waste is coming from, including its sources, and envisage a future state (Vision) that eliminates waste. Therefore, it presents an opportunity for organisations to focus and deviate scarce to value creation activities. VSM activities are necessary and pre-requisite best practice components of DevOps transformation and can be conducted before the

transformation transition to DevOps. The following diagram depicts typical VSM processes and activities.

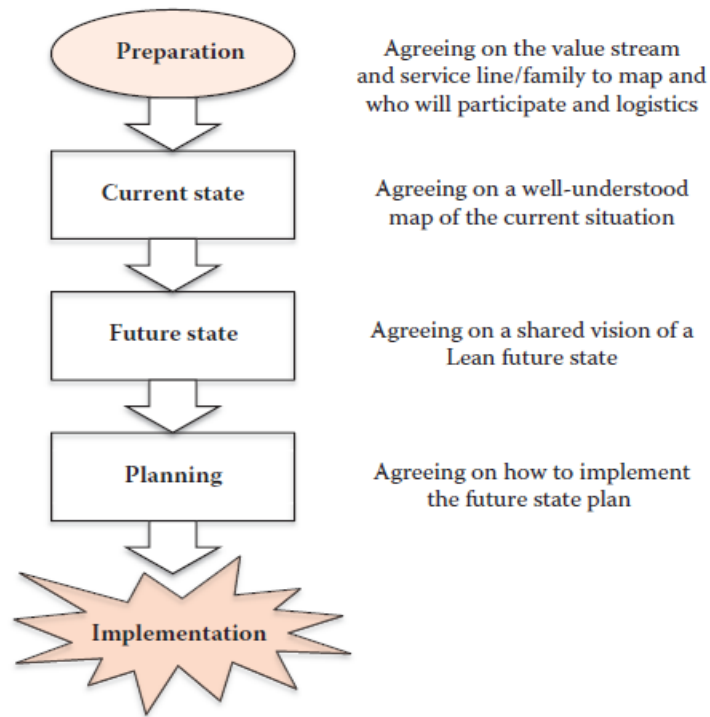


FIGURE 2.2: VALUE STREAM MAPPING PROCESS

Source: Keyte & Locher, 2017

The above diagram shows that VSM is process-based and can be implemented by conducting an in-house workshop. Ali, Petersen and De França (2015) reported that VSM is a technique employed using Lean development methods and has improved critical performances in various organisations and industries. VSM describes itself as best practice standards and admits it straddles the line between strong standards and Lean concepts (Ali, Petersen & De França, 2015).

It builds many principles of Lean development straightforwardly, such as optimising the entire, eliminating waste, and adding to others' satisfaction, such as continuous improvement, low, and pull-based development. In addition, VSM implements the principle

of "optimising the whole". This is achieved by facilitating many processes which implement a system-wide view. In this study, the researcher applied a VSM technique to ascertain the need for DevOps transformation and the overall change management processes.

To clearly understand the practice of value stream mapping, the researcher used the research instruments to collect empirical data from experienced practising software development engineers and operations teams from selected SDH. The research instruments used in this study were questionnaires.

## **2.8 Transitioning to DevOps**

Organisations needing to adopt and embed DevOps must understand that the transformation roadmap to DevOps is a journey and takes time to transition. Gruver and Mouser (2015) report that transitioning to DevOps is a considerable effort, especially for large organisations. Both process and technical changes are required. Therefore, transformation to DevOps itself must be envisioned as a project undertaking.

Before companies transform, they first need to understand where they are and where they want to be. Moreover, companies need to use a change management model to achieve the desired state.

## **2.9 Transformation Models.**

Several models are used in industry for change management. However, the three common ones are the Kurt Lewin model, McKinney's seven (7S) model and the Burke-Litwin model. The Kurt Lewin model has been widely employed, mainly in management, due to its simplicity in facilitating change. Change is not a linear event but an ongoing realignment in expectancy of or in reaction to changing environments. Therefore, unfreezing, changing and refreezing are generally accepted in the field of management for implementing transformation (Hussain et al., 2018a).

Transformational change to a new state does not usually occur rapidly but instead incrementally, with the existing state of the organisation gradually being transformed into the desired state.

The three steps 1. Unfreeze, 2. Change, and 3. Freeze—were first suggested by Lewin (Lewin, 1947).

## 2.10 McKinney's Seven (7S) Model

In this section, McKinney's Seven (7S) change management model is presented even though it is not used for benchmarking in this case study. McKinsey's 7S model consists of seven independent variables categorised into two groups; hard elements, which consist of business, strategy, systems, and structures and soft elements, consisting of shared values, corporate culture, management styles, human resources and capabilities (Mamun et al., 2020). McKinsey's 7S model is employed chiefly to make an organisation's performance more efficient. The likely effects of future changes within a company are examined to align relevant activities and departments during acquisition or merger processes. The organisation needs to determine how best to implement a proposed change strategy. The seven components include systems, structure, strategy and soft factors: skills, style, staff and shared values (Kocaoglu & Demir, 2019).

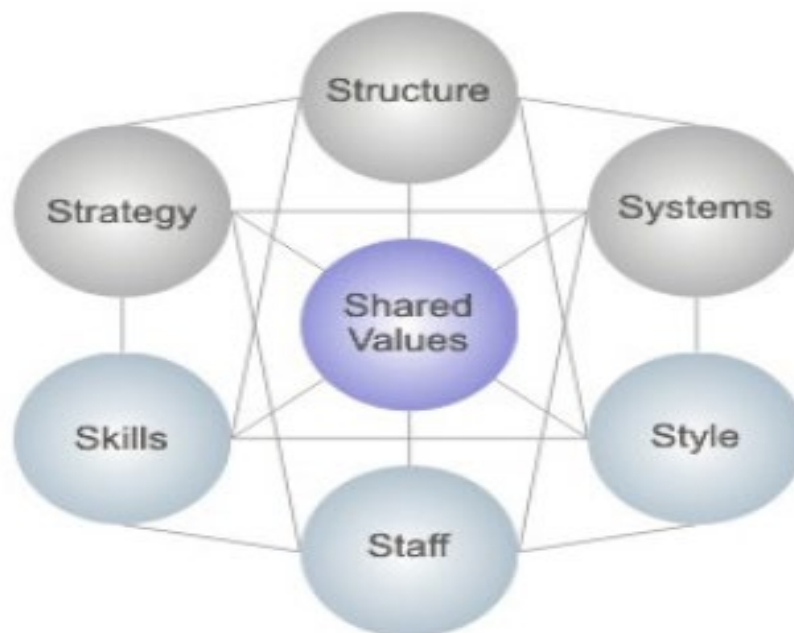


FIGURE 2.3: MCKINSEY'S 7S MODEL

Source: Kocaoglu & Demir, 2019

This model is mainly employed as a company's analytical technique for monitoring and assessing changes in the company's internal situation (Kocaoglu & Demir, 2019). This model presupposes that the seven items must be aligned and consolidated for a company to improve. This model is employed in assisting the process of identification of what requirements are needed to make the company more efficient.

## 2.11 Burke-Litwin Model

In this section, the Burke-Litwin change management model is discussed, although it is not used as the benchmark model in this study. Instead, the Burke-Litwin model is employed to understand the current situation and the complexity of the impact of proposed changes. The steps employed are: (a) Identify where change is coming from, (b) Assess the current situation using a model which outlines the relationships between elements in the company, and (c) Incorporate all affected elements in the change plan.

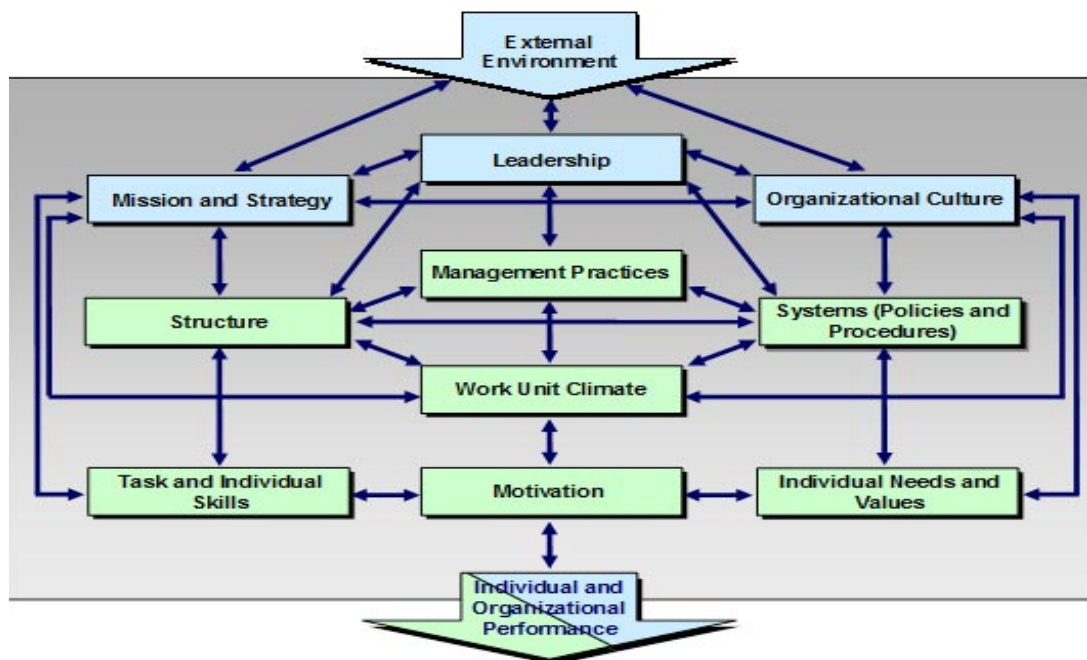


FIGURE 2.4: BURKE-LITWIN MODEL

Source: Burke, 2002



The Burke-Litwin Model spell out twelve factors that aid in diagnosing the situation for change. It outlines overall change activity that involves the following:

- vision and approach,
- leadership,
- external environment,
- structure,
- systems,
- work unit climate,
- organisational management best practices,
- culture work items and skillset,
- individual values and individual requirements aligned to overall organisational performance (CA, 2018).

## 2.12 The Change Management Model by Kurt Lewin

In this section, the Kurt Lewin change management model is described. The Kurt Lewin change management model is used in this study as a benchmark for the case study findings due to its popularity and simplicity.

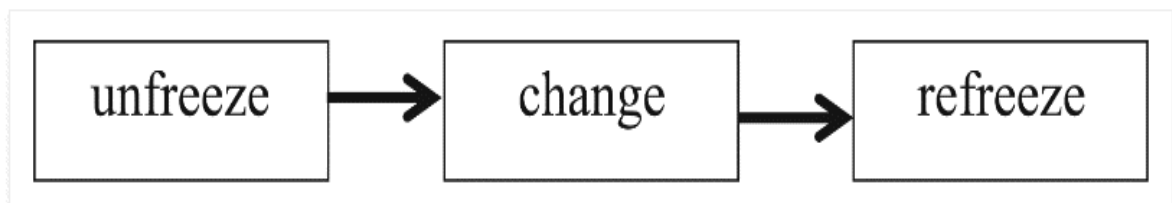


FIGURE 2.5: KURT LEWIN MODEL

Source: Cummings, Bridgman & Brown, 2016

### **Unfreeze Phase.**

The first process in change management is the Unfreezing stage (Cummings, Bridgman & Brown, 2016). This activity involves reviewing the status quo by the Board of Directors to

check what aspects need to be changed. In addition, it consists in working on the readiness and making people aware of the need for change (Bhayangkara et al., 2020).

### **Change Phase.**

Organisations need to develop support, secure buy-in from senior management and manage the transition phase. Delivering the change phase and the refreezing state of the change phase requires a process-based approach. During the change phase, people are 'unfrozen' people can start to move. Now that the people are 'unfrozen', they can begin to move. This is when change becomes a known reality to most people in the organisation and is accompanied by uncertainty and fear, making it the most challenging phase to undertake (Hussain et al., 2018a).

### **The Refreeze Step**

The refreeze step aims to make the enacted changes sustainable. The objective is for stakeholders to accept this new condition as the new status quo rather than resisting forces that seek to bring about change. Burnes (2020) states that Freezing attempts to maintain behaviour at a new quasi-stationary equilibrium generally resistant to regression. From an organisational perspective, freezing needs changes to cultural norms, policies and practices (Cummings, Bridgman & Brown, 2016). Burnes (2020) perceived refreezing as an action arising from the essence of the change process itself.

There is a need for DevOps transformational leadership during the unfreeze, change, and refreeze stages of transformation. This is what this research study will seek to determine during this research work. What transformational leadership and other factors are necessary to undertake a successful DevOps transformation? It will also be essential to assess the post-DevOps implementation impact on the software development house.

Given the above, the researcher utilised the Lewin change management model—unfreeze, change, and refreeze - as a guiding theoretical model for investigating DevOps implementation.

