Investigating Agile Adoption in Saudi Arabian Software Industry

Fahad Sulaiman Altuwaijri, BSc, MSc
School of Computing and Communications
Lancaster University

A thesis submitted for the degree of
Doctor of Philosophy

November, 2022

Declaration

I declare that the work presented in this thesis is, to the best of my knowledge and belief, original and my own work. The material has not been submitted, either in whole or in part, for a degree at this, or any other university. This thesis does not exceed the maximum permitted word length of 80,000 words including appendices and footnotes, but excluding the bibliography. A rough estimate of the word count is: 66192

Fahad Sulaiman Altuwaijri

Investigating Agile Adoption in Saudi Arabian Software Industry

Fahad Sulaiman Altuwaijri, BSc, MSc.
School of Computing and Communications, Lancaster University

A thesis submitted for the degree of *Doctor of Philosophy*. November, 2022

Abstract

Agile is an established software development methodology that helps develop software by improving time to market, quality, customer engagement and reducing costs. Factors underpinning its adoption, such as social and technical factors, have been widely researched. However, most of these studies have been conducted in developed countries, particularly Europe and North America, with only a handful of studies carried out in developing countries, particularly in the Middle East. This is problematic given the strategic and economic importance of the software industry in such places as Saudi Arabia, where Agile adoption remains in the early stages, despite the country heavily investing in this industry in recent years to diversify its oil-dependent economy. Therefore, this thesis empirically investigates the factors influencing Agile adoption by Saudi Arabian software SMEs.

The research starts with reviewing existing literature on Agile adoption to explore its influential factors. Then, it proposes a framework incorporating these factors from literature. A series of empirical studies are conducted, and they are outlined below. Firstly, a mixed-methods study, including four expert interviews and a survey with 31 participants, is employed to understand the awareness and perceptions of Agile. Secondly, a multi-case study, involving semi-structured interviews with 12 software practitioners and a focus group discussion with five practitioners in three software SMEs, investigates the influential factors by refining the proposed framework. Thirdly, 132 participants completed a questionnaire to evaluate the impact of Agile adoption factors within Saudi software SMEs.

The results reveal a low level of awareness and usage of Agile in Saudi Arabia. Several factors are identified as enablers for Agile adoption, such as team capability, organisational environment, and tools and technologies, while the most significant hindrances are pinpointed as organisational culture, awareness and knowledge, and customer involvement. The thesis finally introduces a framework incorporating Agile adoption factors, which can serve as a research tool and a guideline for software SMEs in Saudi Arabia and other Middle Eastern countries, notably the Gulf Cooperation Council member countries, who wish to adopt Agile. Overall, this thesis provides valuable information to help software practitioners, senior management, decision makers and government bodies understand the factors influencing Agile adoption and ways of increasing Agile awareness and knowledge among stakeholders, which can assist in the adoption and use of Agile in the country.

Publications

The list below details the publications which contribute to the research described in this thesis.

Contributing Publications

- **Altuwaijri, F.S.** and Ferrario, M.A., (2020, June). "Investigating Agile Adoption in Saudi Arabian Mobile Application Development". In *International Conference on Agile Software Development Workshops, XP2020*. Ed. by Maria Paasivaara and Philippe Kruchten. Cham: Springer International Publishing, (pp. 265-271). ISBN: 978-3-030-58858-8. Springer, Cham.

- **Altuwaijri, F.S.** and Ferrario, M.A., (2021, May). "Awareness and Perception of Agile in Saudi Software Industry". In *2021 IEEE/ACM 43rd International Conference on Software Engineering: Software Engineering in Society (ICSE-SEIS)*, (pp. 10-18). IEEE, Madrid, Spain. doi: 10.1109/ICSE-SEIS52602.2021.00010. [**This paper received the Distinguished Paper Award for ICSE-SEIS 2021**]

- **Altuwaijri, F.S.** and Ferrario, M.A., (2021, November). "A Framework for the Adoption of Agile within Software SMEs in Saudi Arabia". In *2021 2nd European Symposium on Software Engineering (ESSE 2021)*, (pp. 73–77). ACM, New York, USA. doi: https://doi.org/10.1145/3501774.3501785

- **Altuwaijri, F.S.** and Ferrario, M.A., (2022, August). "Factors affecting Agile adoption: An industry research study of the mobile app sector in Saudi Arabia". *Journal of systems and software*, 190, p.11134. doi: https://doi.org/10.1016/j.jss.2022.111347

Contributing Publications under Preparation

- "A Systematic Literature Review on Research of Agile in Mobile Application Development".

- "The Impact of Factors on Agile Adoption: An Evaluation Study of Saudi Arabian Software Industry".

Acknowledgements

First of all, all my thanks and praise go to Almighty Allah for giving me the opportunity, patience and strength to complete this thesis. I give special thanks to my dear mother, Norah, for her unconditional support, motivation and prayers for me to attain my goal. I could never forget to express my gratitude to my father, who passed away before I travelled abroad to study, for supporting me to believe in myself and showing me the way to a happy life. May Allah grant him mercy, forgiveness and the highest level of Jannah.

I am thankful to my supervisor, Dr Maria Angela Ferrario, who has been a wonderful supervisor, for her precious feedback, endless encouragement, motivation, invaluable guidance and patience to complete this thesis, and for everything she has done to me during my PhD journey. I would also like to thank panel members Dr Gerald Kotonya, Dr Antonios Gouglidis and Dr Jean Petric for their invaluable feedback and comments, which have been instrumental to my PhD success. I also wish to extend my gratitude to Dr Amit Chopra, Dr Ahmad Daryanto and Dr Sandra Awanis for the comments and precious they offered to me during my studies. I also want to acknowledge the well-equipped environment and intellectual atmosphere provided by the School of Computing and Communications at Lancaster University.

I am extremely grateful to Qassim University in Saudi Arabia for their financial support and granting me this opportunity to complete my PhD degree at Lancaster University. I also extend my thanks to the Saudi Arabian Cultural Bureau in London for supporting me during my PhD journey. Special thanks go to the organisations and participants for their cooperation and for kindly taking part in this research. A warm thanks to a number of people who have supported me during my studies with their expertise and invaluable advice, especially Dr Ali Alkhalifah, Dr Sultan Alharbi, Dr Abdullah Altaleb, Dr Armaya'u Zango Umar, Dr James Gaskin and Dr Ibrahim Alghamdi.

Finally, I would like to give my deep thanks to my family and friends for their encouragement, support and prayers. My sincere thanks also go to my wife, Mrs Najla Alrubayan, for her patience, assistance and prayers and the same for my two sons, Hussam and Rayan.

Contents

List of Figures

List of Tables

List of Abbreviations

SMEs	Small and Medium-sized Enterprises
SMEGA	Small and Medium Enterprises General Authority
PLS-SEM	Partial Least Squares-Structural Equation Modelling
NTP	National Transformation Program
GDP	Gross Domestic Product
ICT	Information and Communications Technology
MCIT	Ministry of Communications and Information Technology
CITC	Communications and Information Technology Commission
PDI	Power Distance Index
IDV	Individualism versus collectivism
MAS	Masculinity versus Femininity
UAI	Uncertainty Avoidance Index
LTO	Long- vs. Short-term Orientation
IND	Indulgence versus Impulses
SEM	Structural Equation Modelling
FSTREC	Faculty of Science and Technology Research Ethics Committee
CMB	Common Method Bias
CB-SEM	Covariance Based-Structural Equation Modelling
CR	Composite Reliability
AVE	Average Variance Extracted
VIF	Variance Inflation Factor

Chapter 1

Introduction

This thesis presents the research undertaken to identify, investigate and evaluate the factors that can support or challenge the adoption of Agile software development in small and medium-sized software organisations in the Kingdom of Saudi Arabia. This introductory chapter provides an overview of the present research, then the research motivation and scope are provided. After that, it discusses the research aim and objectives, followed by the research questions. Subsequently, details about the research methodology used in this research are provided, followed by the contribution statement. The chapter ends with a description of the structure of this thesis.

1.1 Overview

Agile software development (this will be referred to as 'Agile' throughout this thesis) is a software development methodology that is adaptive, iterative, incremental and people orientated, where demands and solutions evolve through the collaboration of self-organising cross-functional teams (Abbas *et al.*, 2008; Beck *et al.*, 2001; Highsmith and Highsmith, 2002; Larman and Basili, 2003). Agile can help support and manage the dynamic nature of software development, as it helps to develop software by reducing time to market and costs of software products, in addition to improving software quality and customer satisfaction.

Agile divides the development of software into phases that are completed iteratively and incrementally. Clients give their feedback after each phase and can also request changes to improve the software. Many software companies have adopted Agile methods for their software development, in particular in small-sized projects, such as component-based web applications, cloud-based applications, and mobile applications. Agile methods are flexible and are, therefore, appropriate for responding to constant changes and rapid software updates (Larman, 2004; Boehm and Turner, 2003).

While other methodologies discourage changes or try to control them, the Agile mindset encourages change throughout the development process and the collection of client feedback and collaboration during all of the stages of the development process (Abrahamsson *et al.*, 2002; Highsmith and Cockburn, 2001; Williams and Cockburn, 2003). Agile practices tackle the hardest challenges that have been faced by technology and businesses in recent years. These challenges include the need for a dynamic work environment in response to frequent changes and the need for an innovative software development approach (Highsmith and Cockburn, 2001). Since its inception, Agile practices have evolved overtime and several Agile methods have emerged, all of which share the same Agile principles. Such methods include Scrum, Crystal and Extreme Programming, and software engineers may adhere to only one practice or mix and match two or more practices based on their needs.

Although Agile methods offer several benefits outlined above, they are not without their challenges, and organisations trying to adopt Agile methods should be aware of these. The barriers to Agile development include technical and social aspects such as team capability and organisational culture (Boehm and Turner, 2005; Highsmith and Cockburn, 2001; Chow and Cao, 2008; Strode *et al.*, 2009). However, the adoption of Agile is mainly based on people and communities that practise them. This means that Agile is not necessarily suitable for all cultures, as asserted by Lindvall *et al.* (2002, p. 206), *"Agile methods need cultural support otherwise they will not succeed."*

Agile is based on a set of twelve guiding principles and four values (Beck *et al.*, 2001). Although these underpin software engineering practice across the world, it is worth noting that their roots are quintessentially western. The very birth of the Agile Manifesto took place at a United States ski resort, where a fairly culturally homogenous group of software practitioners met and introduced Agile to the world (Beck *et al.*, 2001). With this observation, we mean not to detract from the importance of Agile, but instead wish to draw attention to possible influential factors (i.e. social and technical) that may affect Agile adoption in countries with distinctly different value orientations (Winter *et al.*, 2018, 2019). Hence, organisations need to develop cultural and value aware approaches if they wish to encourage and support their teams to adopt and use Agile (Gregory and Taylor, 2019; Agile Business Consortium, 2017).

1.2 Research Motivation

Agile adoption largely depends on social factors, such as customer involvement and organisational culture (Chow and Cao, 2008; Robinson and Sharp, 2005), meaning that adoption varies according to the cultural differences of the customers and practitioners. According to the literature, influential factors of Agile adoption have attracted much research over the years; however, most of these studies have been conducted in the context of developed countries, particularly in Europe and North

America (Begel and Nagappan, 2007; Chow and Cao, 2008; Salo and Abrahamsson, 2008; Rodríguez *et al.*, 2012; Sheffield and Lemétayer, 2013; Santos *et al.*, 2016; Tam *et al.*, 2020), with only a handful being carried out in developing countries (de O. Melo *et al.*, 2013; Nazir *et al.*, 2016; Salinas *et al.*, 2018; Vithana *et al.*, 2018), particularly in the Middle East. The lack of studies about Agile in Middle Eastern nations such as Saudi Arabia has been a motivating factor of this research, which is conducted to investigate Agile adoption factors from the perspective of Saudi practitioners.

Scientifically and strategically, Saudi Arabia provides an interesting context for this research. Firstly, Agile is a values-based and principled approach to software development that emanated from a rather homogeneous Western worldview of software development. However, Saudi Arabian culture is grounded in different social systems and structures, such as the tribal system and religious observance, which play a crucial role in defining obligations, traditions and social norms in the society and in the workplace (Idris, 2007; Al-Saggaf, 2004; Abdullah *et al.*, 2006). Secondly, in recent years, developing countries such as Saudi Arabia have been heavily investing in the software industry sector, seen as a strategic direction for diversifying the economy beyond the oil industry (Vision2030, 2017; Moshashai *et al.*, 2020). Therefore, neglecting a geographic area where the software industry is rapidly growing seems to be strategically limited.

Therefore, the purpose of this research is to gain a deeper insight into the factors that can support or challenge Agile adoption in the Kingdom of Saudi Arabia, in order to guide organisations to adopt Agile. Specifically, this study focuses on software companies in the small and medium-sized enterprise (SMEs) sector, as the government of Saudi Arabia is making a large-scale effort to support this sector by launching the Small and Medium Enterprises General Authority (SMEGA), so that it may play a major role in diversifying the economy (Monshaat, 2019). SMEGA aims to provide financial guarantees, business incubators and places at training institutions to assist young people and innovators in establishing their own businesses.

To achieve the goals of this thesis, we conduct an empirical investigation of Agile adoption factors in a real-life context, to provide a better understanding of these factors and their impact on the adoption of Agile within the Saudi Arabian software industry. This investigation is conducted through three phases that will be discussed late in this thesis. The scope of the first and second phases focuses on mobile development practice, which is considered one of the fastest-growing sectors of the software industry, both worldwide (Ahmad *et al.*, 2018; Statista, 2020*a*,*b*) and in Saudi Arabia (Communications and Information Technology Commission, 2020; Ernst Young Global Limited, 2019), while the third phase focuses on the software industry in general, as a large sample size is required. Empirical research can provide data to guide the future direction of software engineering and enhance the depth of scientific knowledge in the field.

This research begins by investigating the awareness, current use and perceptions of Agile among mobile app practitioners in Saudi Arabia using a mixed-methods approach through the use of semi-structured interviews with four Agile experts, followed by a survey questionnaire including 31 participants, who have either adopted Agile methods or not. After that, the influential factors (i.e. people, organisational, environmental and technical) are studied, as this is the focal point of this research, through the use of semi-structured interviews with 12 Agile practitioners and a focus group including five practitioners, who all work in Saudi software SMEs. Finally, these factors are examined in terms of their impact on the adoption of Agile in this country and their relationships to adopting Agile using a quantitative research approach in the form of a questionnaire answered by 132 software practitioners.

1.3 Research Aims and Objectives

This research aims to investigate the significant factors (e.g. social and technical) that can support or challenge the adoption of Agile in software SMEs in the Kingdom of Saudi Arabia. It is expected that Middle Eastern countries, notably the Gulf Cooperation Council member countries, will also benefit from the findings of this research. This aim will be achieved by fulfilling the following main objectives:

1. Review the relevant literature and identify the factors that can affect the adoption of Agile.

2. Develop a research framework that can be utilised to guide and support the empirical investigation of Agile adoption in the Saudi Arabian software industry.

3. Investigate the awareness, usage and perceptions of Agile among Saudi software practitioners through empirical research.

4. Obtain a deeper insight into the factors that can influence Agile adoption in the Saudi Arabian software industry through empirical research.

5. Measure the influential factors represented in the framework using empirical research, to understand their impact on Agile adoption by the Saudi Arabian software industry.

The objectives outlined above underpin the research questions that this thesis addresses. These questions are discussed in the following section, and their answers will determine the extent to which these objectives are achieved.

1.4 Research Questions

The ultimate goal of this research is to provide guidance to the Saudi Arabian software industry and businesses that seek to harness the advantages of Agile software development by bringing to their awareness the factors that can support or hinder its adoption. This goal is addressed by the following research questions:

RQ1. What is the current level of awareness, use and perception of Agile in Saudi Arabia?
This question is asked to achieve the third objective of this thesis, as it helps in understanding to what extent Agile has been adopted in Saudi Arabia, how Saudi practitioners perceive Agile and their level of awareness, before determining the factors influencing Agile adoption by software SMEs in this country. This question is answered through a mixed methods approach using semi-structured interviews and a survey questionnaire in Chapter 4.

RQ2: What are the key factors that influence Agile adoption?
The question is related to the first and second objectives of this thesis, which aims to determine the factors identified in the existing literature that influence the adoption of Agile in order to better investigated this in the context of Saudi software SMEs. In order to address this question, the use of a theoretical framework encompassing the identified factors is proposed, as it is intended to serve as both a research tool and a guide for the empirical investigations into Agile adoption factors in Saudi software SMEs, as well as to assess their readiness for Agile adoption. This question is answered through a review of the current literature and the proposed use of the theoretical framework presented in Chapter 2.

RQ3. What are the influential factors that may affect the Saudi Arabian Software industry when adopting Agile?
The answer to this research question fulfils the fourth objective of this thesis and aims to acquire a thorough understanding of the enablers and barriers of Agile adoption in Saudi Arabia. This question is addressed through a multi-case study conducted at three Saudi software SMEs using semi-structured interviews and a focus group discussion, as documented in Chapter 5.

RQ4. What is the impact of each factor on Agile adoption in Saudi Arabian Software SMEs?
This question is asked to accomplish the fifth objective of this thesis and aims to evaluate the relationship between the influential factors and their impact on the adoption of Agile in a Saudi Arabian context, as well as to determine the most

impactful facilitators and barriers to Agile adoption. This question is answered through a quantitative hypothesis-driven approach using an online survey in Chapter 6.

1.5 Research Methodology

This research is based on the pragmatist paradigm to achieve the research questions (Saunders *et al.*, 2016; Creswell and Creswell, 2018). It takes an abductive research approach, which combines the deductive and inductive approaches within the same piece of research (Easterbrook *et al.*, 2008; Brandt and Timmermans, 2021). This is an appropriate method when gathering data from different sources by combining both quantitative and qualitative methods. Hence, mixed methods are used in this research, as the sole use of either a quantitative or qualitative method would not fully answer the research questions. The three data gathering methods used in this research are a survey questionnaire, an interview and a focus group.

The design of this research is mainly explorative and inspired by the interdisciplinary research framework (Ferrario *et al.*, 2014), which is Agile, people-focused and reflective. Hence, the results from each study are used to inform and shape the subsequent studies in the research. Using an Agile approach to manage this research helps the researcher to move forward quickly and reflect during the research process. This research is divided into three cycles (as depicted in Figure 1.1), with each one involving three iterative stages (i.e. plan, act and reflect). These cycles are explained and summarised as follows:

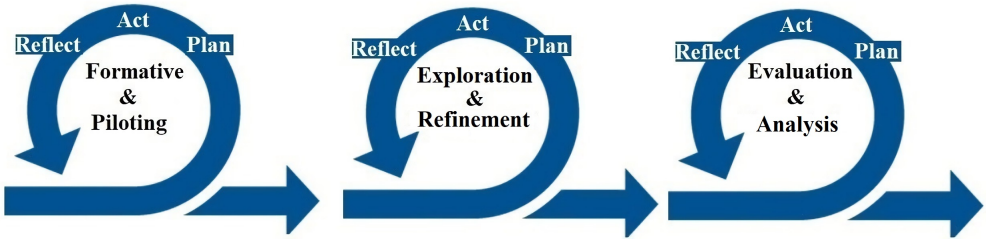


Figure 1.1: Research cycles

- **Cycle 1. Formative and Piloting:** This cycle of this research aims to answer the first main research question and its sub-questions (RQ1.1 and RQ1.2). It first aims to identify the enablers of and barriers to Agile adoption according to the existing literature. Based on these identified factors, a framework is proposed to represent the factors affecting the adoption of Agile to be

investigated in the context of Saudi Arabian software SMEs. Moreover, the level of awareness, current use and perceptions of Agile are investigated during this cycle through a mixed-method approach in two phases. Semi-structured interviews were conducted with four experts in the first phase and a survey questionnaire with 31 participants in the second phase. The results obtained from this cycle are reported in Chapter 2 and Chapter 4.

- **Cycle 2. Exploration and Refinement:** The second cycle aims to answer the first sub-question of the second main question (RQ2.1), which aims to empirically investigate the enablers of and barriers to the adoption of Agile in software SMEs in Saudi Arabia, to refine the framework. To address this research question, a multi-case study, divided into two stages, of three Saudi software SMEs is utilised. Firstly, semi-structured interviews with 12 Agile experts were carried out to analyse the impact of the identified elements in the framework and investigate other aspects from the experts' perspectives. In the second stage, a focus group discussion was held with five software practitioners to critically review the Agile adoption factors incorporated in the framework. The results obtained from this cycle are reported in Chapter 5.

- **Cycle 3. Evaluation and Analysis:** This cycle aims to answer the second and third sub-questions of the second main question (RQ2.2 and RQ2.3). The purpose of these questions is to evaluate the relationships between the influential factors and their impact on the adoption of Agile in a Saudi Arabian context, and to determine the most impactful facilitators and barriers to Agile adoption. This is achieved by employing a quantitative web-based questionnaire answered by 132 software practitioners. The data collected were subsequently analysed using a statistical analysis technique (Partial Least Squares-Structural Equation Modelling (PLS-SEM)). The results obtained from this cycle are reported in Chapter 6.

1.6 Contribution Statement

By investigating the two main research questions and sub-questions outlined above, this PhD thesis contributes to the Agile adoption literature by providing insights into the enablers and barriers influencing Agile adoption in Saudi Arabian software SMEs. This thesis provides a set of contributions to software engineering research and practice. In terms of contribution to research, this thesis first provides a review of the relevant literature to identify and summarise the factors that affect Agile adoption. It explores the awareness and perceptions of Agile among Saudi software practitioners and the extent to which they are currently using Agile methods. In addition, the thesis

develops a framework that incorporates the different factors that play a critical role in the adoption of Agile by software SMEs in Saudi Arabia. The research conducts an in-depth investigation into Agile adoption factors in the Saudi software industry by refining the framework developed. The study develops instruments for evaluating the different factors included in the framework.

The thesis also makes five key contribution to practice. First, drawing from findings from the first empirical study, we outline key steps in the process of raising Agile awareness and knowledge among stakeholders in Saudi Arabia. Second, this research has identified several cultural factors (e.g. national culture and organisational culture in terms of norms, values, attitudes, beliefs and governance structure) that top management teams in Saudi Arabian software SMEs should consider when planning to implement Agile. Third, Saudi organisations should take into account the requirement for a stable and secure environment by supporting Agile-friendly project teams and implementing a suitable reward system that encourages and supports software practitioners to adopt and use Agile. Fourth, senior management and decision-makers are required to support Agile adoption in their organisations. Finally, the government sectors should work together with SMEs to improve Agile adoption in this country. The final chapter (Chapter 7) of this thesis goes into more detail about these contributions and implications.

1.7 Thesis Structure

This thesis is organised into seven chapters. Below is a summary of the content of each chapter.

- **Chapter 2 Background and Literature Review:** The first part of this chapter provides the context of the research in relation to where this thesis is conducted. It starts with an overview of the Kingdom of Saudi Arabia in terms of its Vision 2030, software industry and SMEs. This is followed by a brief background of Agile software development and its values and principles. After that, the chapter discusses the initial reflections of Saudi Arabian culture and Agile. This is followed by a review of the research in relation to Agile awareness and perceptions, as well as the current literature on the enablers of and barriers to adopting Agile. The last part summarises the influential factors in a table and presents them in a theoretical framework, which is used to guide the empirical research of this thesis.

- **Chapter 3 Research Methodology:** This chapter provides a detailed explanation of the research methodology adopted in this thesis. A discussion of the research process (i.e. research philosophy, research approach, research

methods, research strategy, time horizon, data collection methods and data analysis procedures) is explained and justified. It also describes the research design and cycles to manage the flow of the research.

- **Chapter 4 Agile Awareness and Perceptions - Findings and Discussion:** This chapter presents and discusses the results of the first exploratory study conducted in this research, which aims to investigate the awareness, usage and perceptions of Agile among software practitioners in Saudi Arabia. This investigation is conducted utilising a mixed-method approach via expert interviews and a survey.

- **Chapter 5 Investigation of Agile Adoption Factors - Findings and Discussion:** This chapter illustrates the results of the second exploratory study conducted in this research. It aims to investigate the factors related to Agile adoption by software SMEs in Saudi Arabia via semi-structured interviews and a focus group, as well as provide an in-depth discussion of these findings. These findings help in refining the Agile adoption framework that can guide and support Agile adoption in the country.

- **Chapter 6 Evaluation of Agile Adoption Factors - Findings and Discussion:** This chapter shows the findings of the explanatory study undertaken in this research, which aims to analyse the relationships between the influential factors. This analysis is conducted using PLS-SEM technique through a survey questionnaire. This chapter discusses also the results of the PLS-SEM assessment study in detail. It goes into the influence of people, knowledge, cultural, organisational, environmental, technical and process aspects on Agile adoption within Saudi software SMEs. The chapter presents the final framework for Agile adoption in the Saudi Arabian context.

- **Chapter 7 Conclusions and Future Work:** This is final chapter of the thesis. The major findings of this research and how they addressed the research questions are discussed in this chapter. The contributions of this thesis, along with the implications are elucidated. Finally, this chapter concludes by suggesting directions for future work to directly build on this research.

Chapter 2

Background and Literature Review

2.1 Introduction

The main objectives of this chapter are fourfold; firstly, it aims to provide the background to the main focus of the topics in this thesis, and secondly, to review the relevant literature on Agile awareness and perceptions. Thirdly, it seeks to review and identify the Agile adoption factors that might affect the adoption of Agile, and fourthly, to develop a research framework incorporating Agile adoption factors, in order to guide the empirical investigation of this thesis. Therefore, this chapter aims to address the following research question: ***"RQ2: What are the key factors that influence Agile adoption?"***.

2.2 Research Context

This section provides insight into the context of this research, Saudi software companies in the SME sector, particularly in mobile development practice, and the importance of Agile adoption in this context. Saudi Arabia is one of the world's top oil producers and exporters, and it is located on the Asian continent. With a population of more than 34 million in 2019 (General Authority for Statistics, 2020), Saudi Arabia's economy is dominated by petroleum and supplemented by other natural resources. This section highlights the significance of this research, which aims to identify the factors that can support or hinder Agile adoption by Saudi software SME, in the Saudi Arabian context.

2.2.1 Saudi Arabia's Vision 2030

In late 2014, global oil prices suffered a brutal downturn when the price of crude oil plummeted from $114 per barrel in April 2014 to $50 per barrel by the end of the

same year (Raval, 2015; Moshashai *et al.*, 2020). Since then, the government of Saudi Arabia has strived to turn the economic difficulties caused by the oil market crash into a prime opportunity to systemically restructure the Saudi economy. Subsequently, in April 2016, Deputy Crown Prince Muhammad bin Salman revealed an ambitious development initiative known as the 'Saudi Vision 2030' (Vision2030, 2017). This was followed by a more comprehensive National Transformation Program (NTP) (Vision2030-NTP, 2018) to bring about significant changes in Saudi society and its economy by encouraging Saudi people to contribute to the productive workforce in the country. The ambitious plan aimed to help diversify Saudi's income sources to reduce the country's reliance on oil prices. The Saudi Vision 2030 is grounded on three primary themes: a vibrant society, a thriving economy and an ambitious nation.

Saudi Arabia seeks to focus on its people and the Islamic faith in its effort to create a more vibrant society. This initiative includes increasing the Umrah quota to 30 million visitors each year. The government also plans to increase cultural and entertainment activities in the country. The initiatives under this plan include opening the world's largest Islamic museum, doubling the number of UNESCO heritage sites in the country, developing Saudi cities to become the 100 top-ranked cities in the world and promoting healthy lifestyles, such as increasing the number of Saudi citizens who exercise once a week from 13% to 40%.

Saudi Arabia also aims to diversify its economy and create new job opportunities. This will be done by improving education and promoting innovation and entrepreneurship. The government is working to modernise and improve the standards of the curriculum taught from early childhood to tertiary education. Indeed, by 2030, five Saudi universities are expected to be among the world's top 200 universities. In addition, the government aims to diversify the economy by privatising state-owned agencies and creating a sovereign wealth fund. It also aims to grow non-oil exports to 50% of government revenue, the private sector's contribution to the domestic economy from 40% to 65%, and the contribution of SMEs to GDP from 20% to 35% by 2030.

To become an ambitious nation, and one focused on sustainable development, Saudi Arabia plans on increasing the efficacy, accountability and transparency of governance within the country. To curb corruption, the government has put in place a zero-tolerance policy. In line with this, the King Salman Program for Human Capital Development will be established to provide best practice training to more than 500,000 government employees. Lastly, the government is also striving to develop the non-profit sector by increasing its impact and efficiency.

2.2.2 Saudi Arabia's Software Industry

The software industry is an important component in today's world due to the extensive usage of software in our everyday lives. Subsequently, this industry has become a

major catalyst for economic transformations (Ndou, 2004; Nepelski and De Prato, 2018). The Saudi Vision 2030 has put the software sector, a crucial aspect of the ICT industry, at the forefront of digital transformation (Vision2030, 2017). This is in line with the government's emphasis on the software industry's role in its economic diversification effort to reduce the country's reliance on the oil industry. In recent years, this industry has become much more prominent and dynamic, as the nation has increased its investment in software development to fulfil its aspirations of becoming a worldwide leader of the digital economy.

In the last five years, the software industry in the country has seen increased growth due to strong government support, which has significantly contributed to economic growth in Saudi Arabia (Communications and Information Technology Commission, 2020). While there is still a lack of comprehensive statistics on the Saudi software industry, its importance is evident given the enormous investment the Saudi government have made in ICT, which was $36 billion in 2018 and $45 billion in 2019 (Ministry of Finance, 2019; Ministry of Communications, and Information Technology, 2019). In line with the global growth in this industry, the Ministry of Communications, and Information Technology (MCIT) projected that by 2023, more than 50% of SMEs will be IT-based (Ministry of Communications, and Information Technology, 2019). Furthermore, it is predicted that the industry will employ more than 50% of the workforce in the country. The positive outlook of the industry's strong growth has led to structural transformation, innovation, job creation and increased revenue (Ministry of Communications, and Information Technology, 2019). The industry comprises four main areas: mobile and embedded software, application solutions, system infrastructure and application development.

In this context, mobile app development has become one of the fastest-growing sectors of the software industry both worldwide (Ahmad *et al.*, 2018; Statista, 2020*a*,*b*) and in Saudi Arabia (Communications and Information Technology Commission, 2020; Ernst Young Global Limited, 2019). The extensive use of smartphones has transformed how businesses communicate with their customers and channel their concerns to government agencies. Due to its popularity, most government agencies in Saudi Arabia have started providing e-services via mobile apps that aim to make government services accessible from different platforms. Examples of these mobile apps are Tawakkalna and Safeer (Platform Unified National, 2021). A recent report by the Communications and Information Technology Commission (CITC) reported that the number of mobile customers in Saudi Arabia surpasses 40 million (Communications and Information Technology Commission, 2018).

Designing and developing mobile apps on the other hand is not an easy task, as it requires effective project management. Due to the rapid growth and demand of mobile apps (Corral *et al.*, 2013, 2015), researchers have started to investigate the best ways to manage mobile app development for the rapid and secure delivery of high-

quality apps, with a number of studies finding Agile to be one of the most suitable approaches for the purpose (Rahimian and Ramsin, 2008; Wasserman, 2010; Kaleel and Harishankar, 2013; Corral *et al.*, 2013). Specifically, mobile app development operates in a particularly competitive, uncertain and dynamic market environment (Corral *et al.*, 2015), and some of its end-users' technical requirements can bring new challenges to the application of Agile methods to the mobile apps industry (Ahmad *et al.*, 2018; Wasserman, 2010). These specific requirements include platform fragmentation (e.g. IOS and Android), variable resource constraints (e.g. memory space, processing speed, battery power, graphics processing and screen size), rapid time to market, difficult to scope requirements, frequent updating and interoperability with other apps and device resources (Rahimian and Ramsin, 2008; Aldayel and Alnafjan, 2017; Wasserman, 2010; Kaleel and Harishankar, 2013; Francese *et al.*, 2017).

The information mentioned above has fuelled the research's motivation to study Agile adoption in the Saudi software industry and investigate the significant factors that might promote or hinder its adoption in this industry.

2.2.3 Saudi Arabia's SMEs

This research focuses specifically on the adoption of Agile in Saudi software SMEs as there is a dearth of literature in this context in the country. There are a number of definitions of SMEs (Berisha and Pula, 2015). The World Bank (Independent Evaluation Group, 2008) has three main requirements for a business to be classified as an SME: company size, capital and annual revenue. In Saudi Arabia, the SMEGA classifies SMEs based on the total capital and the number of employees (Ministry of Commerce, 2016). Micro-enterprises are SMEs that employ five or fewer employees with a revenue that does not exceed three million Saudi Riyals. Small enterprises employ six to 49 employees and earn between three million and 40 million Saudi Riyals. Lastly, medium-sized enterprises employ between 50 to 249 employees and earn between 40 million and 200 million Saudi Riyals.

SMEs have played a significant role in economic growth and creating employment in both developing and developed economies (Hillary, 2000). As part of the National Development Program within the Saudi Vision 2030 (Vision2030-NTP, 2018; Vision2030, 2017), Saudi Arabia has started to pay more attention to SMEs as a means of diversifying the country's income and has acknowledged the significant role they can also play in increasing the country's GDP. Consequently, one of the government's initiatives seeks to foster entrepreneurship, support productive families and increase employment opportunities.

The government has launched several mechanisms to ensure their Vision 2030 can be fulfilled. One of these mechanisms is the establishment of SMEGA (Monshaat, 2019). The agency is responsible for providing financial aid, business incubators and

training for innovators and young people starting new businesses. SMEGA is also responsible for reviewing policies, breaking down obstacles and providing financial assistance to support innovators and young people marketing their ideas. At the same time, it provides e-marketing support and facilitates collaboration between entrepreneurs and the relevant international bodies to allow them to export their goods and services.

Quoting from the General Statistical Authority, Argaam (2018) stated that at the end of 2017, about 950,000 SMEs were operating in the Kingdom. Of that number, 2.6% (24,699 companies) of these businesses were classified as 'professional and technical enterprises'. For many young people, establishing SMEs is attractive as they are easy to manage. Furthermore, they have a simple administrative structure and only a small amount of capital is needed to start their business. Thus, continuing to grow the number of SMEs and providing stronger support to them could be the key to the diversification of economic activity in Saudi Arabia. Consequently, by 2030, the government projects that SMEs will contribute up to 35% of the country's GDP, as opposed to 20% in 2016 (Vision2030, 2017; Monshaat, 2019). Easy access to financial assistance, continuing government support and training seem likely to ensure the development of SMEs in the near future. In short, SMEs in Saudi Arabia are being encouraged to take this opportunity to expand further with the help of their government. Based on the explanation facts outlined above regarding how the SME sector is important in the country, it seems appropriate and timely to conduct research in this sector.

2.3 Agile Software Development

This section discusses the background of Agile software development methodology, including its definition, values and principles, which emerged to address the challenges of earlier methodologies, such as Waterfall, V-model and Spiral model. The main differences between Agile and earlier methodologies are its focus on iterative and incremental processes, adaptivity and people orientation (Abbas *et al.*, 2008).

2.3.1 Agile Methodology: An Overview

'Agile' represents a philosophy of software development. The term was first coined in a workshop held in early 2001 in a ski resort in Utah that was attended by 17 software practitioners (Beck *et al.*, 2001). These practitioners came to the realisation that traditional methods of delivering software were not producing good results, and thus they wanted to create a more iterative rather than prescriptive way of managing and progressing projects. Thus, they came up with twelve guiding principles and four values to create the mindset they called Agile (Beck *et al.*, 2001).

Agile is often defined with reference to the Agile manifesto and principles. There are many definitions of Agile presented in the literature. Cockburn (2002, p. xxii) defined the process of Agile development as *"the use of light but sufficient rules of project behaviour and the use of human- and communication-oriented tools."* While Cockburn's definition describes Agile as a philosophy, Boehm and Turner's places emphasis on practice orientation, defining it as *"very lightweight processes that employ short iteration cycles; actively involve users to establish, prioritize, and verify requirements; and rely on tacit knowledge within a team as opposed to documentation"* (Boehm and Turner, 2003, p. 17).

2.3.2 Agile Values and Principles

The Agile manifesto consists of four key values and twelve supporting principles which guide the Agile process (Beck *et al.*, 2001). While each Agile process affects these four values in different ways, all of the processes rely on these values for the development and delivery of a high-quality piece of software. The four values in the Agile manifesto are shown in Figure 2.1 (Beck *et al.*, 2001).

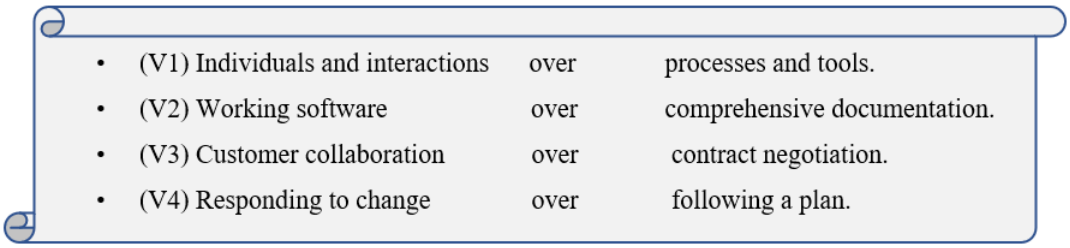


Figure 2.1: Agile values

Although the values on the left and right have equal importance in the process of software development, the values on the left carry more weight in the implementation of Agile. Perhaps the most important value in Agile is its focus on human interactions and characteristics (Beck *et al.*, 2001). Teamwork between developers and between the developers and customers is strongly emphasised, as it recognises the role taken by individuals in being the primary drivers of software success. Agile requires clients to become part of the development team (Fitzgerald *et al.*, 2006; Mangalaraj *et al.*, 2009). Furthermore, Agile highlights the need to respond to changes; more specifically, developers have to embrace any software requirement changes and implement changes to the software. In this regard, Agile is useful even when there are no clear requirements and when frequent changes are required to produce working software (Beck *et al.*, 2001). Dingsøyr *et al.* (2012) asserted that providing clients with working software frequently might bring value to them.

As shown in Table 2.1, the Agile manifesto is supported by twelve principles that have equal significance (Beck *et al.*, 2001) and their corresponding emphasis (Laanti *et al.*, 2013). These principles focus on direct communication between developers and customers and help define the iterative and incremental development life cycles. They also emphasise the collaboration between the developers and small and self-organising development teams. In short, the manifesto and these principles aim to uncover optimal ways for software development. Many Agile supporters agree that Agile presents a common, logical process for software development (Boehm and Turner, 2003; Conboy, 2009). It must also be acknowledged that Agile is not necessarily a new idea; instead, it is a refinement and amalgamation of earlier methodological concepts and practices (Highsmith, 2002). This is underscored by Strode (2005), who contended that Agile and its approaches may appear as new and innovative ideas; however, these practices were adopted some time ago in other fields, including manufacturing.

No.	Agile Principles	Emphasis
P1	The highest priority is to satisfy the customer	Customer satisfaction, Continuous delivery, value, early deliveries
P2	Changing requirements at any stage of development	Adaptability, competitiveness, customer benefit
P3	Ensuring continuous delivery of software	Working software frequently, shorter time scale frequent deliveries
P4	Communication and collaboration between business people and developers	Work together daily, collaboration
P5	Putting motivated individuals in a supportive environment	Motivated individuals, good environment, support, trust
P6	Encouraging face-to-face conversation	Efficiency, communication
P7	Working software is the primary measure of progress	Measure progress via deliverables
P8	Sustainable development	Sustainability, people
P9	Continuous attention to technical excellence and good design	Focus on technical excellence, good design as enabler of agility
P10	Simplicity	Simplicity, optimising work
P11	Self-organising teams	Self-organisation
P12	Teams must adapt their behaviour according to the inspection results	Built-in improvement of efficiency and behaviour

Table 2.1: Agile principles and their emphasis

2.4 Saudi Arabian Culture and Agile

Agile approaches in software development adopt a methodological framework that advances the need for flexibility and demands a high level of practicality in the delivery of the final product. The Agile approach requires a complete cultural shift, as it concentrates on delivering individual features of the software instead of the entire application. As a result, culture remains an important element to consider when evaluating and investigating the adoption of Agile in different regions of the world (Ayed *et al.*, 2017; Misra *et al.*, 2009).

The Agile approach values individuals and interactions over tools and processes. In Agile software development, the project team pays critical attention to working software over comprehensive documentation. Additionally, its approaches respond to change instead of following a particular plan. Moreover, it values customer collaboration over project-related contract negotiation. When considering the principle values outlined, it emerges that the decision to adopt and use Agile is founded on people's beliefs, norms, practices, values, and culture (Lous *et al.*, 2017; Amrit *et al.*, 2014; Lindvall *et al.*, 2002). Besides demanding close collaboration and intensive communication between project team members, it also requires the same from its customers (Misra *et al.*, 2009). Consequently, Agile adoption is culture-specific, which implies that a particular culture must support it to enhance the potential of project success.

Lastly, in Agile software development, people drive the process and respond to all business needs. Highsmith and Highsmith (2002) noted that people are the most important feature of the development milestones, thus they need to be valued and appreciated above tools and processes. As a result, the Agile mindset in software development may not be appropriate for all cultures. For example, in cases when tools or processes drive the development activities, team members will have a lower probability of responding and adapting to change, and thus reduce the likelihood of meeting customer needs and demands.

Therefore, the research into Agile adoption in different countries should be conducted in cultures such as Saudi Arabia, which is unique due to several features, including the tribal system, religious observance and modernisation (Al-Saggaf, 2004). Saudis are religious and devoted followers of Islam, and their lifestyle is heavily impacted by Islamic teaching. Islam teaches its followers to do the right thing and to walk the path of goodness to achieve prosperity. Islam has played a crucial role in defining Saudi culture, as Islamic teachings have become the main influence on their obligations, traditions, and social norms, such as separation of the genders and managerial style (Abdullah *et al.*, 2006; Idris, 2007). By focusing on one country, it will reflect the need to approach Agile development methodology on a country-by-country basis.

2.4.1 Saudi Arabian Cultural Dimensions

Although the focus of this research is not on investigating the impact of cultural differences and values on Agile adoption in Saudi Arabia, Hofstede's cultural dimensions (Hoftede *et al.*, 2010) can help understand the cultural profile of the country and to demonstrate how it may differ from Western cultures, which Agile mindset is originated from. These dimensions are the most prominent and widely adopted when studying cultural differences in the software engineering field (Leidner and Kayworth, 2006). Firstly, each dimension is explained, along with the Saudi Arabia score for each given. These scores are provided based on the values calculated by Hofstede (2020).

- **Power Distance Index (PDI):** The extent to which the individual with less power in communities and organisations accepts and anticipates unequal power distribution. People living in societies with a high PDI score such as Saudi Arabia, which scores 95, have a greater tendency to adhere to hierarchical order. Meanwhile, members of societies with a low PDI score such as the United Kingdom and the United States are more likely to consider hierarchy as a means of inconvenience and prefer a more balanced distribution of power.

- **Individualism versus Collectivism (IDV):** The extent to which members of a community cooperate with one another. In societies with a high IDV, there is a relatively loose tie between individuals. Individuals are expected to make decisions based on their own best interests and the interests of their immediate society. In comparison, people in collectivist societies tend to have a low IDV score and make decisions based on the collective interest of other members of the society. Saudi Arabia is classified as a collective society, as it scores 25 in this dimension.

- **Masculinity versus Femininity (MAS):** The extent to which societal gender roles differ. A High MAS indicates a more masculine society, where there is a high differentiation between the emotional and social role of each gender. A society with a low MAS indicates a more feminine society and minimal emotional and social role differentiation between each gender. Saudi society scores 60 on this scale, reflecting that Saudi Arabia has a masculine culture.

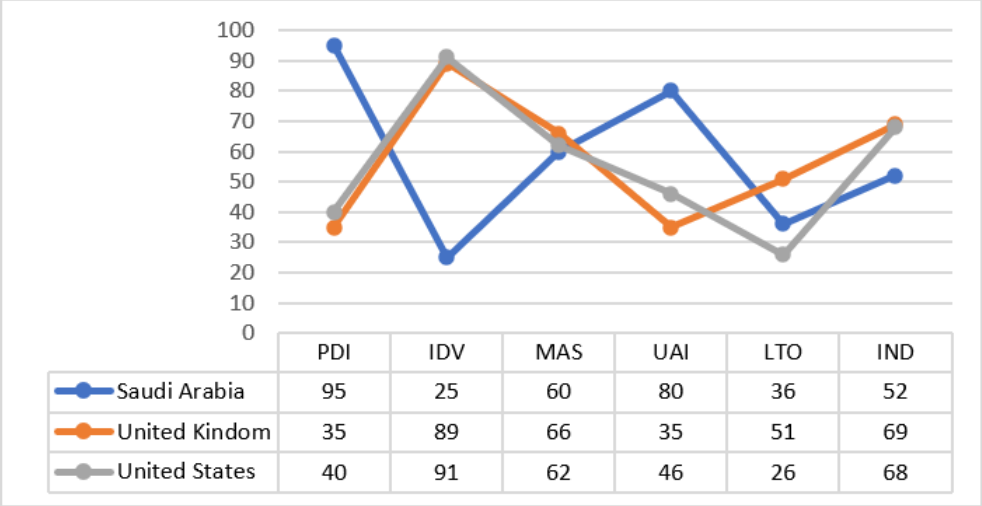
- **Uncertainty Avoidance Index (UAI):** The degree to which members of society feel threatened in the face of vague or confusing settings. Members of a high UAI society often feel insecure in ambiguous and unknown situations, which is the case in Saudi Arabia, as it scores 80. Meanwhile, members of a low UAI society tend to be more accepting of uncertainty, viewing it as an unavoidable part of life and having a 'take each day as it comes' attitude.

- **Long- vs. Short-term Orientation (LTO):** The extent to which individuals in a society are connected to their own history when addressing current and future issues. A society with a High LTO is a long-term oriented society. In these societies, people place more importance on the future and are pragmatic about long term commitments, knowing they need to prepare for the future. People in short-term oriented societies (low LTO), however, place more importance on the present. They tend to maintain time-honoured, past traditions and see societal change as a threat to these traditions. Saudi Arabia has a low score in this dimension (i.e. 36), indicating that establishing the truth, as well as respect for customs, is very important.

- **Indulgence versus Impulses (IND):** The extent to which members of a society have pleasure and enjoy life without being constrained by regulations and norms. A society with a high IND score is more focused on enjoying life. In contrast, societies with a low IND are more restrained. They tend to manage their gratification of needs and regulate through strict social norms. With a score of 52, Saudi Arabia does not clearly indicate whether it prefers to be generous or restricted.

2.4.2 Potential Implications for Agile Adoptions

Figure 2.1 shows the values (0-100), as determined by Hofstede (2020), for each cultural dimension for Saudi Arabia, compared with the United Kingdom and the United States. This comparison between Saudi Arabia and Western nations, where Agile first originated, aids in understanding the meaning of low or high cultural dimensions values.
The diagram in Figure 2.2 above that there is a difference in Saudi culture compared to the cultures of the United Kingdom and the United States. This is noticed in three dimensions of Hofstede's model, specifically (1) power distance, (2) individualism and collectivism, and (3) uncertainty avoidance. These dimensions can be considered the most significant aspects influencing Agile adoption, as they are the most relevant dimensions that directly impact the adoption and practice of Agile methods. The score of 95 for power distance shows that the Saudi culture is based on a hierarchy of power, and subsequently, decisions taken by those in higher or more important positions tend to be accepted without much, if any, discussion. This can be problematic in situations such as the adoption of Agile, as it has a flat structure, with power distributed equally and decisions made based on mutual discussion between peers. However, the low scores of the United Kingdom and the United States scores (35 and 40, respectively) on the power distance dimension, indicating that Western societies are flatter in structure than Saudi society.



	PDI	IDV	MAS	UAI	LTO	IND
Saudi Arabia	95	25	60	80	36	52
United Kindom	35	89	66	35	51	69
United States	40	91	62	46	26	68

Figure 2.2: Cultural dimension values for Saudi Arabia, the United Kingdom and the United States

In addition, Saudi society scores low on the individualism and collectivism dimension, reflecting the collective nature of Saudis which looks after the group. Thus, this element of Saudi culture supports the adoption of Agile. This is in contrast with the United Kingdom and the United States, which score relatively high, with 89 and 91, respectively. On the other hand, the high uncertainty avoidance score (80) means that Saudis tend to avoid risk taking, which may hamper the adoption of new methods, such as Agile; whereas the low scores on this dimension for the United Kingdom (35) and the United States (46) indicate the opposite is more likely to be true. If Saudis tend to avoid uncertainty and risk, this could also mean they are less confident sharing their opinions openly, due to a fear of being judged by their colleagues or facing repercussions from management. Consequently, this could be another barrier to the adoption of Agile. For example, applying and using Agile techniques, such as daily stand-up meetings or pair programming, is influenced by the power distance and individualism and collectivism. If the nature of the culture is based on a hierarchy of power and on working in an individualistic manner, then the team members' benefit from these two techniques is limited.

The apparent differences in these three dimensions between Saudi culture with the United Kingdom and the United States cultures indicate that the suitability of adopting Agile in Saudi Arabia needs to be investigated. Based on this initial analysis using Holsfsted's cultural dimensions, it would appear that of Saudi Arabia is not ready to adopt Agile methods. Thus, empirical investigations will be conducted in this research in order to understand the factors influencing Agile adoption in the country.

2.5 Agile Awareness, Current Use and Perceptions

In this section, the importance of the awareness and perceptions of Agile methods among practitioners are discussed. Understanding practitioners' awareness and perceptions of Agile is considered an essential step in investigating the factors influencing Agile adoption, and a considerable number of research efforts have been reported in this area (Santos *et al.*, 2016; Rodríguez *et al.*, 2012; de O. Melo *et al.*, 2013; Salinas *et al.*, 2018; Nazir *et al.*, 2016; Nanthaamornphong and Wetprasit, 2016; Begel and Nagappan, 2007; Sulaiman *et al.*, 2015; Solinski and Petersen, 2016; Serrador and Pinto, 2015; Pikkarainen *et al.*, 2012). However, there is a lack of such studies in Middle Eastern countries, particularly in Saudi Arabia. Therefore, one of the objectives of this thesis is to address this research gap by conducting a pilot study to investigate the awareness, use and perceptions of Agile among software practitioners in the Saudi mobile app development sector and the extent to which they are adopting Agile methods.

The studies listed above empirically investigated the level of awareness on Agile amongst software practitioners, their current usage and perceptions towards Agile. Their findings revealed that Agile has a positive impact on the software development process. An example of these studies is the work of Rodríguez *et al.* (2012), who studied the impact of Agile usage in the Finnish software industry using a survey completed by 408 participants. The findings of this study indicated that 58% of the respondents used Agile methods. Furthermore, these results showed that adopting Agile can increase productivity and the products' quality, as well as accelerate time-to-market. In addition to these benefits of using Agile, this study revealed that traditional organisational culture and lack of knowledge and training are the main hindrances of Agile adoption.

Begel and Nagappan (2007) investigated the use and perceptions of Agile among Microsoft employees across three continents (i.e. North America, Asia and Europe); however, they only concentrated on one company, which had a distinctly Western cultural orientation. Their study showed that 33% of the developers working in Microsoft used Agile, and that Scrum was the most widely used Agile method. The study focused on Microsoft's organisational culture and did not discuss the differences in Agile adoption and perception across the regions. Their research also revealed that team coding standards and continuous integration were the most used Agile techniques, while pair programming and test-driven development were the least used. In addition, the findings of this study showed that improved communication and coordination, as well as the ability to release updates quickly, were perceived as the main benefits of Agile. At the same time, its scale to larger software teams was considered the top concern among Microsoft developers.

de O. Melo *et al.* (2013) investigated the evolution of Agile and its adoption in

the Brazilian community across various industry sectors. Data were collected using a survey with 471 respondents and seven semi-structured interviews. The study found that 65% of the companies had used Agile for at least one year. In addition, the findings of this study highlighted that the lack of documentation, lack of predictability, and lack of upfront planning were the primary concern for practitioners when adopting Agile. Meanwhile, higher productivity, changing priorities and higher software quality were the main factors encouraging Brazilian companies to adopt Agile. It was also found that more than half of the participants used the Scrum method, and the most frequently used Agile practices were iteration planning, retrospectives, unit testing and daily stand-up meeting.

Bin-Hezam *et al.* (2018) examined to what extent Agile has been adopted and used by SMEs in Saudi Arabia from a variety of industry sectors and their awareness of Agile. The authors distributed a survey that received 26 responses to collect data for their study. The study's findings showed that although many companies follow Agile concepts, most of them were not aware of Agile practices. This study also founds that Scrum was the most used method, followed by lean and XP.

The 14th annual State of Agile survey (CollabNet VersionOne, 2020), conducted by VersionOne inc, provided further insights into the application of Agile across many sectors worldwide. The findings of this survey indicated that 95% of the respondents had adopted Agile, and most of them (61%) had been using Agile for more than two years. The high adoption of Agile has been due to the need for rapid software delivery and enhanced capability to manage changing priorities. In this regard, the most commonly used Agile method was Scrum (58%), followed by ScrumBan (10%). The survey also found that the most frequently used practices include daily stand-up (85%), retrospectives (81%) and iteration planning (79%). In the meantime, general organisational resistance to change and inadequate management support were identified as the biggest barriers to Agile adoption. These findings have been useful in creating an overview of Agile adoption worldwide. However, findings should be interpreted with caution, because the survey was conducted by an Agile solution and training vendor, and the results might be biased to serve their interest.

In general, very few studies have been done on the application of Agile across different industries, particularly in the mobile app development domain. An example of these studies is the study conducted by Santos *et al.* (2016) who investigated Agile perception and the adoption of Agile in mobile app development. Its findings show that the adoption of Agile in mobile app development could reduce the number of associated risks, provide better management and control, as well as provides developers with the flexibility and freedom to develop a mobile app that can adjust to changes quickly.

2.6 Factors Influencing Adoption of Agile

The previous section discussed the awareness and perceptions of Agile methods, such as Scrum, among development teams and the reasons for adopting or not adopting Agile from the perspective of software practitioners, including reasons such as improving team productivity and lack of documentation. This section, which is the main focus of this thesis, aims to understand the factors (features) that may encourage or challenge software organisations to use and adopt Agile methods, for example customer involvement and organisational culture, and how these features influence their adoption, since there is a need to investigate them in the context of different cultures, organisations and environments. It is essential to study the influential factors related to the adoption of Agile methods in developing software projects. This is because such understanding aids in determining to what extent Agile methods can be adopted and how they influence the success of a project.

A reviews of the literature on the success factors and barriers of Agile software development is conducted, and a theoretical framework of the identified factors is proposed. Although this review was not performed in a more systematic way as suggested by Kitchenham and Charters (2007), it reveals a number of studies which have examined these factors. The scope of this review is limited to studies that (1) used an empirical methodology to identify the factors that may support or hinder the adoption of Agile and have more citations; (2) published in well-known journals and conferences in software engineering, specifically in Agile software development; (3) published in the form of journal papers, conference papers, workshop papers or symposium papers; and (4) published in English.

The search for these studies was conducted on the most popular four bibliographic databases in the domain of software engineering and computer science, which are 'IEEE Xplore Digital Library', 'ACM Digital Library', 'Science Direct' and 'Springer Link'. Different search strings and keywords were employed for searching articles in the listed databases to overcome their limitations. The search strings were derived from the study's keywords and their synonyms as suggested by Kitchenham and Charters (2007). Subsequently, the search strings and keywords were combined using Boolean 'AND', and 'OR' operators in digital databases. The main search string used in this study is: ("agile" OR "agile method" OR "agile software development" OR "agile process" OR "agile development" OR "Scrum" OR "extreme programming") AND ("success factor" OR "critical factor" OR "key factor" OR "supporting factor" OR "CSF" OR "barrier" OR "challenge" OR "obstacle" OR "enablers"). Based on this review, a number of factors have been identified, as listed in Table 2.2, and the research framework was proposed (Figure 2.3). Due to the large set of factors discussed in the literature, this research only cited the influential ones mentioned in at least two studies.

Agile methodology depends on a number of factors, including social and technical ones. However, recently there has been more concern with social factors, as evidenced by the work of Iivari and Iivari (2011); Hoda *et al.* (2011); Chagas *et al.* (2015) and van Kelle *et al.* (2015), with several papers advocating that the suitability of Agile much depends on the practitioners' cultural background (Conboy *et al.*, 2011; Cockburn and Highsmith, 2001; Misra *et al.*, 2009; Ozawa and Zhang, 2013; Ayed *et al.*, 2017). Cultural differences are not only a strong determinant of whether an organisation will adopt an innovation, but also of how, when, and what type of innovation will be adopted.

People aspects are at the focus of a lot of studies on the acceptability and implementation of Agile approaches. According to Cockburn and Highsmith (2001), these aspects are considered the most influencing elements in the adoption and practice of Agile, as it has been defined as a collection of methodologies that concentrates on people and social aspects (Conboy *et al.*, 2011). Studies have also found that practitioners' abilities to communicate, skills and experiences are critical factors for Agile adoption (Lindvall *et al.*, 2002; Ayed *et al.*, 2017; Javdani Gandomani and Ziaei Nafchi, 2016). This include the ability of team members to work together efficiently and effectively to develop Agile software projects and to work with uncertain objectives (Cockburn and Highsmith, 2001; Conboy *et al.*, 2011; Sheffield and Lemétayer, 2013; Asnawi *et al.*, 2012; Tam *et al.*, 2020). According to a study conducted mainly in the Americas and Europe (Chow and Cao, 2008), having an efficient and effective team is one of the critical requirements for Agile adoption in software development. Therefore, Agile requires motivated, talented and knowledgeable teams.

Customers also play a critical role in the successful adoption of Agile. Lindvall *et al.* (2002) and Hoda *et al.* (2011) both highlight that fact that having participative, consultative and informative customers during Agile development helps to ensure the project is carried out effectively and to their specification. As stated by Beck *et al.* (2001), one of the Agile principles is that customers should, directly and indirectly, become involved in the Agile development team. This customer-developer relationship is also supported by empirical research by Misra *et al.* (2009); Chow and Cao (2008) and Vithana *et al.* (2018). Furthermore, Sheffield and Lemétayer (2013) conducted a mixed-method approach to investigate the factors associated with the success of Agile projects in the context of developed countries (United States, New Zealand and Australia). They found that clients' involvement in Agile teams influences the success of Agile practice and adoption. Thus, another criterion of successful Agile adoption is meaningful customer engagement. In addition, the results of another study carried out by Tam *et al.* (2020) revealed that customer involvement had an impact on the Agile approach and adoption within different industries in Portugal.

The lack of training and learning events of Agile methods among software

practitioners is also considered a significant issue facing practitioners in adopting Agile, especially by adopters in the early stages (Cockburn and Highsmith, 2001). These events can increase the level of awareness and knowledge of Agile, leading to an increase in the chances of Agile adoption, as advocated by Misra *et al.* (2009); Livermore (2008) and Wan and Wang (2010). These studies also argued that training and learning should be conducted for all stakeholders, such as senior managers and customers, to use Agile methods efficiently and effectively. Thus, one criterion of successful Agile adoption is the provision of sufficient training and learning for stakeholders.

Organisational factors can also have a significant impact on Agile adoption. Although some literature suggests that there is no significant relationship between an organisation's culture and the adoption of Agile (Chow and Cao, 2008; Stankovic *et al.*, 2013), a larger proportion of the literature suggests otherwise. For example, Robinson and Sharp (2005); Tolfo and Wazlawick (2008); Strode *et al.* (2009) and Iivari and Iivari (2011) find that organisational culture and environment are critical success factors in the adoption and use of Agile. A collaborative culture and an appropriate reward system were found to support an Agile-friendly environment, and so was the physical arrangement of the working space, such as having a balance between open and private office spaces. Indeed, a well-designed, socially-mindful physical environment has been shown to increase the morale of teams and project managers, which thus increases performance (Robinson and Sharp, 2005). A study conducted by Sheffield and Lemétayer (2013) established that organisational culture was critical in Agile software development, because it was a significant force propelling Agile forward.

The support of the senior management, good communication flow and collaboration play a significant role in achieving successful Agile adoption (Dyck and Majchrzak, 2012). Rodríguez *et al.* (2012) argue that the support and commitment of senior management are considered one of the main challenges faced by software practitioners in the Finnish software industry. Cockburn and Highsmith (2001) also highlight that good communication and collaboration allow teams and project managers to understand what customers want and what effort will be required. In addition, in research conducted among practitioners involved in Agile projects, primarily in the IT domain, found that the support of top management, communication and collaboration influence Agile adoption and practice (Hummel and Epp, 2015).

Chow and Cao (2008) argue that, in addition to social aspects, technical factors, including applied knowledge of Agile software techniques and delivery strategies, have a significant impact on Agile adoption. Such techniques include correct integration testing and rigorous refactoring activities, which may lead to high and improved performance, while delivery strategy focuses on adaptability and customer satisfaction

facilitated by the rapid and regular delivery of quality products. According to Wan and Wang (2010) and Vithana *et al.* (2018), the use of tools and technologies, such as Kanban boards (Tendedez *et al.*, 2018), are also important influential factors in Agile adoption. These can support Agile work in organisations, as well as improve and accelerate the project work and provide more flexibility for team members, resulting in increased performance. Although these factors are considered technical, it must be acknowledged that they also rely on human skills and collaboration (Robinson and Sharp, 2005).

The majority of past studies that have investigated the factors influencing Agile adoption and use have been conducted in the context of developed countries, particularly Europe and North America, (e.g. Chow and Cao (2008); Pikkarainen *et al.* (2012); Lalsing *et al.* (2012); Rodríguez *et al.* (2012); Stankovic *et al.* (2013); Sheffield and Lemétayer (2013) and Tam *et al.* (2020)), and only a handful conducted in developing countries, in particular, Asian nations (e.g. Wan and Wang (2010); Nanthaamornphong and Wetprasit (2016) and Vithana *et al.* (2018)). However, none of these studies focused on the software industry in Middle Eastern countries. This has created a literature gap regarding the adoption of Agile in the region, specifically in Saudi Arabia, which is constantly looking at the software industry to diversify its economy and reduce its reliance on the oil industry. In addition, as demonstrated by the literature review above, it is important to investigate the enablers of and barriers to Agile adoption in a variety of social and cultural contexts. Indeed, Lindvall *et al.* (2002, p.206), asserted *"Agile methods need cultural support otherwise they will not succeed."* This means that Agile may not necessarily be suitable for all cultures. Therefore, one of the objectives of this thesis is to re-orientate the focus of the Agile studies towards emerging economies, using Saudi Arabia as a case study. Thus, this study aims to investigate the influential factors impacting Agile adoption within software development in Saudi Arabia.

2.6.1 The Key Factors of Agile Adoption: A Research Framework

The previous section shows the importance of investigating the enablers of and barriers to Agile adoption in different cultures. Before focusing my empirical study on the Saudi context, we review the factors impacting Agile adoption, as reported by the state-of- the-art and categorise them, as shown in Table 2.2. A description of each factor is given and 'mapped', including its relationship to Agile principles (Beck *et al.*, 2001). This mapping exercise ensures the direct connection between the adoption factors identified by the literature and Agile principles is explicitly shown (Table 2.1 above). During the mapping exercise, the author noted that some of the principles contain different aspects, which may apply to different factors. For example, Principle

5 focuses on 'motivated individuals' (in the table reported as P5i), 'support and trust' (P5ii), 'team environment' (P5iii). The author then grouped the factors identified in the literature into four broad categories to support a more systematic and structured approach to capture the data for analysis. These categories are: people factors, organisational factors, environmental factors and technical factors.

The author did so also the following literature, although he noted that, according to Fortune and White (2006), there is no agreement between researchers and practitioners on how best to classify these factors. For example, 'customer involvement' has been classified as 'people factors' in Stankovic *et al.* (2013). In contrast, this same factor has been also classified as 'organisational factors' in Misra *et al.* (2009). The author does not consider this as an issue, since he used his categories (or types) as a guide rather than as rigid classification criteria.

	Influential Factors	Agile Principles	Literature
People Factors	Team capability	P5i: motivated individuals; P11: self-organising team	(Chow and Cao, 2008; Misra *et al.*, 2009; Sheffield and Lemétayer, 2013; Lindsjørn *et al.*, 2016; Vithana *et al.*, 2018)
	Customer involvement	P1i: customer satisfaction; P4i: working together daily	(Lindvall *et al.*, 2002; Chow and Cao, 2008; Misra *et al.*, 2009; Hoda *et al.*, 2011; Sheffield and Lemétayer, 2013; Vithana *et al.*, 2018)
	Training and learning	P5i: motivated individuals	(Livermore, 2008; Misra *et al.*, 2009; Wan and Wang, 2010)
Organisational Factors	Organisational culture	P2i: adaptability; P11: self-organising team; P12: team behaviour	(Robinson and Sharp, 2005; Tolfo and Wazlawick, 2008; Strode *et al.*, 2009; Misra *et al.*, 2009; Wan and Wang, 2010; Iivari and Iivari, 2011; Sheffield and Lemétayer, 2013)
	Management support	P5ii: support and trust	(Dyck and Majchrzak, 2012; Sheffield and Lemétayer, 2013)
	Communication and collaboration	P4ii: collaboration; P6: communication	(Cockburn and Highsmith, 2001; Wan and Wang, 2010; Dyck and Majchrzak, 2012; Sheffield and Lemétayer, 2013; Vithana *et al.*, 2018)

Environmental Factors	Organisational environment	P2ii: competitiveness; P11: self-organising team; P12: team behaviour	(Robinson and Sharp, 2005; Chow and Cao, 2008; Sheffield and Lemétayer, 2013)
	Physical environment	P5iii: good team environment; P11: self-organising team	(Robinson and Sharp, 2005; Chow and Cao, 2008)
	National culture	P4ii: collaboration; P6: communication; P11: self-organising team; P12: team behaviour	(Misra *et al.*, 2009; Ozawa and Zhang, 2013; Ayed *et al.*, 2017)
Technical Factors	Tools and technologies	P9: technical excellence	(Wan and Wang, 2010; Vithana *et al.*, 2018)
	Delivery strategy	P8: sustainable development; P9: technical excellence; P10: simplicity	(Chow and Cao, 2008; Stelzmann *et al.*, 2010)
	Agile software techniques	P1ii: continuous delivery; P3: working software frequently; P7: measure progress	(Chow and Cao, 2008; Stelzmann *et al.*, 2010)

Table 2.2: Summary of the significant factors (Pn = principle number)

Drawing on these factors identified in Table 2.2, a research framework was designed for Agile adoption (Figure 2.3). This framework is seen as both a research tool and a guide to support Agile adoption in Saudi software SMEs, as well as a tool to assess their readiness for Agile adoption. A description of each factor is presented in the following subsections.

2.6.1.1 People Factors

People factors comprise human aspects that may impact a company's adoption of Agile software development.

- **Team capability:** Having an efficient and effective team is one of the key requirements for Agile adoption in software development. Team capability refers to the power and ability of team members to work together efficiently and

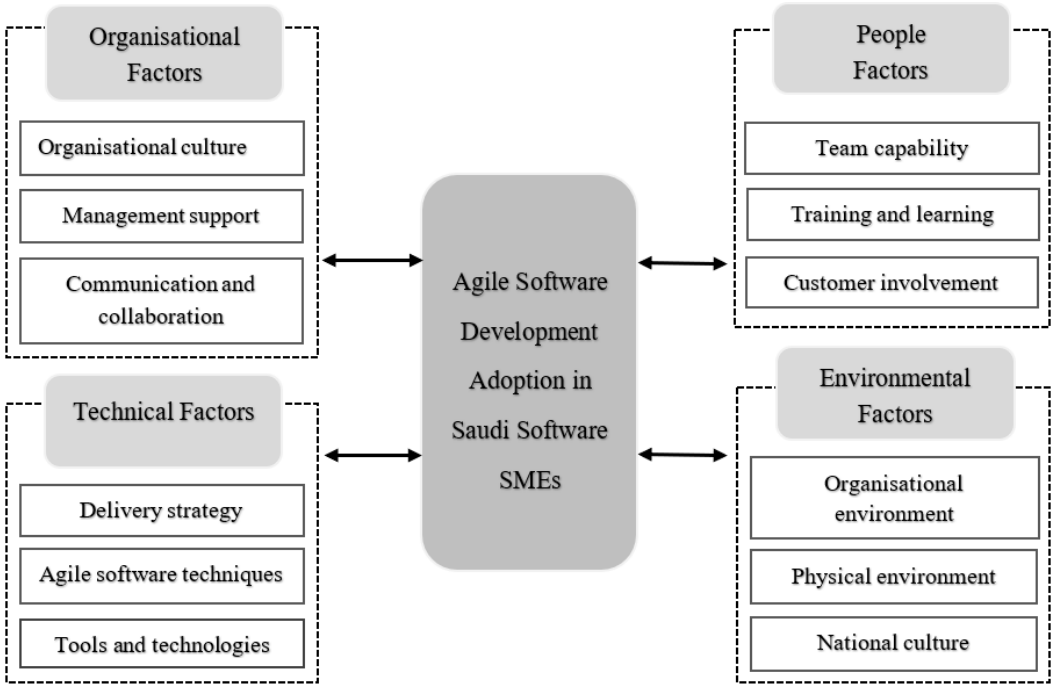


Figure 2.3: The research framework

effectively to develop Agile software projects and work with uncertain objectives (Haas, 2006). It also relates to team members with high competence, high levels of motivation and talent (Chow and Cao, 2008; Misra *et al.*, 2009). This factor is compatible with the motivated individuals' Agile principle and self-organising team principle. Therefore, team capability can be considered a factor that influences the adoption of Agile.

- **Customer involvement:** This refers to the customers involved in the development of Agile to share information and collaborate with the team members to ensure the projects are carried out based on their desire and expectations. Thus, customer involvement ensures that users play participative, consultative and informative roles in Agile teams (Hoda *et al.*, 2011). Moreover, customers' involvement ensures that the project is carried out how they want it. This factor is comparable with the first Agile principle, customer satisfaction, and the fourth one, working together daily. Therefore, substantial user involvement in a project is essential for successful Agile development and adoption in terms of satisfaction, quality and time.

- **Training and learning:** This factor refers to an effort by, for example, individual persons, companies, or academic institutions to facilitate training

and learning to improve the skill level of individuals, their employees or their students, in order to help them achieve their goals and objectives. The 'Training and learning' factor is in line with the motivated individuals' Agile principle. Thus, regardless of anyone's level of Agile expertise and experience, learning and training should continue and happen thoroughly and comprehensively for successful Agile adoption.

2.6.1.2 Organisational Factors

Organisational factors describe organisational elements that might significantly impact the decision of software firms to adopt Agile.

- **Organisational culture:** It is essential to understand an organisation's culture and why it matters in Agile adoption. It refers to an organisation's values, assumptions, attitudes, experiences and beliefs (Hofstede *et al.*, 1990; Iivari and Iivari, 2011). It is also reflected through the organisation's structure. In this regard, organisational culture is critical in Agile development, because it is a significant force propelling Agile forward (Sheffield and Lemétayer, 2013). This culture is not just built overnight, but takes years to develop, binding workers, project managers and customers together. Furthermore, organisational culture is related to three Agile principles (i.e. P2i: adaptability, P11: self-organising team, and P12: team behaviour). Therefore, organisational culture is an essential factor in achieving successful Agile adoption.

- **Management support:** This factor is crucial in ensuring the effectiveness of Agile adoption. It indicates that senior managers are taking the lead and demonstrating change and how they are active and enthusiastic about a proposed innovation (Sultan and Chan, 2000). If a team perceives that the management supports them, they will strive to put more effort into and apply their expertise to Agile adoption. Management support is associated with the fifth Agile principle, in which support and trust should be given to team members to get the job done. Therefore, this factor is a critical factor in affecting the decision of whether Agile is adopted or not.

- **Communication and collaboration:** Agile development is well-facilitated by effective and fluent communication and collaboration. Communication is the process of sharing information between and among teams and managers working together to obtain a much better understanding and performance and meet their customers' expectations (Sultan and Chan, 2000). At the same time, collaboration refers to the action of collaborating among stakeholders in order to improve the state of a product. When there is solid communication, good collaboration is established to facilitate team members working closely together

to achieve a common goal. This factor aligns with the fourth Agile principle (i.e. collaboration) and the sixth Agile principle (i.e. communication). Therefore, good communication and collaboration are necessary for the success of Agile adoption (Chow and Cao, 2008).

2.6.1.3 Environmental Factors

Several environmental factors could affect an organisation's decision to adopt Agile, as discussed below.

- **Organisational environment:** Agile development requires a stable environment that foresees everything is done correctly. The environment of an organisation can be divided into internal and external environments. The internal environment, which this thesis investigates, can include entities, activities and influences within the organisation (i.e. caring about the employees' behaviour, morale and welfare to make them feel happy, valued and essential). On the other hand, the external environment can refer to entities, activities and influences surrounding the organisation (i.e. customers' needs and requirements, government rules and competition). A positive environment could improve the overall performance, as it increases satisfaction among the team members and the clients. The organisational environment is parallel to three Agile practices, namely competitiveness (P2ii), self-organising team (P11), and team behaviour (P12). Therefore, establishing an Agile-friendly organisational environment could influence Agile adoption.

- **Physical environment:** Unlike organisational environment, which involves the teams working together to create a friendly project team, physical environment refers to the organisation's physical environment where the Agile development team is located and the surroundings which encourages team members to rest, re-energise, and collaborate, such as social spaces, prayer room, and office layout. Furthermore, a good physical location can motivate the teams and project managers and subsequently increase their performance. A good physical environment is linked to the fifth and the eleventh Agile principles (i.e. good team environment and self-organising team). Hence, a workplace's physical environment should be favourable to team members, project managers and customers, creating the need for Agile adoption.

- **National culture:** This term refers to norms, behaviours, beliefs, customs, values and assumptions held by individuals within a nation Hofstede (1980); Hoftede *et al.* (2010). Cultural conditions strongly determine whether an organisation will adopt innovation and how, when, and what type of innovation will be adopted. It has been argued that differences in the collective mental

programming of people from different cultures bring different management styles and organisational practices throughout the world. This was evident in Ayed *et al.* (2017) study on how the country's cultural dimensions highly influence the adoption of Agile. This factor aligns with four Agile principles (i.e. P4ii: collaboration, P6: communication, P11: self-organising team, and P12: team behaviour). Thus, national culture can be considered as playing a significant role in accepting innovation and Agile, in particular.

2.6.1.4 Technical Factors

The technical factors discuss the characteristics of the adoption of Agile and determine the factors that influence the decision of companies to embrace Agile.

- **Tools and technologies:** Tools and technologies refer to the technical tools (e.g. communication, storing and management tools) that can support Agile work in organisations, improve and accelerate project work, and provide more flexibility for team members, to increase their performance. This factor is related to the ninth Agile principle, which is technical excellence. Thus, the availability of the tools and technologies in the organisation is an essential factor to adopt Agile.

- **Delivery strategy:** This aspect is linked to adaptability and customer satisfaction, specifically the extent to which the product delivers what it offers. Technological advancements and changing customer expectations create a need for a delivery strategy in organisations. Thus, an Agile delivery strategy offers quality delivery at speed, helping organisations manage any unpredictability arising from deliveries. The delivery strategy factor aligns with the first, third, and seventh Agile principles, namely continuous delivery, working software, and measuring progress. Therefore, implementing a correct delivery strategy is critical in Agile adoption (Chow and Cao, 2008).

- **Agile software techniques:** This factor refers to techniques assisting project managers and their teams in identifying, choosing and practising the best Agile methods and techniques. These techniques include correct integration testing, rigorous refactoring activities, the right amount of documentation, and pursuing simple design, which (all) leads to high-level and improved performance (Chow and Cao, 2008). This factor corresponds to the eighth, ninth and tenth Agile principles (i.e. sustainable development, technical excellence, and simplicity). In light of this, it is evident that these techniques are essential for the critical success of Agile adoption in any organisation. They support the success of Agile adoption, specifically in terms of quality and scope. This is because Agile

software engineering involves numerous challenges and can have a number of shortcomings that sometimes lead to delayed and failed projects.

2.7 Chapter Summary

This chapter has presented the study's background and the review to the development of the research questions. It began with an overview of the research context, specifically with an insight into Saudi Arabia, its Vision2030, and its ICT and SME industries. The chapter then briefly discussed Agile methodology and its values and principles. Next. It discussed the initial reflection on possible misalignments between Saudi cultural orientations and the Agile mindset. It then examined Agile awareness, usage and perceptions among practitioners. Following that, it reviewed the current literature about the factors that can support or hinder the adoption of Agile. Finally, the chapter provided a table summarising the significant factors related to its adoption and the relationships with Agile principles, as well as the framework developed. The factors listed in the framework are used to guide this empirical research. The next chapter presents and justifies the research methodologies adopted in this thesis used to address the research questions and achieve its objectives.

Chapter 3

Research Methodology

3.1 Introduction

In the previous chapter, the emphasis was on reviewing the literature related to Agile awareness, perceptions and adoption, and summarising the influential factors on the adoption of Agile. The goal of this chapter is to explain and justify the research methodologies adopted in this thesis to address the research questions and to achieve the research objectives. According to Kothari (2004), research encompasses a systematic analysis of information to verify facts and reach a conclusion about a specific topic. McGregor and Murnane (2010) further noted that Methodology is a knowledge branch that covers the general concepts and assumptions of new knowledge development. Thus, research methodology reflects how research could be conducted systematically to address the problems of the research (Clough and Nutbrown, 2012). Thus, research methods are referred to as the instruments, processes, and techniques that the researcher can use them in a research.

This chapter is divided into four sections. The first section presents an overview of the research methods, questions and underlying data collection methods adopted to answer these questions. The second section discusses and describes the process involved in this research, including the philosophical approach, research method, research strategy, time scope, data collection methods, and procedures used for the data analysis. The third section discusses the research design and introduces the research cycles. The final section discusses the ethical considerations of this research.

3.2 Overview of Research Methods and Questions

Saunders *et al.* (2016) assert that there are several factors (i.e. the philosophical approach, research method, research strategy, time scope, data collection techniques

and data analysis procedures) that affect the selection of the most suitable methods and strategies for research, which are based on the nature of the research questions. More details about these factors are discussed in the next section of this chapter, while in this section, an overview of the research methods employed for answering the research questions is presented. The research presented in this thesis, which investigates the factors that support or hinder Agile adoption in software SMEs in a Saudi context, includes research questions that are both exploratory and explanatory in nature. It aligns with pragmatist philosophical research, as it is more flexible than other philosophical positions in terms of gathering data from various sources.

Since pragmatism has been adopted, the abductive research approach is considered the most efficient for this research, as it combines inductive and deductive approaches by employing both quantitative and qualitative methods. Thus, a mixed methods approach was used in this research, as the use of either solely quantitative or qualitative methods would not fully answer the research questions. A survey questionnaire, an interview and a focus group were the three data collection methods adopted in this research. Figure 3.1 illustrates the research process utilised in this research. This figure was presented in a workshop at the WABER conference, titled "Research Philosophies, Approaches and Strategies" by Prof Mark Saunders (WABER, 2020).

Figure 3.1: A summary of the steps taken for the research process

Table 3.1 presents an overview of the research questions motivating this research and the data collection methods adopted. In addition, the phase in which each question is discussed in this chapter and the chapter in which each question is answered are provided.

Research Question	Sub-research Question	Research Methods
RQ1. How can we empirically study the factors influencing Agile adoption in Saudi Arabian software development practice?	RQ1.1: What is the current level of awareness, use and perception of Agile in Saudi Arabia? **(Initial Study)**	Semi-structured interviews (N=4); A survey questionnaire (N=31) (Phase 1.3; Chapter 4)

	RQ1.2: Drawing from the state-of-the-art: what research framework can help systematically and empirically investigate Agile adoption factors?	Review of relevant literature (Phase 1.1 and Phase 1.2; Chapter 2)
RQ2. What are the most influential factors impacting Agile Adoption in Saudi Arabian software industry?	RQ2.1: How can we measure the impact of Agile adoption factors in Saudi Arabian software industry? **(Exploratory Study)**	Semi-structured interviews (N=12); A focus group discussion (N=5) (Phase 2.1; Chapter 5)
	RQ2.2: What is the impact of each factor on Agile adoption in Saudi Arabian Software SMEs? **(Evaluation Study)**	A questionnaire (N=132) (Phase 3.1; Chapter 6)
	RQ2.3: What are the most impactful barriers and facilitating factors to Agile adoption?	

Table 3.1: An overview of the research questions and methods used

3.3 Research Process

The research process is described by Saunders *et al.* (2016) as an onion consisting of six layers, as shown in Figure 3.2. Each layer reflects one step in the research process, and a researcher needs to peel off these layers one by one to reach the centre where the data are gathered and analysed. These layers comprise the research philosophy, research approach, research method, research strategy, time scope, and data collection and analysis techniques. The researcher needs to devise a well-thought-out research plan to ensure he can address the research questions and accomplish the study's goals. The next phase, after the research plan has been set, involves identifying the most suitable and feasible way to gather data. The researcher must explain why he chose the data gathering methods based on the design and objectives of the study (Crotty, 1998; Saunders *et al.*, 2016). This study follows the research design presented in Saunders *et al.* (2016) and Creswell and Creswell (2018). To maintain consistency, this study uses Saunders *et al.* (2016) definitions of key concepts and terminology. In this regard, 'methodology' explains how a study is conducted, while the term 'method' denotes whether the study has a quantitative, qualitative or mixed methods design. Lastly, the term 'technique' refers to the tool used for data gathering and analysis of data, such as an interview or a survey.

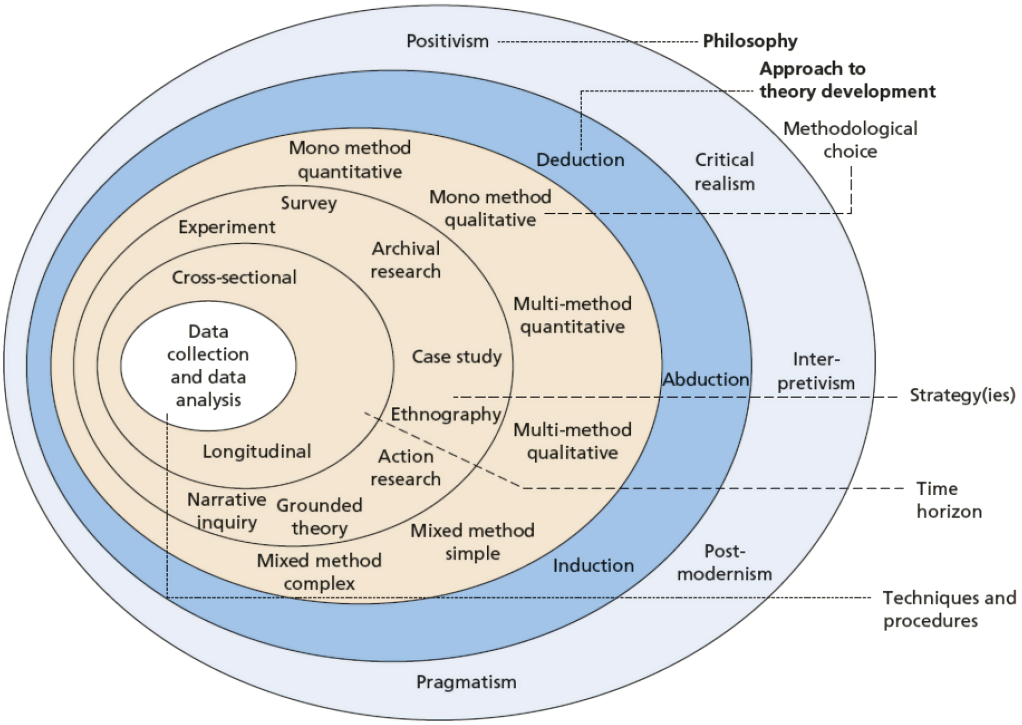


Figure 3.2: Research onion (Saunders *et al.*, 2016, p. 124)

3.3.1 Research Philosophy

Oates (2005, p. 282) defines research philosophy as *"a set of shared assumptions or ways of thinking about some aspect of the world."* Scholars like Saunders *et al.* (2016) and Willis (2007) argue that research philosophy is based on assumptions that could support a researcher to identify the research methods, strategies and data gathering and analysis techniques that address the research questions. These assumptions can be classified into: ontology, which refers to the reality; epistemology, which concerns knowledge and belief; and methodology, which is the application of systematic procedures to address the problems of the research (Creswell and Creswell, 2018). Meanwhile, Saunders *et al.* (2016) classify philosophical assumptions into five philosophies, namely, Positivism, Interpretivism, Critical Realism, Postmodernism and Pragmatism.

This research investigates Agile adoption factors in Saudi Arabian software SMEs, which is considered the first research in this context. This, we argue, requires the adoption of a flexible philosophy that allows for drawing possible explanations of what factors influence Agile adoption in a Saudi Arabian context without being restricted by a theory or ideology. In addition, it also allows data to be collected

from different sources, including semi-structured interviews, a focus group discussion, and surveys. We identify pragmatism as the most appropriate philosophy for this kind of research, as it focuses on the observation of a particular context and attempting to understand it without being constrained by a theory or ideology (Easterbrook *et al.*, 2008; Tashakkori and Teddlie, 2010; Creswell and Creswell, 2018). Pragmatism avoids the forced choice of one approach, and considers both quantitative and qualitative methods compatible with answering the research questions and achieving the research objectives. This allows the researcher to identify patterns, generate hypotheses, and look for possible explanations from the observations. Saunders *et al.* (2016) assert that pragmatism advocates that concepts are only applicable when supporting the research process. In the case of this study, as indicated by Mkansi and Acheampong (2012) and Goldkuhl (2012), the pragmatist approach was chosen as it fits the research of the information system field, giving significance to developing practical outcomes.

3.3.2 Research Approach

When choosing a particular research method, it is very important to consider philosophical assumptions and the research techniques that can be used to explore these assumptions. This is because having such an understanding can help facilitate the research techniques (Creswell and Creswell, 2018). As explained by Saunders *et al.* (2016), the research approach can be divided into deductive, inductive and abductive research approaches. The inductive approach is usually linked to the interpretivist paradigm, while the deductive approach is normally used in the positivist paradigm. In contrast, abductive approach is follows a pragmatist paradigm. The approach chosen depends on whether the research aims to build new theories from the results, or whether it seeks to examine or apply existing theory (Gray, 2018).

The inductive approach is a bottom-up approach, where the focus of analysis shifts from specific issues to general ideas and is often linked to qualitative research. It requires a researcher to develop a theory by identifying a phenomenon, before gathering and analysing the relevant data (Saunders *et al.*, 2016; Gray, 2018). In contrast, the deductive approach is known as the top-down approach, where the analysis shifts from general concepts to specific concrete findings, and is mostly adopted in quantitative studies. It involves developing a theory by formulating hypotheses, collecting data and designing a research strategy to test the hypotheses. The abductive approach combines inductive and deductive approaches rather than moving from data to theory or theory to data (Tavory and Timmermans, 2014; Brandt and Timmermans, 2021). This approach is used for the possible explanations of incomplete observations, which are converted into experience and reality, giving rise to the prediction of truth or the development of a new theory. With the abductive approach, data are collected to investigate an observed phenomenon, identify trends

and patterns and generate suggestions or initial hypotheses. The data are then presented in a framework and tested according to subsequent data gathering.

Given the discussion above, the abductive approach is considered the best fit for this research, as it is based on the pragmatist philosophy and allows to benefit from a combination of qualitative and quantitative methods to collect and analyse data. Saunders *et al.* (2016) state that the abductive approach is suitable for research with a great deal of literature in one context and a lack of literature in the context in which the researcher is interested. Thus, the abductive approach is the most suitable research approach for this research, as there is little in the literature about Agile adoption in the context of Saudi Arabia. Indeed, this research is considered the first empirical research in this country.

3.3.3 Research Methods

As mentioned by Creswell and Creswell (2018), research methods can be classified into quantitative, qualitative and mixed methods, all of which have their advantages and disadvantages. Johnson and Onwuegbuzie (2004) suggest that a mixed methods approach addresses the weaknesses of using one single method and, thus, this approach has gained a great deal of attention from researchers in recent years. The following subsections discuss the research methods adopted in this research.

3.3.3.1 Quantitative Method

In quantitative research, data are expressed by numbers. This method is usually adopted to undertake rudimentary research and confirm an underlying theory (Saunders *et al.*, 2016; Creswell and Creswell, 2018). Numerical data may provide valuable statistics in this type of study and using this method allows data to be collected from a large number of participants. As discussed in Creswell and Clark (2017), various statistical tests can be used to analyse the data obtained and, thus the outcomes are more generalisable to the population. In addition, quantitative researchers can use different data collection techniques such as structured interviews, questionnaires and structured observations to collect data.

In this piece of research, quantitative method employed to collect quantitative data, in order to examine the factors influencing Agile adoption by Saudi software SMEs. Quantitative data collected by utilising questionnaires in the initial and evaluation studies, while five-point Likert scale questions in the semi-structured interviews in the exploratory study.

3.3.3.2 Qualitative Method

A qualitative method is an analytical approach aimed mainly at investigating, evaluating, and interpreting data when they cannot be presented as numbers (Creswell and Creswell, 2018). The technique is exploratory in nature, allowing a researcher to fully understand the issue being studied (Willis, 2007). A qualitative researcher can use various data collection techniques, such as observations, unstructured and semi-structured interviews and focus group discussions. In the studies conducted in this thesis, the qualitative data were collected through semi-structured interviews in the initial and exploratory studies and a focus group discussion in the exploratory study.

3.3.3.3 Mixed Methods

Mixed methods research allows researchers to use both qualitative and quantitative techniques either simultaneously or sequentially (Saunders *et al.*, 2016). It uses both techniques at the research methods stage, where the qualitative method is used to analyse qualitative data and vice versa. Johnson *et al.* (2007) and Creswell and Clark (2017) further determine that mixed method research considers different points of view, positions, beliefs and schools of thought. They advocate that mixed methods research is the most suitable approach for research, as it can help to achieve outstanding results. Saunders *et al.* (2016) highlight that this form of research pools together quantitative and qualitative techniques in various ways (i.e. concurrent mixed methods research (single-phase), sequential mixed methods research (double-phase) and sequential mixed methods research (multi-phase)).

In light of this, mixed methods research is considered as interactive and iterative, where each research phase informs and directs the subsequent data collection and analysis phase. The true nature of the interaction and iteration in a piece of research is imperative to influence how qualitative and quantitative methods could be selected and integrated at each research phase. Due to the more complex nature of mixed methods research, the researcher should determine the best methods to answer the research questions prior to starting the study. Tashakkori and Teddlie (2010) further warn that researchers employing a mixed methods research design should be aware that such research may require more effort, specifically more extensive research time, skills and resources.

Because this study utilises the pragmatism philosophy, there is sufficient evidence to support the claim that pragmatism works well with mixed methods. This kind of research method was used in this research, as it combines both quantitative and qualitative data collection and analysis procedures. Therefore, the qualitative approach in this research provides a deeper investigation of the influential factors on Agile adoption in the Saudi Arabian context from the perspective of Agile experts.

In contrast, the quantitative approach helps to evaluate the impact of these factors and their relationships with the adoption.

3.3.4 Research Strategy

A researcher should identify the purpose of the research prior to finding the most applicable research strategies for their study. Thus, choosing a suitable research strategy for any research project is critical. There are many strategies used in the field of software engineering, including grounded theory, action research, survey, experiment and case study (Kitchenham *et al.*, 2002; Sjoberg *et al.*, 2007; Easterbrook *et al.*, 2008). Selecting the most appropriate strategy is a difficult task in any piece of research, since it requires researchers to find the strategies that suit their research questions and fulfil the research aims and objectives. With this in mind, the research strategies (survey and case study) adopted in this research are detailed below.

3.3.4.1 Survey

A survey is perhaps one of the most common startegies used in studies in the software engineering context (Kitchenham *et al.*, 2002). A survey can include a range of questions to probe the issue being studied and determine who, when, where, how much and how many. In addition, a survey is part of the deductive quantitative approach and data can be collected through questionnaires, structured observations and structured interviews (Saunders *et al.*, 2016). The adoption of a survey approach is useful for several reasons: to quantitatively evaluate the data using descriptive and inferential statistical methods; to describe the relationship between variables; to give greater control over the analysis process; to provide a more generalisable outcome; and to allow for a more flexible data collection process. The data collected are scrutinised to allow researchers to conduct an analysis and produce results (Fink, 2015). For this research, the quantitative data were collected as part of the initial study and evaluation study using a survey strategy in the form of a questionnaire and in the exploratory study using structured questions in the interview.

3.3.4.2 Case Study

A case study uses evidence from multiple sources to provide an empirical enquiry of a specific phenomenon within its real-world setting (Saunders *et al.*, 2016; Runeson and Höst, 2009; Runeson *et al.*, 2012). It also gives further understanding of the phenomenon being studied and its changes. For instance, case studies are commonly used in software engineering to investigate software development activity in real life using specific sample cases (Runeson and Höst, 2009). By using a case study, a researcher can use multiple perspectives to further examine the particular phenomena

in the field. However, a researcher conducting a case study may face challenges in generalising the outcome and mitigating researcher bias. Furthermore, a case study is predominantly qualitative, as it collects rich data in the form of descriptions, words and explanations (Yin, 2018). It might involve an organisation, a community, an association, a person, an event, a group, a change process, a situation or other case subjects. Interviews, focus groups and observations are the most common data collection techniques used in case studies. This research conducted a multi-case study in three software SMEs through the use of semi-structured interviews and a focus group data collection techniques. During the interview, a range of closed- and open-ended, multiple-choice and five-point Likert scale questions were posted to the respondents. This has allowed the researcher to collect data flexibly.

3.3.5 Time Horizon

A study's time scope can be divided into longitudinal and cross-sectional, depending on the study's purposes. With this in mind, a researcher is most likely to opt for a longitudinal study if the research aims to examine something over a certain time span and a cross-sectional study if the research aims to examine something at a specific time point (Saunders *et al.*, 2016). With regard to this research, there is little existing information on Agile adoption among software SMEs in Saudi Arabia, as this study is the first to be conducted in this context. Hence, a cross-sectional approach was used in this research.

3.3.6 Data Collection Techniques

This study used different techniques for data collection. The data in this thesis were collected using survey questionnaires, semi-structured interviews and a focus group discussion with software practitioners. These data collection methods are discussed below.

3.3.6.1 Questionnaires

A questionnaire is a tool commonly utilised to collect specific, relevant information from respondents in a survey (Boynton and Greenhalgh, 2004). Questionnaires are often used to gather factual and opinion-based information. Questions about factual information probe respondents' knowledge of an issue, while opinion-based questions probe their attitudes or preferences (Saunders *et al.*, 2016; Fink, 2015). Developing a good survey involves the researcher laying out a theoretical framework (Brace, 2018). In this case, the researcher possesses a firm understanding of the nature of his research questions and knows the dependent and independent variables that relate to the research, as discussed in the previous chapter. Once the conceptual framework is in

place (Figure 2.3), the researcher begins by designing valid and trustworthy questions. Using a conceptual framework during this process ensures that all of the important variables are included in the study, while also eliminating unnecessary variables.

To properly design a questionnaire, the researcher should adhere to a set of principles: Firstly, the researcher must accurately define the research objectives and identify the information necessary to attain said objectives (Brace, 2018). Additionally, the researcher must identify the population that should answer relating to the research questions. Once these prerequisites are met, the researcher can focus on the remaining principle, which calls for the appropriate design of the questionnaire by ensuring relevant questions are formulated and included. At this stage, the researcher should assume the position of a typical respondent, to ensure that questions are universally understood regardless of the respondents' level of formal education. An effective way of explaining the need for such consideration is by highlighting that the respondents are unlikely to have thought about the questions asked at the level of detail required in the study. The questions must therefore be concise.

In my research, the objectives of each study conducted and the populations targeted are well described. The Agile awareness study (Chapter 4) aims to identify the participants' awareness, current use and perceptions of software development methodologies, particularly Agile, while the evaluation study (Chapter 6) aims to evaluate the relationships between the influential factors and their impact on the adoption of Agile in a Saudi Arabian context and to determine the most impactful facilitators and barriers to Agile adoption. In contrast, participants in the Agile awareness study must be Saudi Arabian mobile app practitioners, regardless of whether they use Agile methods during the development process, whereas participants in the evaluation study must be software practitioners working in Saudi Arabian software SMEs that use Agile methods during the development process.

When designing questions, it is important to consider two important factors, namely question wording and question type. Studies have demonstrated that the alteration of even a single word in a question can markedly modify the distribution of responses and the accuracy of answers provided by respondents (Boynton and Greenhalgh, 2004). To avoid such pitfalls, the wording of questions should adhere to four basic criteria: brevity, objectivity, simplicity, and specificity. In short, questions should be brief and succinct. Additionally, the researcher should avoid leading questions that can push respondents toward a specific answer, thus eliminating objectivity. However, one threat to the validation of good questionnaire design in this research was the use of such questions. An example of leading questions which have to be avoided is *"Are your customers happy with adopting Agile?"*. Questions should also be written using simple, direct, and familiar words, as well as expressions that are unlikely to confuse the intended respondents.

Regarding question type, while questionnaires can be either structured or

unstructured in their format, it is easier to collect and evaluate data using a structured questionnaire, which uses scales categorised into four types: dichotomous, nominal, ordinal, and continuous. A dichotomous questionnaire contains two-choice responses, such as yes/no responses; nominal and ordinal types consist of more than two options, with the latter being ordered. Questions with interval responses allow the respondents to make choices based on a scale, like the Likert scale, with five or more points. Lastly, the continuous response allows open-ended responses, such as short comments (Fink, 2015). Different studies are best served by certain types of questions, a factor that the researcher must consider. Close-ended questions, for instance, give respondents a list of possible answers to pick from. On the other hand, open-ended questions do not limit the answers that respondents can provide. Close-ended questions are preferred in surveys, because they have a higher response rate, since users do not have to type or write too much. Furthermore, answers to such questions can easily be analysed statistically (Brace, 2018).

Another important consideration when designing a questionnaire is question flow (Schwarz, 1999), a term which describes the order in which questions are asked. It is important to make early questions easy and pleasant to answer. The flow should also be tuned to the logical reasoning of the respondent, to make it easier for them to fill in the questionnaire in one go without constantly referring to earlier questions or recalling too many details. The arrangement of questions in a logical sequence can be achieved by grouping related questions together and minimising abrupt topic changes. It is also important to include sufficient items to achieve the study's objectives, but ensure they are not so long that respondents suffer from fatigue or lose motivation while completing the questionnaire. One of the guiding concepts in questionnaire design is to use language that is easy for respondents to understand and cannot be misinterpreted as much as possible. In my research, the questionnaires are written in English and translated into Arabic (the respondents' native language) to overcome the language barrier and ensure that all of the participants understand the questions clearly.

Finally, before distributing the questionnaire to respondents, the researcher should conduct a pilot study, in order to clarify any questions and resolve any potential issues (Fink, 2015). This is an opportunity for the researcher to learn whether any of the questions are unclear and if responders have comments for possible enhancements to the questions. The testing for my questionnaires was done by two PhD candidates at Lancaster University and two mobile app practitioners from Saudi Arabia for the initial study, and six academic experts (four from UK universities and two from Saudi universities) and five software practitioners from Saudi Arabia for the evaluation study. The initial and evaluation studies conducted in Chapter 4 and Chapter 6 adopted this kind of data collection technique, a cross-sectional web-based questionnaire, which was created by one of the online survey tools (i.e., Qualtrics).

More details about the design of these questionnaires are provided in sections 4.2.2 and 6.2.2 in the coming chapters (i.e., Chapter 4 and 6).

3.3.6.2 Interviews

An interview is the most common way to collect qualitative data and one of the main data collection methods used in software engineering (Sjoberg *et al.*, 2007; Myers and Avison, 2002). Interview data allow a researcher to explore more knowledge related to the issue being studied. This method provides a more flexible platform for the interviewer and participants to interact with each other and can prevent questions being misunderstood. However, Creswell and Creswell (2018) raise the concern that it may be difficult to find participants for these kinds of studies. Interviews can be carried out physically (i.e. face-to-face) or virtually (i.e. online) or via phone calls.

There are different types of interview: unstructured, semi-structured and structured interviews (Johnson and Onwuegbuzie, 2004). An unstructured interview uses open questions to examine important data in more detail and allows the interviewer and the participants to interact freely. In contrast, structured interviews involve the use of closed questions to collect data. Lastly, a semi-structured interview combines both closed- and open-ended questions, which are prepared prior to the interviews taking place. In addition, during the interview, the interviewer can ask additional questions to garner more detailed information. Although the researcher is in control of the questions being asked, the respondents are given the scope to provide additional information (Creswell and Creswell, 2018). In this research, semi-structured interviews were adopted in the initial study to investigate the awareness and perceptions of Agile, as well as in the exploratory study to explore the Agile adoption factors.

3.3.6.3 Focus group

A focus group discussion was also conducted in this study. This data collection technique involves a discussion with a group about a specific topic (Kontio *et al.*, 2004, 2008; Liamputtong, 2011). There are between three and 10 people in one focus group and the discussion is often led by one member. The focus group in this study involved experts in Agile and mobile app development. The experts were given the opportunity to express their opinions and ideas with the aim of developing the research. With regard to the interviews and focus group design, these were conducted online and included a combination of closed- and open-ended questions.

3.3.7 Data Analysis Procedures

3.3.7.1 Quantitative Data Analysis

The quantitative data analysis determines the relationships between the variables and illustrates the data trends through graphs and cross-tabulation. The quantitative data collected from the survey questionnaires and semi-structured interviews were analysed using the SSPS statistics software package (Field, 2017). In addition, the Structural Equation Modelling (SEM) statistical technique was used in the evaluation study conducted in Chapter 6 to analyse the quantitative data and determine the impact and relationship between the variables (Kline, 2016; Hair *et al.*, 2014; Hair, 1998). Further details of quantitative data analysis are discussed according to each research phase in the coming chapters (i.e. Chapters 4 - 6).

3.3.7.2 Qualitative Data Analysis

The qualitative data analysis is used as a way to organise and describe meaningful information and help the researcher capture essential data to answer the research questions (Boyatzis, 1998; Miles *et al.*, 2018). In light of this, the data can then be subject to a number of approaches such as thematic analysis, in order to evaluate, classify and report different themes obtained from the raw qualitative data collected (Braun and Clarke, 2006). These themes present the hidden patterns contained in the respondents' feedback about the phenomenon and the critical information explicitly used to answer the research questions. The theoretical or inductive thematic analysis can be used to identify the themes (Braun and Clarke, 2006). A theoretical thematic analysis, which is theory-driven, provides more information regarding some aspects of the data. Meanwhile, during the inductive thematic approach, the data-driven themes identified are used to answer the questions.

As this study aims to investigate the awareness and perceptions of Agile and the factors influencing Agile adoption, it adopted the inductive and theoretical thematic analysis to analyse the data collected from the interviews and the focus group and capture the participants' opinions on the topic. The inductive thematic approach was used for analysing the data collected from semi-structured interviews in the initial study (Chapter 4). In contrast, the data collected in the exploratory study (Chapter 5) were analysed using a hybrid of both the inductive and deductive approaches. The qualitative data collected were captured using digital recorders and notes that were taken during the interviews. Audio content was transcribed verbatim by the researcher and compared with his notes. The qualitative data software, NVivo, was used to support the thematic analysis of the raw data from the interviews.

The data-driven approach is described as an inductive way of seeing data, in which the analysis is conducted from the bottom up. Therefore, in order to develop themes

and codes inductively, there are six steps as suggested by Braun and Clarke (2012), as shown in Figure 3.3. The steps are not necessarily linear, since a researcher can move backwards and forwards among them.

Qualitative data analysis begins with the researcher becoming intimately familiar with the data collected so that the most relevant aspects of the questions put to the interviewers become evident to the researcher. This process requires the researcher to closely study the data obtained (by reading the transcribed interviews in this case) to gain a deep knowledge of it. Additionally, the researcher should make notes on individual transcripts and the entire dataset to help facilitate analysis later in the study. Having become intimately familiar with the data from the interviews, the researcher can embark on the coding process, which involves the generation of codes to identify and provide a label for a feature of the data that is potentially relevant to the interview questions. This coded data is then reviewed and used to identify common or overlapping aspects, which can then be used to generate themes and subthemes that best describe the data. This process further facilitates the identification of coherent and meaningful patterns within the dataset. Consequently, the themes are refined and stated concisely based on the unique characteristics of each one. An analysis report is then prepared to wrap things up. The coming chapters (Chapters 4 and 5) provide more in-depth details of the thematic analysis based on the objectives of each one.

With the data coding process done, the researcher moved on to the qualitative analysis of data collected from the first and second empirical studies presented in Chapters 4 and 5. The data was iteratively cross-referenced and discussed with another researcher (i.e., the PhD supervisor) to ensure consistent and valid interpretation. At this stage, several issues relating to data analysis were discussed in depth. These included finding appropriate names for sub-themes and merging or splitting sub-themes. The data transcripts were also revised to eliminate obvious errors during transcription. The involvement of the PhD supervisor at this point of the analysis is appreciated. In this case, the supervisor acted as a moderator and ensured that personal bias did not influence the analysis process. However, one threat to the validation of our qualitative analysis was the lack of other researchers doing the classifications. The involvement of more researchers to code the data is the best practice to avoid bias in qualitative data analysis (Boyatzis, 1998). This served as a threat to validity that has to be taken into consideration in future work. The use of inter-rater reliability in qualitative coding produces a more accurate and rigorous analysis.

Additionally, the researcher conducted triangulation, which refers to two or more methods being employed to analyse a problem to eliminate personal bias further and reinforce the validity of data analysis (Denzin, 1970). It was used in this research to validate the interview study findings using a focus group discussion. This is conducted in Chapter 5.

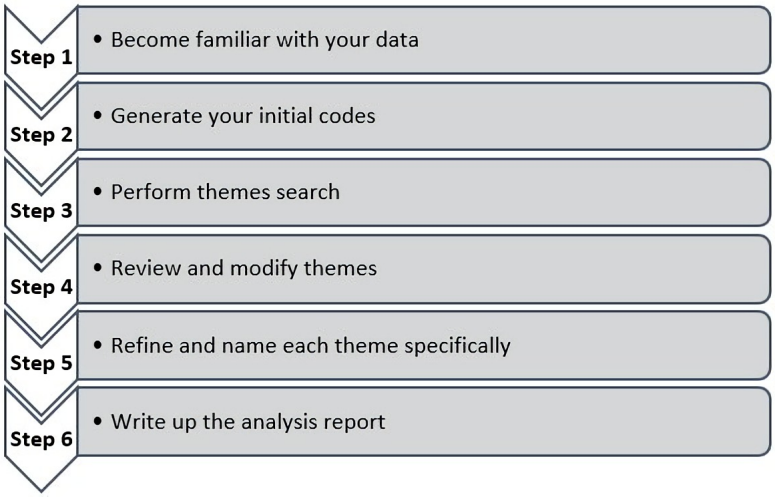


Figure 3.3: Thematic analysis process

3.4 Research Design and Cycles

A research design considers how a research project could be managed to achieve the research aims and objectives and shows data collection methods that can be utilised for that (Easterbrook *et al.*, 2008; Sekaran and Bougie, 2013). It is argued that selecting a suitable research design for the research questions is very important. This is because effective research design helps a researcher to efficiently manage the research flow. Research design purposes can be classified into four categories: descriptive, evaluative, explanatory, and exploratory (Saunders *et al.*, 2016; Creswell and Creswell, 2018). This research is based on the exploratory and explanatory nature of research. An exploratory study design focuses on providing new insights into emerging phenomena and explaining the link between the different variables in a particular context, while taking an explanatory approach helps researchers identify the influence of different factors on a phenomenon. The exploratory approach was adopted in the first and second cycles of this research, which are discussed later in this chapter, by reviewing the existing literature and gathering both quantitative and qualitative data, while the explanatory approach design was utilised in the third research cycle to measure the impact and relationship between the variables.

The design of this research was mainly explorative and inspired by an interdisciplinary research framework (Ferrario *et al.*, 2014), which is Agile, people-focused and reflective. Hence, the results from each phase were used to inform and shape the subsequent phases of the research. Using an Agile approach in managing this research helped the researcher move forward quickly and reflectively through the research process. This research was managed using Kanban boards through the

project management software 'Trello'.

This research was divided into three cycles (i.e. formative and piloting, exploration and refinement, and evaluation and presentation), explained below and summarised in Figure 3.4. Each cycle involved three iterative stages (i.e. plan, act and reflect). In each cycle, there were several sprints, each of which lasted for two-four weeks. For each sprint, a backlog was created with a concise description of what needed to be done. The work was then reviewed with the PhD supervisor at the end of each sprint during scheduled supervision meetings. After each sprint, the research progress was reflected on to explore possible improvements.

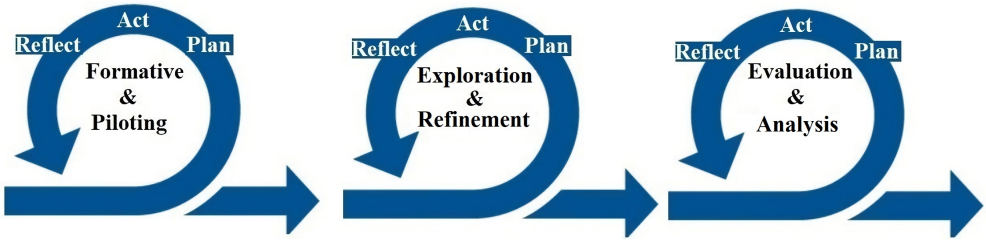


Figure 3.4: Research cycles

A summary of the cycles of this research with their phases and outcomes are outlined in Figure 3.5 and explained in detail below.

3.4.1 The First Cycle: Formative and Piloting

This cycle was divided into three phases, aiming to: review the current literature on the topic to identify the factors influencing Agile adoption; propose a theoretical framework that incorporated the Agile adoption factors; and investigate the level of awareness and perceptions of Agile.