Cross-functional, self-organising development teams are organised by product functional modules. Typical roles in development teams include software developers, quality

assurance software testers, an architect, product owner and a Scrum master, who receive help from the entire product team.

### 2.13 The DevOps Full Stack Maturity

The concept of "DevOps Full Stack Maturity" refers to the idea that in a DevOps culture, it's not only the development and operations teams that should be involved in the transformation, but the entire organization should strive for maturity in various aspects. This concept emphasizes that DevOps is not just about tools and practices (Forsgren et al., 2014). It's also about fostering a culture of collaboration and continuous improvement across the entire organization.

#### **Purpose and Rationale**

**Comprehensive Transformation:** The purpose of the DevOps Full Stack Maturity concept is to ensure that the entire organization, from leadership and management to development, operations, and support teams, is aligned in their understanding and transformation of DevOps principles (Shahin, Babar, 2020). This ensures that DevOps isn't just a set of technical practices but becomes an organizational philosophy.

**Eliminating Silos:** The rationale behind this concept is to break down silos within an organization. Silos can create communication barriers and hinder the flow of information and collaboration. DevOps aims to eliminate these silos by promoting cross-functional teams and shared responsibilities according to (Salih et al., 2023).

**Continuous Improvement:** DevOps Full Stack Maturity promotes a culture of continuous improvement at all levels. It encourages everyone to seek better ways of working, whether it's related to development, operations, quality assurance, security, or any other aspect of the organization (Forsgren et al., 2014).

**Adaptability and Agility:** DevOps emphasizes the ability to adapt to change and respond to customer needs quickly (Salih et al., 2023). This concept ensures that not only the technical teams but also management and leadership are aligned with the need for adaptability and agility in today's fast-paced, technology-driven business environment.

**Improved Collaboration:** Collaboration is a core tenet of DevOps. The concept of Full Stack Maturity reinforces the importance of effective collaboration not only within development and operations but also between various business units and departments. (Forsgren et al., 2014).

**Shared Responsibility:** Full Stack Maturity encourages everyone in the organization to take responsibility for the end-to-end delivery of products and services. It's not just the responsibility of the development or operations team; it's a shared responsibility across the organization.

**Enhanced Customer Focus:** DevOps is driven by a focus on meeting customer needs. The DevOps Full Stack Maturity concept ensures that everyone in the organization understands the importance of customer satisfaction and aligns their efforts with this goal (Salih et al., 2023).

In summary, the purpose and rationale behind using DevOps Full Stack Maturity concept in this research study was to create a holistic, organization-wide approach to DevOps that emphasizes culture, collaboration, and continuous improvement. It's about breaking down barriers, fostering shared responsibility, and ensuring that the entire organization is aligned with the principles and goals of DevOps.

The DevOps full stack maturity consists of three layers mainly organization culture, practices, and automation.

### **Organizational culture**

Organizational culture layer refers to the set of shared assumptions and values that are acquired within an organization according to (Jan-Willem Middelburg, 2017). It is shaped by the observable patterns of behaviour that exist within the organization and is learned over time by its employees. Organizational cultures are not fixed, but rather are the result of both external adaptation and internal integration, which means they evolve over time in response to changes. Furthermore, organizational culture is not developed in isolation, but rather is influenced by the wider cultural context of the society in which the organization is situated. It is also important to note that organizational culture is not necessarily homogeneous, as

subcultures can exist within an organization, such as in the case of IT departments, with their own unique mentalities, values, and attitudes, (Jan-Willem Middelburg, 2017).

## **Practices**

A significant number of DevOps practices align well with the broader realm of IT Service Management and have been derived from several other ITSM frameworks and methodologies.

DevOps implementation can be facilitated more efficiently and expeditiously by adopting and adapting established frameworks rather than creating a new one from scratch. Therefore, DevOps integrates practices from well-documented frameworks such as ITIL, Lean, and Agile.

These frameworks are founded on a shared logic that emphasizes the importance of defining a process to improve it. Once defined, the process can be stabilized and controlled, enabling measurement and monitoring. Based on the identified measurement gaps, opportunities for improvement can be recognized, which in turn inform the creation of a new or modified reference for the process going forward (Jan-Willem Middelburg, 2017).

## **Automation**

One of the fundamental principles of DevOps is automation, although it is often wrongly assumed that DevOps itself is simply automation (Jan-Willem Middelburg, 2017).

This misconception arises from the fact that automation plays a pivotal role in the Three Ways of DevOps. Automation is an effective means of establishing flow, enabling feedback, and facilitating experimentation and learning.

Automation plays a crucial role in DevOps by removing obstacles and enhancing standardization to create an unimpeded flow of work (from input to output) and to establish consistent feedback loops that support this flow. Automation fosters standardization and eliminates obstacles because the process of automation necessitates a thorough examination of existing processes to ensure that they are suitable for automation.

Automating flawed processes will inevitably lead to suboptimal outcomes. This is why, prior to implementing the technological stack, emphasis is placed on addressing the cultural and practice stacks to ensure that they align with DevOps principles. (Jan-Willem Middelburg, 2017).

## **2.14 Chapter Summary**

In this chapter the researcher provided a critical analysis of scholarly articles, books, and other sources related to DevOps and transformation models. The goal was to summarize and synthesize the current state of knowledge on DevOps and various transformation models used in change management models. Finally, the author described the rationale and purpose of DevOps full stack which represents the ultimate optimised DevOps mature state to provide complete and clearer understanding of the three layers of DevOps full stack. The next chapter three presents and discusses the research methodology and approach.

## **CHAPTER 3**

### **RESEARCH METHODOLOGY**

#### **3.1 Introduction**

Research methodology refers to the systematic approach and techniques that researchers use to conduct their investigations and answer research questions. It involves the process of designing, collecting, analysing, and interpreting data to draw meaningful conclusions and make informed decisions. The main problem driving this study was the need for a clearer understanding of specific factors influencing the transformational migration to DevOps by software development houses.

The research questions are outlined in chapters one, which summarise the main problem as the lack of oversight to respond to technological advancement and changes. As a result, companies and organisations not adapting to technological changes risk being left behind and can quickly become insolvent. This is compounded by the emergence of cloud technology which has had an enormous impact on IT and contributes to increasing demand from business partners, stakeholders and customers for speed, flexibility, and innovation. Therefore, a transformation agenda is needed to realise the benefits of DevOps (Sharma, 2017).

This chapter details the research methods following the research onion guide. The remainder of the chapter covers limitation and ethical considerations.

#### **3.2 Research Onion**

The research methodology was guided by the research onion. The research onion model, also known as the research methodology framework, is a concept that helps researchers to understand the different layers involved in the research process. Developed by Saunders et al., (2012), the research onion model is a useful tool that provides a structured and systematic approach to conducting research.

The research onion model comprises several layers, each of which represents a different stage of the research process. These layers include the research philosophy, research approach, research strategy, research design, data collection, data analysis.

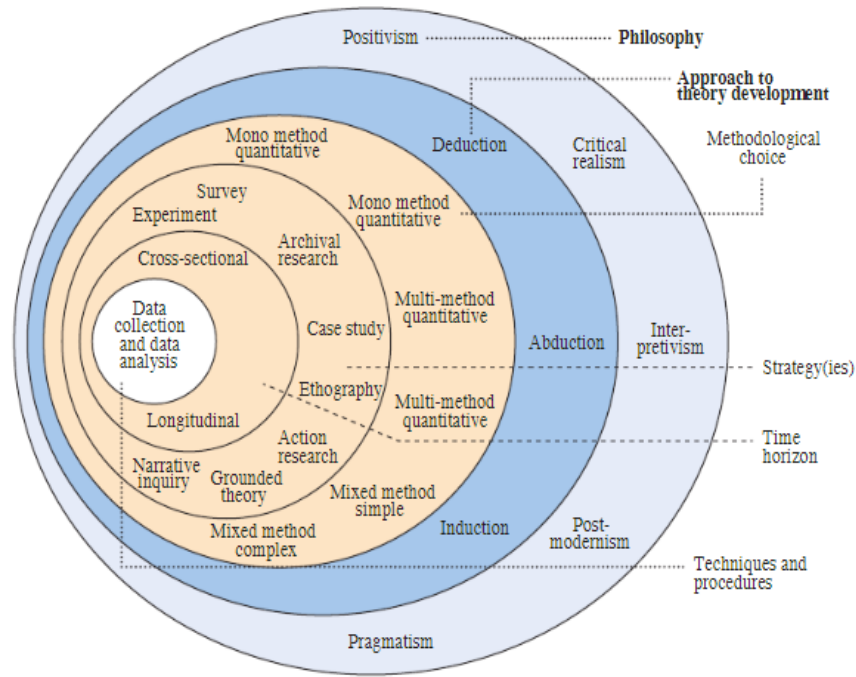


FIGURE 3.1: RESEARCH ONION MODEL SOURCE, MELNIKOVA, 2018

### 3.3 Research Philosophy

This empirical study was based on the interpretivism concept as a philosophy. Since this study sought to investigate factors influencing DevOps transformation, interpretivism was suitable for this study because it focuses on the meaning and may use various methods to reflect multiple facets of the topic. Furthermore, the appropriate techniques for supporting this approach were collecting large amounts of qualitative data from which theories related to the study environment might emerge (Díaz et al., 2021).

### 3.4 Approach to Theory Development

The second layer is the research approach, which includes two main types: deductive and inductive. The deductive approach involves testing a theory, while the inductive approach involves developing a theory based on data. For the qualitative analysis, the researcher opted for thematic analysis method: an inductive reasoning approach, where the themes emerge from the data.



### 3.5 Methodological Choice

The researcher utilised a combination of purposeful and convenience sampling. The criteria for choosing the company were,

- Small to medium-size software development house.
- A software-intensive company with at least a year of DevOps transformation experience.
- To conduct semi-structured questionnaires with the key decision-makers, the researcher issued exploratory questionnaires to the CEO, architect, developers, testers, product owners, and a scrum master, who are the primary roles responsible for DevOps transformation regarding ways of working. The questionnaire took about 45 minutes; after that, some informal discussions were held to clarify and refine issues via telephone calls.

#### 3.5.1 Questionnaire Design

The study questionnaire design was structured around the three stages of Kurt-Lewin's Change Management Model (Unfreezing, Change, Refreezing) and aimed at gathering insights from participants about their readiness and attitudes toward the proposed change to DevOps. It was adapted to specific organizational contexts and change initiatives. Please see **appendix F** for more details.

Kurt Lewin's Change Management Model provides a framework for understanding and managing change within organizations. While it primarily focuses on organizational change, you can adapt its principles to develop a questionnaire for various purposes, such as assessing readiness for change, gathering feedback on change initiatives, or understanding stakeholders' perspectives on change. Excerpt of a questions used in the study questionnaire are based on the Kurt Lewin model. See **appendix F**.

### 3.6 Research Strategy

#### Empirical case

The selected case study company is a software development company based in the information and communication technology (ICT) sector in South Africa. It provides small

and medium-sized enterprises with services through microservices that they offer clients as individual services of a complete suite. The organisation's annual turnover ranges from R101 000 to R500 000. The organisation is rapidly expanding with offices in South Africa's Western Cape Province. The company offers services to retail companies, universities and colleges, tradeshows and exhibitions, shopping centres, parks, and resorts. The organisation has ten (10) employees in the ICT department, of which three people are in development, three are in Operations, and four people are in managerial and support staff.

A typical DevOps agile team normally consists of 6 -13 team members and in this case study the company had a team of 10 members, which is reasonable.

The agile values and principles-based software development approach are implemented using Scrum methodology and roles. A product owner, testers, developers, architect, and a scrum master up the development team.

The researcher looked for software-intensive companies with at least a year of DevOps transformation experience. The study's sampling can be classified as a combination of purposeful and convenience sampling and meets the criteria of a small to medium enterprise software development house. This study looked at a corporation currently undergoing DevOps transformation and has been at it for the past twelve (12) months after determining that the company needs to adapt to stay agile and competitive.

Platform and product development were separate divisions of the company's product team that had exclusive access to production systems prior to the implementation of DevOps.

### **Research design**

The research followed a case study strategy because it allowed the researcher to investigate a current phenomenon in its natural setting and is ideal for topics like DevOps, where theory and practice are still developing (Senapathi, Buchan & Osman, 2018). The purpose of a case study is to generate results that may resonate with those of others (Yin, 2014).

**The limitation of a case study is that it cannot be generalised or transferred to the whole field.**

### 3.7 Research Techniques and Procedures

The study sought clarity on factors influencing DevOps transformation. The research utilised questionnaires via google forms to collect feedback and used follow-up interviews through Skype/Zoom on follow-up clarifications that arose from questionnaires. The data collecting section describes the questionnaire methods.