3.4.1.1 Phase 1.1: Literature Review

This phase developed the initial ideas, aims and objectives of the study and included a literature review on multiple topics. These topics included: Saudi culture and the cultural differences between Saudi Arabia and the Western culture in which Agile was created; Agile awareness; the current use of Agile; and perceptions of Agile among software practitioners. These topics are discussed in Chapter 2, along with an exploration of the factors that impact Agile adoption. After reviewing the current literature on Agile adoption, the influential factors of its adoption were identified and summarised in Table 2.2 in Chapter 2, in order to guide the empirical research of this thesis.

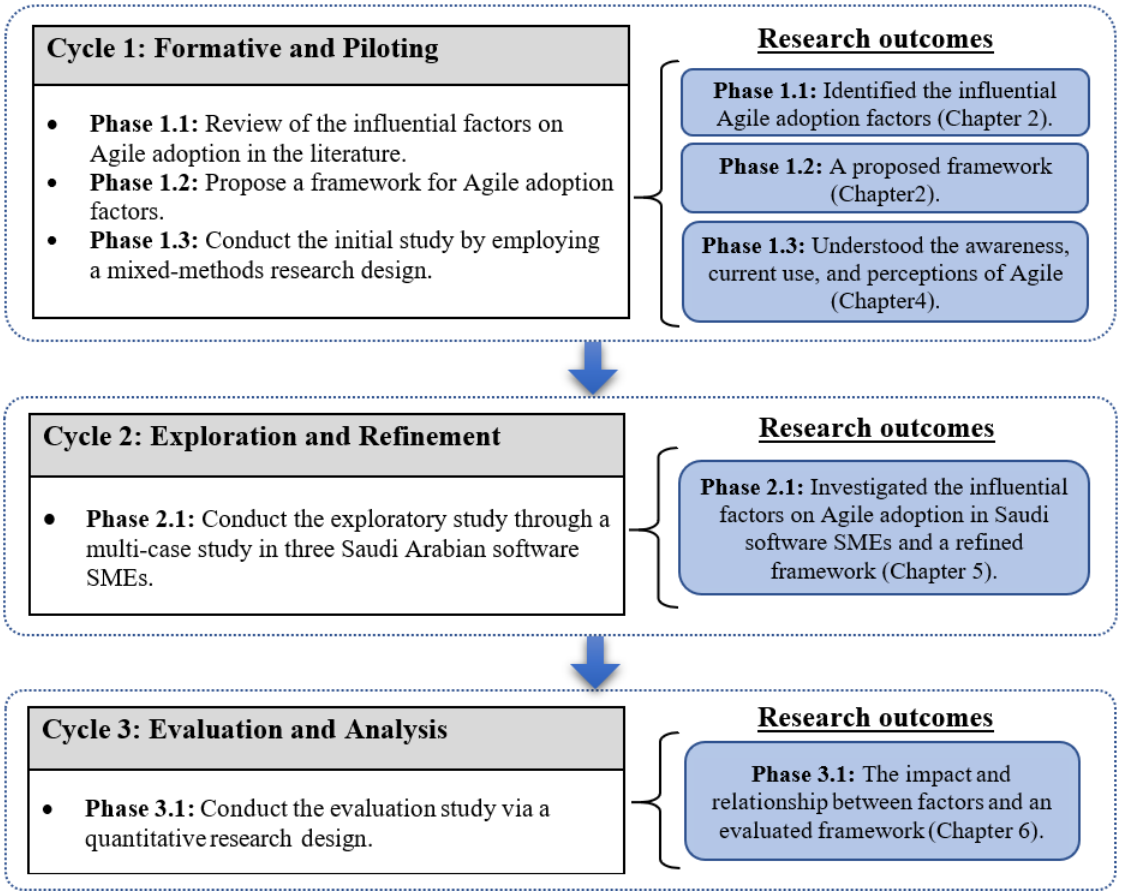


Figure 3.5: Research phases used in this thesis

3.4.1.2 Phase 1.2: Research Framework

During this phase, the classificatory framework of Agile adoption from the perspective of Saudi software SMEs was proposed. This framework, which categorises the key Agile adoption factors, was designed after an extensive literature review (phase 1.1). This framework guided and supported the adoption of Agile in Saudi software SMEs and was critically investigated and evaluated in the next cycles. More details about this phase are provided in Chapter 2, subsection 2.6.1, page 26.

3.4.1.3 Phase 1.3: Awareness and Perception Investigation (Initial Study)

In this phase, an investigation study was conducted to gain a deep understanding regarding the awareness, usage and perceptions of Agile among mobile app practitioners in Saudi Arabia. Its main focus was to address the RQ1.1. This phase was considered an initial step in investigating the factors influencing Agile adoption within

software SMEs in Saudi Arabia. A mixed-methods research was adopted in this phase by conducting interviews with four experts in mobile and Agile development, in order to explore their views about awareness and perceptions of Agile and also to use their feedback to design the second method of this study. The second method involved a survey of 31 mobile app developers in order to understand: (1) the level of awareness and current usage of Agile in the Saudi mobile app industry; (2) the reasons for adopting and not adopting Agile; and (3) software practitioner perceptions of Agile methods. Further details about the design of this phase, its results and discussion are provided in Chapter 4.

3.4.2 The Second Cycle: Exploration and Refinement

This cycle aimed to investigate the influential factors of Agile adoption in Saudi Arabia by refining the Agile adoption framework. This cycle was based on the results and findings of the first cycle.

3.4.2.1 Phase 2.1: Adoption Factors Investigation (Exploratory Study)

In this phase, an in-depth investigation was undertaken to gain a deeper insight into the enablers of and barriers to Agile adoption (i.e. social and technical aspects) in software SMEs in Saudi Arabia. The main focus of this phase was to address RQ2.1. This phase builds on the previous phases in the first cycle. A multi-case study in three Saudi software SMEs is utilised in this phase through a mixed-method design approach, to provide a better understanding of the influential factors. This approach is considered to be the most appropriate to achieve the objectives of this study. The data were collected via two stages. Firstly, semi-structured interviews were conducted to explore practitioners' viewpoints about the factors. The interviewees were 12 mobile app practitioners working in different mobile app teams in various software SMEs with a minimum of two years of experience in Agile. Based on the results of this stage, the Agile adoption framework was refined and validated. Secondly, to critically reviewing this framework for Agile adoption in Saudi Arabia, a qualitative research method was adopted in this stage of the research. The data were collected from a focus group discussion with five participants who had participated in the first stage. This stage targeted participants from each company under study in order to examine the different points of view of developers working for various companies. More details about the design of this phase, its results and discussion are presented in Chapter 5.

3.4.3 The Third Cycle: Evaluation and Analysis

This cycle aimed to evaluate the factors that can support or hinder Agile adoption in software SMEs in Saudi Arabia and measure the impact of these factors on the

adoption and their relationships. Moreover, it concluded the writing up of the thesis.

3.4.3.1 Phase 3.1: Adoption Factors Evaluation (Evaluation Study)

This phase analysed and evaluated the relationship between the influential factors incorporated in the framework and their impact on Agile adoption within a Saudi Arabian software SMEs context. The main focus of this phase was to address RQ2.2 and RQ2.3. It adopted a quantitative hypothesis-driven approach and collected data through an online questionnaire targeting Saudi Arabian software practitioners working in software SMEs. The questionnaire data gathered from 132 software practitioners were analysed using the statistical analysis technique, PLS-SEM. This technique was used to analyse and evaluate the interrelationships among multiple variables (Hair *et al.*, 2014; Hair, 1998; Kline, 2016). More details about the design of this phase, its results and discussion are delineated in Chapter 6.

3.5 Ethical Considerations

Throughout this research, ethics were carefully considered during all points of the research that included human participants (Phase 1.3; Phase 2.1; Phase 3.1). The Lancaster University guidelines for conducting research with human participants were followed so that individuals did not face any negative consequences as a result of their participation. Ethical approval was granted by the University, and as ethical considerations are detailed according to each phase in Chapters 4-6, the approval number is also provided. Creswell and Creswell (2018) claim that there is a need for professional researchers to show their commitment to ethical research. This study has taken into account the following ethical considerations: seeking informed consent; explaining the research aims; purpose and outputs; ensuring anonymity and confidentiality; guaranteeing participants the right to withdraw at any time; providing review notes to participants; conducting the interviews in safe; private spaces to protect participants' privacy; and protecting raw data, i.e. audio recordings and transcripts, by using one laptop with password protection and file encryption.

3.6 Chapter Summary

This chapter provided a detailed discussion of the research process adopted in this thesis. It started by discussing the research philosophy, which utilises the pragmatist philosophical position, thus allowing data to be collected from different sources by combining both qualitative and quantitative methods. Following this, the chapter reported on the adoption of the abductive research approach in line with pragmatism.

The chapter then presented a discussion of the research methods, focusing on the mixed-methods approach, as this was the approach employed to address the research questions. Data collection techniques were then detailed, including a survey questionnaire, semi-structured interviews, and a focus group discussion. Following this, data analysis procedures were presented. PLS-SEM was used to analyse the quantitative data via SSPS software, while a thematic analysis approach was used to analyse the qualitative data via NVivo software. In the second part of this chapter, the design and cycles of the research were discussed and shown to be inspired by the interdisciplinary research framework divided into three cycles. Finally, ethical considerations for the phases that involved human participants were outlined. The next chapter focuses on Phase 1.3 of the research, exploring Saudi mobile app practitioners' awareness, current use and perceptions of Agile.

Chapter 4

Agile Awareness and Perceptions: Findings and Discussion

The results and findings from this chapter have been published as a full research paper at the IEEE/ACM 43rd International Conference on Software Engineering: Software Engineering in Society (ICSE-SEIS 2021) (Altuwaijri and Ferrario, 2021*b*). **This paper received the Distinguished Paper Award for ICSE-SEIS 2021.**

4.1 Introduction

This chapter presents an empirical investigation of the awareness, usage and perceptions of Agile among Saudi software practitioners. This investigation is the initial step in understanding to what extent Agile has been adopted in Saudi Arabia, how Saudi practitioners perceive Agile and their level of awareness before determining the factors influencing Agile adoption by software SMEs in this country. Specifically, this study focuses on mobile development practice, which is considered one of the fastest-growing sectors in the Saudi software industry and which research has found to be particularly suited to Agile, as discussed in Chapter 2. The objectives of this study are to understand (1) the level of awareness and current use of Agile in the Saudi mobile software industry; (2) the reasons for adopting and not adopting Agile; and (3) software practitioners' perceptions of Agile methods. This chapter aims to answer the following research question: ***"RQ1. What is the current level of awareness, use and perception of Agile in Saudi Arabia?"***

To answer this question, a mixed-methods approach was adopted. Firstly, interviews were conducted with four experts in mobile and Agile development to explore their viewpoints about the awareness and perceptions of Agile and to use their feedback to inform the design of the next phase of the study. Secondly, a survey was then conducted with 31 participants to identify their awareness and perceptions

of software development methodologies and Agile. This study contributes to Agile adoption literature, by providing broad insights into current Agile use in the Saudi software community, which is currently under-explored. In addition, it can be used as a roadmap for further investigations. The findings of this study indicate that there seems to be a low level of awareness and usage of Agile in the country. However, they also find that those who use Agile, are appreciative of its benefits, which include project management flexibility, a rapid response to change and a positive effect on team morale and communication.

This chapter starts by describing the research design and methods adopted in this study. Then, it presents the results of the data collected through the interviews and the survey. It ends with a discussion of the results as they relate to awareness, use and perceptions.

4.2 Study Design and Methods

A sequential exploratory mixed methods research design was considered to be the most appropriate to achieve the objectives, because this part of the study required data to be collected from individuals working in different mobile app teams in various software SMEs in Saudi Arabia (Saunders *et al.*, 2016). This design involved collecting and analysing both qualitative and quantitative data sequentially, and it was divided into two phases: qualitative and quantitative. Interviews with four experts were conducted during the first phase of the study, and then a survey was carried among 31 participants out during the second phase. Using a mixed methods approach provided the benefits of mixing both data collection methods, including gaining a better understanding of the problem under investigation, balancing the weakness of one method with the strength of the other and increasing the reliability of the findings (Johnson and Onwuegbuzie, 2004; Johnson *et al.*, 2007; Creswell and Creswell, 2018). For example, using a survey with the interview is considered the best way to collect a broad range of data and to reach a large number of responses in a short time.

The research process for this study is presented in Figure 4.1, starting with the literature review to understand the level of awareness and perceptions of Agile, as discussed in Chapter 2, section 2.5, page 21. Following the literature review, qualitative data were collected by interviews and analysed using a thematic analysis approach supported by NVivo software. Next, based on the results of the interviews, quantitative data was collected using a survey and analysed with the support of SPSS software. Finally, the results of the interviews and survey were discussed in relation to the research question.

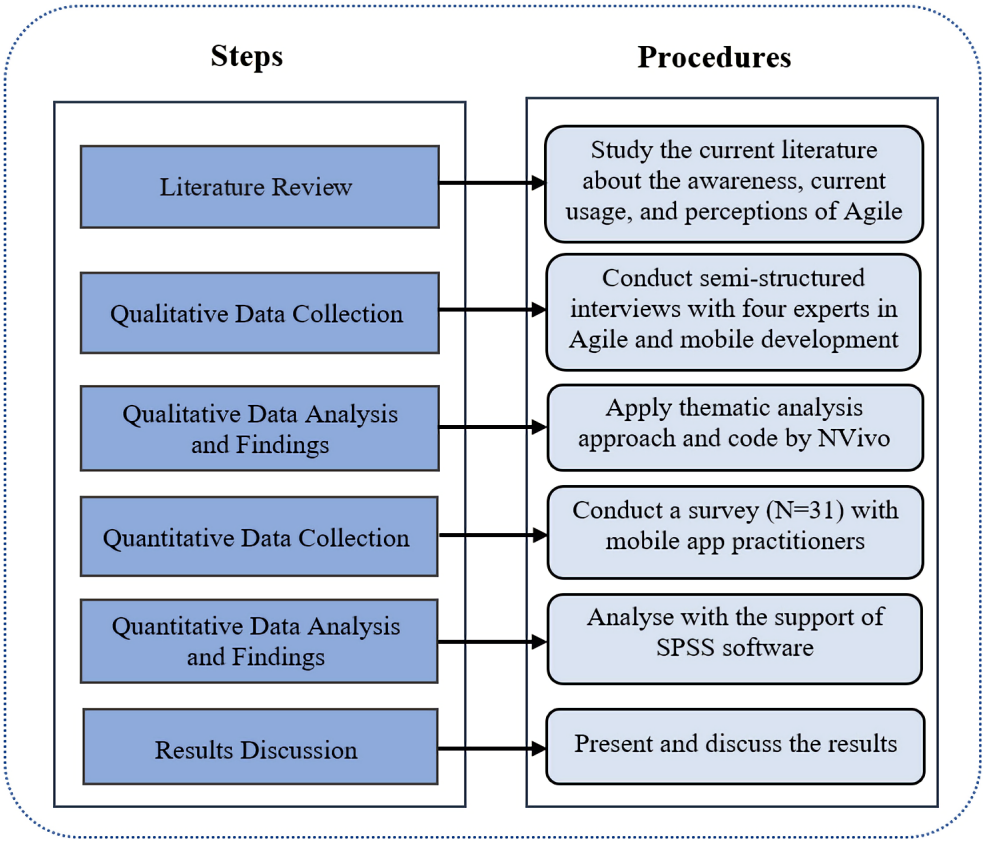


Figure 4.1: Research process for this study

4.2.1 First Phase: Expert Interview

The first phase of data collection was a semi-structured interview with experts. This method allows the researcher to explore knowledge from experts on the topic under investigation (Saunders *et al.*, 2016), as they can share their points of view and give suggestions and recommendations regarding the subject of the research. The aim of the interviews was to examine the experts' views of the general awareness and perceptions of Agile amongst practitioners in Saudi Arabia. The input gathered during this phase was then used to guide and inform the development of the survey used in the second phase.

The expert interviews in this study involved semi-structured interviews with four experts who have many years' industrial experience and knowledge of both mobile app development and Agile software development. These experts worked at different software SMEs in the sector of mobile app development in Saudi Arabia.

4.2.1.1 Interview Design

The interview questions, including open-ended questions, were prepared before the interviews took place, which helped the researcher to understand the awareness, current use and perceptions of Agile, as well as to explore the experts' viewpoints. The interview questions (provided in Table 4.1) were divided into two sections, and each interview session lasted for about 30-60 minutes. This resulted in approximately 180 minutes of recorded material. In the first section, demographic information was collected to examine the interviewees' backgrounds, including their roles and years of experience, as well as details about the organisation where they worked, including the size. In the second section, interviewees were asked to discuss their awareness and perceptions of Agile. The topics explored included the Agile methods used and techniques and challenges they faced when adopting Agile.

The interview questions were written in English first, then translated into Arabic to guarantee that all of the participants understood them without any language obstacles. With regard to the accuracy and clarity of the questions, the researcher conducted pilot interviews with one PhD candidate at Lancaster University and one mobile app practitioner in Saudi Arabia. After these pilot interviews were completed, the researcher modified the interview questions as recommended, for example by rephrasing some questions to improve the clarity.

Question No.	Question
Section A: Demographic Information	
Q1	What is your role?
Q2	How many years of experience do you have in mobile app development?
Q3	How many years of experience do you have in Agile software development?
Q4	How many members do you have in your team?
Q5	How long have you or your team been adopting Agile?
Section B: Awareness and perception of Agile in Saudi Arabia	
Q6	What Agile methods are used by your Agile team? and Why?
Q7	What Agile techniques are used by your Agile team?
Q8	What software development methods did you or your team use before adopting Agile?
Q9	What are the reasons for you to move to Agile?
Q10	How was the decision made to moving to Agile?
Q11	What are the drawbacks of Agile adoption in your mobile app development team?

Q12	What are the challenges you faced when adopting Agile in your mobile app development team?
Q13	What is your opinion about Agile practice in mobile app development in the Saudi context?
Q14	What are the tools and techniques you use to support your Agile work?
Q15	Do you have any questions or suggestions that I need to take into account in the next studies?

Table 4.1: An overview of the interview questions

4.2.2 Second Phase: Survey

The second data collection method was a web-based survey, which also aimed to identify the participants' awareness, current use and perceptions of software development methodologies, particularly Agile. The surveys were distributed via email and social networking applications such as WhatsApp. The survey was published on 28th of June 2020 and was made available online for four weeks. In total, thirty-one completed responses were received, all of which were from mobile app practitioners in Saudi Arabia.

4.2.2.1 Survey Design

A cross-sectional web-based survey was selected and created by one of many online survey tools (i.e. Qualtrics). The survey comprised 26 questions, including closed- and open-ended questions, divided into three sections:

- **Section 1: Demographic Information**
  This section gathered demographic data relating to the participants and their work context, such as participants' gender, age, role, years' experience and organisation size. It also provides information about the average number of team members and platforms used for app development in their workplaces.

- **Section 2: Software Development**
  This section focused on software development in general and the most commonly used methodologies.

- **Section 3: Agile Software Development**
  The participants were asked in this last section to share their views on Agile software development methodology and how they perceived it.

Multiple-choice questions and 5-point Likert scales (strongly agree = 5; agree = 4; neutral = 3; disagree = 2 and strongly disagree = 1) were used to reflect the

respondents' viewpoints. In question 12, the participants were asked about their knowledge of Agile, and if they selected the 'Not known' option, they were able to proceed directly to answer the questions from number 24, which were about the use of Agile techniques, and then continue on to complete the survey. The purpose of this was to investigate whether practitioners who were unfamiliar with Agile actually applied some Agile techniques and adhered to its values. An overview of the survey questions is provided in Appendix A.1.

The survey was translated from English into Arabic, in order to ensure that all of the participants clearly understood it. A pilot study was conducted, with two PhD candidates at Lancaster University and two mobile app practitioners from Saudi Arabia, to test the readability and validity of the questions. Based on their feedback, several amendments were made to the items before the survey was distributed.

4.2.3 Data Analysis

The data collected from the interviews were analysed using the data-driven thematic analysis approach (Boyatzis, 1998; Braun and Clarke, 2012) with the support of NVivo software. More details about this approach are provided in Chapter 3, subsection 3.3.7.2, page 46. Transcribing, coding and organising the data thematically were carried out by the researcher and then discussed with his supervisor. Following the application of coding to the data, sub-themes were created from codes that shared similar characteristics. Then, related sub-themes were grouped to create concepts or themes. The final collection of three themes and eight sub-themes was agreed upon after multiple revisions of the themes and sub-themes created for this study. Table 4.2 summarises the themes, sub-themes and codes emerging from the data qualitative analysis.

The data collected during the second phase of this study through the use of a survey were analysed using statistical software (i.e. SPSS), which determines the relationships and trends in the data and presents them in the form of graphs and cross-tabulated formats (Field, 2017). More details about how the quantitative data were analysed are provided in Chapter 3, subsection 3.3.7.1, page 45.

Main Themes	Sub-themes	Example of Codes
Awareness of Agile	Awareness Level	Low level of Agile awareness; Reasons for the lack of Agile awareness
	Knowledge Source	Ways to Learn Agile 'on the job'; Learning by training events
Use of Agile	Agile Current Usage	Low usage of Agile in development teams; More used in small organisations

	Agile Adoption	How organisations adopt Agile; Notice the benefits from other adopting teams; After attending training events
	Agile Methods	Scrum is one of the most frequently Agile methods; Adopting Scrumban
	Agile Techniques	A daily stand-up meeting is one of the most frequently used among organisations
Perceptions of Agile	Reasons for Adopting Agile	Increase the team's productivity; The flexibility of Agile in managing projects
	Reasons for Not-adopting Agile	Lack of knowledge; Organisational culture

Table 4.2: The themes of the interview data

4.2.4 Population and Sampling Approach

Snowball sampling, a non-probability sampling technique, was adopted in this study to help save time and find suitable participants (Johnson, 2014). This kind of non-probability sampling approach is quick and easy in terms of time management compared to the other approaches, such as probability sampling approaches. It involves finding potential participants and then asking them for recommendations for other participants. The requirements for interview participation were that they had to belong to software SMEs in the Kingdom of Saudi Arabia and be experts in the fields of mobile app and Agile software development. The requirements for survey participation were less strict in that they had to be mobile app practitioners in Saudi Arabia, regardless of whether they were practising Agile methods during the development process or not.

4.2.5 Ethical Considerations

As the research involves human participants, ethical issues were taken into consideration before collecting the data, as discussed in Chapter 3, section 3.5, page 52. The author submitted a 'FSTREC Application Form' to the FSTREC to obtain approval. After three weeks, the submission was approved, and the reference number was given as FST19120 (see Appendix A.2). Prior to conducting the interviews and the survey, each participant was asked to read the participant information sheet (see Appendix A.3 for interview and Appendix A.4 for survey) and sign the consent form (see Appendix A.5 for interview and Appendix A.6 for survey).

4.3 Expert Interview Findings

This section reports the results of the qualitative semi-structured interviews of four mobile app and Agile software development experts from Saudi Arabia, to obtain a deeper understanding of the awareness, current use and perceptions of Agile in Saudi Arabia.

4.3.1 Demographic Information

Table 4.3 summarises the experts' demographic and their work context. Each interviewee was given a pseudonym to conceal their identity and the name of their organisation. Each interviewee had a different role in their organisation, including one CEO, one CTO, one Project Manager and one Senior Developer. Three experts worked at small organisations (between six and 49 employees, as discussed in Chapter 2, Section 2.2.3, page 13), and one expert worked at a medium-sized organisation (between 50 to 249 employees). The average size of the teams appears to be small with no more than eight members. All of the experts had been working with Agile for between three to five years, while their experiences in the development of mobile apps was between five to eleven years. Moreover, all of the interviewees were in an iterative sprint to deliver a release within one week, except for P3 who had a deadline of two weeks.

Questions	**P1**	**P2**	**P3**	**P4**
Position	CEO	CTO	Project Manager	Senior Developer
Company	A	B	C	D
Company size	Small	Small	Medium	Small
No. of teams	3	1	2	1
Average team size	7 members	8 members	7 members	6 members
Agile method	Scrum	Scrum	Scrum	Scrum
Experience in mobile development	11 years	8 years	10 years	5 years
Experience of Agile	5 years	4 years	4 years	3 years

Table 4.3: The experts' demographic information

4.3.2 Awareness of Agile

4.3.2.1 Awareness Level

All of the experts stated that the level of Agile awareness among mobile app practitioners is still low. Therefore, they had only begun adopting Agile in their development process between one to three years prior to the interviews taking place. For instance, P2 stated he had adopted it just one year previously. Furthermore, awareness of Agile is considered a critical issue facing software organisations in the country, as stated by P1 and P4. P1 argued that *"we (decision-makers) faced a challenge because of the low level of awareness of Agile from practitioners' side."* When asked about the reasons for the lack of awareness of Agile, P4 mentioned that the mobile app industry in Saudi Arabia is a young sector and there are still few experts in this domain. Thus, most of the developers who adopt this approach could be considered novices. As stated by P1, who works as a CEO, *"most of the mobile app developers who start to work with us don't have any knowledge about Agile methods, and the reason, I think, behind that is the lack of training events related to Agile in the country."*

4.3.2.2 Knowledge Source

P2 stated that *"the lack of awareness of Agile among developers is not a big issue with us."* He also mentioned that most of the developers who had joined their company had learnt Agile 'on the job'; hence, they had found it easy to learn about Agile. P1 highlighted that Computer Science colleges in Saudi universities do not put much emphasis on Agile methodology in terms of teaching and training compared to other approaches like Waterfall. All of the interviewees also stated that training and practice were the most significant sources of gaining more knowledge about Agile. Indeed, P4 mentioned that he learnt about Agile from university courses in the United States, while the other participants had learned from online courses, training, practice and certifications.

4.3.3 Use of Agile

4.3.3.1 Agile Current Usage

With regard to the use of Agile, P4, a IOS developer with several years' experience, highlighted that Agile was not widely used in mobile app development. He also said that most practitioners he knew did not follow a specific methodology and often used both Waterfall and Agile at the same time. All of the experts rated the extent to which Agile is applied in mobile app development as being minimal, due to a general lack of awareness and knowledge of Agile among practitioners and business teams.

From P3's point of view, *"Agile was generally applied more in small organisations compared to those of other sizes."* This is because these organisations, including large organisations in Saudi Arabia, have a strong culture based on pyramid structures, as they usually deal with complex problems and have larger teams. In addition, although there was a general consensus among interviewees that awareness and knowledge of Agile across Saudi Arabia was limited, they did agree that a number of software organisations were beginning to use Agile.

4.3.3.2 Agile Adoption

Although there was a lack of awareness about Agile in the country, there are some organisations adopting Agile for its perceived benefits. As highlighted by how all of the experts stated that they started adopting Agile. P3 mentioned that app developers began using Agile, as they had first noticed the benefits of using Agile on web app development at their companies. Others agreed, sharing the view that their organisations had adopted Agile after attending training events and realised the benefits organisations can obtain from adopting Agile. P2 added that *"the company used to apply the Waterfall model, but after I joined them one year ago, I encouraged them to adopt Scrum based on my experience with Agile."* Furthermore, all of the experts agreed that the competitive environment in the mobile app industry was another driver for their organisations adopting Agile. According to the CTO of company B, *"mobile app development runs in a competitive and dynamic environment, so Agile is one of the most appreciated software development methodologies in such an environment."* P1 also stated that *"we adopted Agile three years ago due to its suitability for the dynamic environment of mobile app development."*

4.3.3.3 Agile Methods

Based on the experts' responses, as given in Table 4.3, Scrum was found to be the most frequently used Agile method for mobile app development. However, some interviewees, like P3 and P1, stated they did not only use Scrum. P1 asserted that there are some Agile teams that have adopted the Kanban method with Scrum, known as Scrumban. Furthermore, some mobile app teams were using Scrum fully while others were only partially using it.

4.3.3.4 Agile Techniques

Some of the organisations, where full Scrum was used, as alluded to in the previous section, adopted a wide range of Agile techniques (i.e. daily stand-up meetings, sprint planning meetings, sprint reviews, sprint retrospectives, burndown charts, user stories, product backlogs and sprint backlogs). On the other hand, some of the organisations,

where Scrum was only partially adopted, were using fewer Agile techniques, such as daily stand-up meetings, sprint planning meetings, sprint reviews, user stories and sprint backlogs. In addition, the findings showed that daily stand-up meetings, sprint planning meetings, user stories, and sprint backlogs were the most frequently used Agile techniques in mobile-Agile app teams.

4.3.4 Perceptions of Agile

4.3.4.1 Reasons for Adopting Agile

When asked about the reasons that encouraged the interviewees to adopt Agile, the main motivations included the flexibility of Agile to manage projects and team members and an increased level of customer satisfaction compared to other methodologies used. In addition, they asserted that using Agile increased their productivity and the morale of the team members. For example, P2 stated that *"when Agile was adopted one year ago, the team members were extremely happy with it, as they were able to see what they did every week and receive feedback."* Moreover, all of the interviewees affirmed that the main reason for adopting Agile was to decrease the development cycle times and time to market, as well as to improve quality.

4.3.4.2 Reasons for Not-Adopting Agile

Although they agreed that Agile had changed their development process for the better, the interviewees also listed several drawbacks of adopting Agile. One of the key factors preventing Agile adoption in Saudi Arabia is the lack of documentation - Agile is considered an emerging methodology in the country. According to P3, some customers prefer documentation of their projects. He mentioned that *"when working with customers from government bodies, they ask for comprehensive documentation of their projects."* In addition, organisational culture and the business teams' lack of technical knowledge of Agile were considered the most significant reasons for the non-adoption of Agile. According to P4, *"the Saudi organisational culture and the lack of awareness and knowledge of Agile among stakeholders are the main barriers to Agile adoption in the country."*

4.4 Survey Findings

This section presents the findings of the survey. In total, 31 questionnaires were completed and collected from mobile app practitioners working in different mobile app development teams and organisations in Saudi Arabia.

4.4.1 Demographic Information

The data in this section presents the demographic information related to the participants and their organisations. This information provided the researcher of this study with an understanding of the respondents' backgrounds, including their gender, age, position in their respective organisations, years' experience in mobile app development, number of employees in their organisations, number of development teams they work with, the average number of team members, platforms used for app development and types of apps developed.

4.4.1.1 Participants' Information

Table 4.4 represents the demographic information for the survey's participants. Of the respondents, 29 out of 31 (93.5%) were male and the remaining (6.5%) were female. The largest group of respondents were aged between 31 to 39 and 23 to 30, accounting for 51.6% and 41.9%, respectively. The remaining 6.5% were aged 40 and above. In terms of the participants' experience in mobile app development, 48.3% of them had one to four years' experience, while 38.7% had five to 10 years' experience. As shown in the table, the respondents were working in different roles, with the majority working as Developers (46%). This was followed by Project Manager (24.3%), other positions (13.5%), Designers (8.1%), CEO (5.4%) and CTO/CIO (2.7%). Other positions included Software Architect, Analyst, Quality Assurance Engineer and Software Engineer.

Questions	Answer Options	Frequency	Percentage (%)	Cumulative Percent
Gender	Male	29	93.5	93.5
	Female	2	6.5	100.0
Age	Below 23 years	0	0.0	0.0
	23 – 30 years	13	41.9	41.9
	31 – 39 years	16	51.6	93.5
	Above 40 years	2	6.5	100.0
Work experience in mobile development	Less than a year	2	6.5	6.5
	1 – 4 years	15	48.3	54.8
	5 – 10 years	12	38.7	93.5
	More than 10 years	2	6.5	100.0
Role	CEO	2	5.4	5.4
	CIO/CTO	1	2.7	8.1
	Project Manager	9	24.3	32.4
	Developer	17	46.0	78.4

Designer	3	8.1	86.5
Others	5	13.5	100.0

Table 4.4: Demographic information about participants' backgrounds

4.4.1.2 Work Environment

The results of the participants' work environment are illustrated in Table 4.5. The respondents worked in software organisations of different sizes in Saudi Arabia. About 45.2% of them were working in small organisations, 32.2% were working in medium-sized organisations and 19.4% were working in large organisations, while 3.2% were working in micro organisations with five or fewer employees. This illustrates that three out of the four organisations were small and medium-sized enterprises. With regard to the number of development teams the participants were involved in, 54.8% reported being involved in one working team, 9.7% in two working teams, 12.9% in three working teams and 22.6% in three or more working teams. The average number of members in a development team was six to 10 (48.4%) or one to five members (38.7%), and no team had more than 20 members.

Questions	Answer Options	Frequency	Percentage (%)	Cumulative Percent
Organisation size	Micro (1-5 employees)	1	3.2	3.2
	Small (6-49 employees)	14	45.2	48.4
	Medium (50-249 employees)	10	32.2	80.6
	Large (more than 249 employees)	6	19.4	100.0
Number of development teams	1 team	17	54.8	54.8
	2 teams	3	9.7	64.5
	3 teams	4	12.9	77.4
	More than 3 teams	7	22.6	100.0
Average number of team members	1 – 5 members	12	38.7	38.7
	6 - 10 members	15	48.4	87.1
	11 – 20 members	4	12.9	100.0
	More than 20 members	0	0.0	100.0

Table 4.5: Demographic information about participants' organisations

4.4.1.3 App Platforms and Types

Respondents were asked to identify the types of platforms usually used and the types of app developed. The results shown in Table 4.6 indicate that the IOS platform was the most popular platform among the mobile app practitioners, as 50% of the respondents chose IOS. This was followed by the Android platform (38.9%). In addition, most of the participants (50.8%) chose Native apps as the most common app type used, followed by Hybrid apps (28.6%) and Web apps (20.6%).

Questions	Answer Options	Frequency	Percentage (%)	Cumulative Percent
Mobile app platform	IOS	27	50.0	50.0
	Android	21	38.9	88.9
	Windows phone	4	7.4	96.3
	Others	2	3.7	100.0
Mobile app types	Native	32	50.8	50.8
	Hybrid	18	28.6	79.4
	Web	13	20.6	100.0

Table 4.6: Mobile app platforms and types

4.4.2 Software Development Information

This section presents the findings from the second part of the survey, which contains items related to the participants' experience working in software development, as well as the most popular software development methodologies used by mobile app practitioners. Most of the respondents (43%) had one to five years' work experience in software development, while 40% had between five and 10 years' experience. In addition, 10% of the respondents had more than 10 years' experience and 7% of participants had been working for less than a year.

4.4.2.1 Software Development Methodology

The second question measured the participants' usage of software development methodologies, such as Waterfall, Spiral, Rapid Application, V, Agile and others, that they had used during their development process (Dean Leffingwell, 2010). From the results shown in Figure 4.2, it is evident that the Waterfall model is the most commonly used software methodology, used by 40% of the total sample size, followed by Agile software development (29%). Furthermore, as more than one methodology can be used, some participants selected more than one methodology.

For the respondents who answered 'other' (23%), this indicated that they did not use any specific methodology, while others used a combination of Waterfall and Agile. Moreover, no respondent selected the Spiral model and only 2% selected the V model.

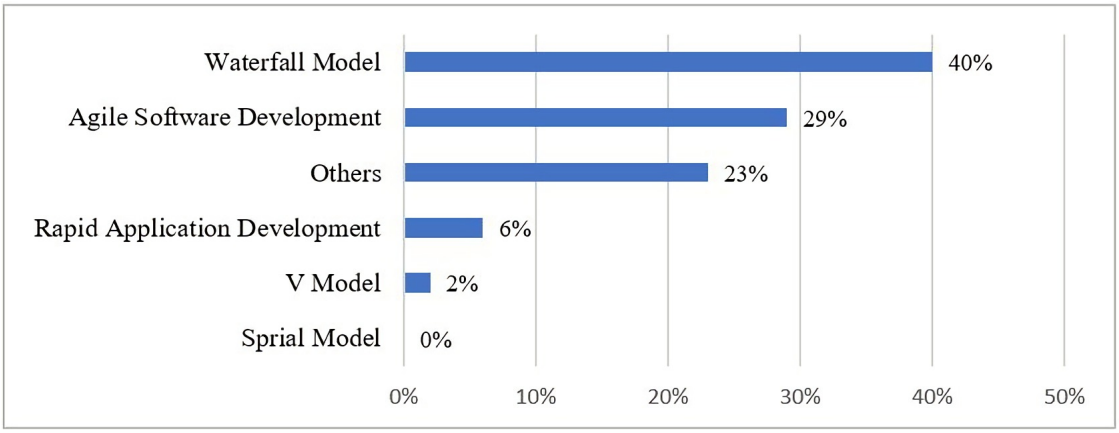


Figure 4.2: The most used software development methodologies

4.4.3 Agile Software Development Information

This section contains items on Agile software development and practitioner awareness, usage and perceptions of it.

4.4.3.1 Awareness of Agile

Awareness Level: Figure 4.3 presents the findings related to the participants' level of awareness of the use of Agile in mobile app development. The survey found that the vast majority of participants (77%) had heard of Agile. That is, 33.5% of them had limited knowledge, while another 33.5% had a good awareness, and only a small number of respondents (10%) had extensive knowledge. On the other hand, 23% of them had never heard of Agile and were unaware of its existence. When participants were asked about their years' experience in Agile software development (see Figure 4.4), most respondents had either less than a year or one to four years' experience using Agile (43% and 48%, respectively). While several had more than five years' experience using Agile (9%), none had more than 10 years' experience.

Knowledge Source: The participants were also asked about how they obtain knowledge about Agile, and the results are shown in Figure 4.5. Practice and reading were the most popular sources of knowledge among mobile app practitioners, with

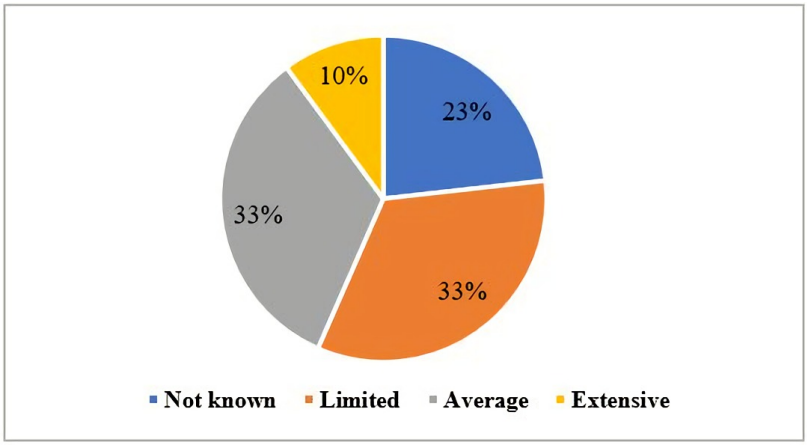


Figure 4.3: Awareness of Agile

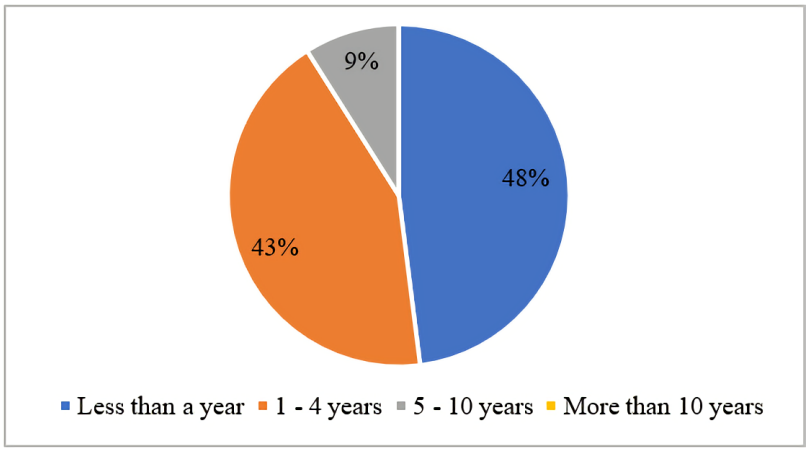


Figure 4.4: Years' experience in Agile

39% and 35%, respectively. Furthermore, 20% of them stated they attend training events and 6% expressed a preference for taking part in Agile certification. When participants were asked about the importance of training team members to use Agile before applying it, over three quarters of them (77%) agreed that training team members is 'very important' and 'important' and 14% described that training as being 'natural'. On the other hand, 9% of the respondents said that they thought that training is 'slightly important'.

4.4.3.2 Use of Agile

Agile Current Usage: The participants were asked if they use Agile in the development of mobile apps and if their current organisations had been adopting

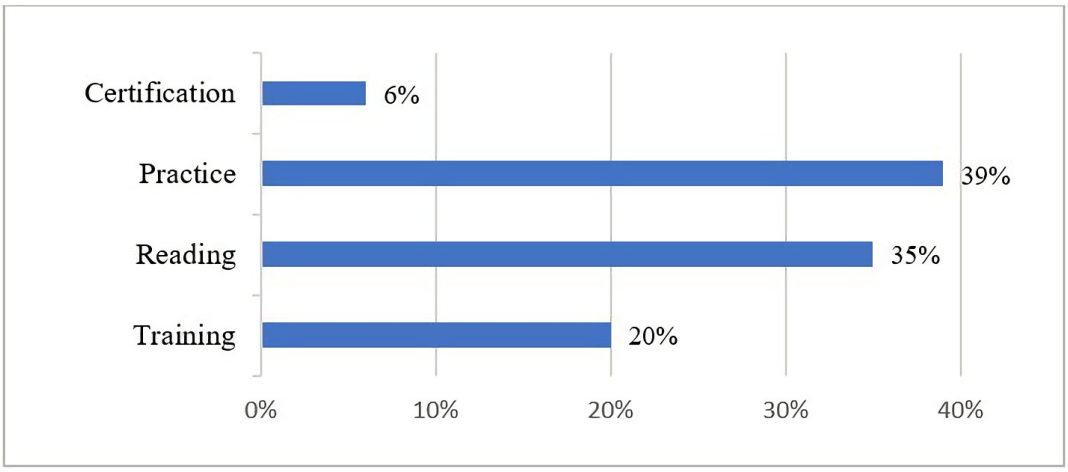


Figure 4.5: Knowledge source about Agile

Agile. As shown in Table 4.7, just under a quarter (21.7%) of them responded that they had fully adopted Agile methodology during the mobile app development process, while about 61% of them stated they had partially adopted Agile during the development process. The remaining 17.4% indicated they had not adopted Agile. On the other hand, the majority of the participants (about 70%) stated that their organisations had not used Agile software development, whereas around 30% of them had adopted Agile during the mobile-apps development process. Approximately half of these organisations had been using Agile for one to two years, while 24% had been using Agile for three to five years.

Questions	Answer Options	Frequency	Percentage (%)	Cumulative Percent
Agile adopted among practitioners	Yes	5	21.7	21.7
	Partially	14	60.9	82.6
	No	4	17.4	100.0
Agile adopted among organisations	Yes	7	30.4	30.4
	No	16	69.6	100.0

Table 4.7: The current use of Agile among practitioners and their organisations

The study found that 41% of the participant' customers were happy with the use of Agile in their development process, while half of them said that they were partially happy (see Figure 4.6). However, 9% of them stated that their customers were not happy. Furthermore, when participants were asked to what extend they think of the current use of Agile in developing mobile apps, the results show that 65% of the

respondents thought that there was a low use of Agile in Saudi Arabia, while 30% of them answered that they felt neutral and 5% agreed that Agile was being extensively applied in the Saudi mobile app development industry (see Figure 4.7).

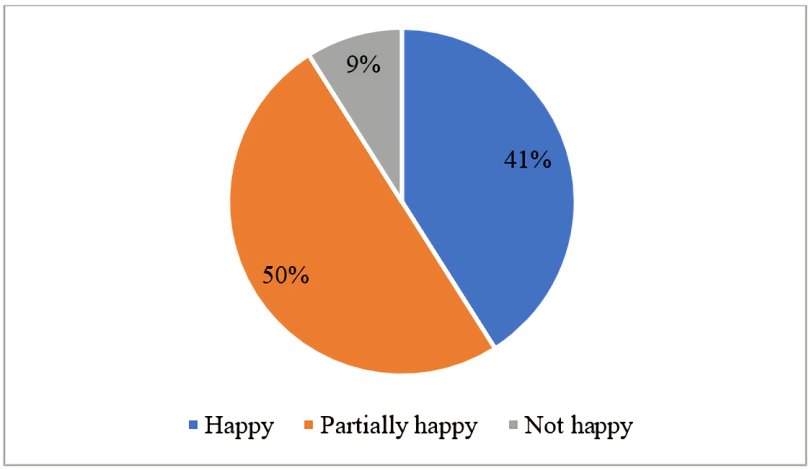


Figure 4.6: Customers' feelings about Agile

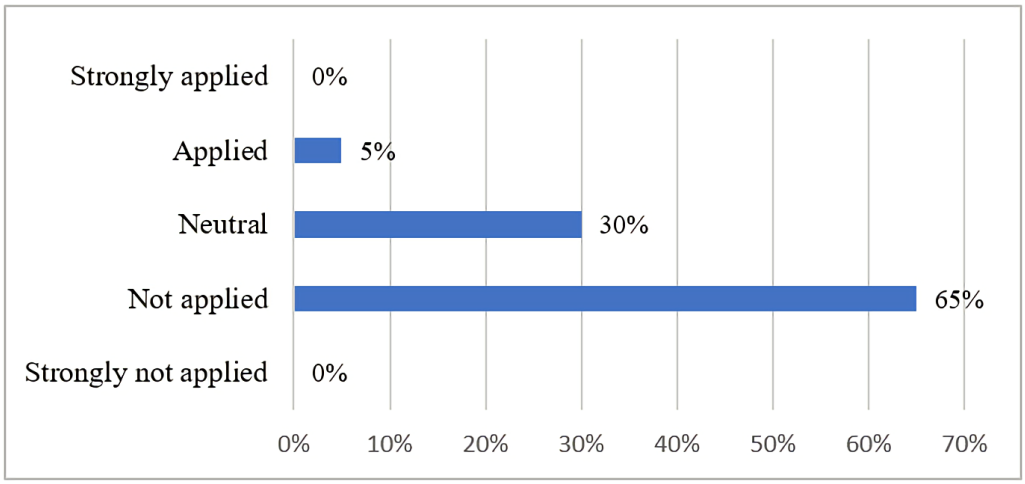


Figure 4.7: Current use of Agile

Agile Methods: A number of Agile methods were raised to determine out what Agile method had widely been used by the respondents. Hence, according to the data shown in Figure 4.8, 48% of participants used Scrum, while others used Kanban (15%), Extreme Programming (12%) and Crystal (12%). These results are aligned with the results of other studies discussed in the related work section.

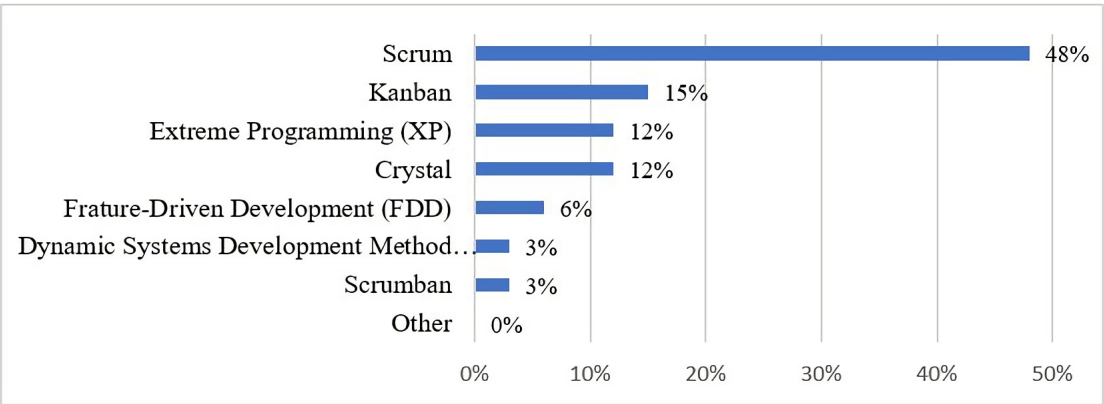


Figure 4.8: Agile methods used

Agile Techniques: The respondents were asked whether they were aware of Agile and the extent to which they use Agile techniques. Table 4.8 shows the frequency of responses for each technique, as well as the number of respondents using each one, and the number of those who claimed to know nothing about Agile. These techniques are ordered based on their usage, from the most to the least used. The study found that the most frequently used practices were 'user stories' and 'daily stand-up meeting', representing about 15% and 11%, respectively. These are followed by 'sprint review', 'iterative development', and 'incremental development'. The practices which were the least popular were 'burndown chart' and 'sprint retrospectives'. However, even though some participants had never heard of Agile or used Agile, they indicated that they did use some Agile techniques, such as 'user stories' and 'daily stand-up meeting'. Moreover, when the respondents were asked about the tools they used in their mobile-Agile team, it was found that GitHub was the most used platform (36%) to manage the source code, followed by Bitbucket. Furthermore, 34% of them specified that they used Asana and Jira for project management, while some of the respondents stated they did not use any tools. With regard to communication tools, they stated that Zoom and Slack are the most popular platforms used.

Techniques	Frequency	Percentage (%)	#NK.
User stories	20	14.9	4
Daily stand-up meeting	15	11.2	4
Sprint review	13	9.7	0
Iterative development	12	9.0	2
Incremental development	12	9.0	2
Product backlog	11	8.2	2
Sprint backlog	11	8.2	0

Sprint planning meeting	11	8.2	0
Test-driven development	8	6.0	2
Pair programming	8	6.0	1
Sprint retrospectives	7	5.2	0
Burndown chart	3	2.2	2
Others	3	2.2	0

Table 4.8: Agile techniques usage

4.4.3.3 Perceptions of Agile

Reasons for Adopting Agile: The participants were asked to rank the reasons for adopting Agile using a Likert Scale. The items were ranked based on 'Strongly Agree' and 'Agree'. As illustrated in Figure 4.9, 'improve team morale' and 'enhance ability to adapt to changes' were the main reasons for the encouragement of Agile adoption. 'Increase team productivity' was also one of the top reasons selected, with more than 80% of the respondents strongly agreeing with the statement. However, 'reduce application development cost' was considered as the least important reason by the respondents.

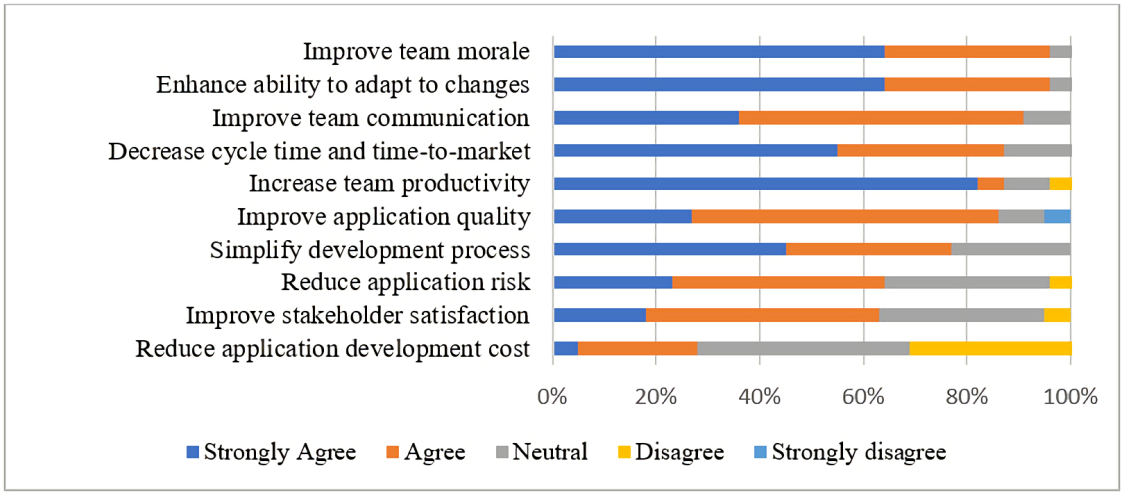


Figure 4.9: Reason for adopting Agile

Reasons for Not-Adopting Agile: Figure 4.10 illustrates respondents' reasons for not adopting Agile. The items were ranked based on 'Strongly Agree' and 'Agree'. The study found that 'lack of knowledge and training' was the most common reason (90%). 'Traditional organisational culture' and 'the difficulty of defining business

value' were the second and third reasons for preventing Agile adoption. On the other hand, the least important reasons for the non-adoption of Agile were 'Lack of tools to support adoption of Agile methods' and 'Application development is not suitable for Agile'.

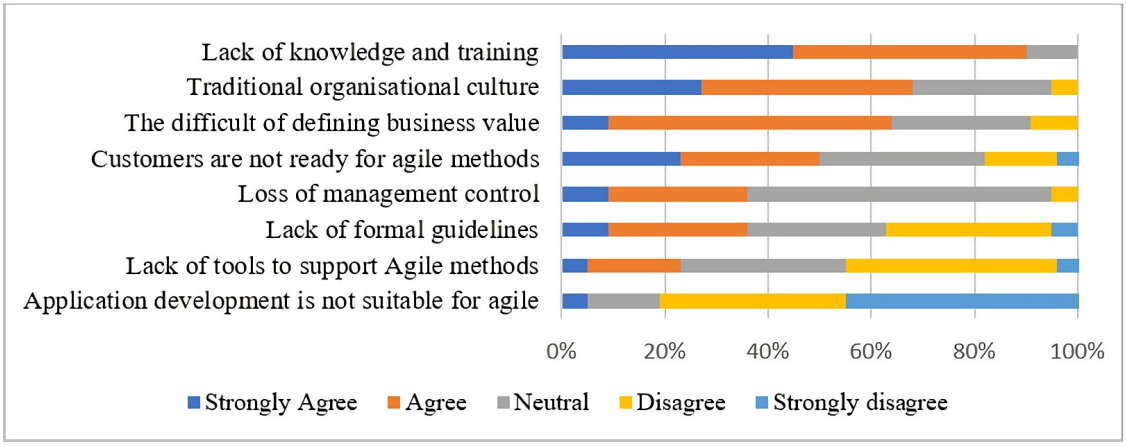


Figure 4.10: Reasons for not-adopting Agile

Agile Values: All of the participants were required to answer a question about the extent to which the four Agile values were applied by their development teams. This presents the level of agility of the participants' teams despite the fact some had never heard of Agile or used Agile. The results presented in Figure 4.11 indicate that most of the participants either strongly applied or applied the Agile values, except the value 'customer collaboration over contract negotiation', which received the highest proportion of neutral responses. Taking into consideration the total percentage of 'Strongly applied' and 'Applied', it can be seen that the most popular value was 'responding to change over following a plan', which represents about 76% of the responses. This is followed by 'individuals and interactions over processes and tools', with around 59%.

4.5 Discussion of the Findings

The main focus of this study is to explore the level of awareness, current usage and perceptions of Agile methodology among mobile app practitioners in Saudi Arabia. This section discusses the significant findings derived from the interviews and the survey conducted in this study.

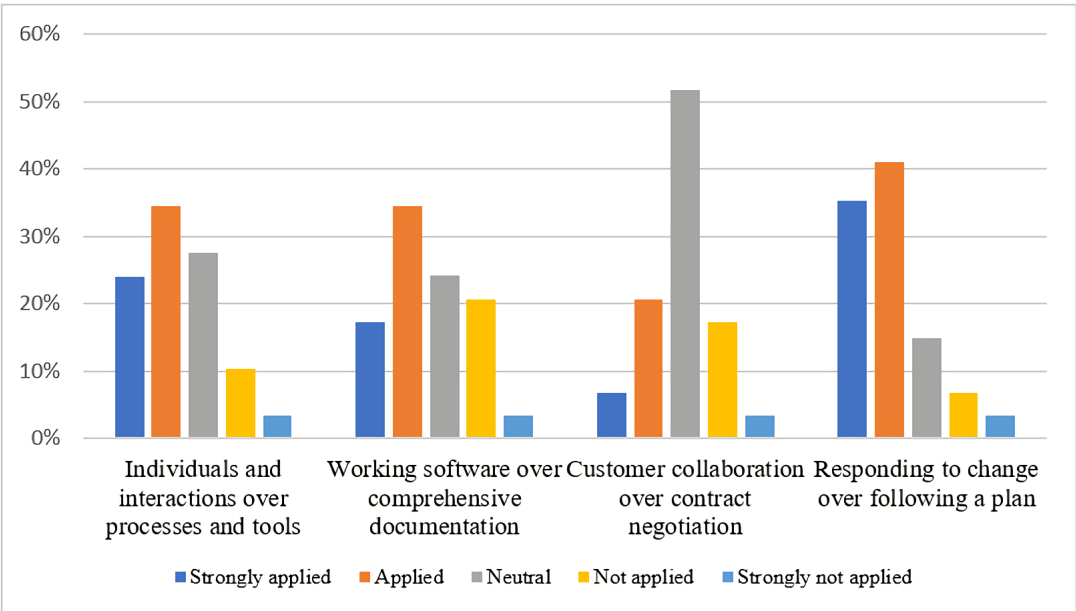


Figure 4.11: Agile values applied

4.5.1 Awareness of Agile

Agile is a well-known methodology and is used by a number of companies in Western countries (Begel and Nagappan, 2007; Rodríguez *et al.*, 2012). However, based on the data collected in this study, Agile is still not widely known in Saudi Arabia, and there is a low level of awareness of Agile amongst mobile app practitioners in the country. These results are similar to those reported in studies conducted in developing countries, such as Bin-Hezam *et al.* (2018); Sulaiman *et al.* (2015) and Nazir *et al.* (2016) regarding the level of awareness of Agile methods. They claimed that Agile methodology is still not widely known among practitioners. Moreover, about a quarter of the survey respondents had never heard of Agile, whereas three quarters of them had heard about it with different levels of expertise.

The results of this study indicate that the majority of the survey's participants have limited knowledge of Agile. This could be due to the lack of training events related to Agile in the country and the lack of emphasis on Agile from Saudi academic institutions. Therefore, including Agile courses in the university curriculum or conducting training events could help improve the awareness and perception of Agile in the country. This is a conclusion also drawn by de O. Melo *et al.* (2013) based on the results of their Brazilian study. The implication of the lack of awareness among mobile app practitioners of Agile is that only a small number of organisations have adopted Agile into their mobile app development. Furthermore, adopters can also misapply

Agile methods. In order to encourage software practitioners or organisations to adopt Agile methods and practice them correctly, raising awareness of Agile is considered an essential, initial step. This study also finds that the awareness and knowledge of Agile are lacking not only among mobile app practitioners, but also among business teams.

4.5.2 Use of Agile

As Agile awareness is low, its use is not widespread in the country, as evidenced by the results of this study, which show that only 30% of the organisations had adopted Agile. However, the early adopters of Agile in the study indicate that adopting Agile methods is highly applicable when developing a mobile app and has a positive impact on producing high-quality apps and reducing the time-to-market. Despite these advantages, Agile has only been fully applied by a minority of organisations in the country. This is due to the low awareness and knowledge the participants have, thus these issues need to be addressed before Agile methods can be implemented properly. This study indicates that there is a low level of Agile use in Saudi Arabia. This is in contrast with the findings of an earlier worldwide survey conducted by CollabNet VersionOne (2020), which reported that 82% of respondents were using Agile.

The results show that the most common Agile method to be adopted was Scrum, which is also considered the most popular method by most of the studies in the literature (e.g. de O. Melo *et al.* (2013); CollabNet VersionOne (2020) and Nazir *et al.* (2016)). This finding broadly supports the work of other studies that were conducted in Western countries, such as the one by Rodríguez *et al.* (2012). However, other studies, for example, the study by Salo and Abrahamsson (2008) found that their respondents were more familiar with XP than Scrum.

This study has also found that the most frequently used Agile practices among software practitioners in Saudi Arabia are 'user stories' and 'daily stand-up meeting'. In addition, the most interesting finding was that these two techniques are the most cited by the respondents who were not aware of Agile or had never used it before. Whereas 'burndown chart' and 'sprint retrospectives' are cited as the least used techniques in our study, they are in contrast to the findings of a report by CollabNet VersionOne (2020), which indicated that one of the most widely employed techniques was retrospectives. Another interesting finding from the current study is that respondents indicated they were applying some Agile values such as 'responding to change over following a plan'. Hence, even though some respondents claimed to have no knowledge of Agile, they might have, in fact, already been adopting some Agile techniques and applying Agile values.

4.5.3 Perceptions of Agile

This study has explored the perceptions of Agile in Saudi Arabia from the mobile app practitioners' perspective. A number of studies have indicated the importance of Agile in the software industry, as reported in the literature. One of the major benefits of Agile is its ability to respond to changes in customer requirements, as mentioned in the Agile Manifesto (Beck *et al.*, 2001). This was echoed by the Agile experts interviewed and the respondents of the survey in this study. In addition, this research has found that improved team morale, communication and productivity are perceived as key benefits, which was also reported by Begel and Nagappan (2007) and Rodríguez *et al.* (2012). The flexibility of Agile to manage projects and the increase in customer satisfaction were stated as reasons for adopting Agile by the early adopters. These benefits have also been stated in previous studies as the main reasons for adopting Agile (Rodríguez *et al.*, 2012; Nanthaamornphong and Wetprasit, 2016; CollabNet VersionOne, 2020).

On the other hand, the perceived drawbacks to Agile adoption include 'lack of knowledge and training', 'lack of documentation', and 'traditional organisational culture'; these findings are not dissimilar to studies conducted in both Brazilian and Thai contexts (de O. Melo *et al.*, 2013; Nanthaamornphong and Wetprasit, 2016). Practitioners should adapt to how Agile works and obtain the relevant knowledge of Agile methods in order to adopt Agile in their development process. Therefore, more training events and learning for practitioners are required in the country to reduce the challenges of adopting Agile. The experts interviewed stated that the most helpful way to learn Agile was by training and practice.

Indeed, this study identifies that awareness and knowledge have been considered as one of the barriers to the adoption of Agile in Saudi Arabia. Besides that, the study revealed that knowledgeable teams, organisational culture, training and learning, customer satisfaction and communication were considered as factors that influence Agile adoption. This is in accordance with the results of other studies,as these factors have been identified as critical success factors for adopting Agile in research carried out by Chow and Cao (2008); Sheffield and Lemétayer (2013) and Misra *et al.* (2009). These factors will be investigated in-depth in the Saudi software industry through empirical research in the next chapter.

4.6 Chapter Summary

This chapter answered the first sub-research question (RQ1.1) aiming to investigate the awareness, current usage and perceptions of Agile software development methodology among software practitioners in Saudi Arabia, with a specific focus of mobile app development sector. This study adopted a mixed method approach to achieve its

aim. The data were gathered first from semi-structured interviews with four experts to understand their viewpoints about the topic investigated and hear their opinions before designing the next studies. In addition, a survey questionnaire completed by 31 participants was used to identify the level of awareness and perceptions of software development in general, particularly Agile, among Saudi mobile app practitioners who either had adopted, or not, Agile methods.

This study concludes that there is currently little awareness of Agile among practitioners in Saudi Arabia, as its implementation is in the early stages in the country. However, it also finds that several practitioners do in fact apply certain Agile techniques and principles at present, despite never having heard of Agile. There is also an indication from the experts' interviews and some of the survey responses that Agile could be the best methodology for developing mobile apps. This study is considered an initial step in investigating the factors influencing Agile adoption in the Saudi Arabian mobile app context, and these factors are discussed in the next chapter. The next chapter builds on this chapter and uses a mixed methods approach, involving quantitative and qualitative data collection via semi-structured interviews and a focus group to explore the enablers of and barriers to Agile adoption within software SMEs in Saudi Arabia.

Chapter 5

Investigation of Agile Adoption Factors: Findings and Discussion

The findings from this chapter have been presented in two research papers. A full research paper has been published in the *Journal of Systems and Software* (Altuwaijri and Ferrario, 2022). A second short paper has been published in the proceedings of the *2021 2nd European Symposium on Software Engineering (ESSE 2021)* (Altuwaijri and Ferrario, 2021*a*).

5.1 Introduction

This chapter presents the second empirical investigation of this thesis which aims to investigate the influential factors that can support or hinder the adoption of Agile in software SMEs in Saudi Arabia. Specifically, this study focuses on Saudi software development companies in the SME sector involved in mobile app development practice. The objectives of this exploratory study are: (1) to gain deeper insight into the enablers and barriers of Agile adoption in the Kingdom of Saudi Arabia; and (2) to refine and review the Agile adoption framework. This chapter aims to address the following research question: ***"RQ3. What are the influential factors that may affect the Saudi Arabian Software industry when adopting Agile?"***

To achieve the aims of this chapter, empirical research through a multi-case study in three Saudi software SMEs is utilised to provide a better understanding of the influential factors and their impacts on Agile adoption. A mixed methods design is employed in this study to collect both quantitative and qualitative data. The research investigating the factors is divided into two phases. First, semi-structured interviews were conducted with 12 Agile experts from three software SMEs to explore their viewpoints about the influential factors. Second, a focus group study was carried out with five software practitioners to review Agile adoption

factors incorporated in the framework. The findings reveal that social factors, such as customer involvement, team capability, organisational and national culture, are considered the most impactful factors affecting the adoption of Agile as opposed to technical factors, such as the availability of specific tools or techniques.

The remainder of the chapter is organised as follows. In the next section, the research design and methods adopted in this study are described along with the research context. Next, the findings of the data collected through the interviews are presented and the discussion ensues. Following this, the data collected through the focus group discussion are presented and discussed. After that, the refined Agile adoption framework is presented. Finally, this chapter ends a discussion of the threats to validity.

5.2 Study Design and Methods

This study is explorative in nature and adopts a mixed-method design approach as it is considered to be the most appropriate to achieve the objectives of this study (Easterbrook *et al.*, 2008). This part of the research required both qualitative and quantitative data collected from individuals and groups working in different mobile app teams in various software SMEs in Saudi Arabia (Saunders *et al.*, 2016). This study utilises empirical research from a multi-case study in three software companies and expands on the existing empirical studies carried out in the context of the influential factors on Agile adoption, as discussed in Chapter 2, section 2.6, page 23. Specifically, this research is divided into two phases. The first is a concurrent embedded mixed methods design using semi-structured interviews with 12 mobile app practitioners to explore their viewpoints about the influential factors. This type of research design uses quantitative and qualitative methods distinctly in one phase during data collection and analysis. The researcher embeds one method within another, for instance, by including some qualitative questions within a questionnaire or quantitative questions in an interview (Saunders *et al.*, 2016; Creswell and Creswell, 2018). The use of this research design could provide richer data than using a single method design. The second phase employs a qualitative method using a focus group discussion with five participants to critically review the identified factors in the designed framework.

The research process for this study is presented in Figure 5.1, starting with the literature review to identify the main factors of Agile adoption investigated so far. Each factor was then mapped onto Agile principles, grouped into four categories and used to guide the empirical research of this thesis. This process is discussed in Chapter 2, subsection 2.6.1, page 26. Following the literature review, mixed data were collected through semi-structured interviews. The qualitative data were analysed with the support of NVivo software while SPSS statistical software was used to support

the analysis of the quantitative data. Next, qualitative data were collected by a focus group discussion and analysed using NVivo software. Following this, the results were presented and discussed. Finally , based on the results of previous steps of the research, a framework categorising key types of Agile adoption factors was refined and reviewed.

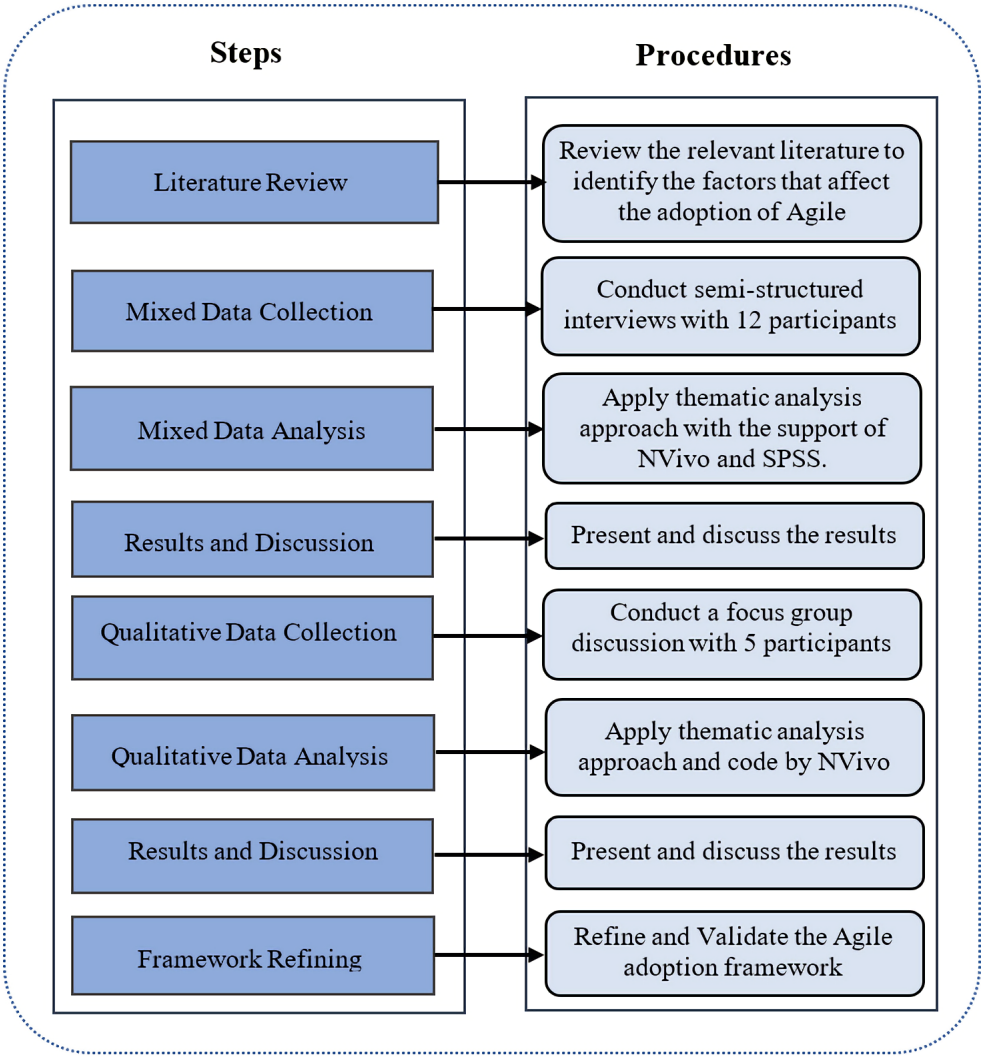


Figure 5.1: Research process for this study

5.2.1 First Phase: Expert Interview

The first phase of the data collection methods for this piece of research involved an expert interview using semi-structured interviews (Saunders *et al.*, 2016). Expert

interviews are a common method of data collection in software engineering, allowing researchers to explore topics in depth, probe responses in a flexible way and clarify any misunderstandings (Sjoberg *et al.*, 2007).

Targeting experts enables the researcher to collect in depth data from those who have a great deal of experience in the topic under investigation. They can share their points of view and give suggestions and recommendations regarding the subject of the research. The aim of the interviews was to investigate the enablers and barriers of the adoption of Agile in the context of software SMEs in Saudi Arabia. The semi-structured interviews were conducted with 12 participants who have at least two years of industrial experience and knowledge of Agile development.

5.2.1.1 Interview Design

Interview questions were developed based on the reviewed literature, and complemented by this study's recent empirical research on awareness and perception of Agile in the Saudi software industry discussed in the previous chapter. A total of twelve interviews were conducted online over six weeks with mobile app practitioners from three software SMEs. Each interview lasted from 40 to 70 minutes, resulting in a total of approximately 650 minutes of recorded material. A mixture of closed- and open-ended questions was used in order to collect quantitative data in addition to qualitative data. The five-point Likert scale (i.e. very important = 5; important = 4; neutral = 3; slightly important = 2 and not important = 1) was used for closed-ended questions, while the open-ended questions helped the researcher to investigate Agile adoption factors, as well as explore other relevant factors.

The interview questions were divided into five sections, with the first focused on information about the organisation, and the second centred around opportunities and challenges of Agile adoption. The third section sought to investigate possible influential factors on Agile adoption (i.e. people factors, organisational factors, environmental factors and technical factors), as well as prompt for any other additional factors. The last section focused on the interviewees' professional backgrounds. Table 5.1 provides an overview of the interview questions, and the completed guideline of the interview is provided in Appendix B.1. The interview questions were first devised in English and then translated into Arabic in order to ensure that all of the participants clearly understood them, and to avoid any language barrier.

Question No.	Question
Section A: Demographic Information about Organisations	
Q1	How long has Agile been adopted in mobile app teams in your organisation?

Q2	What Agile methods are used in your Agile teams?
Q3	What types of mobile apps do you develop?
Q4	What types of mobile platforms do you use?
Q5	How many mobile-Agile teams do you have in your organisation?
Q6	What size are the teams?
Q7	Are the teams co-located or distributed?
Q8	How many employees work in your organisation?
Section B: Opportunities and Challenges of Agile Adoption	
Q9	What motivated your team (organisation) to adopt Agile?
Q10	What are the challenges your team faced with adopting Agile, and how did you overcome them?
Section C: Influential Factors on Agile Adoption	
Q11	Could you rate how important each *people* factor (i.e. Team capability; Training and learning; Customer involvement) was in influencing the adoption of Agile in your team? And can you say how each aspect is going to influence the adoption?
Q12	Could you rate how important each *organisational* factor (i.e. Organisational culture; Management support; Communication and collaboration) was in influencing the adoption of Agile in your team? And can you say how each aspect is going to influence the adoption?
Q13	Could you rate how important each *environmental* factor (i.e. Organisational environment; Physical environment; National culture) was in influencing the adoption of Agile in your team? And can you say how each aspect is going to influence the adoption?
Q14	Could you rate how important each *technical* factor (i.e. Tools and technologies; Delivery strategy; Agile software techniques) was in influencing the adoption of Agile in your team? And can you say how each aspect is going to influence the adoption?
Q15	Are there any additional influential factors (not mentioned) that have to be addressed when implementing Agile in Saudi software organisations?
Section D: Demographic Information about Participants	
Q16	What is your role in the team?
Q17	How many years of experience do you have in mobile app development?
Q18	How many years of experience do you have in Agile software development?

Table 5.1: An overview of the interview questions

5.2.1.2 Interview Pilot Study

Pilot interviews were conducted to assess the accuracy and clarity of the interview questions and to provide some early suggestions on the viability of the research. According to Turner (2010), the pilot interview participants should be selected based on similar criteria to the group of participants for the main study. Thus, two mobile app practitioners with different positions were selected (i.e. a Project Manager and a Developer) working in software development in Saudi Arabia and a PhD candidate at Lancaster University; their results are not included in this study.

Two adjustments to the interviews were made following the pilot study feedback. First, the researcher reduced the recruitment criteria 'years of Agile experience' from four years to two. It was observed that the threshold would have been too high for a country where Agile adoption is only emergent. In addition, some questions were rephrased to improve clarity and encourage deeper reflection. Consequently, the four primary questions in Section C were amended.

5.2.2 Second Phase: Focus Group

The second phase forms the basis of this study and consists of a review of the influential factors by actively engaging the participants in a structured feedback process. This study adopted a qualitative research method in which the data were collected through a focus group discussion. Focus groups are a common data collection method, used to gain in-depth information via structured discussions with groups of participants (Saunders *et al.*, 2016); they give the participants the opportunity to express their opinions and ideas, with the aim of developing the research, as well as to react to responses from other participants (Stewart *et al.*, 2007). They also allow researchers to collect rich amounts of data and to further understand the phenomenon being studied. The aim of this focus group was to review critically the identified factors in the adoption framework that can support or hinder the adoption of Agile in the context of Saudi software SMEs. There were five participants in this group study, all Agile practitioners working in different software SMEs and who participated in the first phase of this research.

5.2.2.1 Focus Group Design

Focus group questions were informed and shaped based on the findings of the semi-structured interviews in the first phase of the research. The overview of the focus group protocol is provided in Appendix B.2 and described in this section. The plan for the focus group was developed with a set of exercises for collaboration with the participants. The focus group agenda was divided into four sections as follows:

- **Section 1:** the session started with an introduction of the group participants, an overview of the research and the purpose and motivation of the session.
- **Section 2:** the adoption framework was presented, and results obtained from the individual interviews were briefly discussed.
- **Section 3:** the framework and the identified factors on the adoption of Agile in the country were discussed in three discrete sections:
  - the impact of identified factors in the framework on Agile adoption.
  - the classification of the framework.
  - the most challenging factors that need to be considered when organisations intend to adopt Agile.
- **Section 4:** the session ended with a summary of the discussion and recommendations for future work.

The focus group session was held online due to COVID-19 and lasted for about 120 minutes in total. Two platforms were used. Microsoft Teams, a video-conferencing platform, was used for the meeting. Miro, an online collaboration platform, was used for responding to set tasks, and Figure 5.2 shows a partial result of the participants' collaboration regarding the factors' classification, which will be discussed in Section 5.5.2. A pilot session was conducted with one PhD candidate and one mobile app

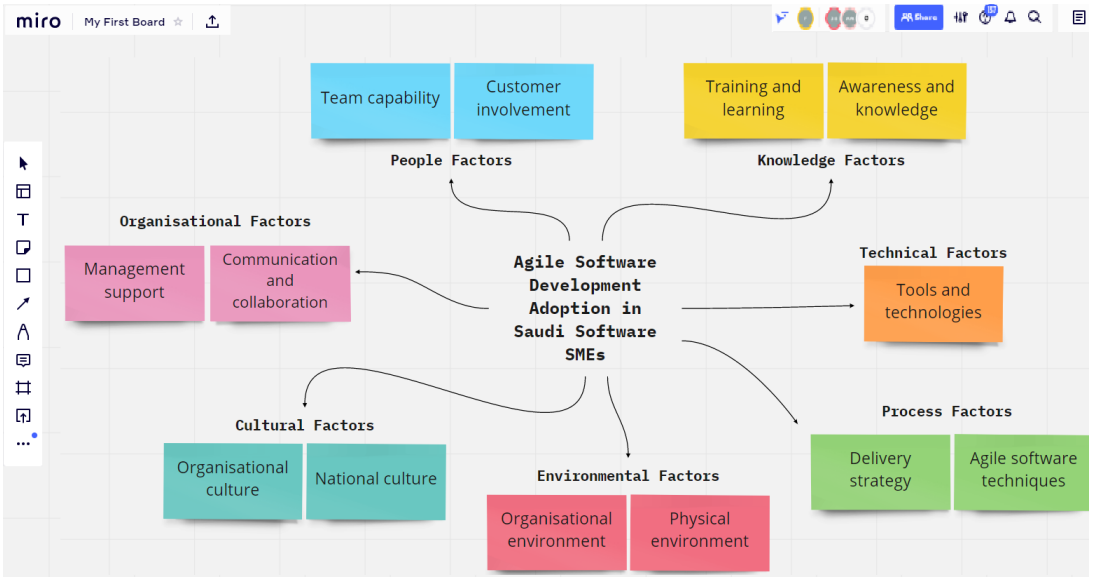


Figure 5.2: A partial result of the collaboration using Miro

practitioner in order to practise and test the focus group process and the questions, as well as to evaluate the platforms. After this pilot session was completed, only minor amendments were made to the process and questions. To avoid any language barriers, the focus group was translated from English and conducted in Arabic to minimise potential misunderstandings.

5.2.3 Research Context

The author recruited participants from three software SMEs, each from a different region in Saudi Arabia. Four participants were recruited from each company, with a total of 12 participants for the interview. Five of these participants then took part in the focus group discussion. Table 5.2 provides an overview of the three companies, and a brief description of each is provided below.

The first company, **A**, is considered a local, medium-sized company with about 200 employees (according to the discussion in Chapter 2). Its main office is located in the capital of Saudi Arabia, Riyadh, with several branches across the country. This organisation is responsible for the production of computer programs, information systems, and the implementation of IT government projects. The mobile app development department, the focus of this research, has two teams with an average number of seven members each. Agile was adopted by a number of departments a few years ago; however, it was only used in mobile app projects three years ago, as stated by the Project Manager: *"we decided to adopt Agile in our mobile app teams when we noticed the benefits of Agile in other teams in the company."* Scrum is the Agile method used in the development teams with the support of Kanban boards. Three app types have been developed (i.e. native, hybrid and web), built to support the IOS and Android platforms. During this research, four participants from this company were interviewed and two of them participated in the focus group.

The second company, **B**, is a local, small-sized software development company with about 45 employees which is also located in Riyadh. It specialises in web and mobile app development, with a primary focus in recent years on developing business mobile apps, such as hotel and food delivery apps. The development process used by the mobile app teams is based on the Scrum method. There are three mobile-Agile app teams with an average number of seven members per team. Both native and hybrid apps are developed in this company, and IOS and Android platforms are supported. According to the CEO, Agile was adopted four years ago in the development of mobile apps, as it is more suited to the dynamic environment of the mobile app industry. Four participants from this company participated in the interview and two of them in the focus group.

The third company, **C**, is a local start-up company, specialising in mobile app development. The company adopted Agile software development two years ago and,

similar to company B, use the Scrum method. Currently, the company has about 15 employees and one mobile app team with eight members, all of whom are distributed. They support and develop IOS and Android native apps. According to the CTO, *"the company used to apply the Waterfall model, but after I joined them two years ago, I encouraged them to adopt Scrum based on my experience with Agile."* Four participants from this company participated in the interview and one of them in the focus group.

Company ID	**A**	**B**	**C**
Company size	Medium	Small	Small
Number of mobile-Agile teams	2	3	1
Average team size	7	7	8
Location of teams	Co-located	Co-located	Distributed
Agile method used	Scrum	Scrum	Scrum
Mobile app types developed	Native, Hybrid, Web	Native, Hybrid	Native
Mobile platforms used	IOS, Android	IOS, Android	IOS, Android
Agile adopted (in years)	3	4	2

Table 5.2: Overview of the companies

5.2.4 Data Analysis

Since the aim of this study was mainly to investigate the factors identified in the framework, a deductive coding approach was mainly adopted to analyse the data; first, the data was labelled with the four-factor types identified from the literature (i.e. people, organisational, environmental and technical), then their sub-themes. Other themes and sub-themes emerged from the thematic analysis; for instance, 'awareness and knowledge' emerged as a new factor affecting Agile adoption, which is not incorporated in the conceptual framework. Table 5.3 illustrates the themes and sub-themes of the interview data. Further details about how the qualitative and quantitative data were analysed are provided in Chapter 3, subsection 3.3.7, page 45.

Main Themes	**Sub-themes**	**Example of Codes**

People People factors relate to individuals and teams, such as practitioners and customers	Team capability	Team members' professional skills; talent and knowledgeable practitioners; lack of skilled teams members
	Customer involvement	Customers' engagement; customers' feedback, vague requirements; time constraints; ways to involvement
	Training and learning	Not enough training events among practitioners; limited training events in the country; Agile learning resources
Organisational Organisational factors relate to the firm level and the way organisations operate	Organisational culture	Organisational structure; corporate culture; cultural changes according to Saudi vision 2030; hierarchical structure
	Management support	The importance of support from senior management; lack of management support; management teams role
	Communication And collaboration	Communication among team members; collaboration among team members; customers' communication and collaboration; difficulties in communication and collaboration
Environmental Environmental factors relate to the context in which organisations, and teams operate	Organisational environment	Work atmosphere; issues of the non-safe environment; ways to improve company environment
	Physical environment	Office layout; team surroundings; social spaces
	National culture	Mixed gender teams; Saudi cultural changes; cultural values
Technical Technical factors relate to the process, tools and technologies that support Agile work	Tools and technologies	Use of tools in the Covid era; the availability of tools; digital or physical tools; collaborations tools used
	Delivery strategy	Influence of delivery strategy

	Agile software techniques	Influence of Agile techniques
Additional Factors Additional Factors relate to the new Factors suggested by the experts	Awareness and knowledge	Agile awareness among management team; Agile awareness among customers; Agile awareness among government agencies
Opportunities and Challenges of Agile Adoption This theme describes the reasons that encourage and challenge Agile usage	Reasons for Adopting Agile	team's members motivation; market competitiveness; senior management decision
	Challenges Adopting Agile	culture of organisations; customer engagement; knowledge and training

Table 5.3: The themes of the interview data

5.2.5 Population and Sampling Approach

A purposive sampling approach (Johnson, 2014) was adopted in this piece of research. This approach is a non-random sampling technique and was adopted as it helps to find suitable participants according to the judgements of the researchers. In this case, participants needed to have a good deal of experience and understanding of the phenomenon under study. The key requirements for selection were that they had to be mobile app practitioners with 1) at least four years' industrial experience of mobile app development, 2) two years' industrial experience of Agile software development, and 3) they had to be from different software SMEs in Saudi Arabia.

In terms of participant numbers, there is no formula for calculating the sample size for interviews. Researchers have suggested an approximate, acceptable number of interviewees. For example, Cresswell (1998) suggests that an acceptable number ranges between five and 25 participants, while Morse (1994) states that the minimum acceptable number of participants is six. However, other researchers such as Corbin and Strauss (2008) and Saunders *et al.* (2018) argue that interviews should be continued until the point that data saturation occurs. Saturation in qualitative research occurs when sufficient data are being gathered and no new information is being acquired (Fusch and Ness, 2015; Saunders *et al.*, 2018; Guest *et al.*, 2020). The data saturation approach, which refers to the point of redundancy in the data, was utilised in this study (Saunders *et al.*, 2018).

By applying this approach, saturation was reached at nine interviews; nevertheless, three extra interviews were added to the sample to guarantee data saturation. In this study, data saturation was achieved when the variation in the data leveled off. At

this point, no new findings or variability were coming from the data. Identifying the saturation point was an easy process since an iterative approach to data collection and analysis was used. The researcher went through cycles of data collection and analysis up to the point where no new information was forthcoming from new interviews. Therefore, it was pointless to continue collecting more data as the value added by new data would be close to none. In terms of the focus group participants, there were five mobile app practitioners, all of whom had participated in the first phase of this study.

5.2.6 Ethical Considerations

As the research involved human participants, ethical issues were taken into consideration before collecting data, as discussed in Chapter 3, section 3.5, page 52. The author submitted a 'FSTREC Application Form' to the FSTREC to obtain approval. After five weeks, the submission was approved, and the reference number was FST20028 (see Appendix B.3). Prior to conducting the interviews and focus group, each participant was asked to read the participant information sheet (see Appendix B.4) and sign the consent form (see Appendix B.5 for interview and focus group). After the interview ended, a debriefing sheet was sent to all participants (see Appendix B.6).

5.3 Expert Interview Findings

A thematic content analysis of the interview transcripts revealed key themes in relation to the four pre-established factor types (i.e. people; organisational; environmental; technical) that may influence the adoption of Agile in Saudi Arabian software SMEs. The findings are presented under the headings below. First, information about the interviewees' professional backgrounds is presented, and then the opportunities and challenges of Agile adoption are provided. After that, the participants' perceived importance of the factor is presented, as indicated on a five-point Likert scale, followed by more detailed results obtained from the qualitative data.

5.3.1 Demographic Information

Demographic information related to the participants was collected in order to provide the researcher of this study with an understanding of the respondents' backgrounds, including their position in their respective organisation, years' experience in mobile app development and years' experience in Agile software development. Table 5.4 presents the demographic information of the interviewees. The interviews were conducted with 12 experts with substantial experiential knowledge of mobile app and

Agile development. At the time of this study, the interviewees were working in three software development SMEs, nine in small organisations and three in medium-sized organisations.

As shown in Table 5.4 below, the interviewees were working in different roles, with the majority working as Developers (five participants). Two were Scrum Masters, and there was a CEO, a CTO, a Project Manager, a Designer and an Analyst. In terms of years' experience in mobile app development, most participants (66.6%) had five to 10 years' experience, 25% had more than 10 years, and one participant (8.33%) had less than five years' experience. Regarding the participants' experiences in Agile software development, the majority (75%) had less than five years' working experience of Agile, 25% of them had more than five years, and no one had more than seven years' experience.

Company Code	Participant Code	Participant Position	Experience in mobile development (in years)	Experience in Agile development (in years)
A	P1	Project Manager	11	5
	P2	Scrum Master	11	4
	P3	Developer	9	3
	P4	Developer	10	3
B	P5	CEO	11.5	6
	P6	Scrum Master	7	4
	P7	Developer	5	3
	P8	Analyst	6	3
C	P9	CTO	9	5
	P10	Developer	10	4
	P11	Developer	6	2
	P12	Designer	4	2

Table 5.4: The demographic information of interviewees

5.3.2 Opportunities and Challenges of Agile Adoption

A previous chapter (Chapter 4) interviewed four experts on the awareness and perceptions of Agile in Saudi Arabia as well as the reasons and challenges for Agile adoption. This study expands the breadth and depth of the previous pilot research by asking the 12 interviewees two questions about the opportunities and challenges of Agile Adoption (Section B of the interview).

5.3.2.1 Reasons for Adopting Agile

This study identifies three main reasons for Agile adoption: to motivate team members, to maintain competitiveness and to adhere to senior management decisions.

The first main reason for adopting Agile is team members' motivation. According to Scrum Master P2 (company A), his team felt that Agile improved their morale and productivity; they discussed the benefits with senior management, who then decided to support Agile adoption. Evidence of drawbacks of traditional methods such as Waterfall also help motivate Agile adoption, as stated by P5 (Company B).

Market competitiveness was found to be another key motivator for Agile adoption; the CTO of company C highlighted that as *"the nature of developing mobile apps is highly competitive and dynamic"*, Agile was introduced to support and manage the dynamic and competitive nature of mobile app development. According to the CEO of company B, *"there is still competition between software organisations in terms of developing apps, and if we do not use Agile, we will lose to the competition."* He also felt that the number of organisations in Saudi Arabia using Agile has increased in recent years.

The third reason for Agile adoption identified by this study is top-down: to adhere to senior management decisions. Company B senior management decided to adopt Agile after attending training events, and mandated its use.

5.3.2.2 Challenges Adopting Agile

The interviews' data indicate that teams face three main challenges when trying to adopt Agile, namely: the organisational and national culture; the involvement of customers in Agile teams; and the level of awareness and knowledge of Agile. Raising awareness about these challenges can help other teams when adopting Agile. In this section, these challenges are outlined and further explored in Sections 5.3.4 to 5.3.8.

Culture of Organisations - The main challenge reported by this study's participants is the tension between Agile 'culture' and Saudi organisational culture. The CTO of company C stated that *"when we decided to adopt Agile in our team, we did our best to adapt our culture to Agile culture."* He argued that adapting to Agile culture was not a difficult step as his company was quite small. The Scrum Master of company A felt that, despite several Saudi organisations branding their working style as 'Agile', these organisations do not use it correctly due to a lack of understanding of the relationship between their organisational culture and Agile. He felt that senior management should examine this relationship in order to realise Agile's full potential. For example, they should understand the impact of hierarchical culture on practising Agile which is based on a flat culture.

Customer Engagement - Several interviewees believed that some of their customers were not interested in being involved in Agile teams. The findings indicate

that customers' lack of knowledge about Agile may prevent its adoption in the development teams. According to P2, *"not all the customers are interested in Agile, especially customers from government sectors."* A Company B interviewee reported that they encourage customers' participation by being mindful of their availability and trying to reduce the number of meetings. They also give their customers access to digital tools, such as Asana or Jira, to participate online.

Knowledge and Training - Lack of knowledge and training is another issue reported to affect the adoption of Agile according to the interviewees. A developer working in Company B commented, *"I see that there is a lack of awareness about Agile from all key stakeholders, including customers, senior management and team members."* Its CEO stated, *"I noticed the lack of awareness, in particular, among software practitioners despite their specialisations in the field of Computer Science."* He argued that there is a gap between higher education and the labour market in the country and encourages universities to invite companies to introduce students to the skills they need. In addition, some participants argued that putting an emphasis on Agile in the university curriculum is needed to increase the level of awareness. The way of overcoming this challenge, according to the interviewees, was to introduce training and workshop events and provide learning resources for their key stakeholders.

Participant, P8 suggested that Saudi organisations should give their team members more time and support to attend workshops and engage in autonomous learning to increase their awareness and knowledge of Agile. Thus, according to interviewees, increasing awareness about Agile in Saudi society may encourage software development SMEs to adopt Agile methods. Some participants (e.g. P5) noted that the limited availability of training and knowledge resources in Arabic (e.g. textbooks) about Agile can be problematic.

5.3.3 An Overview of Influential Factors

This section provides the results of the interviewees' responses to the structured questions. Participants were asked to rate the importance (on a Likert scale from 1 = not at all important to 5 = very important) of the Agile adoption factors reflecting specifically on the Saudi SME software industry (Figure 5.3), the factors were ranked according to their importance. The aim is to assess the importance of these factors from the experts' point of view. From the descriptive analyses presented in Table 5.5, the factors that have a median of above three (neutral) are considered influential. Each category of related factors in the table is ordered based on its median. The median is not affected by extreme data values as a mean value and, together with the range, are considered appropriate descriptive statistics for analysing ordinal data (Jamieson, 2004; Saunders *et al.*, 2016).

Based on the descriptive analysis in the table, the results indicate that all the

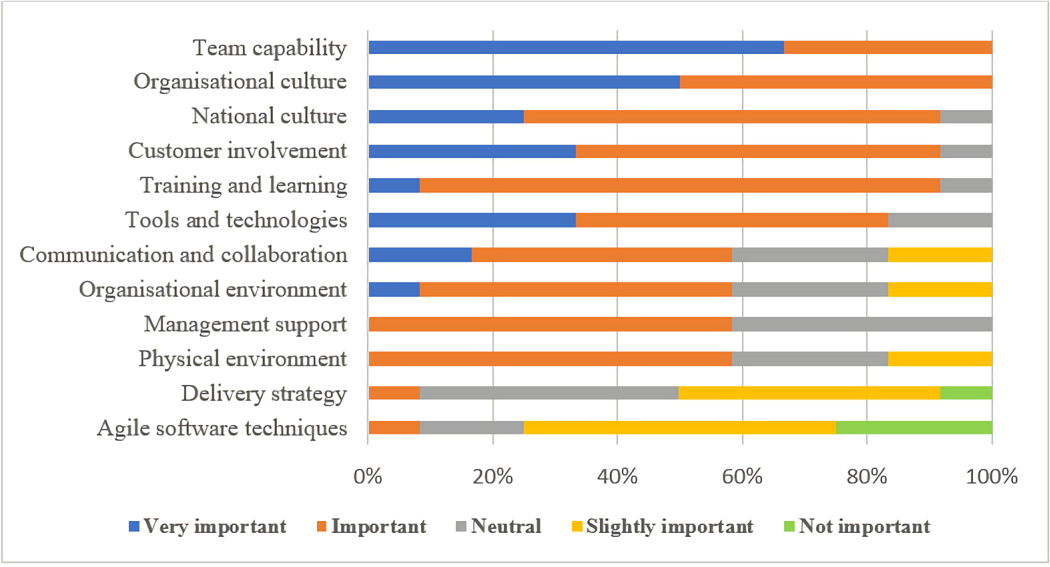


Figure 5.3: Importance level of influential factors

Category	Factors	Median	Range
People Factors	Team capability	5.00	1
	Customer involvement	4.00	2
	Training and learning	4.00	2
Organisational Factors	Organisational culture	4.50	1
	Management support	4.00	1
	Communication and collaboration	4.00	3
Environmental Factors	Organisational environment	4.00	3
	Physical environment	4.00	2
	National culture	4.00	2
Technical Factors	Tools and technologies	4.00	2
	Delivery strategy	2.50	3
	Agile software techniques	2.00	3

Table 5.5: Median and range of influential factors

investigated factors have a median of greater than three, except for two factors (i.e. delivery strategy and Agile software techniques). As illustrated in Figure 5.3, most participants agreed with people factors and their perceived influence on Agile adoption. The results show that all participants either strongly agreed (66.7%) or agreed (33.3%) that 'team capability' is a critical factor impacting the adoption of

Agile, as it represents the highest median score (5.00). This is followed by 'customer involvement' in the Agile team, with most participants either strongly agreeing (33.3%) or agreeing (58.3%) with its importance. 'Training and learning' aspect was the third most important people factor with most of the interviewees (83.3%) agreeing with it.

Organisational factors also have a significant impact on the adoption. The importance of 'organisational culture' was rated by all the participants as 'very important' (50%) and 'important' (50%), with a median of 4.50. In comparison, 'management support' and 'communication and collaboration', both with the same median score (4.00), were considered less important. 58.3% of the interviewees agreed that 'management support' was important, albeit 41.7% were neutral while 16.7% and 41.7% of them strongly agreed and agreed on the importance of 'communication and collaboration', respectively.

The environmental-related factors have the same median value (4.00). However, the 'national culture' of Saudi Arabia was considered most important; 25% of participants said it was 'very important' while 66.7% said it was 'important'. The 'organisational environment' was rated as 'very important' by only 8.3% of the interviewees but half of them stated it was 'important'. The 'physical environment' was considered the third most important environmental factor; 58.30% agreed on its importance, while a quarter of them considered it had a neutral impact.

With regard to the importance of the technical factors, the results show that most participants either strongly agreed (33.3%) or agreed (50%) about the importance of 'tools and technologies' on the adoption of Agile; this has the largest median value of 4.00. This is followed by 'delivery strategy' (with a median of 2.50) and then 'Agile software techniques' (with a median of 2.00). Finally, 50% and 25% of the participants considered 'Agile software techniques' to be slightly important and not at all important.

The results of the quantitative data collected from the interviewees regarding the assessment of the influential factors on Agile adoption in Saudi software SMEs were presented in this section. The next sections provide the qualitative data findings of the interviews by presenting the results of the influential factors under the four identified categories.

5.3.4 People Factors

5.3.4.1 Team Capability

Team capability is considered the most important factor for Agile adoption, with all participants either strongly agreeing (66.7%) or agreeing (33.3%) with its importance. Team capability is linked to team members' professional skills and knowledge of Agile. For example, P5 highlighted that *"if you have talent and knowledgeable practitioners*

in your team, you will be happy with Agile; otherwise, it will be difficult to adopt it." Likewise, P3 asserted that *"it is a challenge to adopt Agile when team members do not know what Agile is and how it works."* Likewise, P12 also felt that *"a lack of skilled and knowledgeable practitioners is a barrier to Agile adoption."*

The findings indicate that the ability of the team members to be collaborative, share a sense of responsibility and have a willingness to learn are considered important factors in adopting Agile methods, as *"Agile needs team members who are collaborative, open-minded and willing to learn"* (P6). In addition, the interviewees indicated that team members need to be organised and motivated to make joint decisions about the task to be implemented next and, thus, improve team efficiency. P2 reported that *"the self-organisation of the team and their motivation are influential factors in the adoption of Agile."* However, P9 also made it clear that when first using Agile, team members' knowledge is less important than their willingness to be open-minded and to learn.

5.3.4.2 Customer Involvement

Our participants consider customer involvement an influential factor for Agile adoption, with 33.3% of the participants interviewed strongly agreeing and 58.3% agreeing with its importance. Customer involvement provides feedback and helps ensure the application meets customers' requirements. One participant said, *"we are always trying to encourage our customers to be involved in our team in order to garner their feedback and comments after each release"* (P6). Customers' feedback gives the developers guidance and helps them to respond rapidly to new requirements. The interviewees stress the importance of this feedback loop as they recognise that most customers are unsure of their exact requirements at the beginning of the process. P2 stated that *"at the outset of the project, our customers did not provide us with clear requirements of their apps. As a result, it was vague when we began."* According to P6, customers only tend to get involved in the retrospective meetings, as most of them do not have time to be involved frequently. He said that *"our customers are busy and do not have much time collaborating with us. So, we don't get their involvement in the development team as much as we want."*

Company B encourages customers to be involved in-person right from the outset, however, due to constraints on their time the company also supports online collaboration. For example, by using the digital Kanban board, customers can access status updates, suggest additional requirements, and make changes in the project backlog. In cases where there is no specific customer, P9 confirmed that one team member acts as product owner, by collecting and analysing the requirements from the market by asking potential end-users.

The participants agreed that it can be difficult to adopt Agile when dealing with

customers from governmental bodies, such as ministries or universities, because their working style tends to be based on Waterfall. They are usually found unwilling to be involved in development teams and to require comprehensive documentation. As the CEO of company B discussed, *"we faced difficulties when working with customers from government agencies as they are not always ready to be involved."* Some interviewees argued that most of the business in software development companies comes from the government sectors, where Agile adoption seems to be low. However, P9 stressed that public sector attitudes to Agile were changing in line with Saudi's Vision 2030.

In addition, participants felt that customers should have some high-level understanding of Agile methods and techniques to be able to collaborate with the development team and build trust in such teams. As stated by P1: *"customers have to trust the Agile team, be aware of Agile and how it works and be involved in the team, providing regular feedback; Agile cannot be adopted correctly when the clients are excluded or if there is a lack of trust."* P1 added that lack of trust between customers and teams is one of the main challenges of adopting Agile. Thus, the participants argued for the importance of involving customers and for building trust by creating direct interaction and strong communication and collaboration.

5.3.4.3 Training and Learning

Most of the participants agreed (83.3%) that education and training should be an essential element in any Agile adoption plan. P2 stated that *"we provide Agile workshops and seminar events for team members regularly."* However, most of the interviewees acknowledged that their team adopted Agile without first accessing enough training, resulting in incorrect use of Agile at the start. P8 stated that *"we adopted Agile although most of the team members did not understand how it works; at the beginning we faced many difficulties, but when the management team provided training, we quickly understood the extent to which Agile can help us and increase our productivity."*

P3, P6 and P11, for instance, argued that securing training events and accessing learning resources have been a challenge in Saudi Arabia historically; however, in recent years there have been more opportunities albeit still limited. P5 thought that the responsibility for training and learning rests more with the individual practitioners than their organisations. Thus, they have to work hard to find suitable courses for them. P12 added that *"even though there are learning resources, finding them in the Arabic language is difficult."* Three quarters of the interviewees agreed with the lack of Agile resources written in Arabic. Some of the interviewees also reinforced the importance of training and learning for the customers, as practitioners and customers need to work collaboratively in a team.

5.3.5 Organisational Factors

5.3.5.1 Organisational Culture

All the participants either strongly agreed (50%) or agreed (50%) that the culture of an organisation influences the adoption of Agile methodology in the country. P2 stated that *"of course, the main obstacle to Agile adoption is the culture and structure of an organisation; there has to be support of Agile values and principles."* Similarly, P4 stated that *"the culture of most software development SMEs in Saudi Arabia does not support the adoption of Agile; and even if it is adopted, it is not practised correctly."* Most Saudi organisations have a similar corporate culture, influenced by the national culture, the vision, values and policies of their organisation and the employees whom they hire. According to the interviewees, a national, Saudi culture permeates organisational culture largely because most of the organisations operate locally rather than internationally. However, as asserted by P10, a number of organisations are trying to bring cultural change by offering training events designed to increase their employees' awareness and acceptance of innovation.

The importance of organisational culture in Agile adoption, was highlighted by Company B practitioners who attributed the adoption of Agile to their company's non-hierarchical culture. In their view, a hierarchical company structure acts as a barrier to Agile adoption, as Agile requires a shift of power and responsibility from the management team to the development team, as well as a dynamic, supportive, and collaborative culture. Again, P5 argued that *"although culture is starting to shift, as per Saudi's Vision 2030, most of the development teams in Saudi Arabia tend to focus more on satisfying management than improving the quality of their work."*

5.3.5.2 Management Support

Senior management support has also been identified as an important factor in Agile adoption with 58.3% of the interviewees agreeing with its importance, albeit 41.7% were neutral. The Scrum Master, P2, from company A, stated that *"as a team, we discussed the importance of adopting Agile because of its advantages to our performance and then discussed that with senior management; however, without their support, we cannot adopt it."* He added that decisions regarding Agile adoption took a long time in his company because of the lack of awareness of Agile among senior management.

This sentiment was echoed by other interviewees who voiced a lack of support from management, resulting in a slow pace of adoption and poor Agile application. P4 stated that *"from my point of view, senior management has to take responsibility to support teams by creating a productive team environment and providing the tools needed."* He added that *"some of the tools that support our teamwork are costly, and*

we cannot obtain them without the support of the management team." In a similar vein, seven participants argued that management teams have a critical role to play in providing training and education for development team members.

5.3.5.3 Communication and Collaboration

Regarding the influence of communication and collaboration, most of the participants strongly agreed (16.7%) or agreed (41.7%) with its influence on Agile adoption. P7 stated that *"of course, it is extremely important that organisations support effective and fluent communication and collaboration among team members; this helps to increase the productivity of the team and meet the expectations of their customers."* It is not only team members that must communicate and collaborate effectively; teams also need to engage their customers for successful Agile adoption. The interviewees made it clear that barriers to Agile adoption are a lack of communication and collaboration among team members and customers, and an organisational culture which does not positively support this. One participant, P2 argued that *"we (as a team) effectively communicate and collaborate with each other, however our problem is communicating and collaborating with clients."* According to some participants, communication and collaboration can be more challenging and problematic in mixed gender teams due to the restrictions of the Saudi culture and the separation of men and women. However, P3 made it known that this separation has changed in the last few years, as he stated that *"a few years ago, we had difficulties in collaboration among us as our team is mixed gender, but these days, we are starting to engage together."* Thus, the 'communication and collaboration' factor has an impact on the success of the adoption and practising of Agile.

5.3.6 Environmental Factors

5.3.6.1 Organisational Environment

Another factor that can influence the adoption of Agile is the organisational atmosphere and cultural environment. According to the frequency table in section 5.3.3, 8.3% of the interviewees identified it as 'very important' and half of them stated as 'important'. They asserted that the work environment has to support the employees to improve their productivity and make them feel comfortable. According to P3, *"Agile requires a stable and safe environment in order for it to be adopted and practised correctly."* The interviewees confirmed that such an environment encourages employees to be more confident to share their opinions openly without fear of judgment from colleagues or repercussions from management, for example, by losing company perks or benefits. In P2's opinion *"the Agile-friendly organisation involves Agile-friendly project teams, a collaborative and supportive environment, and an appropriate*

reward system that motivates and facilitates successful Agile adoption." When the work environment is friendly, the teams and the clients will be satisfied, thereby improving overall performance. The participants interviewed from Company A stated that their management team used regular employee surveys every six months to garner ideas and feedback in order to improve the atmosphere of the company. P4 posited that *"this procedure ensures a positive culture and a healthy environment, one that is favourable for Agile."* The participants of company B agreed that their healthy organisational environment supported them to adopt and practise Agile.

5.3.6.2 Physical Environment

Most of the participants (58.30%) recognised the physical environment as being 'important' for Agile adoption, while a quarter of them considered it to be neutral. According to P7, *"a physical environment designed for Agile collaboration increases project teams' and managers' morale, which, in turn, increases our performance."* One example was the provision of spaces that encourage team members to rest, re-energise and collaborate with each other. Companies A and B both provide prayer rooms and social spaces, which teams can use during break times. In addition, company B provides a nap room, which can be used when a team member feels tired. The interviewees confirmed that the level of care shown in the physical surroundings can have a significant impact on their team's performance. The CEO of company B stated that *"when we decided to adopt Agile, we did our best to make sure that the physical environment was comfortable. For example, we changed the office layout from small, closed offices to a large, open space for each team with just small desk partitions."*

5.3.6.3 National Culture

The interview findings confirm that national culture is considered one of the most important factors affecting the adoption of Agile in Saudi Arabia as most of the interviewees (91.7%) stated that it is 'very important' (25%) and 'important' (66.7%). Participants stated that the culture of Saudi Arabia, based on a power hierarchy, is a barrier to the adoption of Agile. P5 advocated that *"adopting Agile is influenced by Saudi culture in which our organisation operates."* The participants elucidated that Saudi Arabian culture has a unique foundation, built on several aspects, such as the tribal system and religious observance, which play a crucial role in defining people's obligations, traditions and social norms.

For example, according to P3, *"working in mixed gender teams provides a challenge to adopting Agile fully."* He added that *"even though some organisations have one team of both men and women working in one place, many organisations still divide their workplace into male and female parts."* As Saudi culture requires the separation of men and women in the workplace, true collaboration is hindered by not being

able to engage in face-to-face meetings. As pointed out by some participants, like P5 and P1, although the views on gender separation have started to change in recent years, the Saudi culture is still considered a barrier to the adoption of Agile in several aspects. With Saudi Arabia planning to be a fully developed country in the near future, the government has included some cultural change aspect as a part of Vision 2030, according to P5. The results of these changes have been noticed in the daily life. He argued that *"more men and women are becoming open with each other these days, and they can work and meet in the same place."* On the other hand, P10 notes that some aspect of Saudi culture can actually encourage the adoption, as a collective society is valued.

5.3.7 Technical Factors

5.3.7.1 Tools and Technologies

The findings indicate that 83.33% of the participants stated that the use of tools and technologies to support Agile work in the organisation, such as communication, data storing and management tools, is a top technical factor influencing the adoption of Agile. This was agreed by all the participants in Company A, who provided the example of their use of the digital Kanban board, Trello, to manage the flow of their teamwork. One participant confirmed that the *"unavailability of tools and technologies, would make Agile difficult to adopt and practice"* (P2). He added that *"Agile cannot be adopted and used, especially in this Covid era, without tools and technologies."* This quotation highlights the increased importance of tools and technologies in the light of COVID-19, which has demanded new ways of working. Another participant, P6 stated that *"for all-virtual teams, tools are crucial"* as they improve and accelerate the project work and give more flexibility for team members, which increases their performance. In addition, P9 agreed that the availability of tools and technologies has a positive influence on Agile adoption and are particularly important for distributed teams. According to the participants interviewed in company C, they cannot practise Agile with the support of communication tools as their team is not co-located.

When asked which physical or digital tools they tended to use in their organisations, most stated that prior to COVID-19 they relied on both physical and digital Kanban boards to visualise their work. Company C was the exception, using only digital boards, as their teams are not co-located. However, COVID-19 forced all the organisations to use digital tools. When asked about collaboration tools, common responses included Jira and Trello for project management, Slack and Zoom for communication, GitHub and Bitbucket for version control and Google Drive and Box for data storing.

5.3.7.2 Delivery Strategy

This factor is not considered by the interviewees as a critical factor in the adoption of Agile; 41.7% of them agreed on the slightly importance of this factor while no participant considered it 'very important' or 'important'. Although P2 and P6 argued that even though there is a need for delivery strategies in terms of planning a rapid and regular delivery of quality and working products, their view was that the delivery strategy itself does not have a critical impact on the adoption of Agile. In the words of P1, *"I see that delivery strategy has an influence on the success of practising Agile, not adopting Agile."* However, P3 argued that the management teams in their organisations sometimes put pressure on the schedule for delivering the features of apps to the customers, and they know that Agile allows them to deliver work frequently and efficiently. Thus, he thought that the strategies of delivery can be a barrier to adopting Agile. However, P10 and P11 disagreed, asserting that this pressure is related to the organisational structure and the power of the management over the Agile team. Therefore, implementing a correct delivery strategy is not considered as an essential factor in Agile adoption.