#### Data collection

Participants in the study got emails inviting them to participate in a closed-ended and open-ended questionnaire representing both qualitative and quantitative approaches. The participants accessed the questionnaire, which was hosted on Google Forms. The survey was completed by most of the participants, and some of them were not available for face-to-face interviews because of the Covid 19 pandemic restrictions. Therefore, technology was used to mitigate the Covid-19 impact. In some cases, the study used Zoom for clarifications. Every question addressed the research questions stated in chapter one.

Table 3.1 The research matrix

The aim of this research is to comprehensively examine the impact of DevOps on the software development environment within a specific regional context, namely a Software Development House in the Western Cape, South Africa.		
Research question	Goal	Method
What are the enablers and drivers of DevOps?	Determine the need for adopting and embedding DevOps	Literature survey and questionnaire using qualitative questions
What are the value stream mapping	To obtain a value stream map of the pre-DevOps	Questionnaire

elements of pre-DevOps transitions?	transition processes and workflows	
How does DevOps transformation impact on SDH ways of working and productivity?	To ascertain the impact of DevOps transformation amongst SDH	Questionnaire and document analysis
What change management models are currently being used in DevOps transformation?	Benchmark DevOps transformational change management model	Synthesis of results
How can DevOps transform the software development processes to assist in making SDH agile entities?	To develop a set of recommendations towards using DevOPs in software development processes to transform SDHs into agile entities	Questionnaire and document analysis

### Data collection methods

The study included a mixed type of questions, closed-ended and open-ended, to form the basis for qualitative and quantitative analysis. Quantitative data was collected using a

questionnaire built on the Google forms platform. Qualitative data was collected via semi-structured interviews were conducted using Zoom for clarifications only.

### **3.8 Data Analysis**

Quantitative data were analysed using descriptive statistics, Microsoft Excel was the tool, which was utilised in analysing, presenting, and interpreting quantitative data. Thematic analysis was used to analyse qualitative data.

Thematic analysis is a widely used qualitative research method for analysing and identifying patterns or themes within a dataset, often in the context of qualitative data from interviews. Here is an elaboration of thematic analysis:

#### **3.8.1 Thematic Analysis**

##### ***3.8.1.1 Data Collection***

Thematic analysis begins with data collection. In this study the author used semi structured interview questions as a follow-up to questionnaires that collected quantitative data. Few questions were asked to clarify some aspects of DevOps including the subjects' understanding of DevOps and their benefits (Cernasev & Axon,2023).

##### ***3.8.1.2 Data Familiarization***

The researcher started by becoming thoroughly familiar with the collected data. This involves reading and reviewing data multiple times to understand the content, and context (Cernasev & Axon,2023).

##### ***3.8.1.3 Data Coding***

In this study, themes originated from the data. The coding is the process of systematically identifying and labelling segments of data that are relevant to the research question or objectives. These segments can be words, phrases, sentences, or paragraphs (Cernasev & Axon,2023).

There are two main types of coding:

**Open Coding:** This involves initial exploration and labelling of data without any predetermined categories. It's about identifying patterns and ideas as they emerge from the data.

**Selective Coding:** Once initial codes have been identified, researchers start to group them into categories or themes. This involves a more focused and selective approach to coding. In this study the researcher used open coding.

#### ***3.8.1.4 Theme Development***

After coding the data, themes begin to emerge. A theme is a central idea or pattern that captures a significant aspect of the data's meaning (Cernasev & Axon,2023).

Themes can be at different levels of abstraction. Some may be more concrete, representing specific data patterns, while others are more abstract, reflecting broader ideas or concepts.

#### ***3.8.1.5 Data Extraction***

Relevant data excerpts or quotations are extracted and associated with each theme. These excerpts serve as evidence to support the identified themes.

#### ***3.8.1.6 Review and Refine***

Researchers continually review and refine the themes as they analyse more data. It's an iterative process that may involve modifying or reorganizing themes as the analysis progresses.

#### ***3.8.1.7 Define and Name Themes***

Themes are defined and named to accurately represent the content and meaning of the data they encompass. The names should be descriptive and meaningful (Cernasev & Axon,2023).

### ***3.8.1.8 Data Interpretation***

Interpret the themes in the context of research objectives (Cernasev & Axon,2023). Consider what the themes reveal about the research questions and explore the implications and insights that emerge from the analysis.

### ***3.8.1.9 Report Findings***

In our research report, we present the identified themes along with relevant data excerpts. Describe each theme in detail and discuss their significance in the context of our study.

### ***3.8.1.10 Quality and Trustworthiness***

We ensured that the analysis process is rigorous and transparent. Addressed issues of credibility, dependability, transferability, and confirmability to enhance the trustworthiness of our findings.

### ***3.8.1.11 Reflexivity***

Thematic analysis offered the only structured and flexible approach to uncovering patterns and insights in qualitative data. It's widely used across various fields and provides a means to explore, understand, and report on the rich content of qualitative research.

## **3.9 Statistical descriptive analysis**

The purpose of the study was to assess the transformation of the software development environment through DevOps, with a focus on a Software Development House in the Western Cape, South Africa. The investigation also explored the constraints associated with DevOps transformation, the application of value stream mapping, and the specific transformation model implemented. In the process of data analysis, information was reviewed, and interconnected concepts were identified, with similarities consolidated where appropriate. The research questions played a key role in categorizing the collected data and interpreting the outcomes of the surveys.

### **3.10 Limitations**

This case study was based on data collected from a selected small to medium enterprise software development house based in Cape Town. Thus, this work and findings align and pertain only to data collected from this company being the subject of investigation of this research work. Furthermore, results were further compared to the transformation model from literature, specifically the Kurt-Lewin model. Therefore, the study outcome is constrained to the afore-mentioned selected case study.

### **3.11 Ethical Consideration**

The following ethical considerations guided the research.

- The Cape Peninsula University of Technology (CPUT) and the participating company gave their permission and informed consent.
- Participants were advised about the research goal and the purpose of data collection and reporting protocols.
- Participants were given the option of not having the interview recorded, and they were allowed to leave at any time.
- Negligence and careless errors were prevented by analysing one's work carefully and critically.
- The dignity of people and their intellectual property were respected.
- Data, findings, methods and procedures, and the status of publishing were responsibly documented.
- Data integrity was protected by avoiding the fabrication, falsification, or misrepresentation of data.
- By eliminating bias in experimental design, data analysis, data interpretation, data reporting, and other parts of research, the study was able to retain objectivity.

### **3.12 Chapter Summary**

In this chapter, research methodology was presented using the research onion as a model and guide. The empirical case was considered. Using the Kurt Lewin model of Unfreeze, Change, freeze approach as a lens, this research reported on factors influencing DevOps transformation at a small company in the Western Cape. Using a qualitative and quantitative



approach, the questionnaire, hosted on Google Forms, was accessed by the key participants responsible for DevOps transformation. The questionnaire took about 45 minutes to fill in. After that, informal discussions were held to clarify and refine issues. Thematical analysis was proposed to be used for analysing qualitative data. Ethical issues were also taken into consideration. The next chapter four discusses the research findings.

# **CHAPTER 4**

## **DATA PRESENTATION AND RESEARCH FINDINGS**

### **4.1 Introduction**

As stated in chapter one, this research aimed to explore the transformational model and underlying factors influencing DevOps transformation for a Software Development House based on empirical findings.

Qualitative methods typically allow us to collect large amounts of qualitative data, which considers the viewpoints and circumstances of all parties involved from which theories related to the study environment might emerge (Díaz et al., 2021). However, in this case study, they were few open-ended questions where qualitative analysis was employed. The quantitative analysis (descriptive statistics) method was utilised for closed-ended questions.

The remaining sections of this chapter are the comments, interpretation, and discussion of the findings regarding the case study. Detailed tables showing thematical analysis are in appendix E.

Our research objectives and questions as stated in chapter one, guided the formulation of questions in the questionnaire based on the Kurt-Lewin's change management model.

### **4.2 Case Study Details**

The team which participated in the research consisted of the following people and positions: one Chief Executive Officer, scrum master, developer, tester, product owner, and architect. The company has between 41-80 employees and an annual turnover of between 100k to 500k in rands, reasonably falling into the categories of Small and Medium-sized Enterprises. DevOps itself represents development and operations; hence it was essential to establish the percentage of employees in software development and operations. Development and operations had 11% to 20% of employees, respectively.

This study followed a mixed approach utilising both quantitative and qualitative methods. The results are stated with reference to the research objectives and questions as illustrated in Chapter 1 and the Kurt-Lewis transformational theoretical models from Chapter 2.

### 4.3 Thematic Analysis

The researcher closely examined the data to identify common themes, topics, ideas, and patterns of meaning that came up repeatedly. Due to the COVID-19 pandemic prevailing at the time of this study, the researcher decided to use google forms as a means by which to reach out to the respondents. A summary is shown in the following table outlining the demographics of the sample.

The approach was based on the case-study of a small medium software development house based in the Western Cape and for convenience in Cape Town. The company had one team comprising:

*TABLE 4.1 DEVOPS TEAM USED IN CASE STUDY*

No	Role in the organisation	Reference Code
1	CEO— Chief Executive Officer	R1 – Respondent 1
2	DEVELOPER	R2 – Respondent 2
3	TESTER	R3 – Respondent 3
4	PRODUCT OWNER	R4 – Respondent 4
5	SCRUM MASTER	R5 – Respondent 5
6	ARCHITECT	R6 – Respondent 6

*TABLE 4.2: RESEARCH ACTIVITIES*

Phase of the research	What was done	How was it done	Why it was done	When it was done	Where it was done	With whom it was done	What was achieved
Data collection	Questionnaire sent out on Google Forms platform	Using Email addresses of respondents, a Google Forms questionnaire was sent out.	In order to conveniently reach out to respondents, especially during the COVID-19 pandemic	May 2021	In Cape Town	A software development team consisting of: CEO, Architect, Developer, Scrum Master, Tester	A better understanding of factors influencing DevOps transformation in Small and Medium-sized Software development houses

#### 4.4 Strategy for Conducting Thematic Analysis

The researcher employed a mixed-method approach, incorporating quantitative and qualitative questions in the questionnaire. For the qualitative analysis, the researcher opted for thematic analysis method: an inductive reasoning approach, where the themes emerged from the data.

**Integrating thematic analysis** (often associated with inductive reasoning) within a research study on the transformation of DevOps can provide a comprehensive understanding of the research topic. Here's a step-by-step guide on how the researcher achieved this:

##### 1. Defining Research Objectives:

RO1: To identify the enablers and drivers of DevOps transition for SDH

RO2: To critically assess the need for value stream mapping in pre-DevOps transition in SDH

RO3: To determine the impact for adopting and embedding DevOps

RO4: To benchmark DevOps transformation model with known change management models

RO5: To develop a set of recommendations towards using DevOps in software development processes to transform SDHs into agile entities.

##### 2. Data Collection:

The researcher collected data relevant to the outlined research objectives from the respondents. This was done using google forms. Clarifications were done by informal interviews.

### **3. Thematic Analysis (Inductive Reasoning):**

The researcher started with thematic analysis, which is an inductive approach. Conducted open coding of the data to identify themes and patterns that emerge naturally from the data. The researcher explored how the organization and team perceived and implemented DevOps practices without predefined categories.

### **4. Integration of Findings:**

The researcher used the findings from the thematic analysis (inductive). Examined how the themes identified through inductive reasoning relate to the results. Considered whether the findings support, challenge, or expand upon the themes identified in the inductive analysis.

### **5. Interpretation and Discussion:**

In the discussion section of our research, the researcher has provided a comprehensive interpretation of the results as detailed in appendix E. Discussed how the use of inductive findings contributed to a deeper understanding of DevOps transformation. Explored the practical and theoretical implications based on the Kurt-Lewin theoretical model on change management.

### **6. Reflect on Methodological Considerations:**

The researcher has reflected on the strengths and limitations of integrating both approaches in this research. Discussed how this integration enhanced the validity and depth of the study.

### **7. Conclusions and Implications:**

The researcher summarized research findings, highlighting the contributions of inductive components to the understanding of DevOps transformation and transformation. Discussed the practical implications for organizations and the theoretical contributions to the DevOps literature.

### **10. Future Research Directions:**

By using thematic analysis (inductive reasoning) in our research on the transformation to DevOps. The researcher captured both the emergent themes and the Kurt-Lewin change management model of specific to DevOps. This approach provided a more comprehensive and nuanced understanding of how SDH's can implement DevOps practices and the factors that influence transformation.

**Summary of quantitative questions posed to the DevOps team?**

TABLE 4.3: RESPONSE SUMMARY TO QUANTITATIVE QUESTION.

Response summary to quantitative question.