5.3.7.3 Agile Software Techniques

This study finds that three quarters of participants agreed that Agile software techniques factor has limited importance for Agile adoption, as half of them considered it 'slightly important' and a quarter 'not at all important'. There are several techniques that aid project managers and their teams in identifying, choosing and practising the best Agile software techniques. These techniques include correct integrating testing, rigorous refactoring and the right amount of documentation, all of which may lead to high and improved performance. According to P1, *"as traditional software development faces numerous challenges and shortcomings which sometimes lead to delayed and failed dynamic projects, the techniques of Agile software development are essential for the critical success of Agile adoption in any organisation."* For example, P2 stated that some Agile techniques such as regular and short meetings encouraged our company to adopt Agile. Most of the participants interviewed agreed that these techniques help the team to practise Agile methods correctly and obtain its advantages. They stated that 'Agile software techniques' factor can be used to assess to what extent Agile is used. Thus, from the participants' points of view, 'Agile software techniques' is not considered an influential factor on the adoption of Agile in Saudi Arabia.

5.3.8 Additional Factors

A question was posed to the participants about any additional, important factors affecting the adoption of Agile in Saudi Arabia that were not discussed in the interview. The main theme that emerged from the interview data was the importance of practitioners' lack of awareness and knowledge of Agile. Experts argued this as a challenge to Agile adoption (see Section 5.3.2). According to P6, *"a high level of awareness of Agile among practitioners has a key role to play in Agile adoption and usage."* Increasing Agile awareness among team members is a critical factor encouraging Agile adoption in the country. The CTO of company C argued that *"awareness of Agile is a real issue among developers, particularly the novices. So, when we decided to adopt Agile in our development teams, some of our team members did not feel happy as they did not know what Agile was and how it worked."* Likewise, P1 said: *"I noticed the lack of awareness, in particular, among software practitioners despite their specialisations in the field of Computer Science."* Level of awareness was also a key issue identified in our first empirical study, discussed in the previous chapter, revealing a low level of awareness amongst mobile app practitioners.

Apart from the importance of practitioners' awareness, this study's results also revealed additional themes related to this factor. These include the lack of awareness from the management team, the customers and the government.

Management - P4 stated the awareness and knowledge of key stakeholders, such as senior managers and decision makers, has a significant impact on the adoption of Agile. This impacts on the performance and productivity of team members and the extent to which they are able to use Agile correctly. This theme is illustrated by P2, Scrum Master in company A: *"we have faced a critical issue in practising Agile in our teams due to the lack of knowledge from the management team about Agile."* The management team need to raise their Agile awareness in order to understand its benefits and how it will influence development teams. P9 suggested that *"top managers should be aware of their requirements toward Agile and the changes required in their behaviour."*

Customers - The findings of the study indicate that the low level of customer awareness and knowledge is considered a challenge facing Agile teams in the country. Participant, P7 said, *"it is a challenge to use Agile when customers do not understand what Agile is and how it works."* Another participant added that *"many customers have a lack of Agile knowledge, which causes difficulty in adopting and practising Agile"* (P12). Furthermore, P3 argued that due to this low level of customer knowledge, a number of Agile teams are practising Agile without the involvement of their actual customers.

Government - The interview findings show that most of the business in Saudi software companies comes from the government sector. Since this sector's employees are more accustomed to working with the Waterfall model, their knowledge of Agile

is limited. This is made evident in comments from several participants, like P1, who stated: *"we face a challenge when we deal with projects from the government due to their low level of awareness about Agile and how it works."* Another participant, P6, reported that *"much effort is required from the government agencies in raising their employees' awareness of Agile."*

5.4 Expert Interview Discussion

This chapter investigates the enablers and barriers to the adoption of Agile in Saudi software SMEs through in-depth interviews with 12 Agile experts from different software organisations. In this section, the interviews findings are discussed, and the adoption framework for Agile is presented.

5.4.1 Factors Impacting on Agile Adoption

5.4.1.1 People Factors

This study shows that people factors (team capability, customer involvement, training and learning, and awareness and knowledge) are important factors when considering the adoption of Agile in Saudi Arabia. Looking further into the details of these interview outcomes, 'team capability' is considered the most important factor on Agile adoption. 'Customer involvement' was the second most important factor and 'training and learning' the third. These findings are consistent with those reported in numerous studies (e.g. Chow and Cao (2008); Misra *et al.* (2009); Lindsjørn *et al.* (2016); Vithana *et al.* (2018); Livermore (2008) and Sheffield and Lemétayer (2013)).

Team Capability - This factor attracted unanimous support from the interviewees, with 66.7% of them 'strongly agreeing' and 33.3% 'agreeing' to its importance in Agile adoption. One of the necessities of Agile adoption is a team of professional members possessing skills and characteristics, such as how to be self-organised and motivated. They also have to be open and willing to learn and train continuously. These results are also similar to Cockburn and Highsmith (2001), who indicate that Agile is more about people than anything else. This finding is also consistent with previous research which reported that the ability of the team members has a critical influence on Agile adoption (Lindvall *et al.*, 2002; Chow and Cao, 2008; Tam *et al.*, 2020). This factor is not considered a challenge in the adoption of Agile in Saudi Arabia, as there are a reasonable number of team members who possess professional skills. Several interviewees suggested that professional skills are not required from all team members, as these skills can be obtained over time by working with other skilled members. Organisations should select team members carefully, based on skills and knowledge. They also have to be sure of the availability of professionals with the

necessary skills such as commitment, collaboration and communication when adopting Agile.

Customer Involvement - This factor was considered by the participants as one of the main barriers for Agile adoption in Saudi Arabia. This primarily because of the lack of customers' knowledge of Agile, the lack of time they have, as well as the lack of trust between them and Agile development teams. 33.3% of the participants 'strongly agreed' with the importance of this factor on the adoption of Agile, while 58.3% 'agreed'. The results are similar with those reported by Misra *et al.* (2009); Sheffield and Lemétayer (2013) and Tam *et al.* (2020) regarding the important impact of customer involvement on Agile adoption and usage.

This study finds that Agile teams find it challenging to deal with customers from government bodies, as their working style is based on the Waterfall model, and they are usually unwilling to be involved in development teams. Some participants indicated that the frequency of required meetings with customers in Agile teams may hinder their involvement. Thus, companies have to be aware of this, be mindful of customers' time and consider customer availability in order to plan for effective customer involvement in Agile teams seeking to garner regular feedback. Customers' involvement has been found to be influenced by the culture of an organisation as well as the national culture of Saudi Arabia. Future research is encouraged to investigate the influence of this factor on the adoption of Agile in detail and its sub-factors, such as client collaboration, client flexibility, client communication level and client influence.

Training and Learning - The interview findings indicated that 'training and learning' is an important factor in Agile adoption, with most of the participants agreeing (83.3%) with its importance. This is in agreement with studies conducted by Livermore (2008); Wan and Wang (2010) and Misra *et al.* (2009). The interviews revealed several barriers to the training and learning of Agile in Saudi Arabia. One of these barriers was the lack of trainers to run training events for organisations. Another was the lack of support and limited time given for continuing professional development from the senior management team. In addition, individuals have indicated that Agile learning resources in Arabic are scarce, making self-learning challenging. Most of the participants strongly agreed that training and learning for team members needs to be taken into consideration when deciding to adopt and practise Agile. Thus, senior management should provide team members with access to continuous training to increase the capability of their team members to be able to adopt and use Agile methods successfully. In addition, training and learning should be considered for the management teams and customers to understand what Agile is and how it works.

Awareness and Knowledge - This study identifies an additional factor affecting the adoption of Agile in the country. Awareness and knowledge of Agile held by practitioners, as indicated in this study and the previous one discussed in the preceding

chapter, was found to be low, with few Agile training events and experts in what is still a young sector. These results are similar to those reported in studies conducted in developing countries, such as Bin-Hezam *et al.* (2018); Sulaiman *et al.* (2015) and Nazir *et al.* (2016). Most participants in this study are concerned about the lack of awareness and knowledge of other key stakeholders, such as customers and managers, impacting on the adoption of Agile. As discussed previously, customers from government agencies can pose a particular challenge to collaboration. To make Agile work, both management and customers need to have a good understanding of Agile in order to adopt it. Much effort is required from academic institutions, organisations and government agencies to increase the level of Agile awareness among stakeholders by conducting, for example, workshops and seminars. This will lead to an increase in the adoption of Agile in Saudi Arabian software SMEs.

5.4.1.2 Organisational Factors

Based on the findings of this study, 'organisational culture', 'management support', and 'communication and collaboration' are considered important organisational factors influencing Agile adoption. The results pertaining to these organisational-related factors support the findings of other empirical studies, such as those conducted by Robinson and Sharp (2005); Tolfo and Wazlawick (2008); Dyck and Majchrzak (2012); Sheffield and Lemétayer (2013) and Strode *et al.* (2009), all of whom studied the strength of these factors on the adoption of Agile. However, other studies, such as Chow and Cao (2008) and Stankovic *et al.* (2013) have indicated that organisational aspects do not have a significant impact on the adoption of Agile. These conflicting findings reinforce the importance of investigating these factors in context and especially in those countries, such as Saudi Arabia, where Agile has been historically overshadowed by the Waterfall methodology.

Organisational Culture - With all of the participants 'strongly agreeing' or 'agreeing' with the importance of this factor, is one that deserves careful attention. The participants considered this factor to be one of the main barriers to Agile adoption in Saudi software development SMEs. This is because of the apparent inconsistency between the Agile culture, based on a flat structure, and the Saudi organisational culture, mainly based on a hierarchical structure, mirroring that of the Saudi national culture. Thus, Saudi organisations' cultures are similar and impacted by the culture of Saudi Arabia since most of them are local and not a part of international organisations. As such, senior managers should be particularly mindful of culture. More specifically, it should be acknowledged that a hierarchical organisational structure is not conducive to supporting Agile values and principles. Thus, managers need to develop culturally aware approaches to support their teams to adopt Agile. They also have to encourage their cultures to be as dynamic, supportive and collaborative as possible.

Management Support - The majority of interviewees (58.3%) agreed on the importance of Management Support in Agile adoption. This is because the decision to adopt Agile is mainly dependent on the senior management team and not based on the views of team members. Thus, it is up to the team members to convince the management team of the value of adopting Agile, especially in terms of increased team productivity and morale. In addition, the support of senior management is necessary for the provision of resources and training and the facilitation of learning. In other words, senior management holds the key to successful Agile teams. Based on the findings of the interviews, appears to be sufficient support from most senior management teams in Saudi Software SMEs.

Communication and Collaboration - The results of the interviews indicated that this factor is important when deciding to adopt Agile; 16.7% of the participants 'strongly agreed' on its impact and 41.7% 'agreed'. In this study, it was shown that effective communication and collaboration among team members, as well as collaboration with customers, are critical for successful Agile adoption. The participants indicate that their organisations support their teams and customers by creating a positive environment, which encourages communication and collaboration and provides the required tools for this purpose.

5.4.1.3 Environmental Factors

The findings of this study indicate that environmental related factors (national culture, organisational environment and physical environment) need to be taken into consideration before Agile is adopted in software SMEs.

National Culture - This is the most important environmental factor in the adoption of Agile, as confirmed by a quarter of participants 'strongly agreeing' and 66.7% 'agreeing' with its importance. This finding echoes those of Ozawa and Zhang (2013) and Misra *et al.* (2009) and confirms the impact of national culture on organisational culture. Cultural aspects related to national and organisational influence on the software SMEs regarding the adoption of Agile and the way of software practitioners to use it. Future investigation is encouraged of cultural alignment in the influence of Saudi culture on Agile adoption in terms of norms, values and attitudes, for example, gender segregation, managerial style and the avoidance of responsibility.

Organisational and Physical Environment - The participants in this current study also highlight the importance of the organisational and physical environment on the adoption of Agile in Saudi Arabia. These findings are similar to those of Robinson and Sharp (2005) and Sheffield and Lemétayer (2013) but are in contrast to the findings of Stankovic *et al.* (2013). Based on the results of this study, it is clear that Saudi organisations support a stable and safe environment by encouraging Agile-friendly project teams and developing an appropriate reward system, which motivates

and facilitates employees to adopt Agile. The physical environment of the workplace should also be considered by Saudi SMEs, as prayer rooms and social spaces are perceived by employees to improve productivity, comfort and socialisation.

5.4.1.4 Technical Factors

This section discusses the importance of technical factors (tools and technologies, delivery strategy and Agile software techniques) when considering the adoption of Agile in software development SMEs in Saudi Arabia, based on the interview findings.

Tools and Technologies - This research also reveals that technical factors, such as 'tools and technologies', are considered by interviewees as 'very important' (33.3%) or 'important' (50%) to the adoption of Agile in Saudi Arabia. This is a conclusion also drawn by Vithana *et al.* (2018), based on the results of their Sri Lankan study. Whilst technical factors have not received much attention in the literature due to an overriding focus on social factors, the author would argue that they are worthy of further investigation, as they support the development team when using Agile. This has become particularly relevant in the light of COVID-19, when Agile teams cannot practise Agile without the support of tools and technologies. Companies should provide team members with the required tools in order to support Agile adoption in their development teams.

Delivery Strategy and Agile Software Techniques - Regarding these factors, this study has found that they are not important factors impacting Agile adoption in the country. The importance of 'delivery strategy' and 'Agile software techniques' was considered 'slight' by 41.7% and 50% of the participants respectively. Several studies offer similar results to these. For example, Stankovic *et al.* (2013) and Wan and Wang (2010) found that these factors do not impact on Agile adoption. These two factors are also based on and related to the people and organisational factors. In contrast, Chow and Cao (2008) found these factors play a positive role in contributing to successful Agile usage. These results demonstrate that 'delivery strategy' and 'Agile software techniques' factors play a minor contribution to the success of Agile adoption.

Overall, the most important factors have to be considered when adopting Agile in the context of Saudi software development SMEs. Based on the results of this research, these are the factors related to the norms, values and attitudes underpinning national culture and impacting on, for example, ideas surrounding gender. They are also the factors related to the organisation, in terms of the hierarchical structure and the need for a dynamic, supportive and collaborative culture. Finally, they are all related to people (i.e. training and learning, customer involvement and awareness and knowledge) and are the ones that are perceived as barriers to the adoption of Agile.

5.4.2 The Refining Agile Adoption Framework

Related work (Chapter 2) shows the importance of investigating the factors that affect Agile adoption in different contexts and cultures. Before focusing our empirical study on the Saudi context, we review the factors impacting on Agile adoption as reported in current studies and categorise them as shown in Table 2.2 in Chapter 2. Drawing on these factors, a framework for Agile adoption is proposed (see Figure 2.3 in Chapter 2). This study indicates that ten out of twelve factors identified from the literature are found to be particularly relevant for the Saudi Arabia context. However, the two non-influential factors were delivery strategy and Agile software techniques, but they were not excluded from the framework until they had been evaluated with a large number of participants (see Chapter 6). In addition, a new factor (awareness and knowledge) was suggested by the interviewees. Figure 5.4 shows the refining framework for Agile adoption with the new factor added under the people factors category.

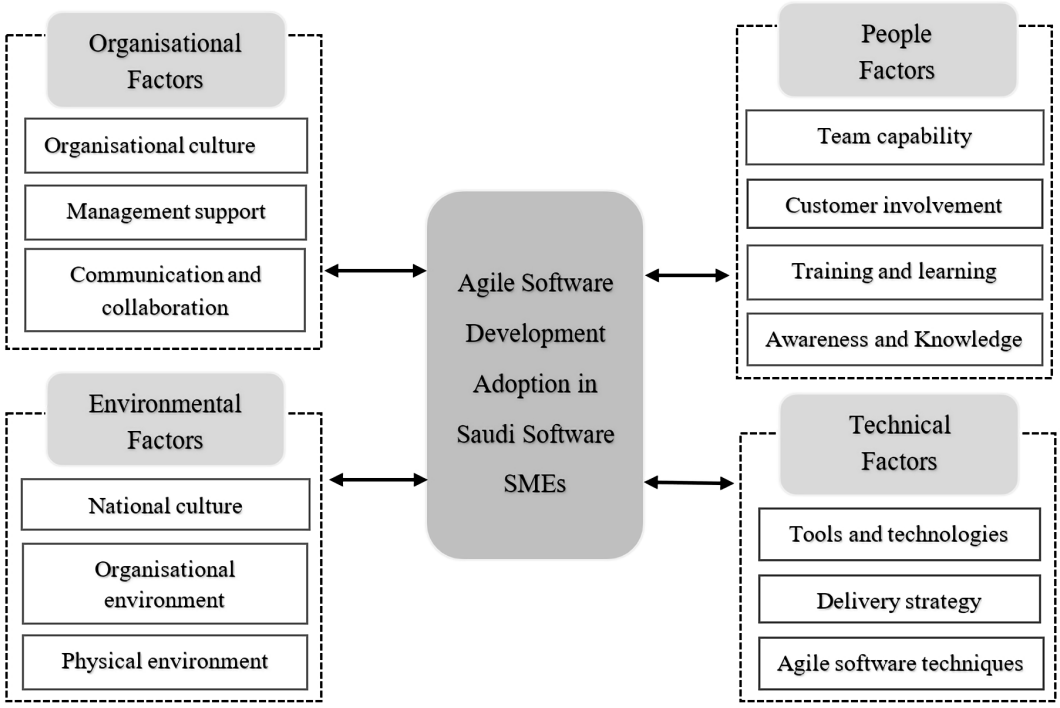


Figure 5.4: The Agile adoption framework

5.5 Focus Group Findings and Discussion

This section presents and discusses the findings of the second phase of this exploartory study, which involved a focus group discussion with five practitioners to feedback about the Agile adoption framework that incorporated factors which can support or challenge the adoption of Agile in software SMEs in Saudi Arabia.

5.5.1 Demographic information

Table 5.6 illustrates the demographic information of the focus group participants, including their position in their respective organisations and years of experience in both mobile app and Agile software development. The focus group was conducted with five mobile app practitioners, all of whom have a minimum of three years of experience in mobile app development and Agile methods. All the participants were working in the three software SMEs under investigation (see Section 5.2.3).

As shown in Table 5.6, the participants were working in different roles, with two participants working as Scrum Masters, two as Developers and one as an Analyst. In terms of participants' experience in mobile app development, the majority of them (four participants) had five to ten years' experience, while one participant had more than ten years' experience. With regard to experience with Agile, all participants had between three- and four-years' experience.

Participant Code	Company Code	Participant Position	Experience in mobile development (in years)	Experience in Agile development (in years)
P1	A	Scrum Master	11	4
P2	A	Developer	9	3
P3	B	Scrum Master	7	4
P4	B	Analyst	6	3
P5	C	Developer	10	4

Table 5.6: The focus group participants' demographic information

5.5.2 Main Findings and Discussion

Influential Factors - The first part of the focus group discussion explored participants' perspectives on the factors listed in the framework and the extent to which they felt these impact Agile adoption. The majority of the participants highlighted that all factors identified in the framework influence Agile adoption in

Saudi software SMEs. However, all of the participants agreed that the least influential factors are 'delivery strategy' and 'Agile software techniques'. They also agreed that this framework can help Saudi practitioners and organisations when trying to make a decision as to whether to adopt Agile or not. When asked about new factors that ought to be represented in the framework, none of the participants could think of any.

Classification of Factors - The second part of the group discussion focused on the classification of these factors. The participants suggested three modifications. The first suggestion was that 'organisational culture' and 'national culture' ought to be grouped into one category called *Cultural Factors*. This is the most important factor, according to the participants, and one that everyone agreed needs more investigation in terms of its impact on the adoption of Agile. The second suggested modification was to split people factors into two separate categories: *People Factors*, to include 'team capability' and 'customer involvement'; and *Knowledge Factors*, to include 'training and learning' and 'awareness and knowledge'. The last suggestion was to regroup 'delivery strategy' and 'Agile software techniques' under *Process Factors*. The partial results of this discussion are shown in Figure 5.3, Section 5.2.2.

Factors Posing the Greatest Challenge - The final part of the main discussion centred around those factors in the framework that pose the greatest challenges to the adoption of Agile in Saudi software development SMEs. Participants were asked two questions. The first one asked them to identify the three most important categories of Agile adoption in the country. Participants P1, P2 and P3 and P5 believed that the *Cultural Factors* category was the most important. However, P1 and P2 chose *People Factors* as second and *Knowledge Factors* as third, whereas P3 and P5 chose *Knowledge Factors* then *People Factors*. Lastly, for P4 it was *People Factors* first, then *Cultural Factors* and finally *Knowledge Factors*. Overall, the *Cultural Factors* category is considered the most important category to be considered when adopting Agile in Saudi Arabia. This is followed by the *People Factors* category and, finally, *Knowledge Factors*.

The second question asked the participants to identify three sub-factors that they considered to be barriers to the adoption of Agile in Saudi Arabia. 'Organisational culture', 'customer involvement' and 'awareness and knowledge' were identified as the most important factors in challenging the adoption of Agile, according to the participants.

Agile Adoption Framework - After careful consideration of the findings of the focus group study, the Agile adoption framework, incorporating the new classifications, is presented in Figure 5.5. The classifications suggested based on this study divide the framework into seven categories, namely people factors, knowledge factors, cultural factors, organisational factors, environmental factors, technical factors and process factors. The findings also indicate the apparent influence of all the identified factors in the framework, except those related to process, with a high

level of importance attached to culture, people and knowledge factors. This study shows that the framework is valuable in demonstrating the factors that influence the adoption of Agile at the organisational level in Saudi Arabia. This framework guides and supports Saudi software SMEs when making decisions about the suitability of Agile methodology. It also seeks to encourage the spread of Agile acceptance in Middle Eastern countries, particularly Saudi Arabia. The impact and relationships of factors incorporated in the framework will be evaluated and analysed in the Saudi Arabian context in the next chapter, using a statistical analysis technique, namely Structural Equation Modelling (SEM).

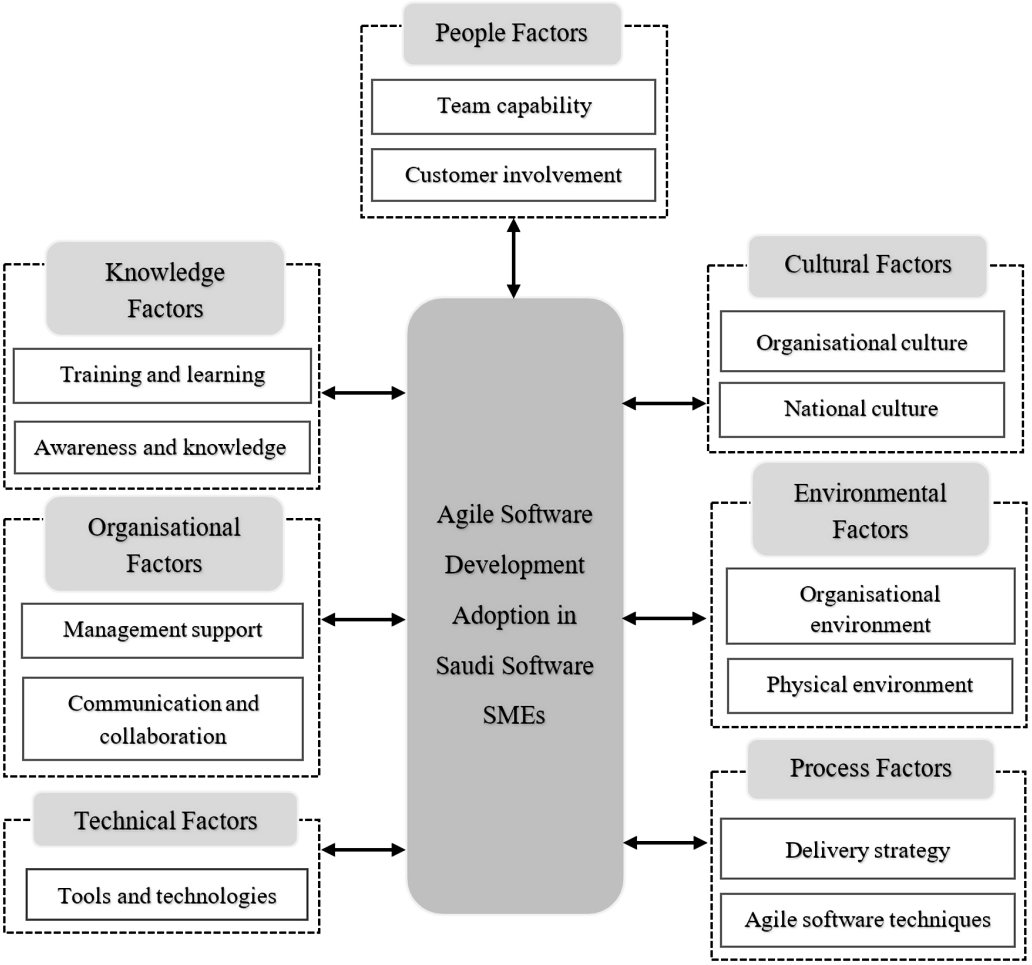


Figure 5.5: The Agile adoption framework

5.6 Threats to Validity

This study has investigated the factors influencing the adoption of Agile in the context of mobile app development in Saudi Arabian software SMEs. Qualitative data were collected through the semi-structured interviews and a focus group, generally considered more vulnerable to risks to validity, generalisability and reliability. Research validity refers to the extent to which the established method could accurately measure what is being examined (Saunders *et al.*, 2018; Creswell and Creswell, 2018). Thus, 'high research validity' demonstrates the consistency of the results obtained with real traits. This section discusses this study's risks to validity and how these were mitigated.

5.6.1 Validity

This study examined factors influencing Agile adoption in Saudi Arabia, and the findings were derived from three Saudi Arabian software SMEs known to use Agile in mobile app development. Semi-structured interviews were conducted to acquire an in-depth understanding of the research topic being investigated. The researcher clarified doubts and discrepancies in the data collected during the interviews, and also remained in contact with the respondents in case additional issues emerged during the data analysis.

Initially, the study design included the use of in-situ field observations and other in-depth qualitative research methodologies to further strengthen data cross-checking. However, the plan was impeded by COVID-19. A structured feedback process (e.g. focus group) to review and feedback the study's findings with participants was considered and then conducted with five participants.

The participants were recruited mainly from mobile app developers - one of the fastest growing business segments in the country. The participants were selected through a rigorous process to ensure they fit the sampling criteria, specifically having a comprehensive understanding of Agile and an informed opinion on its adoption in Saudi Arabia.

5.6.2 Generalisability

Generalisability is concerned with whether it is possible to generalise the findings (Saunders *et al.*, 2016). This research is exploratory and based on qualitative research, therefore, it is not aimed at generalisations, instead, its objective is to study a specific phenomenon in a selected population (Saunders *et al.*, 2016; Easterbrook *et al.*, 2008; Leung, 2015). While this study only involved 12 Agile experts, they all had in-depth experience in developing software using the Agile methods. This trait has

helped the study achieve its aim. Most importantly, though the findings may not be representative of all software SMEs in Saudi Arabia, they do represent the key viewpoints of expert Agile adopters in Saudi Arabia.

5.6.3 Reliability

The term 'reliability' relates to the research's replicability and consistency (Saunders *et al.*, 2016). To mitigate research bias, I conducted and analysed the data (Creswell and Creswell, 2018), whilst my supervisor cross-checked the analysis; where found, divergences were discussed, explained and resolved. As semi-structured interviews are largely open-ended, the responses from the respondents may differ significantly, and the discussion with each participant may differ across interviews. We tested the interview questions and structure with academics and practitioners to ensure that they were coherent and easy to understand.

5.7 Chapter Summary

This chapter answered the first sub-research question of the second main question (RQ2.1) aiming to investigate the influential factors that can support or challenge the adoption of Agile software development methodology within software SMEs in Saudi Arabia by refining the Agile adoption framework. This study, divided into two phases, adopted a mixed methods approach in the first phase and a qualitative approach in the second phase. The data were gathered in the first phase from semi-structured interviews with 12 practitioners working in three software SMEs to elicit their viewpoints about the influential factors on the adoption of Agile. In the second phase, a focus group study was carried out with five participants to review the identified factors investigated in the first phase.

The findings from this study indicate there are a number of factors that impact on the adoption of Agile. The most important one is related to culture: national culture in terms of norms, values, and attitudes (e.g. towards gender), and organisational culture in terms of governance structure (e.g. hierarchical vs flat), and the need for a dynamic, supportive and collaborative work environment. In addition, 'people' factors (i.e. team capability; training and learning; customer involvement; awareness and knowledge) have also been found to be important; and also software tools and technologies, especially in the Covid era. In contrast, other technical factors, such as Agile software techniques and delivery strategy are not considered important factors. This study shows that cultural factors, customer involvement and awareness and knowledge are the main barriers to the adoption of Agile in Saudi Arabia.

The next chapter builds mainly on this chapter and uses a web-based questionnaire to analyse and evaluate the influential factors represented in the framework and their

relationships to understand the impact of these factors on Agile adoption by software SMEs in Saudi Arabia.

Chapter 6

Evaluation of Agile Adoption Factors: Findings and Discussion

6.1 Introduction

Chapter 5 investigates Agile adoption factors as identified in our framework. This chapter reports on an empirical evaluation of the impact of each factor on Agile adoption by software SMEs in Saudi Arabia. The influential factors represented in the framework will be referred to as 'Agile adoption factors' throughout this chapter. The objectives of this chapter are (1) to analyse and validate the relationships among the influential factors and their impacts on the adoption of Agile in Saudi software SMEs; (2) to identify the factors that have a positive or negative relationship with Agile adoption; and (3) to identify the most impactful facilitators and barriers to Agile adoption. This chapter aims to address the following research question: ***"RQ4. What is the impact of each factor on Agile adoption in Saudi Arabian Software SMEs?***

To answer these questions, we adopt a quantitative hypothesis-driven approach; data was collected through an on-line survey targeting Saudi Arabian software practitioners working in SMEs, a total of 132 responses were received and analysed using PLS-SEM (Partial Least Squares-Structural Equation Modelling) approach. The key findings of this chapter obtained using PLS-SEM reveal that team capability, customer involvement, awareness and knowledge, organisational culture, organisational environment, and tools and technologies play a significant role in influencing Agile adoption in Saudi software SMEs. This chapter describes in detail the methodology adopted, techniques used and the findings. It ends with a discussion of the results and the validity and reliability of instruments.

6.2 Study Design and Methods

This study is based on the explanatory research paradigm, as it helps the researcher evaluate the influence of each Agile adoption factor and their relationships (Saunders *et al.*, 2016). In this evaluation study, a quantitative research design was employed, as it was considered the most appropriate to achieve this objective. This design approach is discussed in detail in Chapter 3, section 3.3.3, page 39. The quantitative data was collected using a questionnaire involving 185 respondents, of which there were 132 completed respondents. The respondents were software practitioners from Saudi Arabian software SMEs. This study aims to analyse and evaluate the Agile adoption factors represented in the framework in the previous chapter (Chapter 5, see Figure 5.5) and the hypothesised relationships discussed in the next section.

6.2.1 Development of Hypotheses

The research hypotheses are based on the factors driving Agile adoption as identified in prior research (Chapter 2) and refined in follow-on studies (Chapter 5). These hypotheses was developed to fulfil the study's research objectives and examine the significance of the direct relationships between the people, knowledge, cultural, organisational, environmental, technical and process factors and Agile adoption among Saudi software SMEs, which is the dependent variable, as indicated in Table 6.1. In the following subsection, the relevant hypotheses of the mediating variables (awareness and knowledge, organisational culture and organisational environment) are formulated.

Hypo. ID	Independent Variable	Dependent Variable	Hypothesised Relationships
H1 (+)	Team Capability (TC)	Agile Adoption (AA) in Saudi Software SMEs	TC → AA
H2 (-)	Customer Involvement (CI)	Agile Adoption (AA) in Saudi Software SMEs	CI → AA
H3 (-)	Training and Learning (TL)	Agile Adoption (AA) in Saudi Software SMEs	TL → AA
H4 (-)	Awareness and Knowledge (AK)	Agile Adoption (AA) in Saudi Software SMEs	AK → AA
H5 (-)	Organisational Culture (OC)	Agile Adoption (AA) in Saudi Software SMEs	OC → AA
H6 (-)	National Culture (NC)	Agile Adoption (AA) in Saudi Software SMEs	NC → AA
H7 (-)	Management Support (MS)	Agile Adoption (AA) in Saudi Software SMEs	MS → AA

H8 (-)	Communication and Collaboration (CC)	Agile Adoption (AA) in Saudi Software SMEs	CC → AA
H9 (+)	Organisational Environment (OE)	Agile Adoption (AA) in Saudi Software SMEs	OE → AA
H10 (+)	Physical Environment (PE)	Agile Adoption (AA) in Saudi Software SMEs	PE → AA
H11 (+)	Tools and Technologies (TT)	Agile Adoption (AA) in Saudi Software SMEs	TT → AA
H12 (+)	Delivery Strategy (DS)	Agile Adoption (AA) in Saudi Software SMEs	DS → AA
H13 (+)	Agile Software Techniques (AST)	Agile Adoption (AA) in Saudi Software SMEs	AST → AA

Table 6.1: Research hypothesis (direct relationship)

These hypotheses are presented as statements as follow:

H1: Team capability has a positive influence on Agile adoption in Saudi software SMEs.

H2: Customer involvement has a negative influence on Agile adoption in Saudi software SMEs.

H3: Training and learning has a negative influence on Agile adoption in Saudi software SMEs.

H4: Awareness and knowledge is a factor that contributes negatively to Agile adoption in Saudi software SMEs.

H5: Organisational culture is a factor that contributes negatively to Agile adoption in Saudi software SMEs.

H6: National culture has a negative influence on Agile adoption in Saudi software SMEs.

H7: Management support has a negative influence on Agile adoption in Saudi software SMEs.

H8: Communication and collaboration has a negative influence on Agile adoption in Saudi software SMEs.

H9: Organisational environment is a factor that contributes positively to Agile adoption in Saudi software SMEs.

H10: Physical environment has a positive influence on Agile adoption in Saudi software SMEs.

H11: Tools and technologies have a positive influence on Agile adoption in Saudi software SMEs.

H12: Delivery strategy has a positive influence on Agile adoption in Saudi software SMEs.

H13: Agile software techniques have a positive influence on Agile adoption in Saudi software SMEs.

To provide a clear perspective of the links between each independent variable (i.e. the 13 variables) and the dependent variable (Agile adoption in Saudi software SMEs), the hypothesised relationships are represented as a path diagram using the SmartPLS software package (described in Section 6.2.4.2) in the model below, as shown in Figure 6.1.

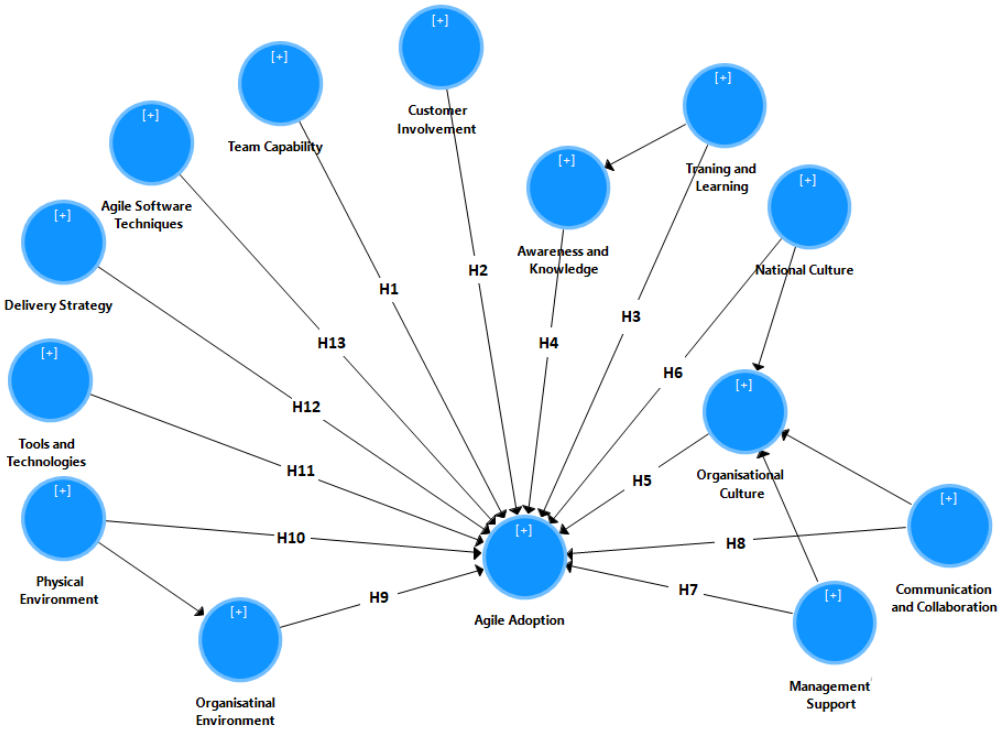


Figure 6.1: Hypotheses and relationships for factors influencing Agile adoption

6.2.1.1 Mediating Constructs Hypotheses

The mediation effect develops when a third mediator construct acts as an intermediate in the interaction between two constructs (Baron and Kenny, 1986; James and Brett, 1984). In this research, three constructs can be seen as mediators (awareness and knowledge; organisational culture; organisational environment), as illustrated in the path diagram in Figure 6.1. Table 6.2 shows the hypothesised relationships between the independent variables and dependent variable through a mediating construct, and these hypotheses are presented as statements after the table.

A mediator such as awareness and knowledge can help to explain the relationship between the dependent variable (Agile Adoption) and the independent variable (training and learning) (Altuwaijri and Ferrario, 2022). Our previous empirical studies conducted in Chapters 4 and 5 indicate that the lack of training and learning events in Saudi Arabia caused a low level of awareness and knowledge among software practitioners, which impacted the use of Agile methods in the country. Organisational culture is another mediating variable that plays a role in the mediating impact of national culture, management support and communication and collaboration of Agile adoption (Ahimbisibwe *et al.*, 2015; Ayed *et al.*, 2017). In addition, the empirical studies conducted in the previous chapters show us that organisational culture can establish a link between these three variables regarding the use and adoption of Agile in Saudi software SMEs. Organisational environment can also be used to explain the relationship between the physical environment and Agile adoption (Altuwaijri and Ferrario, 2022).

Hypo. ID	Independent Variable	Mediating Variable	Hypothesised Relationships
H14 (-)	Training and Learning (TL)	Awareness and Knowledge (AK)	TL → AK → AA
H15a (-)	National Culture (NC)	Organisational Culture (OC)	NC → OC → AA
H15b (-)	Management Support (MS)	Organisational Culture (OC)	MS → OC → AA
H15c (-)	Communication and Collaboration (CC)	Organisational Culture (OC)	CC → OC → AA
H16 (+)	Physical Environment (PE)	Organisational Environment (OE)	PE → OE → AA

Table 6.2: Research hypothesis (indirect relationship)

H14: Awareness and knowledge mediates the negative relationship between training and learning and Agile adoption.

H15a: Organisational culture mediates the negative relationship between national culture and Agile adoption in Saudi software SMEs.

H15b: Organisational culture mediates the negative relationship between management support and Agile adoption in Saudi software SMEs.

H15c: Organisational culture mediates the negative relationship between communication and collaboration and Agile adoption in Saudi software SMEs.

H16: Organisational environment mediates the positive relationship between physical environment and Agile adoption in Saudi software SMEs.

6.2.2 Data Collection Method: Questionnaire

A questionnaire is an effective way to gather original data from a large group of respondents (Creswell and Creswell, 2018). For this study, a web-based questionnaire was deemed the best choice to collect data to test the hypotheses and evaluate the factors affecting Agile adoption among software SMEs in Saudi Arabia. The relationships of these factors were presented in the path diagram (Figure 6.1). This is due to the fact that questionnaires allow gathering data from a large number of participants as well as finding the correlations between various factors. In all, 132 eligible responses were collected from practitioners working in Saudi software SMEs.

6.2.2.1 Questionnaire Design

The questionnaire comprised 52 closed-ended questions and was divided into three sections, described below:

- **Section 1: Demographic Information** (Multiple-choice questions)

  There are nine questions in this section. These questions were designed to gather demographic data from the respondents, including their gender, age, role and work experience. The items also probed information about the respondents' organisation size, number of team members and the market scope of their organisation.

- **Section 2: Influential Factors of Agile Adoption** (Five-point Likert scales)
  There are 38 questions in this section and are the main focus of this study. These questions comprise the 7 categories of factors that influence Agile adoption, specifically: people factors, knowledge factors, cultural factors, organisational factors, environmental factors, technical factors and process factors.

- **Section 3: Relative Advantage of Agile Adoption** (Five-point Likert scales)
  There are five questions in this section. They focused on measuring the main dependent variable of this study, which is Agile adoption in Saudi software SMEs based on participants' experiences.

Most of the items in the questionnaire were adapted and modified from existing studies in the Agile literature to suit the Saudi Arabian context. Examples of these studies were the studies conducted by Chow and Cao (2008) and Misra *et al.* (2009). Fink (2015) recommends that researchers adopt past instruments to ensure their suitability to the respondents. The researcher also developed new items based on the qualitative data findings presented in the previous chapter. Table 6.3 presents the variables, the number of measurement items, and their sources. The instrument contains close-ended questions with a Five-point Likert scale, ranging from strongly agree = 5; agree = 4; neutral = 3; disagree = 2 and strongly disagree = 1, in order to reflect the respondents' perspective.

Variable	Instrument Items	Variable Type	Adapted Source
People Factors			
Team capability	TeamCap1, TeamCap2, TeamCap3, TeamCap4, TeamCap5, TeamCap6	Independent	Misra *et al.* (2009)
Customer involvement	CusInv1, CusInv2	Independent	Misra *et al.* (2009)
Knowledge Factors			
Training and learning	TrainLearn1, TrainLearn2, TrainLearn3	Independent	Developed by the researcher based on qualitative data findings
Awareness and knowledge	AwareKnow1, AwareKnow2, AwareKnow3	Independent	This factor was originally derived from the exploratory study conducted in the previous chapter, and its items were developed based on its data findings
Culture Factors			
Organisational culture	OrgCult1, OrgCult2, OrgCult3, OrgCult4	Independent	Ahimbisibwe *et al.* (2015)
National culture	NationCult1, NationCult2, NationCult3	Independent	Developed by the researcher based on qualitative data findings
Organisational Factors			
Management support	MangSupp1, MangSupp2, MangSupp3, MangSupp4	Independent	Stankovic *et al.* (2013)
Communication and collaboration	CommColl1, CommColl2, CommColl3, CommColl4	Independent	Misra *et al.* (2009)

Environmental Factors			
Organisational environment	OrgEnv1, OrgEnv2	Independent	Stankovic *et al.* (2013)
Physical environment	PhyEnv1, PhyEnv2	Independent	Stankovic *et al.* (2013)
Technical Factors			
Tools and technologies	ToolTech1	Independent	Senapathi and Srinivasan (2014)
Process Factors			
Delivery strategy	DelStr1, DelStr2	Independent	Chow and Cao (2008)
Agile software techniques	AgileTech1, AgileTech2	Independent	Chow and Cao (2008)
Agile Adoption			
Agile Adoption in Saudi software SMEs	AgileAdopt1, AgileAdopt2, AgileAdopt3, AgileAdopt4, AgileAdopt5	Dependent	Vijayasarathy and Turk (2012) and Senapathi and Srinivasan (2014)

Table 6.3: Measurement of research variables

The questionnaire was initially written in English before it was translated into Arabic using the direct translation method (Usunier, 1998). The respondents' native language (Arabic) was used to overcome the language barrier and ensure that all of the participants understood the questions clearly. The link to the online questionnaire was distributed through email and on social network applications such as Telegram and WhatsApp. It was published online on the 14th of June 2021 and was made available online for eight weeks. The questionnaire was distributed to software practitioners working in Saudi Arabian software SMEs. Copies of the bilingual (English and Arabic) questionnaires are attached in Appendix C.1 and C.2, respectively.

6.2.2.2 Questionnaire Pilot Test

Before distributing the questionnaire to the respondents, a pilot study was done to clarify any questions and resolve any potential issues (Saunders *et al.*, 2016). This process was also conducted to enhance the questionnaire's content validity, which is discussed in detail in Section 6.5. This pilot study included six academic experts (four from UK universities and two from Saudi universities) and five software practitioners from Saudi Arabia. Following input from the pilot study, three changes to the questionnaire were made. Firstly, technical words that caused ambiguity were carefully modified to ensure that the meaning was not changed. Secondly, lengthy questions were re-phrased and shortened. Thirdly, a few questions were removed as it

became clear that they were redundant. The modified version was given to the same group of respondents, and their further feedback was considered. In addition, some questions were reworded and modified.

6.2.3 Population and Sampling Size

This study adopted a non-probability sampling approach, specifically the snowball sampling approach (Johnson, 2014). This approach helps to find suitable participants faster than other methods. In addition, this sampling method is easier to apply and not time-consuming. The researcher used this approach to find suitable respondents and then asked them for recommendations for other suitable candidates to join the study. The study participants were software practitioners working in Saudi Arabian software SMEs and using Agile methods during the development processes.

A sufficient sample size is needed to ensure the results are reliable and their findings can be generalised to Saudi software developers. Saunders *et al.* (2016) mention that any errors in generalising the results are lower when the sample size is larger. Furthermore, sample size choice is also influenced by the type of testing performed during the data analysis (Saunders *et al.*, 2016; Creswell and Creswell, 2018). In this study, the PLS-SEM approach was used to analyse the quantitative data. There is no agreed specific sample that researchers should include when using PLS-SEM for data analysis, however, the '10 times rule' approach is one of the common methods used in determining the sample size in information system fields (Hair *et al.*, 2014). It calculates the minimum sample size by multiplying the maximum number of arrowheads pointing at a latent variable in the PLS model by ten. In this model, the latent variable, which is 'Agile adoption' construct, has maximum arrows pointing to it (i.e. 13). By applying this approach to the study, a sample size of at least 130 is required as result of multiplying 13 by 10. However, Hair *et al.* (2014) argues that while this approach is commonly used among researchers, statistical power analyses such as G*Power are more appropriate. Thus, this software was utilised in this study to determine the minimum sample size (Field, 2017).

Four parameters are required to run this software, which are the effect size (f^2), the error probability (α), the statistical power (1- β error prob) and the largest number of predictors pointing at the dependent variable in the model. This study used the Dattalo (2008) settings to estimate the minimum sample size for the f-test family (linear multiple regression, fixed model, R^2 deviation from zero) and the type of power (a priori compute required sample size = given alpha, power and effect size). Table 6.4 summarises the parameters identified to compute the minimum sample size and their values based on Dattalo (2008) settings. Subsequently, as shown in Figure 6.2, the total sample size needed to run PLS-SEM in the developed model was shown to be 131. Thus, the number of study samples (132) exceeds the minimum sample

size for PLS-SEM in this light.

Parameter	Description and Value
Effect size (f^2)	This parameter has three values, small (0.02), medium (0.15) and large (0.35). The suitable effect size for this study is **0.15**.
Error probability (α)	Hence the probability of rejecting the null hypothesis is 5% if it is true. **0.05** value is a common alpha (α) value.
Power (1– β error probability)	Type II error indicates that if the null hypothesis is untrue, it will not be rejected. **0.8** is the common value for power.
Number of predictors	The numbers of arrows pointing at the dependent variable 'Agile software development adoption in Saudi software SMEs'. The largest number of predictors in the framework is **13**.

Table 6.4: G*Power parameters

6.2.4 Data Analysis Steps

The analysis of quantitative data in this research was performed according to Hair's guidelines, consisting of three steps (Hair *et al.*, 2014). These steps begin with analysing preliminary data, assessing the measurement model and evaluating the structural model.

6.2.4.1 Preliminary Data Analysis

It is critical to ensure that data are screened for flaws such as outliers and non-normal data distribution before statistical analyses could be done (Kline, 2016). This evaluation is critical to obtain more accurate and reliable outcomes.This is even more critical when considering that the SEM model is predicated on the assumption of error-free data. The researcher, thus, should address any major issues with the data collected, such as identifying missing data and testing data for potential biases, such as common method bias, normality and outliers (Hair *et al.*, 2014; Pallant, 2016). These major issues were identified by the support of SPSS software. This software was also used to analyse personal demographic data, as well as organisational information, such as the organisation's size and market scope.

6.2.4.2 Structural Equation Modelling (SEM)

The assessment of measurement model and structural model are the second and third steps in the data analysis, which are the main SEM processes. SEM is a second-generation multivariate analysis technique that can be used to test complex models

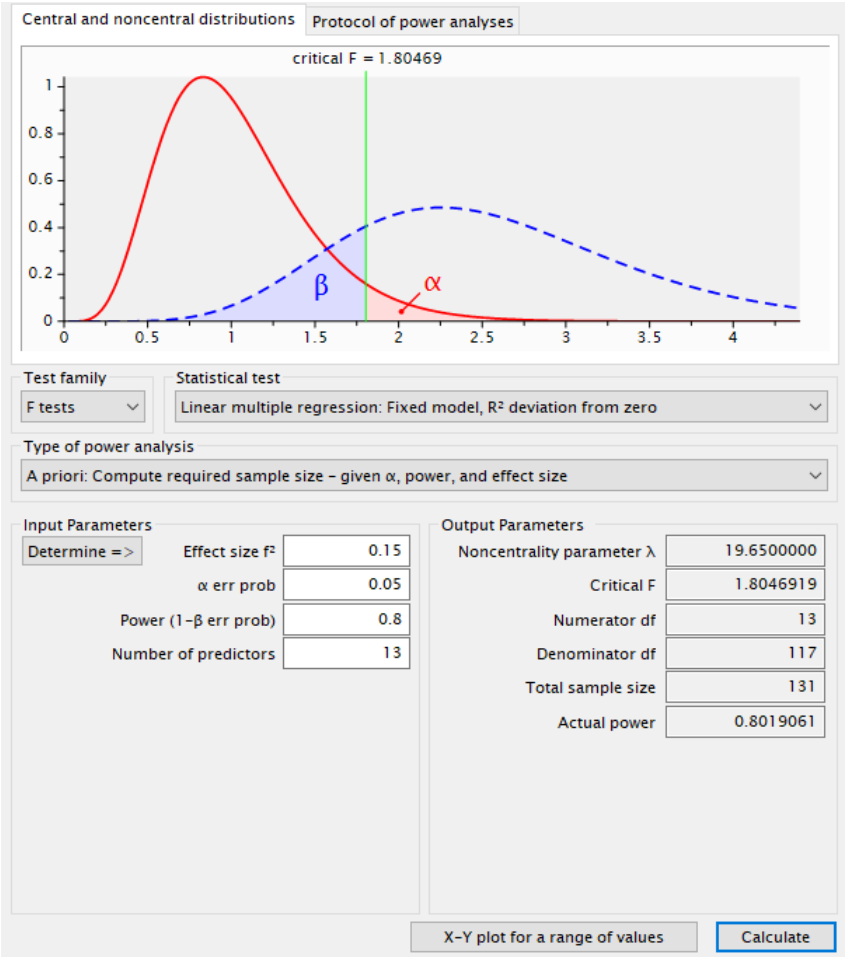


Figure 6.2: G*Power software results

that have a number of variables to be investigated (Chin, 1998*a*; Hair *et al.*, 2011; Chin, 1998*a*; Hair *et al.*, 2014). This technique, for example, can be used by researchers to simultaneously assess the constructs in the measurement model and the associations in the structural mode.

In this study, SEM was used to analyse the correlations between the unobserved variables and their observed variables in the path diagrams and validate the hypotheses concerning the relationships between the variables (Figure 6.1) (Hair *et al.*, 2014; Kline, 2016). The SEM method compares the theoretical model with the data gathered (Bagozzi and Yi, 1988). Wong (2013) states that SEM, which was utilised in this study, can analyse both direct and indirect interactions between variables and analyse a complicated model with several variables. One of the advantages of using SEM is that it allows researchers to investigate and analyse the correlations between

the latent variables assessed using several observable variables. In theory, elements in the proposed model cannot be directly measured. The latent variables are all of the components in the developed model that cannot be assessed directly. All elements in the adoption model were considered latent variables in this study, whereas indicators relate to the measurement items utilised to evaluate these variables.

In SEM, the proposed model was examined at two levels: the measurement and structural models, according to recommendations by Hair *et al.* (2014) and Kline (2016). The measurement model is an important stage in the SEM analysis, as it assesses the correlation among the variables incorporated in the model and items measuring these variables. Moreover, to guarantee the instrument accurately measures what it intends to measure, construct validity and reliability have to be determined at the measurement level (Hair, 1998; Heale and Twycross, 2015). Meanwhile, the relationships among the latent variables were examined by the structural model. In this regard, instead of focusing on the correlation among latent variables and their indicators, this analysis highlighted the relationships among the construct variables at this stage. Here, to test the hypotheses, the relationships between constructors were investigated.

Covariance Based SEM (CB-SEM) and Partial Least Squares SEM (PLS-SEM) are two types of SEM techniques. According to Hair *et al.* (2011) and Hair *et al.* (2012), one clear difference between CB-SEM and PLS-SEM is their research aims. The first one is the best approach to use when testing a theory, whereas the second one is best for building or anticipating a theory. CB-SEM technique must be utilised under particular criteria, including larger sample size, normally distributed data and properly described models. However, when using standard least squares estimates, the PLS-SEM technique aids in assessing the importance of correlations in the model and the resulting R square (R^2) (Gefen *et al.*, 2000). Therefore, the quantitative data analysis was done using the PLS-SEM technique for this investigation.

According to several reasons, the PLS-SEM approach was selected in this study to analyse the collected data. Firstly, as stated in Chapter 1, the aim of this study is to identify how the Agile adoption factors impact the adoption of Agile by Saudi Arabian software SMEs and evaluate the association between these factors and Agile adoption. PLS-SEM is the most acceptable choice for analysis, because it was created primarily for predictive analysis (Hair *et al.*, 2011, 2019; Lowry and Gaskin, 2014). Secondly, the adoption model used in this study contains a considerable number of latent variables (i.e. 13), which adds to the model's complexity. As a result, PLS-SEM was used, since it can be utilised to define a complicated model. Thirdly, compared to CB-SEM, PLS-SEM provides superior statistical power for all sample sizes, which is useful for studies with smaller sample sizes.

PLS-SEM analysis can be conducted using several software packages, including SmartPLS, PLS-Graph and XLSTAT. SmartPLS 3.0 software was used to analyse

the data for this study since it is a user-friendly software that can support results with graphs and illustrations (Ringle *et al.*, 2015).

6.2.4.3 PLS-SEM Analysis Procedures

PLS data analysis is a two-phase procedure that must be followed in order for the analysis to be successful. The measurement model (outer model) is completed first, followed by the structural model (inner model) evaluation. The focus of PLS-SEM evaluation is on the metrics that define the model's prediction capabilities. According to Hair *et al.* (2014), the most essential metrics to consider while assessing the measurement model are indicator reliability, internal consistency reliability, convergent validity and discriminant validity. In terms of the structural model, Hair *et al.* (2014) suggest five phases (Figure 6.3) for evaluating it.

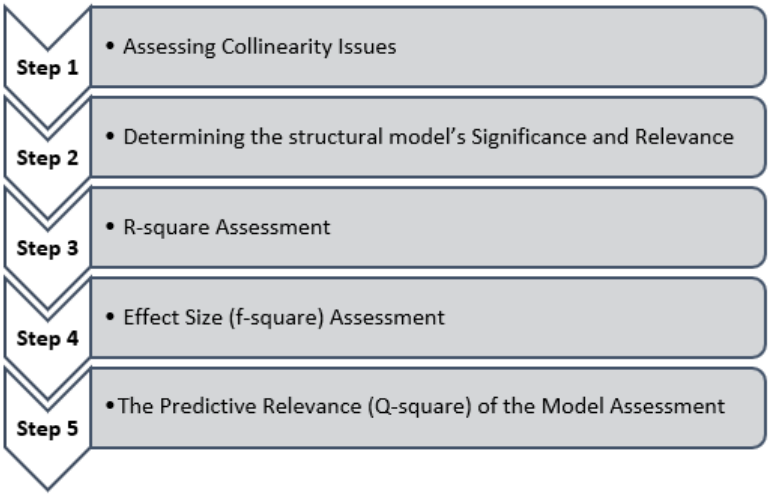


Figure 6.3: Structural model assessment steps

6.2.5 Ethical Considerations

As the study involved human participants, ethical considerations were taken into account before data collection began, as mentioned on page 52 of Chapter 3 (section 3.5). To receive approval, the author completed an FSTREC Application Form. The submission was approved after ten days, and the reference number FST20126 ERGO FPSE was assigned (see Appendix C.3). All participants received a participant information leaflet before answering the questionnaire (see Appendix C.4). They were also required to sign a consent form (see Appendix C.5).

6.3 Data Analysis Results

The results from the questionnaire related to the impact of the factors stated in the research model are presented in this section. Firstly, the results of the preliminary data analysis, specifically testing for missing data, outliers, normality and common method bias, are discussed. The respondents' demographic information follows this. After that, the results of the two stages of SEM analysis (i.e. measurement model and structural model assessment) are presented.

6.3.1 Results of Preliminary Data Evaluation

6.3.1.1 Resolving Missing Data

One of the issues that can arise in studies which use a survey as a data collection instrument is missing data (Acuña and Rodriguez, 2004). Due to the risk of bias, handling missing data is a critical step in statistical analysis (Tabachnick and Fidell, 2007; Hair *et al.*, 2009; Pallant, 2016). Furthermore, SEM analysis can only be conducted when the data is error-free. Indeed, Kline (2016) states that if the data gathered has any missing values, the analysis may fail to give credible findings and establish a model fit.

Despite the careful consideration taken in designing and administering the survey questionnaire, missing data issues sometimes occur. Missing data can be replaced with approximated new values or instances with missing values can be removed (Allison, 2003; Acuña and Rodriguez, 2004; Peugh and Enders, 2004). In light of this, two steps for handling the missing data were used in this study. First, we removed the questionnaire with 15% or more missing data from the dataset (Hair *et al.*, 2014). For this study, missing data were observed in 53 (29.1%) of the responses received. Consequently, the responses with missing data were removed from the dataset, as the missing values exceeded the allowable rate of 15%. Therefore, only 132 out of the 185 questionnaires were retained for the final analysis. The second step involved replacing the missing values for the measurement items with the mean value if the rate of missing data in each item did not exceed 5%. Items with more than 5% of data missing should be removed from the analysis. However, no missing data with more than 5% were detected for any of the indicators of this study, and thus none were removed as a result.

6.3.1.2 Treatment of Outliers

Following the assessment of the missing values in the questionnaire dataset, all individual questions were examined for outliers and other potential concerns (Tabachnick and Fidell, 2007; Hair *et al.*, 2009). Barnett and Lewis (1994) explained that an outlier

happens when there are extreme responses to the questions. In this study, outliers are not considered a concern, because all the items were measured using a Five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). Therefore, all of the values fell between one and five, making the extreme values (1 and 5) valid outliers (Osborne and Overbay, 2004).

The main threat of an outlier comes from responses to certain items being different from other responses (Osborne and Overbay, 2004; Hair *et al.*, 2014). Similarly, human intervention in the data input can also cause outliers. As no human interaction occurs when data is loaded from an internet database into SPSS, the only outliers in this data can be regarded as valid ones, with no significant threat to the data. After a rigorous evaluation of the frequencies and distribution of all variables, no outliers were found in the questionnaire dataset.

6.3.1.3 Normality Assessment

Normality denotes the normal distribution of the sample data. Normality testing of the variables is critical in multivariate analysis (Tabachnick and Fidell, 2007). While the normal distribution of the data is not required for the PLS-SEM analysis, the researcher believes that it is critical to ensure that the data does not deviate significantly from the normal distribution. Hair *et al.* (2014) argue that extreme non-normal distributed data can create challenges in assessing the variables' significance

As recommended by Hair *et al.* (2014), skewness and kurtosis measures are used to determine the distribution of the variables. Skewness reflects the degree of symmetry, or the balance between the number of observations below or above the mean in a distribution (Kim, 2013). Thus, when a case has a positive skewness, most of the cases are below the mean, while a negative skewness shows that the cases are above the mean (Kline, 2016). Kurtosis shows if a distribution is highly peaked around the mean or very flat; in short, a distribution is either excessively peaked or too flat. Positive kurtosis is represented by thicker tails and a higher peak, whereas negative kurtosis is denoted by thinner tails and a lower peak.

All independent variables were subjected to a normality test, and the results are reported in Table 6.5. According to Hair *et al.* (2014), the dataset has a normal distribution if the skewness and kurtosis values are between -1.0 and +1.0. The results revealed that almost all of the items' skewness and kurtosis values are within the range of -1.0 to +1.0, indicating that there is no clear evidence of non-normality. On the other hand, several items such as OrgCult2, DeliStr1, and AdoptAgile3, had skewness and kurtosis values that were not within the -1.00 to +1.00, however, the values were within the usual cut-off threshold of -2.0 and +2.0, indicating that non-normality is negligible (Tabachnick and Fidell, 2007). As a result, no strong evidence of non-normal distributions was observed.

Latent Variables	Indicators	Skewness	Kurtosis
Team capability	TeamCap1	0.197	-0.293
	TeamCap2	-0.072	-0.660
	TeamCap3	-0.024	-0.208
	TeamCap4	-0.367	-0.162
	TeamCap5	-0.026	0.354
	TeamCap6	-0.052	-0.565
Customer involvement	CusInv1	-0.399	-0.334
	CusInv2	0.115	-1.029
Training and learning	TrainLearn1	-0.270	-0.917
	TrainLearn2	-0.033	-0.341
	TrainLearn3	0.288	-0.109
Awareness and knowledge	AwareKnow1	-0.408	-0.385
	AwareKnow2	-0.354	-0.953
	AwareKnow3	0.583	-0.728
Organisational culture	OrgCult1	-0.037	-0.636
	OrgCult2	1.179	1.510
	OrgCult3	-0.006	-1.098
	OrgCult4	0.295	-1.083
National culture	NationCult1	0.562	-0.586
	NationCult2	-0.185	-0.934
	NationCult3	-0.218	-0.802
Management support	ManagSupp1	0.075	-0.874
	ManagSupp2	-0.215	-0.807
	ManagSupp3	0.007	-0.816
	ManagSupp4	0.611	0.035
Communication and collaboration	CommColl1	-0.067	-0.605
	CommColl2	-1.000	0.176
	CommColl3	-0.443	-0.833
	CommColl4	-0.231	-0.270
Organisational environment	OrgEnv1	-0.768	0.266
	OrgEnv2	-0.210	-0.657
Physical environment	PhyEnv1	-0.968	-0.315
	PhyEnv2	-0.360	-0.942
Tools and technologies	ToolTech1	-0.817	-0.300
Delivery strategy	DelStr1	-1.127	1.093
	DelStr2	-1.127	1.093
Agile software development	AgileTech1	-0.449	-0.250
	AgileTech2	-0.041	-0.585
Agile adoption	AgileAdopt1	-1.163	0.306
	AgileAdopt2	-0.503	-0.246
	AgileAdopt3	-1.355	1.466

AgileAdopt4	-1.384	1.609
AgileAdopt5	-1.027	0.438

Table 6.5: Data normality distribution

6.3.1.4 Common Method Bias

Since the data were obtained from the same subjects using a single instrument, common method bias (CMB) may be a concern (Conway and Lance, 2010). When two measures are derived from the same source, any defect in that source may contaminate both measures, presumably in a similar style and direction (Podsakoff *et al.*, 2003). In this regard, both measures may show a correlation that does not reflect a true relationship, leading to incorrect conclusions. Thus, the researcher used two instruments, semi-structured interviews and a survey questionnaire to examine the variables. In addition, CMB checks that measure items can be used for model building using SEM.

To reduce the occurrence of CMB, two remedies can be used: procedural remedies and statistical remedies. Procedural remedies are applied during several steps that are considered part of the research design before gathering quantitative data (Podsakoff *et al.*, 2003; Conway and Lance, 2010). Firstly, the survey items were divided into independent and dependent variables, with each one being grouped and labelled. This eliminated the risk of consistency artefacts, which can contribute to CMB. Secondly, the survey questions were kept to a minimum, in order to reduce the amount of time required to answer the questions and to avoid participant fatigue. Thirdly, all of the elements were double-checked for clarity, conciseness and accuracy. Fourthly, the respondents' identities were kept anonymous to reduce the effects of social desirability, as this can also lead to bias. Lastly, an unrelated question was added to the questionnaire to avoid respondents answering randomly.

Statistical remedies are conducted after the data collection process using different kinds of methods to check for CMB. In this study, two methods were considered, namely Harman's single-factor and unmeasured marker variable methods (Podsakoff *et al.*, 2003). The Harmon single factor test determines how much bias exists in the variance proportion distribution of items. It takes all of the variables (both independent and dependent) to an unrotated first factor, which should be less than 50%, indicating that there are no CMB problems. As shown in Table 6.6, the first factor explained 23.9% of the variation in the data in this research, indicating that CMB was not present and should not be considered a threat. Another method for identifying CMB was performed in this study using unmeasured marker variable. This method is computed by comparing the R^2 values of the dependent variable before and after the factor score variable pointing to it. The factor score was calculated with the

support of the SPSS software. If the differences between the R^2 values is less than 10%, it indicates that there are no CMB issues. The result of this method, as illustrated in Table 6.7, suggested the absence of CMB in the dataset.

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.847	25.225	25.225	10.278	23.903	23.903

Table 6.6: Harmon's single factor result

Latent Variables	R^2 **Values**	
	Without Marker Variable	With Marker Variable
Agile adoption in Saudi Software SMEs	0.587	0.590

Table 6.7: Unmeasured marker variable result

6.3.2 Demographic Information

The demographic information for the respondents and their organisations are presented in this section. Demographic data provide a clear picture of the respondents' backgrounds, including their gender, age, job position, experience in Agile and software development, size of their organisations, average team size and the number of development teams they are working with.

6.3.2.1 Respondents' Demographic Information

The demographic information for the survey's respondents is presented in Table 6.8. Out of the 132 respondents, 117 (88.6%) were males and 15 (11.4%) were females. The majority of the respondents were aged between 23 to 30 (46.9%), followed by 31 to 39 (41.7%) and 40 and above, with 11.4%. In terms of job role, most respondents worked as Developers (52.3%) at the time the survey questionnaire was conducted. Other job roles included Designers (15.5%), Project Manager (13.6%), other positions (7.7%), CTO/CIO (5.8%), CEO (3.2%) and Tester (1.9%). Moreover, the majority 49.3% of respondents had been working in software development for five to 10 years, 26.5% had one to four years' experience and 24.2% had more than 10 years' experience. With regard to their experience working with Agile, 50.7% of the respondents possessed one to four years' experience, 31.1% had between five to 10 years' experience, 10.6% had

less than a year's experience and 7.6% of respondents had been working with Agile for 10 or more years.

Questions	Answer Options	Frequency	Percentage (%)	Cumulative Percent
Gender	Male	117	88.6	88.6
	Female	15	11.4	100.0
Age	Below 23 years	0	0.0	0.0
	23 – 30 years	62	46.9	46.9
	31 – 39 years	55	41.7	88.6
	Above 40 years	15	11.4	100.0
Role	CEO	5	3.2	3.2
	CIO/CTO	9	5.8	9.0
	Project Manager (Scrum Master)	21	13.6	22.6
	Developer	81	52.3	74.9
	Designer	24	15.5	90.4
	Tester	3	1.9	92.3
	Others	12	7.7	100.0
Work experience in software development	Less than a year	0	0.0	0.0
	1 – 4 years	35	26.5	26.5
	5 – 10 years	65	49.3	75.8
	More than 10 years	32	24.2	100.0
Work experience in Agile development	Less than a year	14	10.6	10.6
	1 – 4 years	67	50.7	61.3
	5 – 10 years	41	31.1	92.4
	More than 10 years	10	7.6	100.0

Table 6.8: Demographic information of respondents' background

6.3.2.2 Work Information

Table 6.9 presents the information about the respondents' organisations. The respondents were asked about the size of their organisations, which were then classified into categories based on the SMEGA criteria (illustrated in Chapter 2, Section 2.2.3). Specifically, this study focused on respondents form small organisations (6–49 employees) and medium organisations (50–249 employees). In total, 65.9% of the respondents were working in small organisations, while 34.1% were working in

medium-sized organisations when the survey was conducted. When asked about the number of development teams they were involved in, 77.3% said they were involved in one development team. Meanwhile, 13.7% of the respondents were involved in two teams, 4.5% with three teams, and 4.5% said they were involved in more than three teams. In terms of the size of development team, the respondents mentioned that the average size was six to 10 members (63.6%), or 11 to 20 members (25%), or one to five members (11.4%). Lastly, when asked about the market scope of their organisations, 70.5% of the respondents stated they were working in local organisations, while 29.5% were working in national firms. No one was working for an international organisation.

Questions	Answer Options	Frequency	Percentage (%)	Cumulative Percent
Organisation size	Small (6-49 employees)	87	65.9	65.9
	Medium (50-249 employees)	45	34.1	100.0
Number of development teams	1 team	102	77.3	77.3
	2 teams	18	13.7	91.0
	3 teams	6	4.5	95.5
	More than 3 teams	6	4.5	100.0
Average number of team members	1 – 5 members	15	11.4	11.4
	6 – 10 members	84	63.6	75.0
	11 – 20 members	33	25.0	100.0
	More than 20 members	0	0.0	100.0
Market scope	International	0	0.0	0.0
	National	39	29.5	29.5
	Local	93	70.5	100.0

Table 6.9: Demographic information of respondents' organisations

6.3.3 Measurement Model Assessment

Before conducting further statistical analysis, it is critical to check the instrument's dependability and assure the quality of the measures. Therefore, the associations between latent variables and their indicators were examined at the measurement level. As previously stated in Section 6.2.4.2, latent variables reflect all of the components in the framework, including 'Agile adoption in Saudi software SMEs' component, whereas indicators represent the questions used to test these elements. In total, 14 latent variables were included in this study's analysis, and these variables were

measured using 43 items (indicators). These variables and their indicators used in this study are shown in Table 6.3 in Section 6.2.2.

Assessing the construct reliability and validity is an important stage in SEM that improves the precision of the investigation. As mentioned by Bagozzi and Yi (1988), to avoid random error and method variance, the reliability and validity of constructs can be examined using a variety of ways. As a result, four steps were followed in this study, as suggested by Hair *et al.* (2014); namely indicator reliability, internal consistency reliability, convergent validity and discriminant validity. The next sections will present the results of these four steps.

6.3.3.1 Step 1: Indicator Reliability

The reflective indictor reliability test demonstrates whether the indicator measures the construct accurately (Hulland, 1999). Thus, to measure that in this study, indictor loadings and the Rho-A test were applied (Hair *et al.*, 2014). The estimated correlations in reflective measurement models (as shown in the arrows from the latent variable to its indicators) serve as indicator loadings, whereas Rho-A indicates the degree to which all of the items measure the same construct (Wong, 2013). Thus, loadings have a primary importance in the evaluation of reflective measurement models. The range of indictor loadings and Rho-A values is 0 to 1, with larger value signifying higher reliability.

The general guideline is that an indicator's outer loading value should exceed 0.7, and any loading less than 0.4 should be excluded from the model (Hair *et al.*, 2011). Meanwhile, the researcher should evaluate the indicators with loadings between 0.40 and 0.70. These indicators should only be excluded if they cause the construct's composite reliability or average variance extracted values to exceed the threshold (Hair *et al.*, 2011, 2014). As shown in Table 6.10, the loadings are denoted as 'iteration0' before item deletion and 'iteration1' after item deletion with a loading less than 0.4. Five items (i.e. TeamCap1, TeamCap6, NationCult1, CommColl1, CommColl2) are excluded from the model, as their loadings were less than 0.4. In this regard, the proceeding section will discuss whether this action impacts the composite reliability values and average variance extracted values. Most items show the outer loadings above 0.7, except for TeamCap2, TeamCap4, TrainLearn1, AgileAdopt1, AgileAdopt2 and AgileAdopt5, with the scores of 0.598, 0.697, 0.622, 0.649, 0.686 and 0.668, respectively. As shown in the table below, while these values were below 0.7, they are still higher than 0.4.

The Rho-A test was performed in this study, as it is considered to be more accurate and a good measure of indicator reliability. The higher value of Rho-A reflects a stronger internal consistency, and subsequently, reliability (Pallant, 2016). In general, a Rho-A value of 0.7 or higher is considered extremely good; 0.6 to 0.7 is acceptable,

and less than 0.6 is considered low and unsatisfactory (Pallant, 2016; Field, 2017). Table 6.10 presents the Rho-A values for all of the latent variables. The results reveal that all of the constructs had Rho-A values higher than 0.7, indicating that they exceeded the minimal threshold.

6.3.3.2 Step 2: Internal Consistency Reliability

Another test utilised in this study to analyse the construct reliability is the internal consistency test. This test is a critical step in the SEM analysis, in which any study not considering this step is misleading (Gefen *et al.*, 2000). To do this, the composite reliability (CR) test was employed, as advised by Hair *et al.* (2014). Composite reliability determines an item's absolute contribution to the construct to which it is assigned (Hair *et al.*, 2014). The following formula, proposed by Hair *et al.* (2014), was used to calculate composite reliability, which was used to assess the construct's reliability:

$$p_c = \frac{(\sum_i l_i)^2}{(\sum_i l_i)^2 + \sum_i var(e_i)} \tag{6.1}$$

A figure of l_i denotes the standardised outer loading of the indicator variables, while e_i denotes the measurement error of the indicator variable. $var(e_i)$ represents the variance of measurement error. In light of this, the composite reliability values vary between 0 to 1. The higher reliability of a construct is indicated by a higher value of the composite reliability. For exploratory research, composite reliability between 0.06 to 0.70 is deemed acceptable, while a value of 0.7 to 0.90 is considered satisfactory (Gefen *et al.*, 2000). Any value less than 0.60 indicates a lack of internal consistency reliability.

Table 6.10 lists the composite reliability of all the latent variables. Here, all of the constructs demonstrate composite reliability exceeding 0.7, which is the minimum threshold. Thus, the results showed that the constructs were reliable, and the researcher could proceed with further analysis.

LatentVariables	Indicators	Loadings (iteration 0)	Loadings (iteration 1)	RhoA	CR
Team capability	TeamCap1	*-0.001	–	0.811	0.839
	TeamCap2	0.569	0.598		
	TeamCap3	0.881	0.889		
	TeamCap4	0.680	0.697		
	TeamCap5	0.800	0.806		
	TeamCap6	*0.348	–		

Customer involvement	CusInv1	0.814	0.888	0.709	0.872
	CusInv2	0.853	0.870		
Training & learning	TrainLearn1	0.623	0.622	1.017	0.815
	TrainLearn2	0.935	0.936		
	TrainLearn3	0.737	0.735		
Awareness & knowledge	AwareKnow1	0.899	0.900	0.775	0.846
	AwareKnow2	0.766	0.766		
	AwareKnow3	0.744	0.743		
Organisational culture	OrgCult1	0.878	0.880	0.85	0.891
	OrgCult2	0.761	0.768		
	OrgCult3	0.780	0.777		
	OrgCult4	0.855	0.849		
National culture	NationCult1	*0.343	–	0.736	0.851
	NationCult2	0.794	0.801		
	NationCult3	0.906	0.917		
Management support	ManagSupp1	0.823	0.824	0.810	0.861
	ManagSupp2	0.806	0.805		
	ManagSupp3	0.739	0.739		
	ManagSupp4	0.748	0.748		
Communication and collaboration	CommColl1	0.857	0.887	0.717	0.875
	CommColl2	*0.236	–		
	CommColl3	*0.378	–		
	CommColl4	0.881	0.878		
Organisational environment	OrgEnv1	0.946	0.946	0.879	0.942
	OrgEnv2	0.941	0.941		
Physical environment	PhyEnv1	0.890	0.888	1.911	0.938
	PhyEnv2	0.989	0.989		
Tools and technologies	ToolTech1	1.000	1.000	1.000	1.000
Delivery strategy	DelStr1	0.946	0.946	0.877	0.941
	DelStr2	0.940	0.941		
Agile software development	AgileTech1	0.941	0.952	0.970	0.861
	AgileTech2	0.801	0.781		

Agile adoption	AgileAdopt1	0.611	0.649	0.787	0.847
	AgileAdopt2	0.687	0.686		
	AgileAdopt3	0.803	0.812		
	AgileAdopt4	0.814	0.801		
	AgileAdopt5	0.688	0.668		

Table 6.10: Construct reliability with results (the asterisk implies items with loadings less than 0.4)

6.3.3.3 Step 3: Convergent Validity

Convergent validity is a method for determining the relationship among the measured variables measuring a single construct (Tabachnick and Fidell, 2007; Pallant, 2016). A strong correlation between items for the same construct indicates that items accurately represent the intended construct. The convergent validity of this study was determined using the Average Variance Extracted (AVE) (Fornell and Larcker, 1981; Bagozzi and Yi, 1988). The minimum reference value is 0.50 which shows that the latent variables explain more than half of the variance in their indicators. Hulland (1999) asserts that researchers should analyse the values of AVE for all latent variables in the model. Equation 6.2, as shown below, was used to calculate AVE, as suggested by Hair *et al.* (2014):

$$AVE = \frac{\sum_{i=1}^{M} l_i^2}{M} \tag{6.2}$$

l_i demonstrates the standardised factor loading, which represents the number of items. A specific construct was measured using M indicators. Convergence is denoted when the constructs' AVE values (as shown in Table 6.11) exceed the threshold of 0.5. The researcher deliberated before deciding to remove six indicators with low loadings (less than 0.4), as discussed in Section 6.3.3.1. In addition, two constructs, namely 'team capability' and 'communication and collaboration', were found to have loadings below 0.5. This result implied a low relationship between some measurement items and their latent construct. After removing indictors with loadings less than 0.4 for these two constructs, the AVE value exceeding 0.5, which is the minimum threshold. In light of this, the results of all constructs confirm the convergent validity.

6.3.3.4 Step 4: Discriminant Validity

According to empirical standards, discriminant validity refers to the degree to which a construct is distinct from others and has the strongest relationships with its items

Latent Variables	AVE	Latent Variables	AVE
Team capability	0.571	Customer involvement	0.773
Training learning	0.601	Awareness and knowledge	0.649
Organisational culture	0.672	National culture	0.741
Management support	0.608	Communication and collaboration	0.778
Organisational environment	0.891	Physical environment	0.883
Tools and technologies	1.000	Delivery strategy	0.889
Agile software techniques	0.758	Agile adoption	0.528

Table 6.11: Convergent validity (AVE values)

(Hair *et al.*, 2014). In this sense, discriminant validity verifies that a construct captures a distinct occurrence that is not described by other constructs in the model (Hair *et al.*, 2014). Furthermore, it aids in the reduction of multicollinearity between latent constructs.

Discriminant validity can be obtained through several approaches. In this study, the Fornell-Lacker criterion approach and the cross-loading approach were used to determine the discriminant validity. According to the Fornell-Lacker criterion, discriminant validity is verified when the AVE square root is higher than the correlations between the construct (Fornell and Larcker, 1981). Table 6.12 shows the results of this criterion, which showed that the AVE square roots (the diagonal values in the table) for all of the latent constructs were higher than the correlation between these constructs. The second approach used for determining the discriminant validity in this study was the cross-loading approach. In this case, the loading of items should be higher than all cross-loadings (Chin, 1998*b*,*a*; Götz *et al.*, 2010). The results of this approach are presented in Appendix A.6. Overall, the loading values of each item were higher than the cross-loadings for other items. These results, therefore, show adequate evidence that the latent constructs have discriminant validity.

6.3.4 Structure Model Evaluation

After ensuring that the validity and reliability of the constructs in the measurement model, the next step was evaluating the structural model (Hair *et al.*, 2014). The purpose of the structural model evaluation is to see if the model is supported by the empirical data. This evaluation validates the degree of influence between the model's constructs and the model's predictive aspect. The constructs in the structural model can be divided into exogenous and endogenous constructs. 'Exogenous' constructs are those that are latent and have no structural path leading to them. Meanwhile, 'endogenous' constructs are latent constructs that can be described by other constructs (Kline, 2016; Garson, 2016). Subsection 6.5.4.3 discusses the systematic procedure in

	AA	AST	AK	CC	CI	DS	MS	NC	OE	OC	PE	TC	TT	TL
AA	**0.726**													
AST	0.036	**0.871**												
AK	0.391	0.392	**0.806**											
CC	0.480	0.169	0.564	**0.882**										
CI	0.539	0.096	0.363	0.526	**0.879**									
DS	0.436	0.077	0.276	0.400	0.525	**0.943**								
MS	0.371	0.215	0.573	0.728	0.422	0.140	**0.780**							
NC	0.223	-0.040	0.007	0.105	0.132	0.201	0.162	**0.861**						
OE	0.594	0.179	0.509	0.758	0.604	0.395	0.752	0.187	**0.944**					
OC	0.462	0.177	0.648	0.740	0.580	0.444	0.771	0.250	0.761	**0.820**				
PE	0.223	0.120	0.010	0.183	0.178	0.084	0.309	0.338	0.357	0.180	**0.940**			
TC	-0.275	0.162	0.260	0.214	-0.036	0.006	0.123	-0.120	-0.017	0.026	-0.073	**0.756**		
TT	0.322	0.050	0.221	0.344	0.230	0.282	0.258	0.316	0.324	0.331	0.319	0.082	**1.000**	
TL	0.298	0.145	0.393	0.304	0.151	0.128	0.432	0.160	0.384	0.353	0.140	-0.064	0.028	**0.776**

Table 6.12: Discriminant validity (Fornell-Lacker criterion)

structural model assessment, which is guided by the five steps presented below.

6.3.4.1 Step 1: Assessing Collinearity Issues

The path coefficient (β) results must be examined for collinearity issues among the exogenous constructs. This is because bias may occur if the route's estimation involves crucial collinearity among the predictive constructs (Hair Jr *et al.*, 2017). This assessment ensures that no two or more constructs in the structural model measure the same attributes, as this indicates no collinearity issues among them (Echambadi and Hess, 2007). Collinearity difficulties influencing the endogenous construct are determined by the Variance Inflation Factor (VIF) values. In this study, the VIF values for all constructs were found to be less than the threshold value (i.e. five) (Henseler *et al.*, 2009). This result indicated that there was no substantial collinearity between the model's exogenous components, as shown in Table 6.13.

Exogenous Variables	AA	AK	OE	OC
Team capability	1.314			
Customer involvement	1.959			
Training and learning	1.429	1.000		
Awareness and knowledge	2.504			
Organisational culture	4.594			
National culture	1.355			1.027

Management support	4.481		2.161
Communication and collaboration	3.530		2.128
Organisational environment	4.136	1.000	
Physical environment	1.509		
Tools and technologies	1.384		
Delivery strategy	1.844		
Agile software techniques	1.243		

Table 6.13: Collinearity issues (VIF value)

6.3.4.2 Step 2: Determining the Structural Model's Significance and Relevance

After addressing the collinearity difficulties in the first step, the second step was to examine the potential relationships between the construct variables. The path coefficient, critical ratio and p-value were used to examine the relationships between latent variables in this study (Hair *et al.*, 2011).

The strength of the relationship between two latent variables is represented by the path coefficient values (Wong, 2013; Hair *et al.*, 2014). A standardised value ranging from -1 to +1 is assigned to each path. A negative value denotes that the variables in the structural model are negatively associated and vice versa. Meanwhile, the critical ratio is represented by the t-value or z-value. The t-value, which was used in this study, is determined by dividing the unstandardised path coefficient with the standard error. As suggested by Hair *et al.* (2014), a t-value of 1.96 or higher denotes a significant coefficient value. While the p-value indicates the statistical significance of the relationships between the constructs. In general, the p-value indicators are considered very strong when their value less than or equal to 0.01, strong when its value is greater than 0.01 and less than or equal to 0.05, moderate when its value is greater than 0.05 and less than or equal to 0.10, and weak when its value is greater than 0.10.

Direct Relationships

The PLS bootstrapping function was used in this step to assess the direct relationships with 5,000 subsamples in the SmartPLS software package following Hair *et al.* (2014) recommendation. Figure 6.4 shows the path coefficients of the research model with the p-value in parentheses. In addition, when the t-value of the path was greater than 1.96, it is presented as an asterisk. Meanwhile, the results of direct effects (H1 to H13) are listed in Table 6.14, along with whether the decision to accept or reject the hypotheses relationships was made.

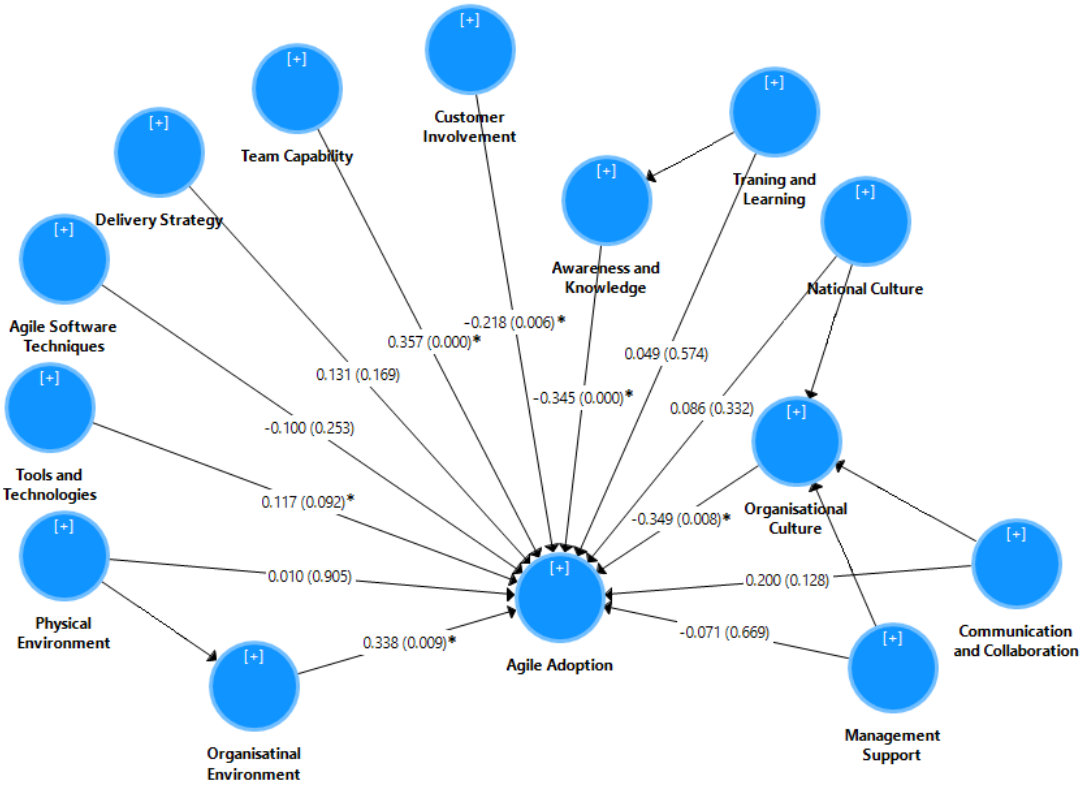


Figure 6.4: Structural model results

H#	Relationship	Std Beta	Std Error	t-value	p-value	Decision
H1	TC → AA	0.357	0.073	4.973	0.000***	Supported
H2	CI → AA	-0.218	0.08	2.736	0.006***	Supported
H3	TL → AA	0.049	0.087	0.562	0.574	Not Supported
H4	AK → AA	-0.345	0.095	3.652	0.000***	Supported
H5	OC → AA	-0.349	0.132	2.654	0.008***	Supported
H6	NC → AA	0.086	0.089	0.971	0.332	Not Supported
H7	MS → AA	-0.071	0.166	0.428	0.669	Not Supported
H8	CC → AA	0.200	0.131	1.523	0.128	Not Supported
H9	OE → AA	0.338	0.129	2.629	0.011**	Supported
H10	PE → AA	0.010	0.08	0.119	0.905	Not Supported
H11	TT → AA	0.117	0.069	1.972	0.092*	Supported
H12	DS → AA	0.131	0.095	1.374	0.169	Not Supported
H13	AST → AA	-0.100	0.088	1.142	0.253	Not Supported

H14	TL → AK → AA	-0.136	0.042	3.232	0.001***	Supported
H15a	NC → OC → AA	-0.047	0.027	1.963	0.088*	Supported
H15b	CC → OC → AA	-0.134	0.049	2.764	0.006***	Supported
H15c	MS → OC → AA	-0.164	0.071	2.317	0.023**	Supported
H16	PE → OE → AA	0.121	0.055	2.209	0.028**	Supported

Table 6.14: Relationships for hypothesis testing (Effect significant:*p<0.10; **p<0.05; ***p<0.01)

According to the structural model results (Figure 6.4) and Table 6.14, six of the 13 hypotheses were statistically significant for predicting Agile Adoption in Saudi SMEs, whereas the remaining seven hypotheses were not. It was found that the hypothese H1, H2, H4, H5, H9 and H11 were statistically significant. The t-values and p-values of the paths estimated for H1, H2, H4 and H5 exceeded 1.96 for t-values and were lower than 0.01 for the p-values. These results provide substantial evidence that these hypotheses are supported and have a very strong effort. Indeed, the hypotheses paths were found to be negatively linked for H2 (β = -0.218), H4 (β = -0.345) and H5 (β = -0.349) while the others are linked positively. Hypotheses H9 were shown to have significant efforts as (t > 1.96, p < 0.05) and was found to be positive supported (β = 0.338). The results also showed that hypothesis H11 are moderately supported (t-value > 1.96, p-value < 0.10). In contrast, the results for a number of hypotheses (i.e. H3, H6, H7, H8, H10, H12 and H13) were not found to be statistically significant. These results will be discussed in detail in the discussion section.

Indirect Relationships

Indirect relationships (i.e. H14, H15a, H15b, H15c, H16) occur when a construct acts as an intermediary in the interaction between two other constructs; this is called a mediation effect, as discussed in Section 6.2.1.1. This effect exists in the model when an independent construct influences the independent construct through a mediator. Using SmartPLS software, the bootstrapping function was used to assess the indirect relationships of 5,000 subsamples following the recommendation of Hayes and Preacher (2014). This mediation effect can be assumed to be a full mediation when there is no direct relationship between the independent and dependent variable. However, when a mediator variable plays an intermediary role between these two variables, there is a significant relationship. On the other hand, the effect can be characterised as a partial mediation when there is a direct significant relationship between independent and dependent variables and also an indirect relationship through a mediator.

Table 6.14 shows the results of the mediator assessment. The results show that mediating variables (i.e. awareness and knowledge; organisational culture;

organisational environment) can be significantly mediate the relationship between the independent and dependent variables. These mediating variables can be characterised as a full mediation, as without them, there is no relationship between the independent variable and dependent variable. Thus, H14, H15a, H15b, H15c and H16 are supported in this study, as the t-values were found to exceed 1.96 and the p-value was lower than 0.10.

6.3.4.3 Step 3: R-square Assessment

The coefficient of determination (R^2 value) measures the accuracy of a model's prediction, which measures the variance in a dependent construct that is explained by other independent constructs. It is one of the most popular statistics in structural model evaluation (Henseler *et al.*, 2009; Hair *et al.*, 2011, 2014). R^2 ranges depend on the model complexity and research discipline. In this study, the analysis of variance of the construct was conducted based on works by Cohen (1988) and Chin (1998*b*). In general, the range of R^2 values is between 0 and 1. Furthermore, when the R^2 values for endogenous latent constructs are higher, the model's predictive accuracy is higher. The rule of thumb of R^2 values categorised by Chin (1998*a*) is 0.75 being substantial, 0.50 being moderate and 0.25 being weak.

As shown in Figure 6.4 presented in the previous step, the R^2 of the study's dependent variable 'Agile adoption in Saudi software SMEs' was 0.587. These independent constructors may explain 58.7% of the variance in SMEs' desire to embrace Agile. The findings suggest that the study model may be utilised to statistically explain the adoption of Agile by Saudi Arabian software SMEs. As suggested by Hair *et al.* (2014), the adjusted coefficient of determination (R^2Adj) was calculated to avoid bias in the complex model using the formula below:

$$R^2_{adj} = 1 - (1 - R^2).\frac{n-1}{n-k-1} \tag{6.3}$$

n represents the sample size, and k denotes number of exogenous latent variables predicting the endogenous latent variable examined. In this regard, the R^2_{adj} of the main exogenous latent variables (AA) = 0.541 was significant, hence, the enhanced conceptual model is considered acceptable.

6.3.4.4 Step 4: Effect Size (f^2) Assessment

After examining the R^2 for all of the endogenous constructs, the effect size (f^2) was the first quality criterion used for evaluating the structural model, which measured the R^2 value changes in the exogenous construct. When an exogenous construct is removed from the model, the effect size f^2 predicts the R^2 value. This difference indicates whether the missing construct significantly impacts the endogenous construct (Hair

Jr *et al.*, 2017). Based on its importance, the impact size for this study was calculated using the formula put forward by Hair *et al.* (2014):

$$f^2 = \frac{R^2_{included} - R^2_{excluded}}{1 - R^2_{included}} \tag{6.4}$$

$R^2_{included}$ and $R^2_{excluded}$ represent the R^2 values of the endogenous latent variable after the inclusion or exclusion of specific exogenous from the model. The threshold of f^2 values follows Cohen's guidelines, which are: 0.02 shows a small effect, 0.15 represents a moderate effect, and 0.35 represents the significant effects of the exogenous latent variables (Cohen, 1988). Changes in the R^2 values can be determined by calculating the PLS path model twice. The first calculation included the exogenous latent variable, as calculated in the previous section (R^2 values = 0.587). The second calculation was conducted by excluding the exogenous latent variable.

Table 6.15 presents the effect size, f^2, for all of the exogenous variables in this study. As described in Cohen (1988) criteria, 'team capability' had both a medium and high effect, while the other variables had a small effect on the decision to adopt Agile among software SMEs. Other constructs, including 'management support' and 'physical environment', were shown to have no effect on Agile adoption, because the effect size was below 0.02.

Exogenous Variables	**R^2 excluded**	**Effect size (f^2)**
Team capability	0.499	0.213
Customer involvement	0.563	0.058
Training and learning	0.572	0.036
Awareness and knowledge	0.548	0.094
Organisational culture	0.561	0.063
National culture	0.581	0.014
Management support	0.586	0.002
Communication and collaboration	0.576	0.027
Organisational environment	0.562	0.060
Physical environment	0.586	0.002
Tools and technologies	0.578	0.022
Delivery strategy	0.580	0.017
Agile software techniques	0.578	0.022

Table 6.15: Effect size (f-square)

6.3.4.5 Step 5: The Predictive Relevance of the Model Assessment

The second criterion for evaluating the structural model's quality was predictive relevance, as measured by Q^2 (Chin, 1998*a*; Henseler *et al.*, 2009; Hair *et al.*, 2014).

In reflective measurement models of dependent constructs, Q^2 is a measure of the model's predictive significance, as it predicts the data points of the indicators. In addition, it emphasises the extent to which the model's prediction is accurate.

The blindfolding algorithm was used to determine the adjusted predictive relevance of the model for the main endogenous construct 'Agile Adoption in Saudi software SMEs'. When using this algorithm, the omission distance (D) had to be set between five and 10, as recommended by Hair *et al.* (2014). In this study, the omission distance d was set at seven. As a guideline by Chin (1998*b*) and Hair *et al.* (2014), a Q2 value of an exogenous variable larger than zero indicates the presence of predictive relevance of the model for that variable.

In this study, the Q^2 value of the endogenous construct exceeded the threshold of 0 at 0.281. The result confirms that the structural model has a predictive relevance in examining Agile adoption among Saudi software SMEs, confirming the quality of the study's structural model.

6.4 Discussion of the Findings

This section discusses the findings of the quantitative analysis (presented in the preceding section) of data collected through a survey of 132 software practitioners in Saudi Arabia. Specifically, the section focuses on how the factors identified (people, knowledge, cultural, organisational, environmental, technical and process factors) as well as the correlations between these, directly affect the adoption of Agile by software SMEs in Saudi Arabia. This study also examines the mediating effects of the variables (awareness and knowledge; organisational culture; organisational environment) and concludes by presenting the final model for Agile adoption in Saudi software SMEs.

6.4.1 The Relationship Effects

The relationship effects between factors were examined by conducting the PLS-SEM analysis (see Table 6.14). The analysis found six factors which had a statistically significant direct relationship with Agile adoption, while seven factors were found to have no significant relationship. The findings support six hypothesised relationships (H1, H2, H4, H5, H9 and H11). These hypotheses relate to the role of team members, customer involvement, awareness and knowledge, organisational culture, organisational environment and tools and technologies. On the other hand, the other hypotheses (H3, H6, H7, H8, H10, H12 and H13) did not show significant direct relationships, as they obtained low t-values and high p-values. These hypotheses relate to training and learning, national culture, management support, communication and collaboration, physical environment, delivery strategy and Agile software techniques.

This study also considered the mediation effects on Agile adoption of awareness and knowledge, organisational culture and organisational environment, as shown in the study model (Figure 6.1). All the hypotheses relating to the mediation constructs were validated by the PLS data (H14, H15a, H15b, H15c and H16). Training and learning, national culture, management support, communication and collaboration and physical environment were found to have an indirect impact on Agile adoption. The model shows that 58.7% of the variances in Agile adoption in Saudi software SMEs can be explained by the model's independent factors.

This study's findings are statistically significant, indicating that the study model has good explanatory power in predicting the factors influencing Agile adoption. The most impactful facilitators to Agile adoption are 'team capability', 'organisational environment' and 'tools and technologies'. In contrast, 'organisational culture', 'awareness and knowledge' and 'consumer involvement' are the most significant hindrances to adoption. Each of these factors is discussed and examined in the following subsections based on the literature (Chapter 2) and the empirical investigation undertaken in Chapter 5. All path coefficient (β) values, t-values and p-values in this section are presented in Table 6.14 in Section 6.3.4.2.

6.4.1.1 Team Capability

One of the essential prerequisites for Agile adoption in software development is the presence of a capable team that is technically skilled, competent and motivated. An efficient and successful team increases the likelihood of adopting Agile (Cockburn and Highsmith, 2001). **The PLS-SEM analysis finds that 'team capability' has a statistically significant influence on Agile adoption.** This relationship has a t-value of 4.973 and a p-value of less than 0.01, indicating that this factor has a very strong effect on Agile adoption. The path coefficient (β) value of 0.357 indicates a positive association between 'team capability' and Agile adoption. It indicates that this factor has the strongest relationship and is the most impactful facilitating factor on Agile adoption in Saudi Arabia, supporting hypothesis H1, *"team capability has a positive influence on Agile adoption in Saudi software SMEs."*

These results go in parallel with those of Chow and Cao (2008); Conboy (2009); Asnawi *et al.* (2012); Sheffield and Lemétayer (2013) and Tam *et al.* (2020). Even though these earlier studies were conducted in different settings, they also show that 'team capability' has a significant impact and positively influences Agile adoption. This finding is also supported by the experts interviewed (see Chapter 5), of whom 66.7% strongly agreed and 33.3% agreed that 'team capability' is one of the most significant factors for Agile adoption. The experts believed that there are a number of professional and skilful practitioners in Saudi Arabia who encourage the adoption of Agile. Thus, the exploratory and explanatory findings show that 'team capability'

is considered one of the main facilitators for Agile adoption in this context. This factor plays a significant role, as SMEs are mostly made up of teams, where team members' skills such as self-organising and motivating are undeniably vital to Agile adoption. Senior management should therefore select team members carefully, based particularly on their skills and knowledge.

6.4.1.2 Customer Involvement

This factor revolves around customers' role in the development of Agile. It encompasses customers sharing information and collaborating with team members to ensure that projects are completed in accordance with needs and expectations. **The PLS-SEM analysis finds that the level of customer involvement influences Agile adoption.** A negative relationship was also found between this factor and Agile adoption, as (β = -0.218). The 'customer involvement' factor has a significant influence on adoption, with the t-value equal to 2.736 and the p-value smaller than 0.01. This variable path coefficient indicates that low customer involvement significantly hinders Agile adoption among Saudi software SMEs, with an impact of 0.218, and could reduce the chances of Agile adoption. Based on this finding, hypothesis H2, *"customer involvement has a negative influence on Agile adoption in Saudi software SMEs"*, was supported.

The current study's findings are consistent with those of previous empirical studies (Chow and Cao, 2008; Misra *et al.*, 2009; Sheffield and Lemétayer, 2013; Vithana *et al.*, 2018; Tam *et al.*, 2020), which confirmed that 'customer involvement' has an impact on Agile adoption and is one of the major prerequisites for successful adoption. According to the experts interviewed in the previous chapter, 33.3% 'strongly agreed' and 58.3% 'agreed' about the necessity of customer interaction in Agile adoption. They believe it presents a key challenge to Agile adoption in Saudi Arabia, owing to a lack of consumers' awareness of Agile, a lack of time, and a lack of confidence between them and Agile development teams. In this light, both the qualitative and quantitative findings highlight the importance of 'customer involvement' in SMEs' acceptance of Agile adoption.

As a result, firms must be aware of this, be conscious of their customers' time, and take client availability into account in order to arrange for effective customer engagement in Agile teams. Furthermore, clients - and particularly customers from government agencies - must be aware of Agile and how it works in order to be successfully involved in Agile teams, and must be able to make decisions such as approval, rejection and defining project goals and priorities. Based on these findings, additional research using a qualitative approach should be conducted to study the impact of this element on the adoption of Agile in Saudi Arabia. This is because a key aim of Agile is to develop software as efficiently as possible to satisfy consumers'

needs. It requires customers' involvement, commitment to the project and engagement with the development team. Thus, a study of the practical challenges of involving customers and collaborating with them in Saudi Arabia is suggested.

6.4.1.3 Training and Learning

This factor relates to stakeholders' use of training and learning events to improve their skills to help achieve their goals and objectives. These events help to accelerate the adoption of Agile by software organisations, and they should be ongoing and regular for effective adoption. **The PLS-SEM analysis finds that the 'training and learning' factor has no statistically significant direct correlation with software SMEs' desire to adopt Agile,** since the t-value is less than 1.96 and the p-value exceeds 0.10. Hence, the findings of this study do not support hypothesis H3, *"training and learning has a negative influence on Agile adoption in Saudi software SMEs."* This result contradicts the findings of a previous study by Wan and Wang (2010), which indicated that 'training and learning' could encourage Agile adoption. The present finding is however consistent with that of another study by Vithana *et al.* (2018), which found that this factor does not affect Agile adoption among Sri Lankan software developers. As well as this, the exploratory findings from the interviews (Chapter 5) revealed that the majority of experts (83.3%) agreed that 'training and learning' are essential factors in Agile adoption. They also stated that a lack of such events has prevented Saudi software SMEs from adopting Agile.

Even though the findings of this study suggest that 'training and learning' has no direct effect on Agile adoption, **they indicate that it has an indirect relationship with Agile adoption via the 'awareness and knowledge' factor.** The PLS data revealed that 'awareness and knowledge' mediates the relationship between the 'training and learning' factor and Agile adoption. This indirect relationship is negative (β = -0.136) and has a statistically significant effect, with a t-value of 3.232 and a p-value of 0.001. As there is no direct relationship between the 'training and learning' factor and Agile adoption, the 'awareness and knowledge' factor is considered to have a full mediating effect on this relationship. This finding thus confirms hypothesis H14, *"awareness and knowledge mediates the negative relationship between training and learning and Agile adoption."* This finding contradicts previous studies which found that 'training and learning' had a direct impact on adoption.

Organisations should therefore give their employees access to continuous training and learning. This will enhance their awareness and knowledge of Agile and increase their ability to adopt Agile methods. In addition, these training and learning events must be conducted for other stakeholders, for example, management teams and customers. These events also have to come from academic institutions and government bodies. Additional research should be conducted utilising different approaches to

study this issue in greater depth.

6.4.1.4 Awareness and Knowledge

This factor refers to the level of awareness and knowledge of Agile which stakeholders require in order to understand such things as the information, skills and expertise needed to adopt and use Agile methods. It emerged from interviews with software development experts, as presented in Chapter 5. **The PLS-SEM analysis finds that the 'awareness and knowledge' factor has a statistically significant influence on the adoption of Agile in Saudi Arabia.** This association has a t-value of 3.654 and a p-value less than 0.01. It has a negative effect (β = -0.345), indicating that the low level of Agile awareness and understanding among stakeholders in Saudi Arabia hinders software SMEs from adopting Agile. The findings of this study revealed that this relationship has a strong effect relative to the strengths of the other independent components, with an impact score of 0.345. As a result, hypothesis H4, *"awareness and knowledge is a factor that contributes negatively to Agile adoption in Saudi software SMEs"*, was supported.

The PLS-SEM analysis result supports the findings of previous studies, such as Cockburn and Highsmith (2001), which discuss the influence of practitioners' level of Agile awareness on its adoption and usage. This finding suggests that lack of 'awareness and knowledge' is a barrier to Agile adoption in Saudi Arabia. The qualitative analyses conduced in Chapter 5 found that most experts interviewed are concerned about the impact of this factor among important stakeholders, such as software practitioners, customers and managers, and believe this element has a substantial impact on Agile adoption. Furthermore, it has a mediating effect on the relationship between 'training and learning' and Agile adoption, as previously discussed. The result implies that Saudi software SMEs must consider this factor when adopting Agile.

There is a need to increase the awareness and knowledge of Agile among stakeholders in the country. This can be achieved by paying attention to the training and learning events by a growing number of Agile education initiatives, workshops and seminars for software practitioners, students, customers and public in Saudi Arabia from institutions and organisations to have a good understanding of Agile in order to increase its adoption among software SMEs.

6.4.1.5 Organisational Culture

Organisational culture is defined as a set of values, assumptions, attitudes, experiences and beliefs that define an organisation and differentiate it from other organisations. **The PLS-SEM analysis finds that 'organisational culture' has a negative contribution on Agile adoption in Saudi Arabia (β = -0.349).** According to

the correlation path coefficient, which reflects the strength of its relationship with Agile adoption, 'organisational culture' is the second strongest of the 13 factors hypothesised, with an impact of 0.349. In the context of Saudi Arabian software SMEs, this factor is seen as one of the most significant hindrances to Agile adoption. The association between this factor and Agile adoption has a t-value of 2.654 and a p-value of less than 0.01, also indicating a very substantial influence. Therefore, hypothesis H4, *"organisational culture is a factor that contributes negatively to Agile adoption in Saudi software SMEs"*, was supported.

These findings are consistent with the findings of other studies that identified organisational culture to be a significant factor in the adoption of Agile. Robinson and Sharp (2005), for example, found that this factor is crucial in Agile development since it is a substantial force moving Agile ahead. In addition, other research conducted by Strode *et al.* (2009); Iivari and Iivari (2011) and Sheffield and Lemétayer (2013) is in agreement with the findings of this study. The successful development of Agile software is therefore dependent on dynamic and fast-changing organisations (Tolfo and Wazlawick, 2008). Turning to the expert interviews presented in Chapter 5, it is noted that all the interviewees either strongly agreed or agreed that 'organisational culture' impacts Agile adoption in Saudi Arabia. The experts' views and the quantitative study both support the conclusion that this factor has a considerable impact on the decision of SMEs to adopt Agile.

Organisations should possess a supporting culture that encourages rapid communication, adaptability to changing requirements, trust between individuals and quick client feedback. However, it was found that most Agile software development practitioners agreed that the culture of Saudi organisations does not promote the successful adoption of Agile. Organisational culture should therefore be considered as one of the most significant variables which constitute a barrier to Agile adoption in the country. If organisations want to encourage their teams to embrace and implement Agile and support them, they must take an approach which recognises cultural factors and values. They must also work to make their cultures as vibrant, supportive and collaborative as possible.

Further research is therefore suggested to evaluate the impact of culture on Agile adoption in the Saudi Arabian setting, as well as the obstacles associated with it. It is recommended that organisational culture should be broken down into sub-factors which mediate the relationship between other factors and Agile adoption. Furthermore, this factor has a mediating effect on three elements (national culture, management support and communication and collaboration) and Agile adoption, which will be discussed in the following subsections.

6.4.1.6 National Culture

National culture is grounded in different social systems and structures such as the tribal systems and religious observance which play a crucial role in defining obligations, traditions and social norms in wider society and in the workplace (Hofstede, 1980). It influences whether, how, when and what type of innovation an organisation will adopt and implement. **However, the PLS-SEM analysis finds that 'national culture' has no direct influence on Agile adoption in Saudi Arabia.** This influence has a t-value of 0.971, which is less than 1.96, and the p-value of 0.332, which is larger than 0.10. Therefore, the hypothesis H5, *"national culture has a negative influence on Agile adoption in Saudi software SMEs"*, was rejected. This conclusion appears to be consistent with the study conducted by Sheffield and Lemétayer (2013) in the context of developed countries (the United States, New Zealand and Australia) although it is not consistent with similar studies conducted by Misra *et al.* (2009). According to the data from software experts, 25% of them 'strongly agreed' and 66.7% 'agreed' on the importance of the influence of 'national culture' on Agile adoption and validated the impact of Saudi culture on organisational culture.

This finding indicates that even though the quantitative findings show that the 'national cultural'has no direct effect on adoption, **it does have an indirect association with Agile adoption through the 'organisational culture' factor.** The results of the PLS analysis revealed a mediating impact for the 'organisational culture' on the relationship between the 'national culture' and Agile adoption, indicating an indirect but statistically significant relationship between them, as the t-value is larger than 1.96 and the p-value is less than 0.010. The data suggest that the effect of the relationship is negative (β = -0.047). This implies that Saudi Arabian culture has a detrimental impact on organisational culture, which subsequently acts as a barrier to Agile adoption. In view of this, because there is no direct association between the 'national culture' factor and Agile adoption, the impact of organisational culture on this relationship is regarded as having a full mediating effect. Based on this result, hypothesis H15a, *"organisational culture mediates the negative relationship between national culture and Agile adoption"*, was supported.