No	Question	R1	R2	R3	R4	R5	R6	YES	NO
1	Where all stakeholders involved in the transformation process?	Yes	Yes	Yes	Yes	No	Yes	83%	17%
2	Did senior management communicate the adoption and embedding of DevOps to the entire organisation?	Yes	Yes	Yes	Yes	Yes	Yes	100%	0%
3	Did all the stakeholders have the right skills for the organisation to transform to DevOps?	No	No	No	No	No	No	0%	100%
4	Was the Pre-DevOps value stream mapping exercise undertaken ?	Yes	Yes	Yes	Yes	Yes	Yes	100%	0%
5	Did the company understand the scope of the problem they were trying to solve?	Yes	Yes	Yes	Yes	Yes	Yes	100%	0%
6	Does the company value stream map show any gaps in communication between teams and cross functions?	Yes	Yes	Yes	Yes	Yes	Yes	100%	0%
7	Does the value stream map cater for continuous improvement through iteration?	Yes	Yes	Yes	Yes	Yes	Yes	100%	0%
8	Did the company conduct a skills mapping exercise?	Yes	Yes	Yes	Yes	Yes	Yes	100%	0%
9	Where any lessons learnt generated?	Yes	Yes	Yes	Yes	Yes	Yes	100%	0%
10	Did you do any DevOps maturity assessments?	No	No	No	No	No	No	0%	100%
11	When transforming to DevOps did you use any transformation model?	Yes	Yes	Yes	Yes	Yes	Yes	100%	0%
12	Has the cost of Software Release reduced?	Yes	Yes	Yes	Yes	Yes	Yes	100%	0%
13	Has process management improved?	Yes	Yes	Yes	Yes	Yes	Yes	100%	0%
14	Has the number of workarounds decreased under DevOps?	Yes	Yes	Yes	Yes	Yes	Yes	100%	0%
		12	12	12	12	11	12		
		2	2	2	2	3	2		

As indicated in the above quantitative analysis summary in table 4.3:

Question 1: Where all stakeholder involved in the transformation process? Five (5) respondents said Yes, and one responded with a No.

Question 2: Did senior management communicate the adoption and embedding of DevOps to the entire organization? All six (6) respondents said Yes, and no one responded with a No.

Question 3: Did all the stakeholders have the right skills for the organization to transform to DevOps? All six (6) respondents said No, and no one responded with a Yes,

Question 4: Was the pre-DevOps Value Stream undertaken? All six (6) respondents said Yes, and no responded with a No.

Question 5: did the company under the scope of the problem they were trying to solve? All six (6) respondents Yes, and no one responded with a No.

Question 6: Does the company Value Stream Map show any gaps in communications between teams and cross-functions? All six (6) respondents said Yes, and no one responded with a No.

Question 7: Does the Value Stream Map cater for continuously improvement through iteration? All six (6) respondents said Yes, and no one responded with a No.

Question 8 Did the company conduct a skills mapping exercise? All six (6) respondents said Yes, and no responded with a No.

Question 9? Were any lessons learnt generated? All six (6) respondents said Yes, and no responded with a No.

Question 10: Did you do any DevOps maturity assessments? All six (6) respondents No, and no one responded with a Yes.

Question 11: When transforming to DevOps, did you use any transformation model? All six (6) respondents said Yes, and no one responded with a No.

Question 12: Has the cost of Software release reduced? All six (6) respondents said Yes, and no one responded with a No.

Question 13: Has process management improved? All six (6) respondents said Yes, and no one responded with a No.

Question 14: Has the number of work-arounds decreased under DevOps? All six (6) respondents said Yes, and no one responded with a No.

## **Response Analysis from DevOps Enablers and Drivers**

### ***What are the DevOps enablers and drivers?***

The respondents were asked to state what prompted the company to adopt and embed DevOps, and the findings state that there are many reasons. These have been qualitatively analysed. The same applies to the qualitative question, "What were the specific activities (enablers) undertaken to support DevOps transformation". Respondents identified DevOps training, knowledge transfer, and self-study as specific enablers which supported DevOps transformation.

## **4.5 Response Analysis on Stakeholder Involvement**

### ***Stakeholder involvement in DevOps transformation***

The respondents were asked to state the stakeholder's engagement and stated that stakeholders were involved. The respondents were also asked to state whether senior management had communicated the transformation and embedding of DevOps. Respondents responded that communication was done through weekly meetings and stated that communication was done.

## **4.6 Response Analysis on Obstacles in DevOps Transformation**

### ***Which obstacles stood in the way of DevOps transformation?***

The respondents were asked to state the mode of communication used in the organisation; stated that communication was done via daily stand-up meetings and retrospectives, whilst indicated that stand-up meetings were used. The respondents were also asked whether stakeholders had the right skills for DevOps transformation, and all responded with a No.

## **4.7 DevOps Leadership**

### ***Response analysis on DevOps leadership***

The respondents were asked to state what management did to fill up the gap in skills; the response was that short training, training, and upskilling were the interventions made. The respondents were also asked to state who was driving the DevOps leadership. This was a



straightforward question on the questionnaire. The rationale behind this question was to determine whether the people driving DevOps transformation have authority enough. The CEO and team leader drive DevOps transformation in the case company. Half of respondents stated that the CEO and Team leaders were at the helm.

#### **4.8 What Are the Value Stream Mapping Elements of Pre-DevOps Transitions?**

##### ***Response Analysis on Value Stream Mapping***

Source: Questionnaire data

The respondents were asked whether the pre-DevOps value stream mapping exercise was undertaken. All respondents said yes. Then secondly, the respondents were also asked to state who performed the value stream map. All of respondents stated that it was management.

#### **4.9 Value Stream Mapping**

##### ***Response Analysis on Value Stream Mapping***

Source: Questionnaire data

The respondents were asked a qualitative question to highlight what problems they were trying to solve when undertaking value stream mapping, and Figure 4.6 show interesting responses. Secondly, the company indicated that they understood the scope of the problem they were solving, which was good.

This question was to determine whether the case company's management performed DevOps value stream mapping. The response from the questionnaire revealed that the management understood the scope of the problem they were trying to solve. They also did conduct a skills mapping exercise.

#### **4.10 What Change Management Models Are Being Used in DevOps Transformation in the Case Study?**

This question sought to determine whether they documented information highlighting the positive and negative aspects of a project's experience. This question ascertained whether

the company undertook a preparedness DevOps maturity assessment. The case company did not conduct a DevOps maturity assessment.

#### **4.11 Chapter Summary**

In this chapter, the researcher presented evidence of study findings covering both qualitative and quantitative analysis. To understand what change management models are currently being used in DevOps transformation, the researcher used the questionnaire as a research instrument to collect empirical data from experienced practising software development engineers, operations teams, and senior management teams from selected SDH. The research instrument used in this study was a questionnaire consisting of both quantitative and qualitative questions. The next chapter five discusses the research findings.

# CHAPTER 5

## DISCUSSIONS

### 5.1 Introduction

Overall, the research findings in the previous section are consistent with prior DevOps transformational studies and provide additional empirical evidence for this body of knowledge and its transformational journey. The research findings are compared to the literature in this section, and benchmarks with known transformational models and the implications for educators, practitioners, and researchers are reviewed and examined.

As stated in chapter one, this research aimed to explore the transformational model and underlying factors influencing DevOps transformation for a Software Development House based on empirical findings.

Factors influencing the transformation of DevOps practices in small and medium-sized software houses are characterised by a combination of factors, ranging from organizational culture to technical considerations. Understanding these factors is crucial for successfully implementing DevOps. Below is a discussion of some key factors that influence DevOps transformation in small to medium-sized software houses:

### 5.2 Enablers and Drivers of DevOps

Respondents from top management, including the CEO, indicated high levels of buy-in toward the company's vision and mission. Policies were formulated to support the DevOps transformational agenda. The vision statement for DevOps transformation was clearly formulated and constantly communicated to staff, as evidenced in the findings in the previous chapter.

When we at the themes identified, we discover commonality in terms of keywords, categories, and themes for example:

#### **What prompted the company to adopt and embed DevOps?**

The identified keywords, categories and themes include:

*TABLE 5.1 RESPONSE TO WHAT PROMPTED COMPANY TO ADOPT DEVOPS*

Keywords	Categories	Themes
Development Team Operations Team Requirements Streamline Delivery pipeline Client requirements Development team Feedback loop Operations team Constantly changing environment.	IT Project Management Software Development Operations Management Customer/ Client Service	Agile methodology: To Collaboration Continuous improvement Customer satisfaction
Decision	Management	Strategic planning Risk management Resource allocation Change management. Performance improvement
New company direction	Business Strategy	Strategic planning Organizational change: Innovation. Growth

		Customer focus
Quality software	Software Development" or "Quality Assurance".	Customer Satisfaction Continuous Improvement. Software Development Process Technical Excellence
Deliver software quickly	Software Development or Agile Methodology.	Agile Software Development Time-to-Market Continuous Delivery: Customer Satisfaction Efficiency and Productivity
Quality software	Software Development or Agile Methodology	Agile Software Development Time-to-Market Continuous Delivery: Customer Satisfaction Efficiency and Productivity.

TABLE 5.2: MAPPING OF KURT LEWIN MODEL TO THE CASE STUDY

Kurt Lewin model	Case study Notable high-level findings
Unfreeze	<p>Pre-transition activities – Corporate buy-in and policy towards DevOps transformation and embedding. (User training, town hall meetings for awareness campaigns), Preparedness and user readiness</p> <p>Preparing Transition plans</p> <p>Value stream mapping exercises</p>
Kurt Lewin model	Case study Notable high-level findings
Change	<p>Transition activities (start using DevOps in teams). Implement transition plans</p> <p>Support for business</p> <p>Adopt DevOps new ways of working (WoW)</p> <p>Knowledge transfer</p> <p>Potentially implementing new business processes</p>
Refreeze	<p>Post-Transition activities (Evaluate, Assessments whether DevOps has been achieved)</p> <p>Realising, measuring benefits</p> <p>DevOps maturity assessments</p>

### **5.3 Transformation Models**

There are many transformational models used in industries for transformation. Literature has highlighted the three most used transformation models these are:

- McKinney's seven (7S) model
- Burke-Litwin model
- Kurt Lewin model

### **5.4 Realised Benefits**

The switch to DevOps was motivated by a business need to get past the constraints and annoyances of the pre-existing situation and a desire to boost the organisation's agility and competitiveness. The respondents stated that using DevOps had several benefits. They saw DevOps as a means of reducing defects and increasing the productivity of software delivery, low deployment frequency, lead time for changes, improved software quality, and process management improved 100%. Amongst other notable mentioned benefits, the following benefits were also reported by respondents this includes:

- Re-work costs have reduced caused by the number of defects experienced.
- Productivity increased amongst the development team.
- Product quality has improved.
- Waste has been reduced in the delivery pipeline.
- Unit of efficiency has increased.
- The company has more effective processes now.

Compared to the literature, the case study company has definitely realised some of the benefits of adopting DevOps, including better collaboration between engineers working on operations and software developers. This is evidenced by Figure 20: Response analysis based on the positive impact of DevOps.

The collaboration encourages cooperation to improve the development process and final product. Other benefits include automation, which was considered to aid in the improvement of release quality, reduced waste in the delivery pipeline, and real-time monitoring, which developers emphasised as an element that aids in the creation of fault-aware systems and

encourage a quick feedback loop, a more significant number of high-quality deployments and customer satisfaction.

## **5.5 Chapter Summary**

This chapter mainly looked at the empirical research findings from the case study. They analysed the results and explained the rationale behind the questions posed in the questionnaires and follow-up questions. The transformational model used in the case study was the Agile DevOps Transformational Model. Upon close interrogation of this model, it was discovered that it aligns well with the Kurt-Lewin model, which was used as a model in this study, especially phases of unfreezing, change and freeze. This finding validates the assumption that transformation models from the literature still play an important role in DevOps transformation. Therefore, it is recommended that all transformation models consistent with the Kurt-Lewin transformation model be applied in the DevOps transformation journey.

Another exciting finding points to DevOps' transformational leadership in companies. For example, the CEO of the case company fully supported DevOps transformation at strategic and policy levels. Therefore, senior management support is essential for DevOps transformation to succeed in software development houses. The next chapter six presents study achievements, contributions, and recommendations.



## CHAPTER 6

### CONCLUSIONS, CONTRIBUTIONS AND RECOMMENDATIONS.

This study focused on the transformative impact of DevOps in the software development environment, using a case study of a Software Development House in the Western Cape, South Africa. It aimed to explore how the adoption of DevOps practices influences and changes traditional software development processes within this specific context. The research delved into the challenges, opportunities, and outcomes associated with the implementation of DevOps in the mentioned software development setting.

#### 6.1 Agile DevOps Transformation model roadmap

Interesting findings in this case study included that the DevOps transformational model unveiled was different in terms of terminology from the transformational model. However, the underlying transformation activities were consistent with the Kurt-Lewin model. In addition, the researcher's findings from the case study revealed that the transformational model used was the agile DevOps transformation model. This was an exciting finding because the Agile DevOps transformational used in the case study was consistent with the Kurt Lewin model used as a benchmark.

This is also evidenced by the responses to the questions relating to the Unfreeze, Change and Freeze activities. The terminologies used in the Agile DevOps transformation model were customised and tailored to suit the company's environment whilst preserving Kurt-Lewin's underlying model of transformation Figure 5.1. depicts the agile DevOps transformation model.

Agile DevOps way of working involves a major change to the organisation's culture, people, structure, and technical/business orientation towards achieving enterprise agility. The Agile DevOps transformation model used in the case study relied on lean values and principles and introduced the highest levels of productivity, collaboration, flexibility, quality, and efficiency. This revelation is consistent with the ethos of DevOps and its industry best practices.

It is also evident that customisations, tailoring and improvisation have taken place in the case study transformation model, as seen from the 1. Unfreeze Current Status Quo, 2.

Transform Organisation to the state of Continuous Delivery and, thirdly, Freeze New Status Quo to ensure sustainability. Therefore, the researcher can safely state that the company in the case study is in a continuous DevOps improvement stage.

6.2 Comparing Kurt Lewin with the Agile DevOps Transformation model roadmap used in the case study.

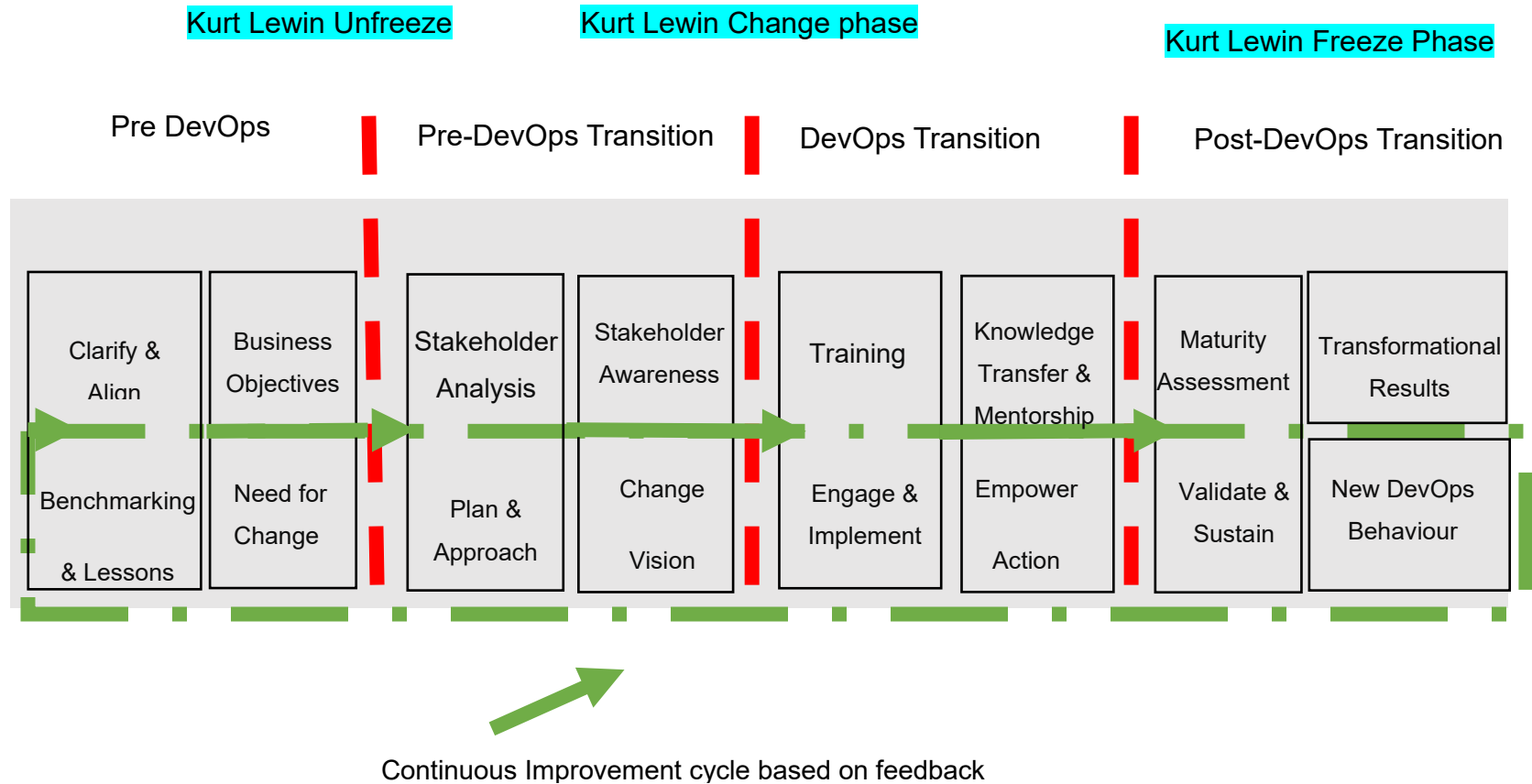


FIGURE 6.1: AGILE DEVOPS TRANSFORMATION

Source: Authors construct

Figure 6.1 represents four phases the case study company used in its DevOps transformational journey, namely pre-DevOps, Pre-DevOps Transition, DevOps Transition and Post-DevOps Transition. It is possible to map these phases to the Kurt-Lewin model as follows:

- Pre DevOps maps to Unfreeze Phase.
- Pre-DevOps Transition maps to Unfreeze Phase.
- DevOps Transition maps to Change Phase.
- Post-DevOps Transition maps to Freeze phase.

As can be seen from the Agile DevOps Transformation model used, the new DevOps behaviour is attained as a result or output of the transformation process. This phase aligns well with the Freeze phase of the Kurt Lewin model. However, the company implemented a continuous improvement plan based on feedback assessment results. This was a good strategy because of the risk of backsliding should there be no continuous improvement plan.

Another intriguing discovery was that the organisation's CEO in the case study took a highly active role in the DevOps transformation process. As a result, he was a catalyst for change. A change agent is never just one person; instead, they are a renowned, powerful, knowledgeable, and experienced team of seasoned internal and external experts who are knowledgeable about all parts of Agile, DevOps, and organisational change systems. In order to overcome objections and remove obstacles, the company's CEO demonstrated leadership and buy-ins and assembled a larger coalition of powerful and influential managers and members. Together, the CEO and senior team modified the organisational structure, culture, procedures, plans, relationships, behaviours and how the staff members approached their work.

The case study company did not use any outside consultants or change agents. However, it is important to recognise the benefits that outside change agents can offer. The advantages include a plethora of industry expertise and freedom from the constraints of the established business model. In addition, internal company leaders add value to the group by providing expertise and insights about the organisation's culture, structure, people, and procedures, as well as inherent power, authority, and recognition. They can also supervise, coordinate, and support the transformation effort.

Other critical aspects are authority, respect, confidence, knowledge, and experience to lead change. The company's CEO in the case study was selected by the organisation to serve as the primary change agent, and he was fully qualified for this role.

### **6.2.1 Summary of research questions (RQ) and findings and recommendations**

#### **RQ1: What are the enablers and drivers of DevOps?**

The respondents in the case study indicated the following:

"We intensely focused on the following activities as guidelines to imbed the culture of DevOps:

1. Ensure that the Operations Team is involved continually during the development and testing process, not only at the release stage. We achieve this continuous integration by using Code Magic integrated within Slack to ensure automated builds and tests are run.
2. Our design architecture approach is subdivided into microservices that we will offer clients as individual services of a complete suite. Subdividing services allows the teams to be focused, identify problems quickly and get the relevant team member to fix them. For example, we currently offer a marketing tool, analytics tool, positioning tool, mapping tool, and all these are separate functional modules.
3. Automated monitoring and logging - at an operational level, it is critical that client complaints are handled by the correct team and the appropriate level of expertise based on risk level, affected client priority, technical requirements to fix the problem, etc. Automating the process from the client logging side past the ops to the dev team is critical for efficiency and reducing frustration to the teams. In practice, we implement 1st to 4th line support systems and also the tier 0 which is self-service that we are currently implementing.

Continuous communication is critical for our work in DevOps, and we absolutely believe that everything breaks due to lack of communication at the right levels and at the right time. We do not work in siloes and completely run connected teams. We achieve this by using a single communication platform with complete transparency among the teams and access to information. Chat platforms, open sprint planning and tracking, open access to meeting notes and ideas are all integrated across the organisation. "

In summary, the enablers and drivers of DevOps work synergistically to create an environment where collaboration, automation, and continuous improvement are prioritized. Cultural transformation, technological advancements, leadership support, and a commitment to ongoing learning collectively contribute to the successful transformation of DevOps methodologies in modern software development and IT operations.

**RQ2: What are the value stream mapping elements of pre-DevOps transitions?**

The respondents answered this question as follow: Value stream mapping was conducted by management and Process time—we wanted to ensure that the team, given all necessary information in the correct format would execute quickly with minimal challenges.”

In summary, the value stream mapping elements in pre-DevOps transitions involve visualizing the software development and delivery process, analysing time metrics, identifying handoffs, understanding work in progress, and assessing the impact of manual tasks. This mapping serves as a foundation for organizations to identify areas of improvement and streamline their processes before embarking on the DevOps journey.

**RQ3: How does DevOps transformation impact on SDH ways of working and productivity?**

In summary, DevOps transformation profoundly impacts SD and Ops ways of working by promoting collaboration, automation, and a culture of continuous improvement. The result is increased efficiency, faster delivery, and enhanced productivity throughout the software development lifecycle.

**RQ4: What change management models are currently being used in DevOps transformation.?**

All the respondents unanimously answered Agile DevOps Transformation Model”. Upon analysis and scrutiny, the researcher discovered many similarities of the Agile Devo Transformation Model used in the case study with the Kurt-Lewin change management model. This mapping is illustrated in figure 5.1.

## 6.2.2 *Recommendations emanating from the study.*

### 6.2.2.1 *Organizational Culture*

- **Resistance to Change:** In many cases, a traditional or siloed organizational culture can resist DevOps transformation. Employees may be resistant to changes in processes and workflows.
- **Leadership Support:**  
Top-Down Support: Effective leadership and management support are critical. Without buy-in from top-level executives and managers, it can be challenging to drive DevOps transformation.
- **Skill and Training:**  
Skill Gaps: The skill level of the existing workforce can be a significant factor. Employees may need training to acquire the necessary DevOps skills and knowledge.
- **Tools and Technology:**  
Tool Selection: The choice of DevOps tools and technologies is crucial. Compatibility, ease of integration, and scalability of these tools are factors that can influence transformation.
- **Process Alignment:**  
Process Complexity: Existing processes and workflows need to align with DevOps practices. Complex or rigid processes may require substantial restructuring.
- **Communication and Collaboration:**  
**Cross-Functional Collaboration:** Effective communication and collaboration among cross-functional teams are essential. Silos and communication gaps can hinder DevOps.
- **Scalability:**  
Scalability Challenges: As small and medium-sized software houses grow; the scalability of DevOps practices becomes a factor. Scalable DevOps processes must be in place to accommodate growth.
- **Cost Considerations:**

Resource Allocation: The cost of implementing DevOps, including tool investment and training, is a factor. Smaller organizations may have limited resources for DevOps transformation.

- **Continuous Improvement:**

Continuous Learning: DevOps is built on a culture of continuous improvement. Organizations that are open to learning from failures and iterative improvements are more likely to succeed.

- **Vendor and Community Support:**

Vendor Ecosystem: Leveraging support from DevOps tool vendors and engaging with the open-source community can provide valuable resources and insights.

- **Customer and Market Demand:**

Market Pressure: The demand from customers or market competition can push software houses to adopt DevOps to deliver more frequent and reliable updates.

- **Measuring Success:**

Key Performance Indicators (KPIs): The ability to measure the success of DevOps transformation through KPIs, such as deployment frequency, lead time, and change failure rate, is critical.

- **Industry Specifics:**

Regulatory Environment: The specific industry and its regulatory environment can significantly influence DevOps practices. Highly regulated industries may face additional challenges.

Successful DevOps transformation in small and medium-sized software houses often requires a holistic approach that addresses cultural, technical, and process-related factors. Organizations that adapt to change, prioritize collaboration, and continuously learn from their experiences are better positioned to navigate the complexities of DevOps transformation. It's essential to tailor DevOps practices to the specific context and needs of the organization.

In summary, DevOps transformations often draw on a combination of change management models to address the complexities of organizational change. Models in literature like Kotter's 8-Step Change Model, ADKAR, Prosci's ADKAR Model, Lewin's Change Management Model, Bridge's Transition Model, and ITIL provide frameworks for guiding and managing the transition to a DevOps culture and practices. The choice of model depends on the organization's specific needs, culture, and the nature of the DevOps transformation. In the



case study, it was discovered that the organization used Kurt-Lewin change management model.