This finding should not be interpreted as a criticism of Saudi culture. Rather, an impartial evaluation is required to identify characteristics of the culture that appear to be barriers to Agile adoption, such as gender segregation, managerial style and the avoidance of responsibility, and to devise strategies for mitigating their influence. Furthermore, positive aspects of Saudi culture that promote adoption should be highlighted and supported. Most significantly, this study recommends national awareness campaigns and actions to mitigate the culture of aversion to change and lessen the preference for status. Future research could consider the impact of cultural aspects in terms of norms, values and attitudes on the adoption of Agile.

6.4.1.7 Management Support

Management support refers to the degree to which senior managers understand the importance of adopting Agile and can make the requisite changes to their organisations. If a team believes that management is behind them, they will work harder and apply their skills to Agile adoption. **The PLS-SEM analysis finds that this variable had no significant (direct) effect on Saudi software SMEs' adoption of Agile,** since the t-value was less than 1.96 and the p-value was larger than 0.10. Therefore, hypothesis H7, *"management support has a negative influence on Agile adoption in Saudi software SMEs"*, was not supported.

This finding is in agreement with a previous study by Chow and Cao (2008), which found not significant relationship between 'management support' and Agile adoption, and Stankovic *et al.* (2013), which also found that it has no direct impact on Agile adoption among IT companies in the former Yugoslavia. On the other hand, the finding is in disagreement with the conclusions of Sheffield and Lemétayer (2013), who found that top management support influences the success of Agile adoption and practices. The findings of the exploratory study (Chapter 5) showed that senior management support has been identified as an important factor in Agile adoption in the country, with 58.3% of the interviewees agreeing with its importance, albeit 41.7% gave neutral responses.

However, it was found in this study that this factor has an indirect impact through the 'organisational culture' variable. This means the effect of this factor on software SMEs' decision to adopt Agile depends on the 'organisational culture'. It was found that this indirect relationship was negative, as the path coefficient was -0.164. The t-values and p-values for this relationship were 2.317 and 0.023, respectively, as shown in Table 6.14. Thus, hypothesis H15b, *"organisational culture mediates the negative relationship between management support and Agile adoption"*, was supported.

Senior management support is necessary to promote the adoption of Agile software development in Saudi Arabia. Senior managers should pay special attention to their organisation's culture. They must establish culturally appropriate strategies to assist their teams in adopting Agile. Additionally, they must select team members carefully, provide ongoing training and learning, and consider the availability of tools and technology.

6.4.1.8 Communication and Collaboration

Communication refers to the process of exchanging information among stakeholders in order to increase comprehension and performance, whereas collaboration refers to the action of collaborating among stakeholders in order to improve the state of a product. **The PLS-SEM analysis finds that the 'communication and collaboration'**

factor does not significantly influence the Saudi software SMEs' decision to adopt Agile. The analysis found the relationship has a weak effect, with a t-value of 1.374, which is below the threshold and the p-value of > 0.10. Thus, hypothesis H8, *"communication and collaboration has a negative influence on Agile adoption in Saudi software SMEs"*, was rejected. This result is supported by studies conducted by Misra *et al.* (2009); Wan and Wang (2010), which reported that this factor does not affect project success and adoption. At the same time, studies such as Cockburn and Highsmith (2001) and Lindvall *et al.* (2002) found that effective communication and collaboration mechanisms are linked to effective Agile adoption. In terms of the the result of the exploratory study presented in Chapter 5, the majority of experts interviewed strongly agreed (16.7%) or agreed (41.7%) on the importance of this factor in relation to Agile adoption. They noted that efficient communication and collaboration among team members and with customers are important for the successful implementation of Agile.

However, the findings of this study indicate that although this factor has no direct effect, it does have a strong, indirect relationship with Agile adoption via the 'organisational culture' variable. Therefore, 'organisational culture' factor has a fully mediating impact on the relationship between 'communication and collaboration' and the adoption of Agile within Saudi software SMEs ($t = 2.764$, $p = 0.006$). This finding indicates that hypothesis H15c, *"organisational environment mediates the negative relationship between communication and collaboration and Agile adoption"*, was supported.

Effective communication and collaboration among developers and between developers and customers should be encouraged in the development team. This will lead to an increase in the adoption and use of Agile in Saudi software SMEs. Furthermore, the management team has to support the availability of the communication and collaboration tools for developers and their customers.

6.4.1.9 Organisational Environment

This factor encompasses entities, actions and impacts within the organisation, for example demonstrating concern for employees' behaviour, morale and welfare in order to make them feel happy and appreciated. It was hypothesised that an organisation's environment could have a favourable impact on its decision to adopt Agile. **The PLS-SEM analysis finds that 'organisational environment' has a positive associated with Agile adoption, with statistically significant results ($\beta = 0.338$, $t = 2.629$, $p = 0.011$).** This finding indicates that practitioners believe that this factor would most likely contribute to Agile adoption. Therefore, hypothesis H9, *"organisational environment is a factor that contributes positively to Agile adoption in Saudi software SMEs"*, was supported. The results of a previous study conducted

by Robinson and Sharp (2005) are consistent with these findings. On the other hand, Stankovic *et al.* (2013) reported contradictory results, i.e. that the 'organisational environment' does not influence the success and acceptance of Agile projects by software organisations in former Yugoslavian countries. Most experts interviewed in the exploratory study (Chapter 5) considered 'organisational environment' to be one the most important factors influencing Agile adoption: 8.3% of the interviewees stated that this factor was 'very important' and half felt it was 'important'.

Both the exploratory and explanatory studies reported in this and the preceding chapter suggest that this factor is considered one of the most impactful facilitating factors in the adoption of Agile in Saudi Arabia, with an impact of 0.338, as Saudi organisations support a stable and safe environment by encouraging Agile-friendly project teams and developing an appropriate reward system, which motivates and facilitates employees to adopt Agile.

6.4.1.10 Physical Environment

An organisation's physical environment encompasses the Agile development team's location, as well as their surroundings. There is a need for a physical environment that inspires team members to rest, re-energise and interact. Amenities like social areas, prayer rooms enable this, as does office layout. **However, the PLS-SEM analysis finds that in Saudi Arabia, 'physical environment' has a negligible effect on software SMEs' decisions to adopt Agile.** This direct association has a path of 0.010, a t-value of 0.119 and a p-value of 0.905, which show a weak effect. Therefore, hypothesis H10, *"physical environment has a positive influence on Agile adoption in Saudi software SMEs"*, was rejected. This finding is in line with previous studies (Stankovic *et al.*, 2013) indicating a weak link between 'physical environment' and Agile adoption. However, other studies (Chow and Cao, 2008) in different contexts indicate that the environment of the team could influence the adoption of Agile by organisations. The exploratory component of this study, as presented in Chapter 5, revealed that this element has an impact on Agile adoption. The majority of experts (58.3%) agreed that the 'physical environment' has a major influence on Agile adoption, while 25% had a neutral view of its importance.

In this regard, while the quantitative results reflect that the 'physical environment' does not directly affect Agile adoption, they indicate that it has an indirect relationship through the 'organisational environment'. The PLS analysis showed that the 'organisational environment' factor could have a moderate impact on the relationship between the 'physical environment' and Agile adoption in Saudi software SMEs. There is therefore an indirect relationship between these variables. The t-value of this relationship is 2.209 and the p-value is 0.028, indicating that this indirect association has a statistically significant effect. The

route value for this indirect relationship is positive at 0.121. This element has a full mediating effect in this relationship as there is no direct link between the 'physical environment' factor and Agile adoption, Thus, hypothesis H16, *"the organisational environment mediates the positive relationship between physical environment and Agile adoption"*, was accepted.

6.4.1.11 Tools and Technologies

Tools and technologies such as productivity software can support Agile work in organisations, improve and accelerate the project work and provide more flexibility for team members to increase their performance. **The PLS-SEM analysis finds that the hypothesised 'tools and technologies' factor was found to have a direct, significant effect on Agile adoption in software SMEs.** The t-value of this relationship is 1.972, and the p-value is 0.092, which indicates a moderate influence on Agile adoption. These findings reveal a statistically significant association between the 'tools and technologies' factor and Agile adoption. This relationship is a positive one, with a path coefficient of 0.177. This indicates a relatively weak correlation compared to other significant factors. The strength of this association in comparison with the other variables makes it negligible. Such a result is predictable from a review of the available literature. Thus, as proposed in the model, H11, *"tools and technologies have a positive influence on Agile adoption in Saudi software SMEs"* was accepted.

This result is in agreement with the conclusion of Vithana *et al.* (2018) on the basis of the results of their Sri Lankan study. As presented in the preceding chapter, the experts either strongly agreed (33.3%) or agreed (50%) about the relevance of tools and technologies to the adoption of Agile in Saudi Arabia. These results show that 'tools and technologies' is seen as one of the supporting factors that encourage Saudi software SMEs to embrace Agile. This finding is especially relevant in the context of the COVID-19 pandemic, as tools and technologies have become more accessible in Saudi Arabia and practitioners receive extensive support in their use.

Organisations should therefore equip team members with the necessary tools in order to facilitate the adoption of Agile practices in their development teams. While cultural and social factors are considered important in the adoption of Agile, technical factors such the availability of communication tools and technologies should not be neglected. We argue that technical aspects are worth investigating further since although they assist the development team in implementing Agile, they have not been given adequate attention in the literature.

6.4.1.12 Delivery Strategy

The 'delivery strategy' factor refers to the strategies that focus on adaptability and customer satisfaction arising from the rapid and regular delivery of quality products, and specifically the extent to which the product delivers what it offers. The effect of the 'delivery strategy' factor on the adoption and practice of Agile in software organisations was suggested by Chow and Cao (2008) as a factor that should be investigated further. **The PLS-SEM analysis finds that this factor was a non-significant predictor of the intention to adopt Agile in Saudi Arabian software SMEs ($t = 1.374$, $p > 0.10$).** Based on the result, hypothesis H12, *"delivery strategy has a positive influence on Agile adoption in Saudi software SMEs"*, was rejected.

Several researchers such as Wan and Wang (2010) and Stankovic *et al.* (2013) concluded that this factor has little impact on Agile adoption. However, different conclusions are reached by other studies such as Chow and Cao (2008). In addition, it was also found to be a non-significant predictor in the expert interviews presented in Chapter 5; 41.7% of the respondents rated it as 'slightly important', and none rated it as 'very important'. This result suggests that 'delivery strategy' is not a significant factor in Agile adoption in Saudi Arabia.

6.4.1.13 Agile Software Techniques

This factor comprises techniques which help project managers and their team members to apply Agile software development, such as using correct integration testing and rigorous refactoring activities. **The PLS-SEM analysis finds that 'Agile software techniques' do not affect Agile adoption by Saudi software SMEs.** This is because the t-value of the relationship between this factor and Agile adoption is below 1.96 and the p-value exceeds 0.10. For this reason, hypothesis H13, *"Agile software techniques have a positive influence on Agile adoption in Saudi software SMEs"*, was not supported.

Prior studies such as those of Stankovic *et al.* (2013) in the former Yugoslavian and Chiyangwa and Mnkandla (2017) in South African organisations have come to similar conclusions, namely that there is no significant relationship between Agile software techniques and the success of Agile software adoption and practices. This conclusion is also consistent with the findings of the exploratory study (see Chapter 5) in terms of the impact of this factor on Agile adoption in the country. Half of the software professionals saw this aspect as 'slightly important', while 25% regarded it as 'not at all essential', although they agreed that the 'Agile software techniques' factor can be used to determine how Agile is being used. These findings indicate that this factor does not significantly contribute to the adoption of Agile in the context of Saudi Arabian software SMEs.

6.4.2 Final Model for Agile Adoption

Following a thorough review of the relevant literature as well as the empirical studies undertaken in this thesis, the designed research model (Figure 6.5) was improved to investigate the relationship between 13 influential factors and Agile adoption in Saudi software SMEs. The model depicts all core linkages as well as all potential mediating effects. It moderates the relationship between the independent variables and Agile adoption. The model is able to answer the main research questions to identify the factors that can support or hinder Agile adoption by Saudi software SMEs.

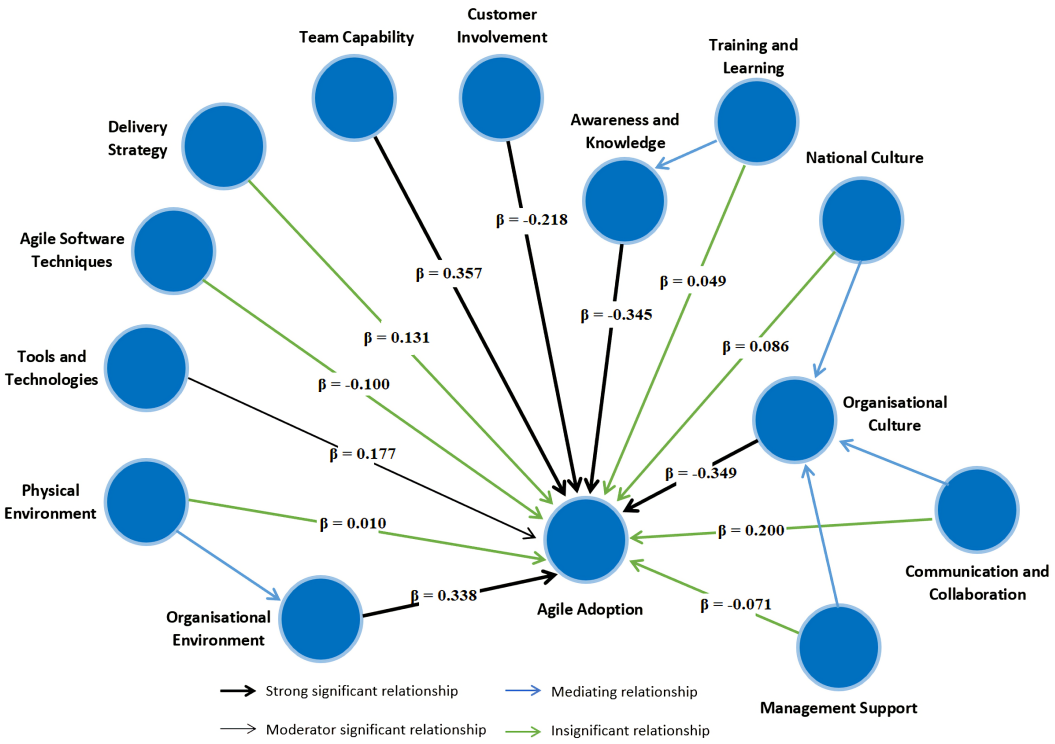


Figure 6.5: Model of the significant paths

Based on the explanatory analysis presented in this chapter, 11 of the 13 factors identified have been shown to have a significant direct or indirect relationship with Agile adoption in Saudi Arabia. Three of the factors (awareness and knowledge, organisational culture, and organisational environment) mediated the research model significantly. It was observed that 11 of the study hypotheses are supported while the remaining seven are not. Figure 6.6 therefore illustrates the final model of Agile adoption in Saudi Arabian software SMEs after removing all insignificant relationships. The model has a moderate to high explanatory power of 58.7%, indicating that the factors analysed explain 58.7% of the variance in the Agile adoption

variables in Saudi Arabia. The model is unique as it examines the correlations between the key factors which influence Agile adoption in Saudi Arabia software SMEs, something which has yet to be addressed in other studies. This model can also serve as a research tool to provide useful guidance for Saudi organisations wanting to adopt Agile. The model can also aid decision-making on Agile adoption in other Middle Eastern countries, notably Gulf Cooperation Council member countries.

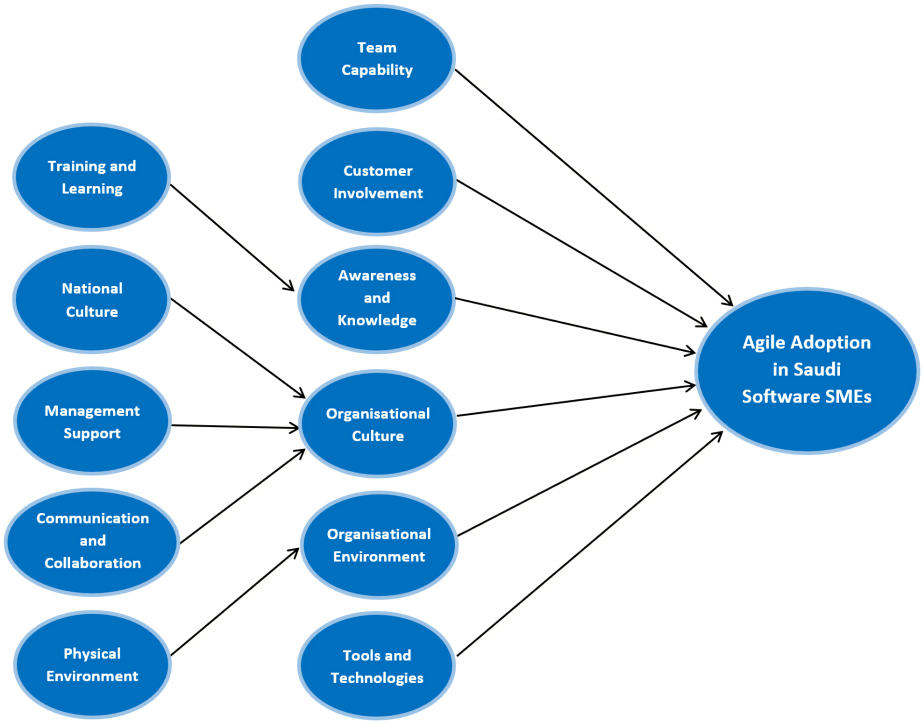


Figure 6.6: Final model for Agile adoption

6.5 Validity and Reliability of the Instrument

The instrument's validity was determined before and after the collection of data. It was also necessary to evaluate the instrument's reliability in order to improve the study's accuracy. To clarify, it is essential to ensure that the items in the questionnaire are designed accurately so that they measure what they are supposed to measure. Therefore, to obtain accurate and reliable results, validity and reliability tests should be conducted (Heale and Twycross, 2015; Saunders *et al.*, 2016; Easterbrook *et al.*, 2008). In this study, validity was measured both pre- and post-data collection, while reliability was assessed after collecting the data. The following sections explain the validity and reliability of the instrument.

6.5.0.1 Validity

According to Pallant (2016), an instrument should be valid so that it can measure the variables. In this sense, a valid instrument gathers data and findings that reflect the current situation. Therefore, content and construct validity tests were utilised to assess the instrument's validity in this study.

Content Validity - An instrument's content validity should be measured after the questionnaire is designed and before data collection has commenced. Heale and Twycross (2015) describe content validity as an evaluation of whether the item is deemed appropriate by knowledgeable subject matter reviewers. The review process employed in this study was to ensure that all the relevant measurement items were included in the instrument. However, Garver and Mentzer (1999) argue that researchers cannot establish construct validity without considering content validity.

The inclusion of a literature review and expert consultation can ensure content validity (Pallant, 2016; Heale and Twycross, 2015; Fink, 2015), and this study used these two methods. It is generally agreed that adapting validated items from the literature is preferable to designing new questions. Consequently, this study adapted items from previous studies to test the components in the Agile adoption framework, as shown in Table 6.3, Section 6.2.2.1. Some questions were adjusted to fit the context of the study, while others were developed from scratch.

Further assessment of the instrument items was required. The expert review process involved six experts with experience in questionnaire design. According to (Lynn, 1986), one should involve a minimum of five experts. However, the number can be changed based on their availability. Four of the experts involved in the review are researchers currently working at UK universities. The researcher also enlisted the help of two Saudi university lecturers who were fluent in both Arabic and English to check the translated version of the questionnaire. After assessing the instrument, these academic professionals were requested to offer individual feedback and ideas to ensure content readily. Based on their feedback, as discussed in Section 6.2.2.2, several typographical errors were corrected, and some items were modified to improve clarity.

Construct Validity - An instrument's construct validity must be determined to increase the accuracy of the study's results. Hair *et al.* (2009) define construct validity as the extent to which measurement items reflect the construct they measure. Construct validity therefore shows the extent to which the items in the questionnaire reflect what they are supposed to measure, which is crucial in Structural Equation Modelling (SEM) (Hair *et al.*, 2014). Construct validity should be evaluated in various ways to avoid method variance and random error. In this study, this form of validity

was determined after data collection using two methods: convergent validity and discriminant validity (Hair *et al.*, 2014). Section 6.3.3.3 and Section 6.3.3.4 explain these two-validation tests and presents and discusses the results.

6.5.0.2 Reliability

Reliability analysis is crucial in order to guarantee an instrument's accuracy and goodness (Saunders *et al.*, 2016). To ensure the internal consistency of these items, a reliability test should be undertaken, especially when there is more than one item for each construct (Field, 2017; Pallant, 2016). Reliability is extremely important when using Likert scales in a questionnaire, and internal consistency and indicator reliability are two extensively used methods for verifying reliability.

The internal consistency test was applied to examine the indicators' reliability of each construct in this study. This test relates to the extent to which the indicators' measurements are internally consistent (Pallant, 2016). One of the most widely used measures for this purpose is Cronbach's alpha (Hair *et al.*, 2014), yet the latest studies recommend performing a Rho-A test instead of Cronbach's alpha, as Rho-A is considered to be more accurate as well as being a good measure of indicator reliability (Dijkstra and Henseler, 2015; Demo *et al.*, 2012). In this study, Rho-A was determined during the assessment of the measurement model using SmartPLS software. Rho-A measures how effectively the internal consistency of a set of items could be used to measure a single variable. Rho-A is influenced by the number of items used to measure each element (Dijkstra and Henseler, 2015). Following data collection, the reliability of this investigation was assessed using Rho-A. Finally, the variable reliability was measured using the composite reliability, which is significant in the SEM analysis. The results of all these tests are presented in Section 6.3.3.1 and Section 6.3.3.2.

6.6 Chapter Summary

This chapter has presented the findings from the 132 questionnaires completed by software practitioners working for software SMEs in Saudi Arabia. It discussed missing data, outliers, normality and common method bias before the assessment of SEM. Then information about the respondents was presented. After that, the model was analysed using PLS-SEM in two stages, namely the measurement model and the structural model. Finally, the findings of the study were discussed with reference to the literature.

The measurement model was assessed in four steps. First, the indicator loadings were assessed to ensure that the indicators accurately measure the construct, and certain indications (less than 0.4) were eliminated because they failed to meet the

threshold requirements. Then, consistency reliability and convergent validity were examined in the second and third steps. The results showed a high level of both reliability measures. In the final step, the discriminant reliability of the model was assessed using two criteria, namely the Fornell-Larcker criterion and cross-loadings. The two assessments confirmed that the model constructs and indicators had a high level of discriminant validity.

Following that, the structural model of SMEs' decision in relation to adopting Agile was evaluated. The correlations between the latent variables were also investigated. The findings show that six variables have a direct impact on software SMEs' adoption of Agile in Saudi Arabia, namely team capability, customer involvement, awareness and knowledge, organisational culture, organisational environment and tools and technologies. However, five variables (training and learning, national culture, management support, communication and collaboration and physical environment) indirectly impacted the adoption of Agile. The relationships of these variables were mediated by awareness and knowledge, organisational culture and organisational environment variables.

The assessment of the structural model indicated that the exogenous construct explained 58.7% of the variance on the endogenous construct (Agile adoption in Saudi software SMEs). Additionally, the structural model was evaluated for predictive relevance, and this was confirmed with a good Q^2 and effect size (f^2), which showed higher than the minimum acceptable levels. This chapter also presented the final model for Agile adoption factors in detail. The following chapter will conclude the research and suggest directions for further study.

Chapter 7

Conclusions and Future Work

7.1 Introduction

This study presented an empirical investigation on the factors that either support or hinder the adoption of Agile in Saudi software SMEs. This chapter summarises the investigation into this topic by revising the research's questions. It also outlines this study's theoretical and practical contributions to software engineering, specifically in Agile software development. Finally, it identifies and discusses future research opportunities and directions.

7.2 Revisiting the Research Questions

An Agile 'mindset', and the practice of Agile software development is becoming increasingly important in software organisations, particularly in the emerging era of advanced technology and increased competition. This research aimed to examine the factors contributing to the decision to adopt and implement Agile by Saudi software SMEs and to answer the two primary research questions. The first research question sought to understand the current level of use, awareness and perceptions of Agile in Saudi Arabia, while the second one examined the important factors of Agile adoption based on current literature and proposed a theoretical study framework that includes these factors. The third research question investigated the most relevant factors influencing Agile adoption in Saudi Arabia using a multi-case study conducted at three Saudi software SMEs while the fourth question evaluated the relationship between the influential factors and their impact on the adoption of Agile using the statistical analysis technique, PLS-SEM. The findings corresponding to these questions were discussed.

- ***RQ1: What is the current level of awareness, use and perception of***

Agile in Saudi Arabia?

The purpose of this question was to investigate the awareness, current usage and perceptions of Agile software development methodology among Saudi software practitioners. Specifically, this investigation focused on mobile development practice, one of the fastest expanding sectors of the software industry both worldwide (Ahmad *et al.*, 2018; Statista, 2020*a*,*b*) and in Saudi Arabia (Communications and Information Technology Commission, 2020; Ernst Young Global Limited, 2019). The objectives of first study were to understand: 1) the level of awareness and current use of Agile in the Saudi mobile software industry; 2) the reasons for adopting and not adopting Agile; and 3) software practitioners' perceptions of Agile methodology. By addressing this question, the third objective of this research, *"objective 3: investigate the awareness, usage and perceptions of Agile among Saudi software practitioners through empirical research"*, was addressed.

As discussed in Chapter 4, empirical research using a mixed-method approach was used to answer this research question through two phases. The first phase was conducting semi-structured interviews with four specialists in mobile and Agile development to ascertain their awareness and perceptions. These experts' feedback informed the second phase of the study, which included a survey of 31 participants to determine their level of awareness and perceptions on Agile software development approaches. Critically, this phase helped identify practitioners' level of awareness of Agile, how they perceive it and the level of Agile adoption in Saudi Arabia.

This phase was considered as a preliminary step toward delving into the major focus of this thesis, specifically identifying factors influencing Agile adoption in the Saudi Arabian software context. As a result, the findings contribute to greater understanding of Agile among Saudi software practitioners and organisations. They also enrich the body of knowledge on Agile deployment in Middle Eastern countries. The initial survey found a limited understanding of Agile among practitioners in Saudi Arabia, as its adoption is in its early phase; roughly 23% of the respondents had never heard of Agile, while 77% had heard about it, but had different levels of expertise. Only 30% of organisations have adopted Agile, so far. However, several practitioners do actually apply certain Agile techniques and principles, without having heard of it.

According to the findings, the most popular Agile method used by software practitioners in Saudi Arabia is Scrum, and the most commonly employed Agile practices are 'user stories' and 'daily stand-up meetings'. According to expert interviews and surveys, Agile approaches have a positive influence on generating high-quality apps, reducing the time-to-market, responding to consumer changes, and improving team morale, collaboration and productivity. The two key reasons for early adopters to embrace Agile are its flexibility to manage projects and the rise in customer satisfaction, while the main reasons for not adopting it are a lack of knowledge and training, a lack of documentation and a traditional organisational

culture.

• ***RQ2: What are the key factors that influence Agile adoption?***

The goal of this question was to determining the factors identified in the existing literature that influence Agile adoption. A review of the relevant literature provided the answer to the query. Twelve factors were identified and arranged in four groups based on the literature offered in Chapter 2, section 2.6.1: people factors, organisational factors, environmental factors and technical factors. These are listed in Table 2.2 according to their categories, with each element mapped to Agile principles. Team capabilities, customer involvement and training and learning were all included in the category of people factors. Organisational culture, management support and communication and collaboration were all covered in the organisational factors category. The organisational environment, physical environment and national culture were all included in the environmental factors group. Finally, delivery strategy, Agile software techniques and tools and technology were included in the technical elements group.

As a result, by addressing this question, the theoretical framework is developed that encompassed the factors that influence Agile adoption. This developed framework was divided into four main categories (people factors, organisational factors, environmental factors, and technical factors), as seen in Figure 2.3 in Chapter 2. It is intended to serve as both a research tool and a guide for the empirical investigations into Agile adoption factors in Saudi software SMEs and to assess their readiness for Agile adoption. The answer of this question accomplished the first research's objective, *"objective 1: review the relevant literature and identify the factors that can affect the adoption of Agile."* and the second objective, *"objective 2: develop a research framework that can be utilised to guide and support the empirical investigation of Agile adoption in the Saudi Arabian software industry"*

• ***RQ3. What are the influential factors that may affect the Saudi Arabian Software industry when adopting Agile?***

As this study focuses on software development firms, specifically SMEs, the goal of this question was to acquire a thorough understanding of the enablers and barriers of Agile adoption in Saudi Arabia. The four objective of this thesis, *"Objective 4: obtain a deeper insight into the factors that can influence Agile adoption in the Saudi Arabian software industry through empirical research"*, was achieved by addressing this question. The objectives of this question were to: (1) gain deeper insight into the enablers and barriers of Agile adoption in the Kingdom of Saudi Arabia; (2) refine and validate the design and development of an Agile adoption framework; and (3) critically review the influential factors identified in the framework that can support or challenge Agile adoption in software SMEs. By answering the question, the proposed Agile adoption framework was reviewed and refined.

This study used the mixed methods research design to address and answer this

research question. As discussed in Chapter 5, the answer to this question was obtained in two stages. First, semi-structured interviews were conducted with 12 Agile experts from three software SMEs to analyse the impact of the identified elements in the framework and investigate other aspects from the experts' perspectives. According to the findings, the identified elements stated in the Agile adoption framework have an impact on Agile adoption in Saudi Arabian software SMEs, with the exception of the delivery strategy component and the Agile software techniques factor. Previous research, however, found that the delivery strategy factor and Agile software techniques influence Agile adoption. As a result, these factors were retained in the framework at this stage to be evaluated with a large number of participants in the next stage of the research (RQ4). In addition, it was suggested by experts that a new element (awareness and knowledge) should be included in the framework.

In the second phase, a focus group discussion was held with five software practitioners from various software SMEs. Its goal was to critically review the identified factors in the adoption framework that may assist or hinder Agile adoption in the context of Saudi software SMEs. The findings of this focus group study revealed that the framework is useful in highlighting the elements influencing Agile adoption in Saudi Arabia. This investigation led to the creation of a refining framework, as seen in Figure 5.5 in Chapter 5. When selecting to implement Agile methodology, Saudi software development SMEs could be guided and supported by the framework. This strategy also encourages the adoption of Agile in other Middle Eastern countries. The factors in the refined framework were added to the next step of this research to measure the correlations between these factors and the decision of SMEs to embrace Agile.

• ***RQ4. What is the impact of each factor on Agile adoption in Saudi Arabian Software SMEs?***

This question aimed to evaluate the Agile adoption factors and comprehend their impact on the adoption in the Saudi software context. The last objective of this thesis, *"Objective 5: measure the influential factors represented in the framework using empirical research, to understand their impact on Agile adoption by the Saudi Arabian software industry"*, was accomplished by addressing this question. There were two objectives of this question: (1) to analyse and evaluate the relationships among the Agile adoption factors and their impacts on the adoption in Saudi software SMEs; and (2) to determine the factors positively or negatively linked to Agile adoption.

As discussed in Chapter 6, a quantitative web-based questionnaire was administered to 132 software practitioners working in Saudi software SMEs to collect quantitative data. The data were then analysed using PLS-SEM, a strong analytical multivariate approach. According to the findings, there are six factors in the Agile adoption model that have a substantial direct association with Agile adoption in Saudi software SMEs, these are: people-related (team capability; customer involve-

ment), knowledge-related (awareness and knowledge), culture-related (organisational culture), environment-related (organisational environment), and technical-related (tools and technologies). Furthermore, it was revealed that five aspects have an indirect influence on Agile adoption, these are: knowledge (training and learning), cultural (national culture), organisational (management support; communication and collaboration), and one environmental (physical environment). All these factors were presented in the final model for the Agile adoption framework (Figure 6.6). The ones incorporated in the study model have been validated and represent 58.7% variance on software SMEs' decisions to adopt Agile software development in Saudi Arabia.

By addressing this question, the most impactful facilitators and the most impactful barriers to Agile adoption in Saudi Arabian software SMEs were identified. According to the PLS-SEM analysis presented in Chapter 6, the most three impactful facilitators to Agile adoption from the perspective of software practitioners in Saudi Arabia are: team capability, organisational environment, and tools and technologies, respectively. Meanwhile the most significant hinderances are at the organisational level (i.e. organisational culture), followed by awareness and knowledge and, finally, consumer involvement. It is recommended for future studies to further examine and address these barriers in the Saudi context; this will be discussed in detail in Section 7.5. Furthermore, all five elements with an indirect impact on adoption, except for physical environment, are regarded as hurdles to Agile adoption, and need to be studied and addressed. Tables 7.1 and 7.2 present their characteristics, and they are ranked according to the most impactful facilitators and barriers to the adoption of Agile.

H#	Independent Variable	Relationship	Std Beta	Effect	Rank
H1	Team Capability	TC → AA	0.357	Direct and strong significant effect	1
H9	Organisational Environment	OE → AA	0.338	Direct and strong significant effect	2
H16	Physical Environment	PE →OE→ AA	0.121	Indirect and a full mediating effect	3
H11	Tools and Technologies	TT → AA	0.117	Direct and moderate significant effect	4

Table 7.1: The most impactful facilitators of the adoption of Agile in Saudi software SMEs

H#	Independent Variable	Relationship	Std Beta	Effect	Rank
H5	Organisational Culture	OC → AA	0.349	Direct and strong significant effect	1
H4	Awareness and Knowledge	AK → AA	0.345	Direct and strong significant effect	2
H2	Customer Involvement	CI→ AA	0.218	Direct and strong significant effect	3
H15b	Management Support	MS →OC→ AA	0.164	Indirect and a full mediating effect	4
H15c	Communication and Collaboration	CC →OC→ AA	0.136	Indirect and a full mediating effect	5
H14	Training and Learning	TL →AK→ AA	0.134	Indirect and a full mediating effect	6
H15a	National Culture	NC →OC→ AA	0.047	Indirect and a full mediating effect	7

Table 7.2: The most impactful barriers of the adoption of Agile in Saudi software SMEs

7.3 Contributions of the Research

Prior to this study, there was little research into Agile adoption among Saudi Arabian software SMEs, specifically the factors that can facilitate or impede adoption. The examination of the overarching research issue in this thesis was prompted by knowledge gaps discovered while reviewing past research (Chapter 2). This study aims to identify the factors that support or hinder Agile adoption in the context of software SMEs in Saudi Arabia. To the best of the researcher's knowledge, past studies have yet to examine the social and technical aspects influencing the adoption of Agile in Saudi software SMEs. This study will be the first to narrow the literature gap. This research contributes to software engineering research in the following four key areas:

- This research has provided a review of the relevant literature to identify and summarise the factors that affect the adoption of Agile (Chapter 2). These are collected from different studies conducted worldwide and mapped onto Agile

principles. This mapping exercise helps provide an explicit representation of the direct connection between the adoption factors identified by the literature and Agile principles. These factors have guided this empirical research to investigate Agile adoption among software SMEs in Saudi Arabia and are applicable to wider contexts.

- This research contributes to greater knowledge of Agile in the Saudi software community by providing broad insights on the level of awareness among practitioners and current use of Agile, and may also increase awareness of Agile in Saudi Arabia (Chapter 4). It also adds to the body of knowledge on Agile implementation in Middle Eastern countries. In addition, it provides the reasons for adopting and not adopting from the perspective of Saudi software practitioners and their perceptions of Agile methods. This research finds that there is currently little awareness of Agile among practitioners. It also finds that several practitioners apply certain Agile techniques and principles, even without having heard of Agile.

- This research has led to the design and development of the Agile adoption framework. The framework is geared to the Saudi and Middle Eastern software development industry to improve decision-making about Agile adoption. This framework underwent several stages of empirical research in Saudi Arabian software SMEs, which began with the researcher conducting a multi-case study in three software SMEs through semi-structured interviews with 12 Agile experts and a focus group discussion with five Agile experts to investigate and review the factors in the framework (Chapter 5). Then, using a large sample (n = 132), the influential factors represented in the Agile Adoption framework were quantitatively evaluated to better understand how they affect the Agile adoption factors. Hence, this study identified factors that encourage or impede Agile adoption by software SMEs in Saudi Arabia (Chapter 6). As previously mentioned, the Agile adoption model accounts for 58.7% of the variability in Agile adoption in Saudi software SMEs, which the model's independent factors explain. The result indicates that the model is considered valid and could help explain the Agile adoption factors in Saudi Arabian software SMEs.

- This study has led to the development of new instruments for evaluating the different factors included in the framework. The items in the questionnaire were adapted from previous research and used to assess the factors in the Agile adoption framework. Some items were changed to suit the topic and context of the study, and some new questions were introduced. The measurement items were also translated into Arabic and checked by professionals. It was also subjected to reliability and validity tests, as detailed in Chapter 6.

Consequently, other researchers interested in studying Agile adoption in the Middle Eastern context can utilise the translated version of the instruments. This research is thought to be an important knowledge resource for future Agile researchers and researchers in the field of software engineering in general.

7.4 Implications for Practice

This research makes five key implications to software engineering practice. The findings of the empirical studies presented in this thesis provide valuable information that can help software practitioners, senior management, decision makers and government agencies understand the factors influencing Agile adoption and ways of raising Agile awareness and knowledge among stakeholders, which can assist in the adoption and use of Agile in the country. These main implications are described as follow:

- The findings of this study are stepping stones in the effort to increase awareness and understanding of Agile among stakeholders in the country. It is the first step in increasing the rate of Agile adoption among Saudi software SMEs. Greater Agile awareness can be accomplished by intensifying training and efforts on Agile education among Saudi Arabian institutions and organisations. The empirical findings highlight the necessity for Agile software development training. Saudi academic institutions should include Agile courses in their computer science curricula to improve awareness and perceptions of Agile among their students. In addition, institutions and organisations should conduct training events, workshops, and seminars for stakeholders to increase Agile awareness. This will help them better understand and appreciate the benefits of Agile software development. Arabic materials (e.g. textbooks) must be provided to encourage stakeholders who do not speak English to learn about Agile independently.

- The research identified some cultural aspects that management teams and decision-makers in Saudi Arabian software SMEs should consider when deciding to adopt Agile. Addressing these aspects is important to encourage Saudi organisations to adopt Agile successfully. One significant aspect to consider in adopting Agile is organisational culture, influenced by national culture. Positive organisational culture can affect other factors, ultimately leading to success. It is proposed that the smooth and successful adoption of Agile in an organisation may require transition to more flexible and less hierarchical structures and increasing its employees' confidence. The top management of software SMEs should pay special attention to organisational culture. They should recognise that rigid hierarchical structures is incompatible with Agile

values and principles. The study also concluded that decision-makers in Saudi Arabian software SMEs need to develop culturally aware approaches to support their teams to adopt Agile. They also have to encourage their cultures to be as dynamic, supportive and collaborative as possible.

- Even though Saudi software SME environments positively support the adoption of Agile, they should consider the need for a stable and safe environment by encouraging Agile-friendly project teams and developing an appropriate reward system, which motivates and facilitates employees to adopt Agile. The physical environment of the workplace should also be taken into account. Prayer rooms and social spaces, which teams can use during break times to improve productivity, comfort and socialisation, would be advantageous.

- Top management support is required to enhance Agile adoption in the context of Saudi Arabian software SMEs. According to the findings of this study, several Saudi software SMEs face a lack of top-level support for Agile adoption. In this regard, decisions on adopting Agile are not just based on the perspectives of decision-makers in development teams. Adoption requires the support of both senior management and decision-makers in development teams. The framework and study findings have provided substantial information for managers. They may assist them in evaluating the qualities of Agile and the organisational characteristics and its setting prior to using Agile methods. Moreover, managers should select team members carefully, based on skills and knowledge, and provide them with continuous training to increase their ability to adopt and use Agile methods successfully. Managers also need to take into consideration the availability of tools and technologies as these have the potential to influence and support Agile teams. Furthermore, they should consider the availability of their customers to be involved in Agile teams to provide regular feedback.

- The findings of this study indicate a lack of government support for adopting and practicing Agile. Software SMEs in Saudi Arabia faced challenges when dealing with customers from governmental bodies because their working style tends to be based on Waterfall and they have limited knowledge of Agile as well as unwillingness to be engaged in development teams. In this light, the government sector should work together with SMEs to enhance Agile adoption in this country. The government should raise Agile awareness and knowledge among its employees to allow them to collaborate with Agile teams in software companies. In addition, the government needs to understand the benefits of Agile in their progress and how it can help in achieving Saudi Arabia's Vision 2030. This understanding will enable them to use Agile and encourage more software SMEs to do so. Thus, this study's findings contribute to the government's attainment

of its vision in the software development industry. The government must play a role in encouraging the adoption of Agile in Saudi Arabia. For instance, the Communications and Information Technology Commission could implement measures to boost Agile adoption, such as introducing free workshops to increase Agile awareness.

Considering the above implications, this thesis has provided essential information, guidelines and checklists to enhance organisations, managers, practitioners, government agencies and customers involved in adopting Agile in Saudi Arabia. It can also assist in determining whether they are fit for using Agile or how they might become more able to embrace Agile methods. Furthermore, this thesis can be advantageous for countries within the same region, specifically members of the Gulf Cooperation Council.

7.5 Future Research Directions

This part of the chapter discusses the opportunities and suggestions for future work, corresponding to the thesis's findings and main limitations.

7.5.1 Agile Awareness and Knowledge

Chapter 4 (Agile Awareness and Perceptions) investigated the awareness, current usage and perceptions of Agile software development methodology among mobile app practitioners in Saudi Arabia. Although this study has been carried out with a limited sample size, which may limit the generalisability of the results (through semi-structured interviews with four experts and a survey with 31 participants), the study protocol was rigorously constructed. Thus, its findings are robust, and the protocol can be more widely adopted in future studies. Most importantly, it offers first insights into an emerging and significant area of research in Saudi Arabia. A similar study should be conducted with a large number of participants to generalise the results. Future research should also investigate the awareness, current usage and perceptions on Agile from different perspectives, such as customers and project managers.

Furthermore, future work could investigate Agile in different development contexts such as web app development or desktop software development in Saudi Arabia. This work provides a 'birds-eye-view' of this emerging research area across different organisations; future research may focus on specific case studies to gain a deeper insight into the use of Agile in different and more specific contexts. As part of that, there were discussions about how training and learning events could raise Agile awareness and improve knowledge of Agile for stakeholders. This study highlighted the need to conduct courses in Saudi universities about Agile to increase students'

awareness. Thus, there is a need to investigate the gap between the Agile industry and education in Saudi Arabia. Other interesting further work would be to explore the factors that can contribute to awareness and knowledge.

7.5.2 Agile Adoption Factors

Chapter 5 (Investigation of Agile Adoption Factors) investigated the enablers and barriers of Agile adoption in Saudi Arabian software SMEs. Meanwhile, Chapter 6 (Evaluation of Agile Adoption Factors) evaluated the impact of Agile adoption factors and their relationships with Agile adoption. This research was first carried out in three Saudi software SMEs. Data were gathered from 12 Agile practitioners through semi-structured interviews and five through a focus group discussion. Then, the Agile adoption factors were evaluated through a questionnaire with 132 participants from the Saudi software industry. Moreover, Chapter 5 and Chapter 6 provide conceptual and empirical foundations for further studies.

- Although this study mainly achieved its objectives, the study scope was confined to small and medium-sized software organisations, therefore, excluding micro and large firms. Thus, future studies could look into Agile adoption among micro and large firms in the country and other organisations in other industries, including government agencies and non-software organisations. A comparison of the results could be made between the findings of these studies to examine whether organisation size and type affect the adoption of Agile in the country.

- This study looked into the factors influencing the adoption of Agile based on Saudi Arabian SMEs that have adopted it. These SMEs were chosen as they know and understand Agile software development. Future work should study these factors from the perspective of non-adopting businesses and compare the findings between adopter and non-adopter businesses regarding their impact. Furthermore, future studies could investigate Agile adoption in partnership with the international software industry in the country.

- As described in Chapter 5, the study sample was limited to mobile app practitioners in Saudi Arabia since this domain has gained prominence over these past years, and it is regarded as one of the fastest-growing industries in Saudi Arabia. Future research should consider the perspectives of other software practitioners, such as web apps developers and desktop software developers.

- Most of the participants (61.4%) in the evaluation study have four years or less experience with Agile methods. Hence, the participants who evaluated the research framework can be regarded as moderately knowledgeable about Agile methods. Another future work opportunity is to validate the framework with

a large number of participants and more experienced Agile practitioners. The findings can be compared with the results of this study.

- The Agile adoption model developed could be adopted in other Middle Eastern countries or neighbouring countries, including Gulf Cooperation Council member countries. Furthermore, the model can be applied in future research in other countries to explore factors driving Agile adoption.

- As part of this research's findings, organisational culture is one of the main barriers to Agile adoption in the country. This study, therefore, highlighted the need to conduct an in-depth investigation of the impact of this factor and its sub-factors on the adoption and use of Agile in Saudi Arabia and how this barrier could be addressed. The study revealed direct relationships between organisational culture and other factors, including national culture, management support, and communication and collaboration. Researchers could consider organisational culture as a dependent variable influenced by different independent variables which could affect Agile method adoption. In this situation, further research might examine the possibility of changing Saudi organisational culture toward Agile culture and how realistic culture changes are being practiced. Further studies could concentrate on how Agile approaches are appropriated and adapted in specific cultural situations.

- This study's findings showed that Saudi culture affects organisational culture in Saudi Arabia. This factor negatively affects the adoption of Agile. Therefore, further studies could explore the effect of the Saudi culture on organisational and management cultures, as most organisations are local and not owned by international entities. Future studies can examine Saudi organisational norms, values, and attitudes and how these aspects influence the effective adoption of Agile in the country.

- In this study, customer involvement was identified as one of the major challenges to Agile adoption in the country, so future research should examine its impact and other related factors, like clients' collaboration, flexibility, communication level and influence on Agile adoption.

- The methods employed to fulfil the study objectives include semi-structured interviews, a focus group and questionnaires. Even though the research used the PLS-SEM technique to analyse the data, future studies could use more in-depth qualitative research methodologies, such as in-situ observations, case studies and action research, to observe the use of Agile in the Saudi software sector. These were initially part of this study, but the COVID-19 pandemic impeded the plan.

Bibliography

Abbas, N., Gravell, A. M. and Wills, G. B. (2008). Historical Roots of Agile Methods: Where Did "Agile Thinking" Come From?. In *International conference on agile processes and extreme programming in software engineering, (XP2008)*. pages 94–103. Springer: Limerick, Ireland. doi: https://doi.org/10.1007/978-3-540-68255-4_10.

Abdullah, A., Rogerson, S., Fairweather, N. and Prior, M. (2006). The motivations for change towards e-government adoption: Case studies from Saudi Arabia. In *E-government Workshop 06 (eGOV06)*. pages 1–21. Brunel University: London, UK.

Abrahamsson, P., Salo, O., Ronkainen, J. and Warsta, J. (2002). Agile software development methods: Review and analysis. VTT Publications 478. Technical Research Center of Finland Ltd: Finland. **URL:** *http://www.vtt.fi/inf/pdf/publications/2002/P478.pdf.*

Acuña, E. and Rodriguez, C. (2004). The Treatment of Missing Values and its Effect on Classifier Accuracy. In *Classification, Clustering, and Data Mining Applications*. pages 639–647. Springer: Chicago, USA. doi: https://doi.org/10.1007/978-3-642-17103-1_60.

Agile Business Consortium (2017). Towards an Agile Culture: Agile Culture and Leadership. White paper. Kent, UK. **URL:** *https://www.agilebusiness.org/page/Resource_paper_TowardsanAgileCulture.*

Ahimbisibwe, A., Cavana, R. Y. and Daellenbach, U. (2015). A contingency fit model of critical success factors for software development projects: A comparison of agile and traditional plan-based methodologies. *Journal of Enterprise Information Management*, **28**(1), 7–33. doi: https://doi.org/10.1108/JEIM-08-2013-0060.

Ahmad, A., Li, K., Feng, C., Asim, S. M., Yousif, A. and Ge, S. (2018). An Empirical Study of Investigating Mobile Applications Development Challenges. *IEEE Access*, **6**, 17711–17728. doi: https://doi.org/10.1109/ACCESS.2018.2818724.

Al-Saggaf, Y. (2004). The Effect of Online Community on Offline Community in Saudi Arabia. *The Electronic Journal of Information Systems in Developing Countries*, **16**(1), 1–16. doi: https://doi.org/10.1002/j.1681-4835.2004.tb00103.x.

Aldayel, A. and Alnafjan, K. (2017). Challenges and Best Practices for Mobile Application Development. In *Proceedings of the International Conference on Compute and Data Analysis, (ICCDA'17)*. pages 41–48. ACM: Lakeland, USA. doi: https://doi.org/10.1145/3093241.3093245.

Allison, P. D. (2003). Missing Data Techniques for Structural Equation Modeling. *Journal of Abnormal Psychology*, **112**(4), 545–557. doi: https://doi.org/10.1037/0021-843X.112.4.545.

Altuwaijri, F. S. and Ferrario, M. A. (2021*a*). A Framework for the Adoption of Agile within Software SMEs in Saudi Arabia. In *2021 2nd European Symposium on Software Engineering (ESSE 2021)*. p. 73–77. ACM: New York, NY, USA. doi: https://doi.org/10.1145/3501774.3501785.

Altuwaijri, F. S. and Ferrario, M. A. (2021*b*). Awareness and Perception of Agile in Saudi Software Industry. In *2021 IEEE/ACM 43rd International Conference on Software Engineering: Software Engineering in Society (ICSE-SEIS)*. pages 10–18. IEEE: Madrid, Spain. doi: https://doi.org/10.1109/ICSE-SEIS52602.2021.00010.

Altuwaijri, F. S. and Ferrario, M. A. (2022). Factors affecting agile adoption: An industry research study of the mobile app sector in saudi arabia. *Journal of Systems and Software*, **190**, 111347.

Amrit, C., Daneva, M. and Damian, D. (2014). Human factors in software development: On its underlying theories and the value of learning from related disciplines. a guest editorial introduction to the special issue.

Argaam (2018). Number of SMEs in Saudi Arabia. **URL:** *https://www.argaam.com/ar/article/articledetail/id/535529.*

Asnawi, A. L., Gravell, A. M. and Wills, G. B. (2012). Emergence of agile methods: Perceptions from software practitioners in Malaysia. In *2012 Agile India*. pages 30–39. IEEE: Bengaluru, India. doi: https://doi.org/10.1109/AgileIndia.2012.14.

Ayed, H., Vanderose, B. and Habra, N. (2017). Agile cultural challenges in Europe and Asia: Insights from practitioners. In *2017 IEEE/ACM 39th International Conference on Software Engineering: Software Engineering in Practice Track (ICSE-SEIP)*. pages 153–162. IEEE: Buenos Aires, Argentina. doi: https://doi.org/10.1109/ICSE-SEIP.2017.33.

Bagozzi, R. P. and Yi, Y. (1988). On the evaluation of structural equation models. *Journal of the Academy of Marketing Science*, **16**(1), 74–94. doi: https://doi.org/10.1007/BF02723327.

Barnett, V. and Lewis, T. (1994). *Outliers in statistical data*. 2nd edn. John Wiley and Sons: Chichester, UK.

Baron, R. and Kenny, D. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of personality and social psychology*, **51**(6), 1173–1182.

Beck, K., Beedle, M., van Bennekum, A., Cockburn, A., Cunningham, W., Fowler, M., Grenning, J., Highsmith, J., Hunt, A., Jeffries, R., Kern, J., Marick, B., Martin, R. C., Mellor, S., Schwaber, K., Sutherland, J. and Thomas, D. (2001). Manifesto for Agile Software Development. **URL:** *http://agilemanifesto.org*.

Begel, A. and Nagappan, N. (2007). Usage and Perceptions of Agile Software Development in an Industrial Context: An Exploratory Study. In *The First IEEE International Symposium on Empirical Software Engineering and Measurement (ESEM 2007)*. pages 255–264. IEEE: Madrid, Spain. doi: https://doi.org/10.1109/ESEM.2007.12.

Berisha, G. and Pula, J. (2015). Defining Small and Medium Enterprises: a critical review. *Academic Journal of Business, Administration, Law and Social Sciences*, **1**(1), 17–28.

Bin-Hezam, R., Bin-Essa, A. and Abubacker, N. F. (2018). Is the Agile Development Method the Way to Go for Small to Medium Enterprises (SMEs) in Saudi Arabia?. In *2018 21st IEEE Saudi Computer Society National Computer Conference, (NCC 2018)*. pages 1–6. IEEE: Riyadh, Saudi Arabia. doi: https://doi.org/10.1109/NCG.2018.8592990.

Boehm, B. and Turner, R. (2003). *Balancing Agility and Discipline: A Guide for the Perplexed*. 1st edn. Addison-Wesley Professional:Boston, USA.

Boehm, B. and Turner, R. (2005). Management challenges to implementing agile processes in traditional development organizations. *IEEE software*, **22**(5), 30–39. doi: https://doi.org/10.1109/MS.2005.129.

Boyatzis, R. (1998). *Transforming Qualitative Information: Thematic Analysis and Code Development*. Sage Publications: Thousand Oaks, USA.

Boynton, P. M. and Greenhalgh, T. (2004). Selecting, designing, and developing your questionnaire. *Bmj*, **328**(7451), 1312–1315.

Brace, I. (2018). *Questionnaire design: How to plan, structure and write survey material for effective market research*. Kogan Page Publishers.

Brandt, P. and Timmermans, S. (2021). Abductive logic of inquiry for quantitative research in the digital age. *Sociological Science*, **8**, 191–210.

Braun, V. and Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, **3**(2), 11–101. doi: https://doi.org/10.1191/1478088706qp063oa.

Braun, V. and Clarke, V. (2012). Thematic analysis. In *H. Cooper, P. M. Camic, D. L. Long, A. T. Panter, D. Rindskopf and K. J. Sher, eds, APA handbook of research methods in psychology, Vol. 2: Research designs: Quantitative, qualitative, neuropsychological, and biological*. American Psychological Association: Washington, USA. pages 57–71. doi: https://doi.org/10.1037/13620-004.

Chagas, A., Santos, M., Santana, C. and Vasconcelos, A. (2015). The impact of human factors on agile projects. In *2015 Agile Conference*. pages 87–91. IEEE: National Harbor, USA. doi: https://doi.org/10.1109/Agile.2015.11.

Chin, W. (1998*a*). Issues and opinion on structural equation modeling management. *Information Systems Quarterly*, **22**(1), 19–24.

Chin, W. W. (1998*b*). The partial least squares approach to structural equation modeling. *Modern methods for business research*, **265**(2), 295–336.

Chiyangwa, T. and Mnkandla, E. (2017). Modelling the critical success factors of agile software development projects in South Africa. *South African Journal of Information Management*, **19**(1), 1–8. doi: https://hdl.handle.net/10520/EJC-cd6fb1ea0.

Chow, T. and Cao, D. B. (2008). A survey study of critical success factors in agile software projects. *Journal of systems and software*, **81**(6), 961–971. doi: https://doi.org/10.1016/j.jss.2007.08.020.

Clough, P. and Nutbrown, C. (2012). *A student's guide to methodology*. 3rd edn. Sage publications: London, UK.