The research findings generally show that the DevOps transformation and transformation embarked on by the company in the case study is by far and large appreciated by the employees and their customer base. However, more can be done to increase the level of customer satisfaction and appreciation of DevOps to achieve value co-creation in the ecosystem. The following sections will serve as a synthesis of the findings and insights obtained throughout the research.

### **6.3 Overview of the purpose and significance of the study.**

In summary, the aim of this study was to investigate the factors influencing the transformation of DevOps, with a case study approach providing real-world insights. The significance was in its potential to contribute to academic knowledge, offer practical guidance to industry practitioners, enhance organizational performance, and serve as a foundation for ongoing research in the field of DevOps.

#### **6.3.1 Purpose of the Study:**

The main purpose was to understand the dynamics involved in the transformation of DevOps: Explore Motivations: Investigate the factors that drive organizations to adopt DevOps practices. This included understanding the motivations behind the decision to implement DevOps methodologies in the software development and IT operations processes.

#### **6.3.2 Identifying Key Influencing Factors:**

In-Depth Analysis: The researcher conducted a comprehensive examination of the various elements that influence the successful transformation of DevOps. This involved looking into cultural, technological, organizational, and procedural aspects that contribute to or hinder the transformation process.

### **6.3.3 Learning from Real-world Cases:**

Case Study Approach: The researcher utilized a case study methodology to delve into a real-world scenario where DevOps transformation has taken place. This approach provided an in-depth and contextualized understanding of the challenges, successes, and lessons learned in the transformation process.

### **6.3.4 Informing Decision-Making:**

Practical Insights: This research provided actionable insights for organizations considering or in the process of adopting DevOps. The study has offered practical guidance by identifying key success factors and potential pitfalls based on the experiences of the case study subjects.

## **6.4 Significance of the Study:**

### **6.4.1 Contributing to Academic Knowledge:**

Research Gap Addressed: This study filled in a gap in the existing academic literature by conducting a focused study on the factors influencing DevOps transformation. Contributes a new knowledge to the field of software engineering, IT management, and organizational studies.

This study has achieved three main things:

- This research has brought out factors influencing transformation of based on the case study.
- This work has outlined the transformation to DevOps change management model recommended for the DevOps transition journey by software houses.

#### **The theoretical contribution**

- By focusing on the challenges that typically drive a DevOps transition and the most likely anticipated results, the study adds to the body of knowledge about DevOps and helps practitioners make better-informed decisions during DevOps transformation processes.

- The Kurt Lewin change management model was used to analyse and benchmark empirical DevOps transformation within the software development house. Develop the knowledge base for the DevOps Transformational roadmap approach.
- This research has recommended DevOps transformational roadmap, which many Software Developments Houses can adopt. Further, this research contributes to lessons learnt and best practices for DevOps.

#### **6.4.2 *Practical Implications for Industry:***

Guidance for Practitioners: Offers practical recommendations for industry practitioners, including IT managers, CTOs, and DevOps teams. This study aims to help organizations navigate the complexities of DevOps transformation by highlighting critical success factors.

##### **6.4.2.1 *The practical contribution***

The researcher evaluated one purposeful case study of the DevOps transformational roadmap scenario that has been compared with best practice change management models. Highlighted insights about the common DevOps transformational roadmap. The work brings awareness about DevOps standardisation and common transformation approaches.

##### **6.4.2.2 *Contribution to DevOps Community:***

Community Insights: This work has contributed valuable insights to the broader DevOps community. The study aimed to foster knowledge-sharing and collaboration among organizations and professionals involved in or considering DevOps transformation.

#### **6.4.3 *Enhancing Organizational Performance:***

Performance Optimization: Facilitate the optimization of organizational performance by identifying and emphasizing the factors that positively impact the successful implementation of DevOps. This includes considerations related to efficiency, collaboration, and overall productivity.

#### **6.4.4 *Foundation for Further Research:***

Future Exploration: This work lays the groundwork for future research on DevOps transformation. The findings of this study can serve as a basis for more extensive research projects, exploring additional dimensions of DevOps implementation and its impact on various organizational contexts.

#### **6.5 Recommendations**

Current research on DevOps mainly focuses on DevOps as a whole and in its various phases, but there is little research on the specific aspects that influence DevOps transformation. As the case study shows, senior management plays a crucial role in driving the DevOps transformation process.

Knowing more about the additional impact and effects of DevOps would be interesting. For instance, fast release cycles and other DevOps techniques have benefits, such as the positive effects which come with constantly releasing software. Software development organisations need to embed and adopt DevOps using known transformational models. As seen in the case study, the Agile DevOps transformational model was employed. The DevOps transformational model used was consistent with the Kurt Lewin change management model indicating best practice. It has also been shown that DevOps transformation positively affects productivity and working practices in software development firms. It has also been shown that understanding the factors on a bigger scale could aid in determining DevOps' actual value.

#### **6.6 Chapter Summary**

The final chapter of this thesis is typically the Conclusion chapter. Its primary purpose is to summarize the key findings of the study, evaluate the significance of the research, and offer recommendations for future research.

The author begins by restating the research problem and research questions, and then summarizes the key findings of the study. This involved discussing the main results, highlighting the strengths and limitations of the study, and identifying any unexpected findings.

The author then evaluates the significance of the research, explaining how the study contributes to the existing body of knowledge and addressing the research questions. This involved discussing the implications of the findings for theory, practice, and policy, and explaining how the study advances the field of DevOps.

Finally, the author offers recommendations for future research, identifying areas where further research is needed and suggesting potential avenues for future study. This involved highlighting limitations of the current study and suggesting ways to address them, or identifying new research questions that arise from the current findings.

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## Appendices

### APPENDIX A: CONSENT LETTER

#### Research Consent letter



Cape Peninsula University of Technology  
District Six Campus  
Faculty of Informatics and Design  
Department of Information Technology.

#### Factors influencing DevOps transformation in Software Houses in the Western Cape.

##### Dear Participant

The goal of this proposed research project is to identify the factors that influence DevOps transformation of Software Development Houses (SDH) in the Western Cape. DevOps adoption and embedding is gaining tremendous appetite in industry due to the fact that DevOps focuses on continuous integration and continuous delivery of business value. However, most organizations are still struggling to survive because they are failing to respond timeously to changes in the marketplace fast enough to realize business value. This has led to business organization getting frustrated. To embark on any transformation change, firstly organizations need to understand their business objectives as the first step in transformation.

##### About the Study

This study aims to explore transformational models and underlying factors influencing DevOps transformation for software development houses (SDH) in the Western Cape. To achieve this, the researcher needs first to gather information about the factors influencing DevOps transformation, the challenges companies face when transforming to DevOps and the transformation model used for transformation. The information will help to analyze the factors that influence DevOps transformation of software houses in the western cape, to analyse the challenges faced during the transformation process and to determine the transformation model used.

##### Request to you

With your considerable experience in the business, kindly share the factors that enabled your organisation to transform to DevOps, the challenges your company faced/facing during transformation as well as the transformation model used/ been used for transformation.

##### About the interview

The interview or questionnaire will take between 30 to 45 minutes. To ensure confidentiality of information, no attempt will be made to identify you with responses you make to the interview. So you

**Research Consent letter**

free to respond without any fear of victimization. Findings will be used for academic purposes, and recommendations may be used only to inform improvements, with no reference to the identity of the sources. Finally, this research is authorized by, and is in full compliance with the guidelines of the Cape Peninsula University of Technology (CPUT) research ethics.

Thank you for participating



Annie Mwansa Mwakawamfwa  
Researcher

**Agreement to participate:**

I am participating in this study out of the free will. I may refuse to participate, or can stop participating at any time, without being penalized for doing so. If I wish, I will be given a copy of this consent.


I John Mazanga.....(Position)

Director.....from

Stellaverse Inc...... (Company), hereby

accepts the invitation to participate in this research interview as outlined above.

Signed at on this 10th..day of February...2022

Signature .....

## APPENDIX B: ETHICS APPROVAL



PO Box 1906, Bellville, 7535 | Symphony Way, Bellville, Cape Town, South Africa  
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**Office of the Research Ethics Committee**  
Faculty of Informatics and Design  
Room 2.09  
80 Roeland Street  
Cape Town  
**Tel: 021-469 1012**  
**Email: [ndedem@cput.ac.za](mailto:ndedem@cput.ac.za)**  
**Secretary: Mziyanda Ndede**

2 November 2021

Annie Mwakawamfwa  
c/o Department of Information Technology  
CPUT

**Reference no:** 217173098/2021/35

**Project title:** Factors influencing DevOps adoption: A case of software development houses in the Western Cape

**Approval period:** 2 November 2021 – 31 December 2022

This is to certify that the Faculty of Informatics and Design Research Ethics Committee of the Cape Peninsula University of Technology approved the methodology and ethics of Anni Mwakawamfwa (217173098) for the Master of ICT.

Any amendments, extension or other modifications to the protocol must be submitted to the Research Ethics Committee for approval.

The Committee must be informed of any serious adverse event and/or termination of the study.



**Dr Blessing Makwambeni**  
**Acting Chair: Research Ethics Committee**  
**Faculty of Informatics and Design**  
**Cape Peninsula University of Technology**

**APPENDIX C: ETHICS COMPLIANCE AGREEMENT**



**Ethics Compliance Agreement**

Name: Annie Mwakawamfwa

Student No: 217173098

**Title of Thesis: Factors influencing DevOps adoption: A case of software development houses in the Western Cape**

I read and understood CPUT institutional Ethics requirements for my research. I will make sure I adhere to the stipulated ethics requirements

Signed: 

Date: 23rd September, 2021

# DevOps Questionnaire

Questionnaire Cover Letter

Date: .....

Dear Participant,

My name is Annie Mwakawamfwa and I am a Masters student at the Cape Peninsula University of Technology in pursuit of an Master of ICT specialisation. The research title for my thesis is "Factors influencing DevOps Transformation in Software Development Houses of the Western Cape". The aim of this research is to explore transformational models and underlying factors influencing DevOps transformation for Software Development Houses (SDH) in the Western Cape. To this end, DevOps transformation data (from Software Houses) will be gathered, analysed and evaluated. We think that DevOps transformational models need to be investigated further in order to provide more insights in best practices of delivering software.

I am inviting the Software Development Houses in the Western cape of South Africa to participate in this research study by completing the attached questionnaire which will take approximately 30 – 45 minutes

There is no compulsion for responding nor is there any company risk with the information attained in this interview/Questionnaire. In order to ensure that all information will remain confidential, the name of the company and individuals will not be mentioned publicly or in the final research work to be produced.

Thank you for taking the time to assist me in my educational endeavours. The data and information collected will be useful for the improvement in DevOps transformational agenda in Software Development Houses, it also serves in the advancement to South Africa at large, myself and future researchers.

Yours Sincerely,

-----  
Researcher Name: Annie Mwakawamfwa  
Contact No:0717680271  
Email Address: [AnnieMwaka08@gmail.com](mailto:AnnieMwaka08@gmail.com)





**APPENDIX C: QUESTIONNAIRE**

3 What percentage of your employees are in operations Department?

- 5% or less
- 6% to 10%
- 11% to 20%
- Other:

5 What prompted the company to adopt and embed DevOps?

Your answer

6 What were the specific activities (enablers) undertaken to support Devops transformation?

Your answer

7 What were the specific activities (enablers) undertaken to support Devops transformation?

Your answer

8 What were/are the major roadblocks to your DevOps transformation?



Your answer



9 Where all stakeholders involved in the transformation process?

Yes

No

10 Did senior management communicate the adoption and embedding of DevOps to the entire organisation? If yes how often do they communicate the change?

Your answer

11 If the adoption and embedding of DevOps was/ is communicated to the entire organisation what mode of communication was/ is used?

Town hall meetings

workshops

Seminar

Other:

12 Did all the stakeholders have the right skills for the organisation to transform to DevOps?

Yes

No



13 If the employees didn't have the right skills required to transform to DevOps how did the management fill up the gap?

- Re Skill
- Upskill
- Employed

14 Who was driving DevOps Leadership

- Consultant
- Management
- Team lead
- Other:

15 Was the Pre-DevOps value stream mapping exercise undertaken ?

- Yes
- No

16 Who Performed the value stream map?

Your answer

17 What problem were you trying to solve when the company obtained a value stream map?

Your answer

18 Did the company understand the scope of the problem they were trying to solve?

- Yes
- No
- Maybe

19 Does the company value stream map show any gaps in communication between teams and cross functions?

- Yes
- No

20 Does the value stream map cater for continuous improvement through iteration?

- Yes
- No

21 Has the company value stream map shown any reduction in terms of down time and process delay?

- Strongly agree
- Strongly disagree
- Neutral



21 Did the company conduct a skill's mapping exercise?

Yes

No

22 Where any lessons learnt generated?

Yes

No

If lessons were learnt what went right?

Your answer

If lessons were learnt what went wrong?

Your answer

23 How long did the transformation journey take from inception to completion?

Your answer



24 Did you do any DevOps maturity assessments?



Yes

No

25 When transforming to DevOps did you use any transformation model?

Yes

No

If yes what transformation model did you use?

Your answer

27 What was/is the reason behind the selection of the transformation model?.

Your answer

28 What has changed positively

Your answer

29 Has Continuous Integration (CI)/ Continuous Delivery (CD) Automation being achieved ?

Yes

No



30 Has collaboration between teams improved?

- Strongly agree
- Strongly disagree
- Neutral

31 Has the speed of software delivery improved?

- Strongly agree
- Strongly disagree
- Neutral

32 Has the number of defects in software reduced?

- yes
- No

33 Has the cost of Software Release reduced?

- Yes
- No

34 Has customer satisfaction improved?

- Strongly agree
- Strongly disagree
- Neutral



35 Has process management improved?





Yes

No

36 Has process management improved?

Strongly agree

Strongly disagree

Neutral

37 Has the number of workarounds decreased or increased under DevOps?

Yes

No

38 . Has quality of software improved?

Agree

Disagree

Neutral

39. Software performance metrics (Low, Mid, High)

1

2

3

4

5



40 Low Deployment frequency



- Monthly or less often (Low)
- Between daily and weekly(Mid)
- On demand (whenever we want)(High)

41 Lead time for changes

- Between a week and 6 months (Low)
- Less than a week (Mid)
- Less than an hour (High)

42 MTTR (Mean Time to Recovery)

- Less than a week (Low)
- Less than a day (Mid)
- Less than an hour (High)

Thank you so much, Appreciated

Submit

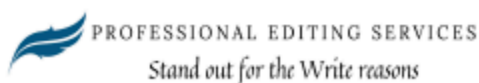
Clear form

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Google Forms

## APPENDIX D: EDITOR'S CERTIFICATE



Gerald T du Preez  
PhD

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### Certificate of Editing

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**FACTORS INFLUENCING DEVOPS TRANSFORMATION: A CASE STUDY**

By

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**APPENDIX E: THEMATIC ANALYSIS**

**WHAT PROMPTED THE COMPANY TO ADOPT AND EMBED DEVOPS?**

TABLE 6.1: RESPONSE TO WHAT PROMPTED COMPANY TO ADOPT AND EMBED DEVOPS.

RESPONDENT	RESPONSE	Keywords	Categories	Themes
R1	In a constantly changing environment and client requirements, it was critical for us to streamline our delivery pipeline to the client (managed by Development Team) and the feedback loop(managed by Operations Team).	Development Team Operations Team Requirements Streamline Delivery pipeline Client requirements Development team Feedback loop Operations team	IT Project Management Software Development Operations Management Customer/ Client Service	Agile methodology: To adapt to the constantly changing environment and client requirements, the team may have adopted agile methodology to streamline their delivery pipeline and feedback loop.  Collaboration: Streamlining the delivery pipeline and feedback loop requires collaboration between the Development Team and Operations Team, indicating the importance of teamwork and communication.  Continuous improvement: The need to streamline the delivery pipeline and feedback loop suggests that the team is focused on continuous improvement to enhance their processes and meet client requirements more efficiently.  Customer satisfaction: The ultimate goal of streamlining the delivery pipeline and feedback loop is to ensure customer

		Constantly changing environment.		satisfaction by delivering products and services that meet their changing requirements.
R2	Management decision	Decision	Management	<p>Strategic planning: The decision may be related to the development of a long-term strategy for the organisation, such as entering a new market or diversifying the product line.</p> <p>Risk management: The decision may involve identifying and mitigating potential risks to the organisation, such as financial, legal, or reputational risks.</p> <p>Resource allocation: The decision may relate to the allocation of organisational resources, such as budget, personnel, or technology, to support specific projects or initiatives.</p> <p>Change management: The decision may be related to managing change within the organisation, such as restructuring or implementing a new process or technology.</p> <p>Performance improvement: The decision may aim to improve the overall performance of the organisation, such as by increasing productivity, efficiency, or quality of products or services.</p>

R3	We were informed as the new company direction	new company direction	Business Strategy	<p>Strategic planning: The new company direction may be related to the development of a long-term strategy for the organisation, such as entering a new market or diversifying the product line.</p> <p>Organisational change: The new company direction may involve significant changes to the structure, culture, or processes of the organisation, such as restructuring or implementing new policies.</p> <p>Innovation: The new company direction may aim to promote innovation within the organisation, such as developing new products, services, or business models.</p> <p>Growth: The new company direction may focus on growth opportunities for the organisation, such as expanding into new markets or acquiring new businesses.</p> <p>Customer focus: The new company direction may prioritise the needs and expectations of customers, such as by improving the quality or delivery of products or services.</p>
R4	I think the urge to deliver quality software	Quality software	Software Development" or "Quality Assurance".	Customer Satisfaction: The focus on delivering quality software suggests that the organisation places a high value on meeting or exceeding customer expectations, which can improve customer satisfaction and loyalty.

				<p>Continuous Improvement: The urge to deliver quality software implies a commitment to continuously improving processes, methodologies, and technologies to ensure that software quality remains high and consistent over time.</p> <p>Software Development Process: The emphasis on quality software suggests that the organisation prioritises implementing effective software development processes, including quality assurance, testing, and code review, to ensure that the final product meets high standards.</p> <p>Technical Excellence: The focus on quality software may reflect a culture of technical excellence within the organisation, emphasising the use of modern software development tools, techniques, and best practices to produce software of the highest possible quality.</p>
R5	To deliver software quickly to customers	Deliver software quickly	Software Development or Agile Methodology.	<p>Agile Software Development: The focus on delivering software quickly suggests that the organisation may prioritise Agile software development methodologies, such as Scrum or Kanban, to enable rapid delivery of software updates and features.</p> <p>Time-to-Market: The emphasis on quick delivery of software may reflect a focus on reducing time-to-market for new products or</p>

				<p>features, which can help the organisation stay ahead of competitors and respond to changing customer needs.</p> <p>Continuous Delivery: The focus on delivering software quickly may reflect a commitment to continuous delivery, which emphasises the use of automation and collaboration tools to speed up the development, testing, and deployment of software updates.</p> <p>Customer Satisfaction: The emphasis on delivering software quickly may reflect a desire to meet or exceed customer expectations, by delivering updates and features quickly and frequently to address customer needs and preferences.</p> <p>Efficiency and Productivity: The focus on delivering software quickly may reflect a culture of efficiency and productivity within the organisation, emphasising the use of efficient development processes, tools, and techniques to accelerate software delivery while maintaining high-quality standards.</p>
R6	I think the urge to deliver quality software and quickly	Quality software	Software Development or Agile Methodology	<p>Agile Software Development: The focus on delivering quality software quickly suggests that the organisation may prioritise Agile software development methodologies, such as Scrum or Kanban, to enable rapid delivery of software updates and features while maintaining high-quality standards.</p>



				<p>Time-to-Market: The emphasis on delivering quality software quickly may reflect a focus on reducing time-to-market for new products or features, which can help the organisation stay ahead of competitors and respond to changing customer needs.</p> <p>Continuous Delivery: The focus on delivering quality software quickly may reflect a commitment to continuous delivery, which emphasises the use of automation and collaboration tools to speed up the development, testing, and deployment of software updates while maintaining high-quality standards.</p> <p>Customer Satisfaction: The emphasis on delivering quality software quickly may reflect a desire to meet or exceed customer expectations, by delivering updates and features quickly and frequently to address customer needs and preferences, while also ensuring the software meets high quality standards.</p> <p>Efficiency and Productivity: The focus on delivering quality software quickly may reflect a culture of efficiency and productivity within the organisation, emphasising the use of efficient development processes, tools, and techniques to accelerate software delivery while maintaining high-quality standards.</p>
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**What were the specific activities (enablers) undertaken to support DevOps transformation?**

TABLE 6.2: RESPONSE TO WHAT WERE THE SPECIFIC ACTIVITIES (ENABLERS) UNDERTAKEN TO SUPPORT DEVOPS TRANSFORMATION?

Respondent	Response	Keywords	Categories	Themes
R1	<p>We intensely focused on the following activities as guidelines to imbed the culture of DevOps: "We intensely focused on the following activities as guidelines to imbed the culture of DevOps :</p> <p>1. Ensure that the Operations Team is involved continually during the development and testing process, not only at the release stage. We achieve this continuous integration by using CodeMagic integrated within Slack to ensure automated builds and tests are run.</p> <p>2. Our design architecture approach is subdivided into microservices that we will offer clients as individual services of a</p>	<p>Operations Team involvement</p> <p>Microservices design architecture</p> <p>Automated monitoring and logging</p> <p>Continuous communication</p> <p>Incentive mechanisms</p>	<p>Continuous Integration</p> <p>Microservices Architecture</p> <p>Automated Monitoring and Logging</p> <p>Continuous Communication</p> <p>Incentive Mechanisms</p>	<p>The themes in these guidelines to embed the culture of DevOps are:</p> <p>Continuous integration and involvement of the Operations team throughout the development and testing process.</p> <p>Subdivision of design architecture into microservices to allow teams to be focused and identify problems quickly.</p> <p>Automated monitoring and logging to ensure client complaints are handled by the correct team and reduce frustration.</p> <p>Continuous communication across the organisation using a single communication</p>

	<p>complete suite. Subdividing services allows the teams to be focused, identify problems quickly and get the relevant team member to fix them. For example, we currently offer a marketing tool, analytics tool, positioning tool, mapping tool, and all these are separate functional modules.</p> <p>3. Automated monitoring and logging - at an operational level, it is critical that client complaints are handled by the correct team and the appropriate level of expertise based on risk level, affected client priority, technical requirements to fix the problem, etc. Automating the process from the client logging side past the ops to the dev team is critical for efficiency and reducing frustration to the teams. In practice, we implement 1st to 4th line support systems and also the tier 0 which is self-service that we are currently implementing.</p> <p>4. Continuous communication is critical for our work in DevOps, and we absolutely believe that everything breaks</p>	<p>DevOps culture</p> <p>CodeMagic</p> <p>Slack</p> <p>Automated builds and tests</p> <p>Individual services</p> <p>Focused teams</p> <p>Client complaints handling</p> <p>1st to 4th line support systems</p> <p>Tier 0 self-service</p> <p>Connected teams</p> <p>Single communication platform</p> <p>Transparency</p>		<p>platform with complete transparency among teams and access to information.</p> <p>Incentive mechanisms to encourage collaboration between teams and reward innovation to make the work of other teams easier to handle.</p>
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	<p>due to lack of communication at the right levels and at the right time. We do not work in siloes and completely run connected teams. We achieve this by using a single communication platform with complete transparency among the teams and access to information. Chat platforms, open sprint planning and tracking, open access to meeting notes and ideas are all integrated across the organisation.</p> <p>5. Creating incentive mechanisms that encourage collaboration between teams is critical. We realised early on that siloed teams are mainly due to how the incentives are set up. We reward teams based on how they innovate to make the work of the other team easier to handle—this encompasses communication, delivery methods, architecture design, etc. "</p>	<p>Incentivising collaboration</p> <p>Innovation</p> <p>Delivery methods.</p>		
R2	I attended DevOps training	DevOps	Information Technology	DevOps Training." The theme refers to the main subject or topic of the statement. In this case, the main subject is the training

				attended on DevOps, which suggests a focus on learning about the principles and practices of DevOps methodology.
R3	Knowledge transfer within the teams	Knowledge transfer	Business or Management	Knowledge transfer within teams.
R4	Knowledge sharing within the teams	Knowledge sharing	Business or Management	Knowledge transfer within teams.
R5	Self-study and knowledge transfer	Self-study and Knowledge transfer.	Education or Learning and Development	Self-study and Knowledge transfer.
R6	I attended DevOps training	DevOps	Information Technology	DevOps Training. The theme refers to the main subject or topic of the statement. In this case, the main subject is the training attended on DevOps, which suggests a focus on learning about the principles and practices of DevOps methodology.

**What were/are the major roadblocks to your DevOps transformation?**

TABLE 6.3: RESPONSE TO WHAT WERE/ARE THE MAJOR ROADBLOCKS TO YOUR DEVOPS TRANSFORMATION?

RESPONDENT	RESPONSE	Keywords	Category	Theme
R1	<p>1. Rapid changes in client requirements - clients are always changing their delivery requirements due to market changes, and this has to be handled quickly by the Sales Teams, Ops Teams, and Dev Teams in a seamless collaborative fashion.</p> <p>2. Incentive mechanisms—it is part of our goal to ensure that incentives encourage collaboration. However, this is more difficult to implement than it seems, as we have to clearly measure what that means and allocate the reward system accordingly. We are still figuring this out.</p> <p>3. Implementation cost - DevOps is great at achieving efficiencies but also requires great software tools for implementation. This requires an unwavering willingness</p>	<p>Rapid changes, client requirements, Sales Teams, Ops Teams, Dev Teams, collaborative fashion.</p> <p>Incentive mechanisms, collaboration, measure, allocate, reward system.</p> <p>Implementation cost, DevOps, efficiencies, software tools, investment, hiring, capital cost, startup, investors, shareholders.</p> <p>Training, local developers, hackers, discipline, system procedures, scalable systems, educational system fault, rewarding, students,</p>	<p>Client management and collaboration.</p> <p>Incentive and reward systems.</p> <p>Implementation and investment.</p> <p>Developer training and education.</p>	<p>Agile and Collaborative Development</p> <p>Incentive Systems and Collaboration</p> <p>DevOps Implementation and Cost Management</p> <p>Education and Skill Development in Software Engineering.</p>

	<p>to invest in the right software tools to achieve the requirements and hiring the right teams to work for us. The capital cost of any other way of doing it is less than the correct way of doing it, and as a startup, every cent that we spend has to be explained to both investors and shareholders, not only how it affects the long time but in the South African climate, how it affects the short term as well.</p> <p>4. Training—most local developers are generally "hackers"; they can make the system work. However, they lack the discipline and system procedures to implement scalable systems. This is an educational system fault at large which has to be resolved mainly by rewarding students based on understanding development procedure, not only producing functional code and education on the complete development and delivery pipeline.</p>	<p>development procedure, functional code, delivery pipeline.</p>		
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R2	Time seemed to be too little	Time scarcity	Time Management	Productivity
R3	To find companies to benchmark with	Benchmarking	Business or Management	Benchmarking
R4	To maintain consistency in the ways of working	Consistency, Ways of working	Process Improvement	Process management or process standardisation.
R5	To reach the required levels of trust	Required levels of trust	Team Dynamics	Trust Building within a Team at Workplace
R6	Embracing the new DevOps ways of working	Embracing, DevOps, ways of working	Organisational change or Technology adoption	Adoption of DevOps methodology



***If the employees didn't have the right skills required to transform to DevOps how did the management fill up the gap?***

*TABLE 6.4: RESPONSE TO IF THE EMPLOYEES DIDN'T HAVE THE RIGHT SKILLS REQUIRED TO TRANSFORM TO DEVOPS HOW DID THE MANAGEMENT FILL UP THE GAP?*

<b>RESPONDENT</b>	<b>RESPONSE</b>	<b>Keywords</b>	<b>Category</b>	<b>Theme</b>
R1	Upskill	Upskill	Competence	Education
R2	Upskill	Upskill	Competence	Education
R3	Upskill	Upskill	Competence	Education
R4	Short Training	Short Training	Training	Education
R5	Short Training	Short Training	Training	Education
R6	Short Training	Short Training	Training	Education

### Who was driving DevOps Leadership?

TABLE 6.5: RESPONSE TO WHO WAS DRIVING DEVOPS LEADERSHIP?

RESPONDENT	RESPONSE	Keywords	Category	Theme
R1	Team lead	Team lead	Business	Management
R2	CEO	CEO	Business	Management
R3	Team lead	Team lead	Business	Management
R4	CEO	CEO	Business	Management
R5	CEO	CEO	Business	Management
R6	Team lead	Team lead	Business	Management

**Who Performed the value stream map?**

TABLE 6.6: RESPONSE TO WHO PERFORMED THE VALUE STREAM MAP?

RESPONDENT	RESPONSE	Keywords	Category	Themes
R1	Management	Management	Business	Management
R2	Management	Management	Business	Management
R3	Management	Management	Business	Management
R4	Management	Management	Business	Management
R5	Management	Management	Business	Management
R6	Management	Management	Business	Management

**What problem were you trying to solve when the company obtained a value stream map?**

TABLE 6.7: RESPONSE TO WHAT PROBLEM WERE YOU TRYING TO SOLVE WHEN THE COMPANY OBTAINED A VALUE STREAM MAP?

RESPONDENT	RESPONSE	Keywords	Category	Themes
R1	Process time—we wanted to ensure that the team, given all necessary information in the correct format would execute quickly with minimal challenges.	Process time Team Necessary information Correct format Execute quickly Minimal challenges	Objective: Ensuring quick execution with minimal challenges  Process: Steps or actions taken to achieve the objective  Team: Group of individuals responsible for executing the process  Information: Necessary data or details needed to carry out the process  Format: The structure or arrangement of the information  Efficiency: The speed and effectiveness of the process execution	Efficiency and speed  Effective communication of necessary information  Proper formatting of information  Team collaboration and coordination  Identifying and addressing potential challenges in the process  Continuous improvement and optimisation of the process

R2	Less defects	Defects	Quality Control/Quality Assurance.	Improving the quality of products or services by reducing the number of defects
R3	Long delivery time	Delivery time	Logistics	Addressing the issue of extended delivery times to improve customer satisfaction
R4	Efficiency	Efficiency	Business Operations/Management.	Maximising productivity and minimising waste by streamlining business operations and processes.
R5	Quality of code	Code	Software Development	Ensuring that software code is of high quality, meets industry standards, and is optimised for performance, reliability, and maintainability.
R6	Communication channels	Communication channels	Communication	Identifying and utilising appropriate channels of communication to facilitate effective and efficient communication within a team or organisation.

***If lessons were learned what went right?***

TABLE 6.8: RESPONSE TO IF LESSONS WERE LEARNED WHAT WENT RIGHT?

ROLE	RESPONSE	Keywords	Category	Themes
R1	We realised that most individuals we hired were experts in their individual siloes, which did not completely benefit the overall team at this stage of the organisation. We quickly implemented an 80/20 split where every team member would work 80% in their core competence and 20% in the rest of the organisation. This quickly improved collaboration and general empathy whenever work is delivered, understanding challenges at all levels.	Individual siloes Core competence Collaboration Empathy Work delivery Challenges 80/20 split.	Hiring Strategy Team Management Skillset Allocation Collaboration Empathy Building Work Delivery Organisational Challenges 80/20 Split.	Specialisation vs Generalisation in hiring strategy Balancing core competencies with cross-functional collaboration Improving team dynamics and communication Understanding and addressing organisational challenges Empathy building and fostering mutual understanding between team members Continuous improvement and optimisation of team performance

R2	Communication	Communication	Communication	Communication channel
R3	We realised that most of the challenges were around communication. However, not just unwillingness to communicate but comfort to communicate a certain way. Some are verbal communicators, some prefer text, and most were visual communicators. We have to strike a decentralised balance across the teams to ensure the maximum impact. We are still figuring this out."	Communication challenges Verbal communication Text communication Visual communication Decentralised balance Impact.	Communication Communication Preferences Team Dynamics Decentralisation Collaboration Impact Maximisation.	Understanding and addressing communication challenges Recognising and respecting different communication preferences Improving team dynamics and collaboration Decentralisation of communication channels Maximising the impact of communication Continuous improvement and optimisation of communication strategies.
R4	Communication	Communication	Communication channels	Communication channels
R5	Meeting expectations	Expectations	Performance measurement	Fulfilling the requirements
R6	Customer satisfaction			

***If lessons were learnt what went wrong?***

*TABLE 6.9: RESPONSE TO IF LESSONS WERE LEARNT WHAT WENT WRONG?*

<b>RESPONDENT</b>	<b>RESPONSE</b>	<b>Keywords</b>	<b>Categories</b>	<b>Theme</b>
R1	Our incentives we more aligned with technical expertise than collaborative skills. Well, we have not figured how to fix this and more importantly, how to measure this not only using results but during the process.	Incentives, Technical expertise Collaborative skills	Human Resources: incentives and skills (technical and collaborative).  Management and Leadership: fixing the misalignment and measuring performance.  Performance Evaluation: measuring performance not only based on results but also during the process	Incentives and Rewards: The focus of incentives is on technical expertise rather than collaborative skills, which indicates that incentives play a crucial role in driving performance and behaviour.  Technical and Collaborative Skills: The distinction between technical expertise and collaborative skills highlights the importance of both in the workplace.  Performance Measurement: The need to measure performance is emphasised, particularly in terms of collaborative skills.



				<p>Continuous Improvement: The recognition that the issue needs to be addressed and fixed indicates a commitment to continuous improvement.</p> <p>Process Improvement: Measuring performance during the process is a theme that suggests a focus on process improvement rather than just outcomes.</p>
R2	Some delays experienced	Delays	Problem reporting	Obstacles that hinder progress
R3	Collaboration was initially difficult to achieve	Collaboration	Problem reporting	Challenges in establishing collaboration among individuals or groups in a work setting.
R4	Trust	Trust	Trust	Trust
R5	Some delays experienced	Delays	Problem reporting	Obstacles that hinder progress
R6	Some delays were experienced	Delays	Problem reporting	Obstacles that hinder progress

**What transformation model did you use?**

TABLE 6.10: RESPONSE TO WHAT TRANSFORMATION MODEL DID YOU USE?

RESPONDENT	RESPONSE	Keywords	Category	Theme
R1	Agile DevOps Transformation Model	Agile DevOps Transformation Model	Framework or Methodology	Transforming the software development and operations process to be more agile and efficient.
R2	Agile DevOps Transformation Model	Agile DevOps Transformation Model	Framework or Methodology	Transforming the software development and operations process to be more agile and efficient.

R3	Agile DevOps Transformation Model	Agile DevOps Transformation Model	Framework or Methodology	Transforming the software development and operations process to be more agile and efficient.
R4	Agile DevOps Transformation Model	Agile DevOps Transformation Model	Framework or Methodology	Transforming the software development and operations process to be more agile and efficient.
R5	Agile DevOps Transformation Model	Agile DevOps Transformation Model	Framework or Methodology	Transforming the software development and operations process to be more agile and efficient.

R6	Agile DevOps Transformation Model	Agile DevOps Transformation Model	Framework or Methodology	Transforming the software development and operations process to be more agile and efficient.
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**What was the reason behind the selection of the transformation model?**

TABLE 6.11: RESPONSE TO WHAT WAS THE REASON BEHIND THE SELECTION OF THE TRANSFORMATION MODEL

RESPONDENT	RESPONSE	Keywords	Category	Themes
R1	It is a faster approach to measure progress and implement changes	Faster approach, measure progress, implement changes	DevOps methodology/ approach	Suggests an agile methodology or similar iterative development process that prioritises speed and responsiveness.
R2	It's faster	Faster	Faster	
R3	It's good	Good	Good	Good
R4	No Comment			
R5	No Comment			
R6	No Comment			

## **APPENDIX F QUESTIONNAIRE DESIGN**

### **Section 1: Unfreezing (Current State)**

In these questions, we aimed to understand participants perceptions of their current state and the need for change to DevOps.

**Q5: What prompted the company to adopt and embed DevOps?**

**Q6: What were the specific activities (enablers) undertaken to support DevOps transformation?**

**Q7: What were the specific activities (enablers) undertaken to support DevOps transformation?**

**Q8: What were/are the major roadblocks to your DevOps transformation?**

**Q9: Where all stakeholders involved in the transformation process?**

**Q10: Did senior management communicate the DevOps transformation and embedding of DevOps to the entire organisation? If yes how often do, they communicate the change?**

**Q11: If the DevOps transformation and embedding of DevOps was/ is communicated to the entire organisation what mode of communication was/ is used?**

**Q12: Did all the stakeholders have the right skills for the organisation to transform to DevOps?**

**Q13: If the employees did not have the right skills required to transform to DevOps how did the management fill up the gap?**

**Q14: Who was driving the leadership?**

**Q15: Was the Pre-DevOps value stream mapping exercise undertaken?**

**Q16: Who Performed the value stream map?**

### **Section 2: Change (Transition)**

In these questions related to transition, we explored the thoughts and feelings of participants related to the change process to DevOps.

**What were the specific activities (enablers) undertaken to support DevOps transformation?**

**What were your concerns or reservations about the proposed change?**

**What were/are the major roadblocks to your DevOps transformation?**

**Where all stakeholders involved in the transformation process?**

### ***Section 3: Refreezing (Future State)***

In these questions, we considered participants vision for the future and their commitment to the change top DevOps.

**What has changed positively?**

**Has Continuous Integration (CI)/ Continuous Delivery (CD) Automation been achieved?**

**Has collaboration between teams improved?**

**Has the speed of software delivery improved?**

**Has the number of defects in software reduced?**

**Has the cost of Software Release reduced?**

**Has customer satisfaction improved?**

Generally, the questionnaire was divided into two portions; the first section included descriptive statistical inquiries about the demographics of the respondents and organisations. The company's demographics are part of the qualitative data, and they are essential since they contextualise the respondent's experience with DevOps features. The questionnaire's second portion contained both closed- and open-ended questions.

The questionnaire's validity was checked during the test by three business professionals. These experts have a great deal of experience creating enterprise applications using DevOps. The experts reviewed the descriptive and objective questions, and they were asked for their opinions. The experts were also directed to search for any ambiguity or misleading information that can result in misinterpretation and biased or incorrect statistics.