Cockburn, A. (2002). *Agile Software Development*. 1st edn. Addison-Wesley: Boston, USA.

Cockburn, A. and Highsmith, J. (2001). Agile software development, the people factor. *Computer*, **34**(11), 131–133. doi: https://doi.org/10.1109/2.963450.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. 2nd edn. Lawrence Erlbaum Associates: Hillsdale, New Jersey.

CollabNet VersionOne (2020). The 14th annual State of Agile Report. Technical report. **URL:** *https://digital.ai/catalyst-blog/the-14th-annual-state-of-agile-report.*

Communications and Information Technology Commission (2018). ICT Performance Indicators Third Quarter - 2018. Technical report. **URL:** *https://www.citc.gov.sa/en/reportsandstudies/indicators/Indicators%20of%20 Communications%20and%20Information%20Techn/ICTIndicators-Q32018En.pdf*

Communications and Information Technology Commission (2020). Anuual report 2020. **URL:** *https://www.citc.gov.sa/ar/mediacenter/annualreport/Documents/ PR_REP_016A.pdf*

Conboy, K. (2009). Agility from first principles: Reconstructing the concept of agility in information systems development. *Information Systems Research*, **20**(3), 329–354. doi: https://doi.org/10.1287/isre.1090.0236.

Conboy, K., Coyle, S., Wang, X. and Pikkarainen, M. (2011). People over process: Key challenges in agile development. *IEEE Software*, **28**(4), 48–57. doi: https://doi.org/10.1109/MS.2010.132.

Conway, J. M. and Lance, C. E. (2010). What Reviewers Should Expect from Authors Regarding Common Method Bias in Organizational Research. *Journal of Business and Psychology*, **25**(3), 325–334. doi: https://doi.org/10.1007/s10869-010-9181-6.

Corbin, J. M. and Strauss, A. L. (2008). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. 3rd edn. Sage publications: Thousand Oaks, USA.

Corral, L., Sillitti, A. and Succi, G. (2013). Agile software development processes for mobile systems: Accomplishment, evidence and evolution. In *International conference on mobile web and information systems*. Vol. 8093 LNCS. pages 90–106. Springer: Paphos, Cyprus. doi: https://doi.org/10.1007/978-3-642-40276-0_8.

Corral, L., Sillitti, A. and Succi, G. (2015). Software assurance practices for mobile applications: A survey of the state of the art. *Computing*, **97**(10), 1001–1022. doi: https://doi.org/10.1007/s00607-014-0395-8.

Cresswell, J. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Sage publications: Thousand Oaks, USA.

Creswell, J. and Clark, V. (2017). *Designing and conducting mixed methods research*. 3rd edn. Sage publications: Los Angeles, USA.

Creswell, J. W. and Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches*. 5th edn. Sage publications: Los Angeles, USA.

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. Sage publications: Sydney, Australia.

Dattalo, P. (2008). *Determining sample size: Balancing power, precision, and practicality*. Oxford university press: Oxford, UK.

de O. Melo, C., Santos, V., Katayama, E., Corbucci, H., Prikladnicki, R., Goldman, A. and Kon, F. (2013). The evolution of agile software development in Brazil: Education, research, and the state-of-the-practice. *Journal of the Brazilian Computer Society*, **19**(4), 523–552. doi: https://doi.org/10.1007/s13173-013-0114-x.

Dean Leffingwell (2010). *Agile Software Requirements: Lean Requirements Practices for Teams, Programs, and the Enterprise*. Addison-Wesley Professional: Boston, USA.

Demo, G., Neiva, E., Nunes, I. and Rozzett, K. (2012). Human resources management policies and practices scale (HRMPPS): Exploratory and confirmatory factor analysis. *BAR-Brazilian Administration Review*, **9**(4), 395–420. doi: https://doi.org/10.1590/S1807-76922012005000006.

Denzin, N. K. (1970). The research act in sociology: A theoretical introduction to sociological methods. , .

Dijkstra, T. K. and Henseler, J. (2015). Consistent Partial Least Squares Path Modeling. *MIS Quarterly*, **39**(2), 297–316. doi: https://doi.org/10.25300/MISQ/2015/39.2.02.

Dingsøyr, T., Nerur, S., Balijepally, V. and Moe, N. B. (2012). A decade of agile methodologies: Towards explaining agile software development. *Journal of Systems and Software*, **85**(6), 1213–1221. doi: https://doi.org/10.1016/j.jss.2012.02.033.

Dyck, S. and Majchrzak, T. (2012). Identifying common characteristics in fundamental, integrated, and agile software development methodologies. In *IEEE 45th Hawaii International Conference on System Sciences*. pages 5299–5308. IEEE: Maui, HI, USA. doi: https://doi.org/10.1109/HICSS.2012.310.

Easterbrook, S., Singer, J., Storey, M. and Damian, D. (2008). Selecting empirical methods for software engineering research. In *In Guide to advanced empirical software engineering*. pages 285–311. Springer: Londonm UK. doi: https://doi.org/10.1007/978-1-84800-044-5_11.

Echambadi, R. and Hess, J. D. (2007). Mean-Centering Does Not Alleviate Collinearity Problems in Moderated Multiple Regression Models. *Marketing Science*, **26**(3), 438–445. doi: https://doi.org/10.1287/mksc.1060.0263.

Ernst Young Global Limited (2019). Unlocking the digital economy potential of the Kingdom of Saudi Arabia. Technical report. **URL:** *https://www.ey.com/Publication/vwLUAssets/ey-unlocking-the-digital-economy-potential-of-the-kingdom-of-saudi-arabia/$File/ey-unlocking-the-digital-economy-potential-of-the-kingdom-of-saudi-arabia.pdf.*

Ferrario, M. A., Simm, W., Newman, P., Forshaw, S. and Whittle, J. (2014). Software engineering for 'social good': Integrating action research, participatory design, and agile development. In *Companion Proceedings of the 36th International Conference on Software Engineering*. pages 520–523. ACM: Hyderabad, India. doi: https://doi.org/10.1145/2591062.2591121.

Field, A. (2017). *Discovering statistics using IBM SPSS statistics*. fifth edn. Sage publications: London, UK.

Fink, A. (2015). *How to conduct surveys: A step-by-step guide*. 6th edn. Sage publications: Los Angeles, USA.

Fitzgerald, B., Hartnett, G. and Conboy, K. (2006). Customising agile methods to software practices at Intel Shannon. *European Journal of Information Systems*, **15**(2), 200–213. doi: https://doi.org/10.1057/palgrave.ejis.3000605.

Fornell, C. and Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research*, **18**(1), 39–50. doi: https://doi.org/10.1177/002224378101800104.

Fortune, J. and White, D. (2006). Framing of project critical success factors by a systems model. *International Journal of Project Management*, **24**(1), 53–65. doi: https://doi.org/10.1016/j.ijproman.2005.07.004.

Francese, R., Gravino, C., Risi, M., Scanniello, G. and Tortora, G. (2017). Mobile App Development and Management: Results from a Qualitative Investigation. In *2017 IEEE/ACM 4th International Conference on Mobile Software Engineering and Systems (MOBILESoft)*. pages 133–143. IEEE: Buenos Aires, Argentina. doi: https://doi.org/10.1109/MOBILESoft.2017.33.

Fusch, P. and Ness, L. (2015). Are we there yet? Data saturation in qualitative research. *The qualitative report*, **20**(9), 1408–1416. doi: https://doi.org/10.46743/2160-3715/2015.2281.

Garson, G. D. (2016). *Partial Least Squares: Regression Structural Equation Models*. Statistical Associates Publishing: Asheboro, NC, USA.

Garver, M. and Mentzer, J. (1999). Logistics research methods: employing structural equation modeling to test for construct validity. *Journal of business logistics*, **20**(1), 33–57.

Gefen, D., Straub, D. and Boudreau, M.-C. (2000). Structural Equation Modeling and Regression: Guidelines for Research Practice. *Communications of the Association for Information Systems*, **4**(7), 1–79. doi: https://doi.org/10.17705/1CAIS.00407.

General Authority for Statistics (2020). Saudi Reports and Statistics. **URL:** *https://www.stats.gov.sa/en.*

Goldkuhl, G. (2012). Pragmatism vs interpretivism in qualitative information systems research. *European journal of information systems*, **21**(2), 135–146. doi: https://doi.org/10.1057/ejis.2011.54.

Götz, O., Liehr-Gobbers, K. and Krafft, M. (2010). Evaluation of Structural Equation Models Using the Partial Least Squares (PLS) Approach. In *V. Esposito Vinzi, W. Chin, J. Henseler and H. Wang, eds, Handbook of Partial Least Squares. Springer Handbooks of Computational Statistics*. Springer: Berlin, Heidelberg. pages 691–711. doi: https://doi.org/10.1007/978-3-540-32827-8_30.

Gray, D. (2018). *Doing research in the real world*. 4th edn. Sage publications: London, UK.

Gregory, P. and Taylor, K. (2019). Defining agile culture: a collaborative and practitioner-led approach. In *2019 IEEE/ACM 12th International Workshop on Cooperative and Human Aspects of Software Engineering (CHASE)*. pages 37–38. IEEE: Montreal, QC, Canada. doi: https://doi.org/10.1109/CHASE.2019.00016.

Guest, G., Namey, E. and Chen, M. (2020). A simple method to assess and report thematic saturation in qualitative research. *PLoS ONE*, **15**(5), 1–17. doi: https://doi.org/10.1371/journal.pone.0232076.

Haas, M. R. (2006). Knowledge gathering, team capabilities, and project performance in challenging work environments. *Management Science*, **52**(8), 1170–1184.

Hair, J. (1998). *Multivariate data analysis*. 5th edn. Prentice Hall: Upper Saddle River, New Jersey, USA.

Hair, J., Black, W., Babin, B. and Anderson, R. (2009). *Multivariate Data Analysis: A Global Perspective*. 7th edn. Prentice Hall: Upper Saddle River, New Jersey, USA.

Hair, J. F., Hult, G. T. M., Ringle, C. and Sarstedt, M. (2014). *A primer on partial least squares structural equation modeling (PLS-SEM)*. 3rd edn. Sage publications: Londonm UK.

Hair, J. F., Ringle, C. M. and Sarstedt, M. (2011). PLS-SEM: Indeed a Silver Bullet. *Journal of Marketing Theory and Practice*, **19**(2), 139–152. doi: https://doi.org/10.2753/MTP1069-6679190202.

Hair, J. F., Ringle, C. M. and Sarstedt, M. (2012). Partial Least Squares: The Better Approach to Structural Equation Modeling?. *Long Range Planning*, **45**(5-6), 312–319. doi: https://doi.org/10.1016/j.lrp.2012.09.011.

Hair, J. F., Risher, J. J., Sarstedt, M. and Ringle, C. M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, **31**(1), 2–24. doi: https://doi.org/10.1108/EBR-11-2018-0203.

Hair Jr, J., Matthews, L. M., Matthews, R. L. and Sarstedt, M. (2017). PLS-SEM or CB-SEM: updated guidelines on which method to use. *International Journal of Multivariate Data Analysis*, **1**(2), 107–123. doi: https://doi.org/10.1504/IJMDA.2017.087624.

Hayes, A. F. and Preacher, K. J. (2014). Statistical mediation analysis with a multicategorical independent variable. *British Journal of Mathematical and Statistical Psychology*, **67**(3), 451–470. doi: https://doi.org/10.1111/bmsp.12028.

Heale, R. and Twycross, A. (2015). Validity and reliability in quantitative studies. *Evidence-Based Nursing*, **18**(3), 66–67. doi: https://doi.org/10.1136/eb-2015-102129.

Henseler, J., Ringle, C. M. and Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. Vol. 20. pages 277–319. doi: https://doi.org/10.1108/S1474-7979(2009)0000020014.

Highsmith, J. (2002). What is agile software development?. *The Journal of Defense Software Engineering*, **15**(10), 4–9.

Highsmith, J. and Cockburn, A. (2001). Agile software development: the business of innovation. *IEEE Computer*, **34**(9), 120–127. doi: https://doi.org/10.1109/2.947100.

Highsmith, J. and Highsmith, J. (2002). *Agile software development ecosystems*. Addison-Wesley Professional: Boston, USA.

Hillary, R. (2000). *Small and medium-sized enterprises and the environment: business imperatives*. 1st edn. Greenleaf Publishing: Sheffield, UK.

Hoda, R., Noble, J. and Marshall, S. (2011). The impact of inadequate customer collaboration on self-organizing Agile teams. *Information and Software Technology*, **53**(5), 521–534. doi: https://doi.org/10.1016/j.infsof.2010.10.009.

Hofstede (2020). Hofstede Insights Country Comparison. **URL:** *https://www.hofstede-insights.com/product/compare-countries/.*

Hofstede, G. (1980). *Culture's consequences: International differences in work-related values*. Sage Publications: Beverly Hills, USA.

Hofstede, G., Neuijen, B., Ohayv, D. D. and Sanders, G. (1990). Measuring organizational cultures: A qualitative and quantitative study across twenty cases. *Administrative science quarterly*, pages 286–316.

Hoftede, G., Hofstede, G. and Minkov, M. (2010). *Cultures and organizations: software of the mind: intercultural cooperation and its importance for survival*. McGraw-Hill Professional Publishing: New York, USA.

Hulland, J. (1999). Use of partial least squares (PLS) in strategic management research: a review of four recent studies. *Strategic Management Journal*, **20**(2), 195–204. doi: https://doi.org/10.1002/(SICI)1097-0266(199902)20:2¡195::AID-SMJ13¿3.0.CO;2-7.

Hummel, M. and Epp, A. (2015). Success factors of agile information systems development: A qualitative study. In *48th Hawaii International Conference on System Sciences*. pages 5045–5054. IEEE: Kauai, HI, USA. doi: https://doi.org/10.1109/HICSS.2015.598.

Idris, A. (2007). Cultural barriers to improved organizational performance in Saudi Arabia. *SAM Advanced Management Journal*, **72**(2), 36–53.

Iivari, J. and Iivari, N. (2011). The relationship between organizational culture and the deployment of agile methods. *Information and Software Technology*, **53**(5), 509–520. doi: https://doi.org/10.1016/j.infsof.2010.10.008.

Independent Evaluation Group (2008). Financing Micro, Small, and Medium Enterprises : An Independent Evaluation of IFC's Experience with Financial Intermediaries in Frontier Countries. **URL:** *https://openknowledge.worldbank.org/bitstream/handle/10986/6485/448160PUB 0Box327413B01official0use0only1.pdf?sequence=1isAllowed=y.*

James, L. R. and Brett, J. M. (1984). Mediators, moderators, and tests for mediation.. *Journal of Applied Psychology*, **69**(2), 307–321. doi: https://doi.org/10.1037/0021-9010.69.2.307.

Jamieson, S. (2004). Likert scales: how to (ab)use them. *Medical Education*, **38**(12), 1217–1218. doi: https://doi.org/10.1111/j.1365-2929.2004.02012.x.

Javdani Gandomani, T. and Ziaei Nafchi, M. (2016). Agile transition and adoption human-related challenges and issues: A Grounded Theory approach. *Computers in Human Behavior*, **62**, 257–266. doi: https://doi.org/10.1016/j.chb.2016.04.009.

Johnson, R. B. and Onwuegbuzie, A. J. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher*, **33**(7), 14–26. doi: https://doi.org/10.3102/0013189X033007014.

Johnson, R. B., Onwuegbuzie, A. J. and Turner, L. A. (2007). Toward a Definition of Mixed Methods Research. *Journal of Mixed Methods Research*, **1**(2), 112–133. doi: https://doi.org/10.1177/1558689806298224.

Johnson, T. P. (2014). *Snowball Sampling: Introduction*. John Wiley & Sons Ltd: Chichester, UK.

Kaleel, S. B. and Harishankar, S. (2013). Applying agile methodology in mobile software engineering: Android application development and its challenges. Computer science technical reports. Department of Computer Science, Ryerson University. doi: https://doi.org/10.32920/ryerson.14637270.v1.

Kim, H.-Y. (2013). Statistical notes for clinical researchers: assessing normal distribution (2) using skewness and kurtosis. *Restorative Dentistry Endodontics*, **38**(1), 52. doi: https://doi.org/10.5395/rde.2013.38.1.52.

Kitchenham, B. A., Pfleeger, S. L., Pickard, L. M., Jones, P. W., Hoaglin, D. C., El Emam, K. and Rosenberg, J. (2002). Preliminary guidelines for empirical research in software engineering. *IEEE Transactions on Software Engineering*, **28**(8), 721–734. doi: https://doi.org/10.1109/TSE.2002.1027796.

Kitchenham, B. and Charters, S. (2007). Guidelines for performing Systematic Literature Reviews in Software Engineering. Technical report. Keele Univversity: Keele, United Kingdom. **URL:** *http://www.dur.ac.uk/ebse/resources/Systematic-reviews-5-8.pdf.*

Kline, R. (2016). *Principles and practice of structural equation modeling*. 4th edn. The Guilford Press: New York, USA.

Kontio, J., Bragge, J. and Lehtola, L. (2008). The focus group method as an empirical tool in software engineering. In *Guide to advanced empirical software engineering*. pages 93–116. Springer: London, UK.

Kontio, J., Lehtola, L. and Bragge, J. (2004). Using the focus group method in software engineering: obtaining practitioner and user experiences. In *2004 International Symposium on Empirical Software Engineering, (ISESE'04)*. pages 271–280. IEEE: Redondo Beach, CA, USA. doi: 10.1109/ISESE.2004.1334914.

Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International: New Delh, India.

Laanti, M., Similä, J. and Abrahamsson, P. (2013). Definitions of agile software development and agility. In *European Conference on Software Process Improvement*. pages 247–258. Springer: Dundalk, Ireland. doi: https://doi.org/10.1007/978-3-642-39179-8_22.

Lalsing, V., Kishnah, S. and Pudaruth, S. (2012). People factors in agile software development and project management. *International Journal of Software Engineering & Applications*, **3**(1), 117–137. doi: https://doi.org/10.5121/ijsea.2012.3109.

Larman, C. (2004). *Agile and iterative development: a manager's guide*. Addison-Wesley Professional: Boston, USA.

Larman, C. and Basili, V. (2003). Iterative and incremental developments. a brief history. *Computer*, **36**(6), 47–56. doi: https://doi.org/10.1109/MC.2003.1204375.

Leidner, D. E. and Kayworth, T. (2006). A review of culture in information systems research: Toward a theory of information technology culture conflict. *MIS quarterly*, **30**(2), 357–399.

Leung, L. (2015). Validity, reliability, and generalizability in qualitative research. *Journal of family medicine and primary care*, **4**(3), 324–327. doi: https://doi.org/10.4103/2249-4863.161306.

Liamputtong, P. (2011). *Focus group methodology: Principle and practice*. Sage publications.

Lindsjørn, Y., Sjøberg, D. I., Dingsøyr, T., Bergersen, G. R. and Dybå, T. (2016). Teamwork quality and project success in software development: A survey of agile development teams. *Journal of Systems and Software*, **122**, 274–286. doi: https://doi.org/10.1016/j.jss.2016.09.028.

Lindvall, M., Basili, V., Boehm, B., Costa, P., Dangle, K., Shull, F., Tesoriero, R., Williams, L. and Zelkowitz, M. (2002). Empirical findings in agile methods. In *Conference on extreme programming and agile methods*. pages 197–207. Springer: Chicago, IL, USA. doi: https://doi.org/10.1007/3-540-45672-4_19.

Livermore, J. (2008). Factors that significantly impact the implementation of an agile software development methodology. *Journal of Software*, **3**(4), 31–36.

Lous, P., Kuhrmann, M. and Tell, P. (2017). Is scrum fit for global software engineering?. In *2017 IEEE 12th International Conference on Global Software Engineering (ICGSE)*. pages 1–10. IEEE.

Lowry, P. and Gaskin, J. (2014). Partial least squares (PLS) structural equation modeling (SEM) for building and testing behavioral causal theory: When to choose it and how to use it. *IEEE transactions on professional communication*, **57**(2), 123–146. doi: https://doi.org/10.1109/TPC.2014.2312452.

Lynn, M. (1986). Determination and quantification of content validity. *Nursing research*, **35**(6), 382–386. doi: https://doi.org/10.1097/00006199-198611000-00017.

Mangalaraj, G., Mahapatra, R. and Nerur, S. (2009). Acceptance of software process innovations–the case of extreme programming. *European Journal of Information Systems*, **18**(4), 344–354. doi: https://doi.org/10.1057/ejis.2009.23.

McGregor, S. and Murnane, J. (2010). Paradigm, methodology and method: Intellectual integrity in consumer scholarship. *International journal of consumer studies*, **34**(4), 419–427. doi: https://doi.org/10.1111/j.1470-6431.2010.00883.x.

Miles, M., Huberman, A. and Saldana, J. (2018). *Qualitative data analysis: A methods sourcebook*. 4th edn. Sage publications: Thousand Oaks, USA.

Ministry of Commerce (2016). The Board of Directors of the General Authority for Small & Medium Enterprises Specifies the Definition of Micro, small and Medium Enterprises. **URL:** *https://mci.gov.sa/en/MediaCenter/News/Pages/13-12-16-03.aspx.*

Ministry of Communications, and Information Technology (2019). Communications and Information Technology Sector Strategy. Technical report. **URL:** *https://www.mcit.gov.sa/sites/default/files/mlkhs$_l$strtyjy$_0$.pdf*.

Ministry of Finance (2019). Suadi Budget 2019. **URL:** *https://www.mof.gov.sa/financialreport/budget2019.*

Misra, S. C., Kumar, V. and Kumar, U. (2009). Identifying some important success factors in adopting agile software development practices. *Journal of Systems and Software*, **82**(11), 1869–1890. doi: https://doi.org/10.1016/j.jss.2009.05.052.

Mkansi, M. and Acheampong, E. (2012). Research philosophy debates and classifications: students' dilemma. *Electronic Journal of Business Research Methods*, **10**(2), 132–140.

Monshaat (2019). The General Authority for Small and Medium Enterprises. **URL:** *https://www.monshaat.gov.sa.*

Morse, J. (1994). *Designing funded qualitative research*. 2nd edn. Sage publications: Thousand Oaks, USA.

Moshashai, D., Leber, A. and Savage, J. (2020). Saudi Arabia plans for its economic future: Vision 2030, the National Transformation Plan and Saudi fiscal reform. *British Journal of Middle Eastern Studies*, **47**(3), 381–401. doi: https://doi.org/10.1080/13530194.2018.1500269.

Myers, M. and Avison, D. E. (2002). *Qualitative research in information systems: a reader*. Sage publications: London, UK.

Nanthaamornphong, A. and Wetprasit, R. (2016). A case study: Adoption of agile in Thailand. In *2016 International Conference on Advanced Computer Science and Information Systems (ICACSIS)*. pages 585–590. IEEE: Malang, Indonesia. doi: https://doi.org/10.1109/ICACSIS.2016.7872732.

Nazir, N., Hasteer, N. and Bansal, A. (2016). A survey on agile practices in the Indian IT industry. In *2016 6th International Conference - Cloud System and Big Data Engineering (Confluence)*. pages 635–640. IEEE: Noida, India. doi: https://doi.org/10.1109/CONFLUENCE.2016.7508196.

Ndou, V. (2004). E-government for developing countries: opportunities and challenges. *The Electronic Journal of Information Systems in Developing Countries*, **18**(1), 1–24.

Nepelski, D. and De Prato, G. (2018). The structure and evolution of ICT global innovation network. *Industry and Innovation*, **25**(10), 940–965. doi: https://doi.org/10.1080/13662716.2017.1343129.

Oates, B. (2005). *Researching Information Systems and Computing*. Sage publications: London, UK.

Osborne, J. and Overbay, A. (2004). The power of outliers (and why researchers should always check for them). *Practical Assessment, Research, and Evaluation*, **9**(1). doi: https://doi.org/10.7275/qf69-7k43.

Ozawa, H. and Zhang, L. (2013). Adapting agile methodology to overcome social differences in project members. In *2013 Agile Conference*. pages 82–87. IEEE: Nashville, TN, USA. doi: https://doi.org/10.1109/AGILE.2013.13.

Pallant, J. (2016). *SPSS survival manual : A step by step guide to data analysis using IBM SPSS*. 6th edn. Maidenhead: McGraw-Hill.

Peugh, J. L. and Enders, C. K. (2004). Missing Data in Educational Research: A Review of Reporting Practices and Suggestions for Improvement. *Review of Educational Research*, **74**(4), 525–556. doi: https://doi.org/10.3102/00346543074004525.

Pikkarainen, M., Salo, O., Kuusela, R. and Abrahamsson, P. (2012). Strengths and barriers behind the successful agile deployment-insights from the three software intensive companies in Finland. *Empirical Software Engineering*, **17**(6), 675–702. doi: https://doi.org/10.1007/s10664-011-9185-5.

Platform Unified National (2021). List of Government Applications. **URL:** *https://www.my.gov.sa/wps/portal/snp/content/appslistheader2*$_1$

Podsakoff, P., MacKenzie, S., Lee, J. and Podsakoff, N. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies.. *Journal of Applied Psychology*, **88**(5), 879–903. doi: https://doi.org/10.1037/0021-9010.88.5.879.

Rahimian, V. and Ramsin, R. (2008). Designing an agile methodology for mobile software development: A hybrid method engineering approach. In *Proceedings of the IEEE 2nd International Conference on Research Challenges in Information Science, RCIS 2008*. pages 337–342. IEEE: Marrakech, Morocco. doi: https://doi.org/10.1109/RCIS.2008.4632123.

Raval, A. (2015). The Big Drop: Riyadh's Oil Gamble. **URL:** *https://www.ft.com/content/25f2d7d6-c3f8-%0A11e4-a02e-00144feab7de %0A*.

Ringle, C., Wende, S. and Becker, J. (2015). SmartPLS 3. Boenningstedt: SmartPLS GmbH. **URL:** *https://www.smartpls.com.*

Robinson, H. and Sharp, H. (2005). Organisational culture and XP: Three case studies. In *Agile Development Conference (ADC'05)*. Vol. 2005. pages 49–58. IEEE: Denver, CO, USA. doi: https://doi.org/10.1109/ADC.2005.36.

Rodríguez, P., Markkula, J., Oivo, M. and Turula, K. (2012). Survey on agile and lean usage in finnish software industry. In *Proceedings of the 2012 ACM-IEEE International Symposium on Empirical Software Engineering and Measurement*. pages 139–148. IEEE: Lund, Sweden. doi: https://doi.org/10.1145/2372251.2372275.

Runeson, P. and Höst, M. (2009). Guidelines for conducting and reporting case study research in software engineering. *Empirical Software Engineering*, **14**(2), 131–164. doi: https://doi.org/10.1007/s10664-008-9102-8.

Runeson, P., Höst, M., Rainer, A. and Regnell, B. (2012). *Case Study Research in Software Engineering: Guidelines and Examples*. John Wiley and Sons. Hoboken, USA.

Salinas, M. R., Neto, A. G. S. and Emer, M. C. F. (2018). Concerns and limitations in agile software development: A survey with paraguayan companies. In *Brazilian Workshop on Agile Methods*. Vol. 802. pages 77–87. Springer: Belém, Brazil. doi: https://doi.org/10.1007/978-3-319-73673-0_6.

Salo, O. and Abrahamsson, P. (2008). Agile methods in European embedded software development organisations: A survey on the actual use and usefulness of Extreme Programming and Scrum. *IET Software*, **2**(1), 58–64. doi: https://doi.org/10.1049/iet-sen:20070038.

Santos, A., Kroll, J., Sales, A. and Fernandes, P. (2016). Investigating the Adoption of Agile Practices in Mobile Application Development. In *Proceedings of the 18th International Conference on Enterprise Information Systems (ICEIS 2016)*. pages 490–497.

Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., Burroughs, H. and Jinks, C. (2018). Saturation in qualitative research: exploring its conceptualization and operationalization. *Quality quantity*, **52**(4), 1893–1907. doi: https://doi.org/10.1007/s11135-017-0574-8.

Saunders, M., Lewis, P. and Thornhill, A. (2016). *Research Methods for Business Students*. 7th edn. Pearson Education: London, UK.

Schwarz, N. (1999). Self-reports: How the questions shape the answers.. *American psychologist*, **54**(2), 93.

Sekaran, U. and Bougie, R. (2013). *Research methods for business: a skill building approach*. 6th edn. John Wiley Sons: Chichester, UK.

Senapathi, M. and Srinivasan, A. (2014). An empirical investigation of the factors affecting agile usage. In *Proceedings of the 18th international conference on evaluation and assessment in software engineering*. pages 1–10. ACM: London, UK. doi: https://doi.org/10.1145/2601248.2601253.

Serrador, P. and Pinto, J. K. (2015). Does Agile work? - A quantitative analysis of agile project success. *International Journal of Project Management*, **33**(5), 1040–1051. doi: https://doi.org/10.1016/j.ijproman.2015.01.006.

Sheffield, J. and Lemétayer, J. (2013). Factors associated with the software development agility of successful projects. *International Journal of Project Management*, **31**(3), 459–472. doi: https://doi.org/10.1016/j.ijproman.2012.09.011.

Sjoberg, D. I., Dyba, T. and Jorgensen, M. (2007). The future of empirical methods in software engineering research. In *Future of Software Engineering (FOSE'07)*. pages 358–378. IEEE: Minneapolis, MN, USA. doi: https://doi.org/10.1109/FOSE.2007.30.

Solinski, A. and Petersen, K. (2016). Prioritizing agile benefits and limitations in relation to practice usage. *Software Quality Journal*, **24**(2), 447–482. doi: https://doi.org/10.1007/s11219-014-9253-3.

Stankovic, D., Nikolic, V., Djordjevic, M. and Cao, D. B. (2013). A survey study of critical success factors in agile software projects in former Yugoslavia IT companies. *Journal of Systems and Software*, **86**(6), 1663–1678. doi: https://doi.org/10.1016/j.jss.2013.02.027.

Statista (2020*a*). Combined global Apple App Store and Google Play app downloads from 1st quarter 2015 to 1st quarter 2020 — Statista. **URL:** *https://www.statista.com/statistics/604343/number-of-apple-app-store-and-google-play-app-downloads-worldwide.*

Statista (2020*b*). Smartphone users worldwide 2016-2021. **URL:** *https://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/.*

Stelzmann, E., Kreiner, C., Spork, G., Messnarz, R. and Koenig, F. (2010). Agility meets systems engineering: A catalogue of success factors from industry practice. In *In European Conference on Software Process Improvement*. Vol. 99 CCIS. pages 245–256. Springer: Grenoble, France. doi: https://doi.org/10.1007/978-3-642-15666-3_22.

Stewart, D., Shamdasani, P. and Rook, D. W. (2007). *Focus groups: Theory and practice*. Sage publications: Thousand Oaks, USA.

Strode, D. E. (2005). The Agile Methods: An Analytical Comparison of Five AgileMethods and an investigation of their target environment. PhD thesis. Massey University, Palmerston, NewZealand.

Strode, D., Huff, S. and Tretiakov, A. (2009). The impact of organizational culture on agile method use. In *IEEE 42nd Hawaii International Conference on System Sciences*. pages 1–9. IEEE: Waikoloa, HI, USA. doi: https://doi.org/10.1109/HICSS.2009.436.

Sulaiman, N. L., Mahrin, M. N. R. and Che Mohd Yusoff, R. (2015). Investigating awareness issues with Agile practices. In *9th IEEE Malaysian Software Engineering Conference, (MySEC)*. pages 183–188. IEEE: Kuala Lumpur, Malaysia. doi: https://doi.org/10.1109/MySEC.2015.7475218.

Sultan, F. and Chan, L. (2000). The adoption of new technology: the case of object-oriented computing in software companies. *IEEE transactions on Engineering Management*, **47**(1), 106–126.

Tabachnick, B. and Fidell, L. S. (2007). *Using multivariate statistics*. 5th edn. Pearson/Allyn Bacon: Boston, USA.

Tam, C., Moura, E. J. d. C., Oliveira, T. and Varajão, J. (2020). The factors influencing the success of on-going agile software development projects. *International Journal of Project Management*, **38**(3), 165–176. doi: https://doi.org/10.1016/j.ijproman.2020.02.001.

Tashakkori, A. and Teddlie, C. (2010). *SAGE Handbook of Mixed Methods in Social Behavioral Research*. 2ed edn. Sage publications: Los Angeles, USA.

Tavory, I. and Timmermans, S. (2014). *Abductive analysis: Theorizing qualitative research*. Chicago, IL, USA: University of Chicago Press.

Tendedez, H., Ferrario, M. A. and Whittle, J. (2018). Software development and CSCW: Standardization and flexibility in large-scale agile development.

Proceedings of the ACM on Human-Computer Interaction, **2**(171), 1–23. doi: https://doi.org/10.1145/3274440.

Tolfo, C. and Wazlawick, R. S. (2008). The influence of organizational culture on the adoption of extreme programming. *Journal of Systems and Software*, **81**(11), 1955–1967. doi: https://doi.org/10.1016/j.jss.2008.01.014.

Turner, D. (2010). Qualitative interview design: A practical guide for novice investigators. *The qualitative report*, **15**(3), 754–760.

Usunier, J. (1998). *International and cross-cultural management research*. Sage publications: London, UK.

van Kelle, E., Visser, J., Plaat, A. and van der Wijst, P. (2015). An Empirical Study into Social Success Factors for Agile Software Development. In *IEEE/ACM 8th International Workshop on Cooperative and Human Aspects of Software Engineering*. pages 77–80. IEEE: Florence, Italy. doi: https://doi.org/10.1109/CHASE.2015.24.

Vijayasarathy, L. and Turk, D. (2012). Drivers of agile software development use: Dialectic interplay between benefits and hindrances. *Information and Software Technology*, **54**(2), 137–148. doi: https://doi.org/10.1016/j.infsof.2011.08.003.

Vision2030 (2017). Vision 2030: Kingdom of Saudi Arabia. Technical report. Riyadh, KSA. **URL:** *https://vision2030.gov.sa/sites/default/files/report/Saudi*$_V$*ision*2030$_E$$N_2$017*.pdf*.

Vision2030-NTP (2018). National Transformation Program 2018-2020. **URL:** *https://vision2030.gov.sa/sites/default/files/attachments/NTP English Public Document*$_2$810*.pdf*.

Vithana, V. N., Asirvatham, D. and Johar, M. G. (2018). An empirical study on using agile methods in global software development. In *18th International Conference on Advances in ICT for Emerging Regions, (ICTer 2018)*. pages 150–156. IEEE: Colombo, Sri Lanka. doi: https://doi.org/10.1109/ICTER.8615505.

WABER, C. (2020). Webinar on Research Philosophies, Approaches and Strategies with Prof Mark Saunders. **URL:** *https://www.youtube.com/watch?v=b3kKFNOnwOY*.

Wan, J. and Wang, R. (2010). Empirical Research on Critical Success Factors of Agile Software Process Improvement. *Journal of Software Engineering and Applications*, **03**(12), 1131–1140. doi: https://doi.org/10.4236/jsea.2010.312132.

Wasserman, T. (2010). Software engineering issues for mobile application development. In *Proceedings of the ACM Workshop on the Future of Software Engineering Research, (FoSER)*. pages 397–400. ACM: Santa Fe New Mexico USA. doi: https://doi.org/10.1145/1882362.1882443.

Williams, L. and Cockburn, A. (2003). Agile software development: It's about feedback and change. *Computer*, **36**(6), 39–43. doi: https://doi.org/10.1109/MC.2003.1204373.

Willis, J. W. (2007). *Foundations of qualitative research: Interpretive and critical approaches*. Sage publications: London, UK.

Winter, E., Forshaw, S. and Ferrario, M. A. (2018). Measuring human values in software engineering. In *Proceedings of the 12th ACM/IEEE International Symposium on Empirical Software Engineering and Measurement*. pages 1–4. ACM. Oulu, Finland. doi: https://doi.org/10.1145/3239235.3267427.

Winter, E., Forshaw, S., Hunt, L. and Ferrario, M. A. (2019). Advancing the study of human values in software engineering. In *2019 IEEE/ACM 12th International Workshop on Cooperative and Human Aspects of Software Engineering (CHASE)*. pages 19–26. IEEE: Montreal, QC, Canada. doi: https://doi.org/10.1109/CHASE.2019.00012.

Wong, K. (2013). Partial least squares structural equation modeling (PLS-SEM) techniques using SmartPLS. *Marketing Bulletin*, **24**(1), 1–32.

Yin, R. (2018). *Case study research and applications: Design and methods*. 6th edn. Sage publications: Los Angelesm, USA.

Appendix A

Chapter 4: Agile Awareness and Perceptions

A.1 Survey Design

Section A: Demographic Information

- **Q1. Your gender:**
  - Male
  - Female
  - Prefer not to say
- **Q2. Your age:**
  - Below 23 years
  - 23 - 30 years
  - 31 - 39 years
  - Above 40 years
- **Q3. Your role: (Multiple Answers Allowed)**
  - Project Manager (Scrum Master)
  - CEO
  - CIO/CTO
  - Developer
  - Tester

  - Designer
  - Other (please specify.....)

- **Q4. Years of experience in mobile app development:**
  - Less than a year
  - 1 - 2 years
  - 3 - 5 years
  - More than 5 years
- **Q5. Number of employees in your organisation:**
  - 1 - 5 employees
  - 6 - 49 employees
  - 50 - 249 employees
  - More than 249 employees
- **Q6. Number of development teams you are working with:**
  - 1 team
  - 2 teams
  - 3 teams
  - More than 3 teams
- **Q7. Number of members in your development teams, in average:**
  - 1 - 5 members
  - 6 - 10 members
  - 11 - 20 members
  - More than 20 members
- **Q8. Platforms used for apps development: (Multiple Answers Allowed)**
  - IOS
  - Android
  - Windows Phone
  - Other (please specify.....)

- **Q9. Mobile application types developed: (Multiple Answers Allowed)**
  - Hybrid
  - Native
  - Web

Section B: Software Development

- **Q10. Years of experience in software development:**
  - Less than a year
  - 1 - 4 years
  - 5 - 10 years
  - More than 10 years
- **Q11. Software development methodologies used in your development team: (Multiple Answers Allowed)**
  - Waterfall Model
  - Spiral Model
  - Rapid Application Development
  - V Model
  - Agile Software Development
  - Other (please specify.....)

Section C: Agile Software Development

- **Q12. Your current level of knowledge about Agile methods:**
  - Not known (please move to Q24)
  - Limited
  - Average
  - Extensive
- **Q13. Have you adopted Agile methodology in mobile app development?**
  - Yes
  - Partially

  - No

- **Q14. Years of experience in Agile software development:**
  - Less than a year
  - 1 - 4 years
  - 5 - 10 years
  - More than 10 years

- **Q15. Has your current company been adopting Agile in mobile app development?**
  - Yes
  - No

- **Q16. If yes, how long has your company been adopting Agile?**
  - Less than a year
  - 1 - 2 years
  - 3 - 5 years
  - More than 5 years

- **Q17. Source of knowledge about Agile: (Multiple Answers Allowed)**
  - Training
  - Reading
  - Practice
  - Certification
  - Other (please specify.....)

- **Q18. How important do you think that training team members on Agile is important before applying it in the applications development process?**
  - Very important
  - Important
  - Natural
  - Slightly important
  - Not important (Please specify why? .....)

- **Q19. Agile methods adopt by you or your team: (Multiple Answers Allowed)**
  - Scrum
  - Extreme Programming (XP)
  - Kanban
  - Scrumban
  - Feature-Driven Development (FDD)
  - Dynamic Systems Development Method (DSDM)
  - Crystal
  - Other (please specify.....)
- **Q20. Are your customers happy with adopting Agile in the development process?**
  - Yes
  - Partially
  - No (Please specify why? .....)
- **Q21. To what extend do you think of the current use of Agile in developing mobile applications in Saudi Arabia?**
  - Strongly applied
  - Applied
  - Natural
  - Not applied
  - Strongly not applied
- **Q22. To what extent do you agree with the reasons for adopting Agile within your team or organisation?**

Reasons for adopting Agile	**5**	**4**	**3**	**2**	**1**
Increase team productivity					
Improve team morale					
Improve team communication					
Improve stakeholder satisfaction					
Simplify development process					
Reduce application risk					

Reduce application development cost					
Improve application quality					
Decrease development cycle times and time-to-market					
Enhance ability to adapt to changes					

- **Q23. From your point of views, how much do you agree with the reasons for non-adopting Agile by development teams?**

Reasons for non-adopting Agile	**5**	**4**	**3**	**2**	**1**
Lack of knowledge and training					
Customers are not ready for Agile methods					
Traditional organisational culture					
Application development is not suitable for Agile					
Loss of management control					
Lack of formal guidelines					
The difficult of defining business value					
Lack of tools to support Agile methods					

- **Q24. Techniques adopt by you or your team: (Multiple Answers Allowed)**
  - Daily standup meeting
  - Sprint planning meeting
  - Sprint review
  - Sprint retrospectives
  - Burndown chart
  - Product backlog
  - Sprint backlog
  - Iterative development
  - Incremental development
  - User stories
  - Test-driven development (TDD)
  - Pair programming
  - Other (please specify.....)
- **Q25. Management platforms used: (Multiple Answers Allowed)**

  - Asana
  - Trello
  - Github
  - Jira
  - Don't use
  - Other (please specify. . . . . .)

- **Q26. To what extent do you or your team apply these four values in your development team?**

Agile values	**5**	**4**	**3**	**2**	**1**
Focus more on individuals and interactions than processes and tools					
Focus more on working software than comprehensive documentation					
Focus more on customer collaboration than contract negotiation					
Focus more on responding to change than following a plan					

- **Additional comments**
  If you are interested in inviting for future studies or updating about the results of the study, please write your email in the text box with the required options selected: (You can choose more than one option)

  - Contact me for future studies
  - Update me with the result of this study

  Write here your email .....

A.2 Ethics Approval

FE

FST Ethics
Fri 03/04/2020 13:35
To: Altuwaijri, Fahad (Student)
Cc: Ferrario, Maria Angela

Dear Fahad,

Thank you for submitting your research ethics application for the project '**Investigating Agile Adoption in Saudi Arabian Mobile Application Development**' for review. The application has been reviewed by members of the FST Research Ethics Committee and I can confirm that approval has been granted for this project.

As principal investigator your responsibilities include:

- ensuring that (where applicable) all the necessary legal and regulatory requirements in order to conduct the research are met, and the necessary licenses and approvals have been obtained;
- reporting any ethics-related issues that occur during the course of the research or arising from the research (e.g. unforeseen ethical issues, complaints about the conduct of the research, adverse reactions such as extreme distress) to the Research Ethics Officer;
- submitting details of proposed substantive amendments to the protocol to the Research Ethics Officer for approval.

Please contact the Research Ethics Officer, Becky Case (fst-ethics@lancaster.ac.uk 01542 593987) if you have any queries or require further information.

Kind regards,

Becky Case

Becky Case | Research Ethics Officer
Research and Enterprise Services | Lancaster University
+44 (0)1524 593987
www.lancaster.ac.uk
E-mail: fhmresearchsupport@lancaster.ac.uk, fst-ethics@lancaster.ac.uk

A.3 Personal Information Sheet for Interview

Lancaster University

Faculty of Science and Technology
School of Computing and Communications

For further information about how Lancaster University processes personal data for research purposes and your data rights please visit our webpage: www.lancaster.ac.uk/research/data-protection

I am Fahad Altuwaijri, a PhD student at Lancaster University. I would like to invite you to take part in this study about investigating the awareness and perceptions towards Agile software development in Saudi Arabia.

Please take time to read the following information carefully before you decide whether or not you wish to take part.

What is the study about?
This study aims to understand the awareness, current usage and perception of Agile software development in the development of mobile applications in Saudi Arabia.

Why have I been invited?
You have been approached to participant because you are an expert in mobile app development and Agile working in Saudi Arabia so that this study reflects the point of view of participants which will be used to achieve the study's aim and to shape the sequential studies of my PhD research..

What will I be asked to do if I take part?
If you decided to take part, you will be interviewed online by me, the researcher, at your convenient time. The interview will be held by Microsoft Teams and will last for about 30-60 minutes. I will send you the link of consent form before the interview commences and you will be asked to sign on it. This form is to confirm that you have read and received this information sheet and that you are willing to volunteer in this research.

What are the possible benefits from taking part?
This research will not benefit you personally, but your participation will be helpful and

contributed to our understanding of the awareness and perceptions of Agile practicing in Saudi Arabia as well as help us to inform the next study.

Do I have to take part?
No. It's completely up to you to decide whether or not you take part. Your participation is voluntary, and you are free to withdraw at any time during the interview, without giving any reason.

What if I change my mind?
As explained above, you are free to withdraw at any time during the interview and if you want to withdraw, I will extract any data you contributed to the study and destroy it. However, if you wish to withdraw after the interview is completed, it is difficult and often impossible to take out data from one specific participant when this has already been anonymised or pooled together with other people's data. Therefore, you can only withdraw up to one week after taking part in the study.

What are the possible disadvantages and risks of taking part?
There are no disadvantages and risks, completely.

Will my data be identifiable?
Certainly, no. After the interview, only I, the researcher conducting this study will have access to the data you share with me. I will keep all your personal information and your organisation's name confidential, that is I will not share it with others. Instead, I will use a pseudonym to refer to you in any publications or presentations or any discussions with other colleagues in the University. This means that I remove any personal information that can identify you.

How will my data be stored?
Your data will be stored in encrypted files (that is no-one other than me, the researcher will be able to access them) and on a password-protected laptop.

How will we use the information you have shared with us and what will happen to the results of the research study?
I will use the data you have shared with only in the following ways: I will use it for academic purposes only. This will include (e.g. my PhD thesis and other publications). I may also present the results of my study at academic conferences. When writing up the findings from this study, I would like to reproduce some of the views and ideas you shared with me. When doing so, I will only use anonymised quotes (e.g. from our interview with you), so that although I will use your exact words, you cannot be identified in our publications.

Who has reviewed the project?
This study has been reviewed and approved by the Faculty of Science and Technology Research Ethics Committee.

What if I have a question or concern?
If you have any queries or if you are unhappy with anything that happens concerning your participation in the study, please contact the researchers as follows:
Researcher: Fahad Altuwaijri
f.altuwaijri@lancaster.ac.uk
Supervisor: Dr Maria Angela Ferrario
m.a.ferrario@lancaster.ac.uk

If you have any concerns or complaints that you wish to discuss with a person who is not directly involved in the research, you can also contact:

Professor Adrian Friday
Head of Department, School of Computing and Communications
a.friday@lancaster.ac.uk

Thank you for considering your participation in this project.

A.4 Personal Information Sheet for Survey

Lancaster University

Faculty of Science and Technology
School of Computing and Communications

For further information about how Lancaster University processes personal data for research purposes and your data rights please visit our webpage: www.lancaster.ac.uk/research/data-protection

I am Fahad Altuwaijri, a PhD student at Lancaster University. I would like to invite you to take part in this study about investigating the awareness and perceptions towards Agile software development in Saudi Arabia.

Please take time to read the following information carefully before you decide whether or not you wish to take part.

What is the study about?
This study aims to understand the awareness, current usage and perception of software development, particularly Agile software development in Saudi Arabia.

Why have I been invited?
You have been approached to participant because you are a mobile app practitioner in Saudi Arabia so that this study reflects the point of view of participants which will be used to achieve the study's aim and to shape the sequential studies of my PhD research.

What will I be asked to do if I take part?
If you decided to take part, this questionnaire will take approximately 10 minutes in which you will be asked to answer a number of questions that will help in understanding the awareness and perception about Agile software development.

What are the possible benefits from taking part?
This study will not benefit you personally, but your participation will be helpful and contributed to our understanding of the awareness and perceptions of Agile practicing in Saudi Arabia.

Do I have to take part?
No. It's completely up to you to decide whether or not you take part. Your participation is voluntary, and you are free to withdraw at any time during the study, without giving any reason.

What if I change my mind?
As explained above, you are free to withdraw at any time without the need to give an excuse prior to submitting your participation by simply abandoning the survey and close the browser window. To have your responses included, please click the "submit" button at the end of the survey. If you change your mind after submitting your participation, the researcher will not able to delete your data because the survey will be anonymous, and thus, it will be difficult to identify your data.

What are the possible disadvantages and risks of taking part?
There are no disadvantages and risks, completely.

Will my data be identifiable?
Certainly, no. Only I, the researcher conducting this study will have access to the data you share with me. The data will be numerically coded and kept on a password protected computer system.

How will my data be stored?
Your data will be stored in encrypted files (that is no-one other than me, the researcher will be able to access them) and on a password-protected laptop.

How will we use the information you have shared with us and what will happen to the results of the research study?
I will use the data you have shared with only in the following ways: I will use it for academic purposes only. This will include (e.g. my PhD thesis and other publications). I may also present the results of my study at academic conferences.

Who has reviewed the project?
This study has been reviewed and approved by the Faculty of Science and Technology Research Ethics Committee.

What if I have a question or concern?
If you have any queries or if you are unhappy with anything that happens concerning your participation in the study, please contact the researchers as follows:
Researcher: Fahad Altuwaijri
f.altuwaijri@lancaster.ac.uk

Supervisor: Dr Maria Angela Ferrario
m.a.ferrario@lancaster.ac.uk

If you have any concerns or complaints that you wish to discuss with a person who is not directly involved in the research, you can also contact:

Professor Adrian Friday
Head of Department, School of Computing and Communications
a.friday@lancaster.ac.uk

Thank you for considering your participation in this project.

A.5 Consent Form for Interview

Project Title: Investigating the Awareness, Current Usage and Perception of Agile
Name of Researchers: Fahad Altuwaijri
Email: f.altuwaijri@lancaster.ac.uk

Lancaster University

By agreeing to participate you are indicating that you have read the description of the study and that you agree to the terms as described. If you have any questions, please contact me.

Thank you in advance for your participation!

Please tick each box

1. I confirm that I have read and understand the information sheet for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily. ☐
2. I understand that my participation is voluntary and that I am free to withdraw of all or part of the study at any time, without giving any reason. If I withdraw within a week of commencement of the study, my data will be removed. ☐
3. I understand that any information given by me may be used in future reports, academic articles, publications or presentations by the researcher, but my personal information will not be included, and I will not be identifiable. ☐
4. I understand that my name/my organisation's name will not appear in any reports, articles or presentation without my consent. ☐
5. I understand that any interviews will be audio-recorded and transcribed, and that data will be protected on encrypted devices and kept secure. ☐
6. I understand that data will be kept until the researcher finishes his course and will be completed destroyed by him. ☐
7. I agree to take part in the above study. ☐
8. By providing contact details, I understand that I will be contacted further by the researcher with updates about the study and participate in the subsequent studies. ☐

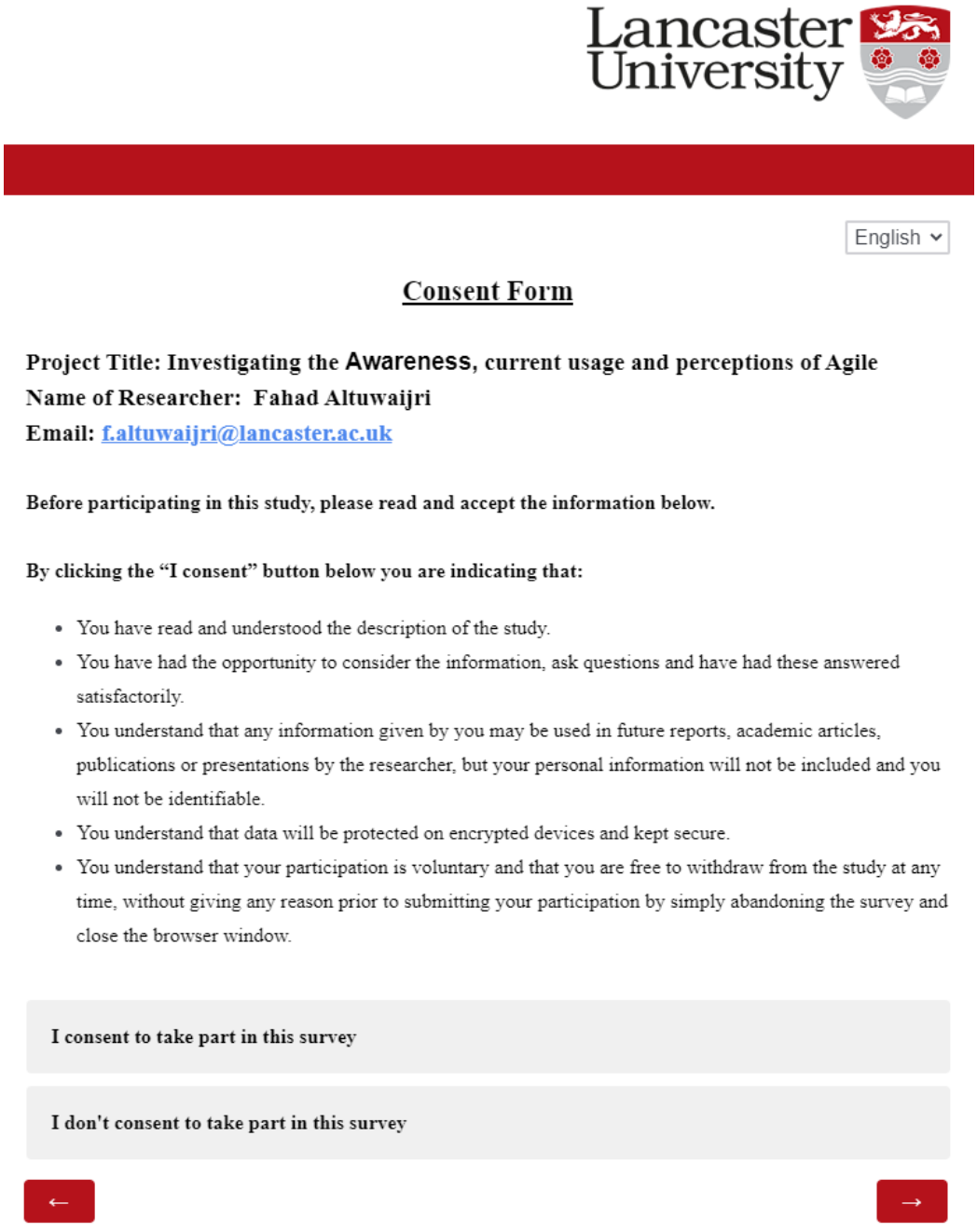
Name of Participant	Date	Signature	Email/Phone number *(optional)*

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

Signature of Researcher /person taking the consent_____ **Date** _____ Day/month/year

One copy of this form will be given to the participant and the original kept in the files of the researcher at Lancaster University

A.6 Consent Form for Survey



Lancaster University

English

Consent Form

Project Title: Investigating the Awareness, current usage and perceptions of Agile
Name of Researcher: Fahad Altuwaijri
Email: f.altuwaijri@lancaster.ac.uk

Before participating in this study, please read and accept the information below.

By clicking the "I consent" button below you are indicating that:

- You have read and understood the description of the study.
- You have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.
- You understand that any information given by you may be used in future reports, academic articles, publications or presentations by the researcher, but your personal information will not be included and you will not be identifiable.
- You understand that data will be protected on encrypted devices and kept secure.
- You understand that your participation is voluntary and that you are free to withdraw from the study at any time, without giving any reason prior to submitting your participation by simply abandoning the survey and close the browser window.

I consent to take part in this survey

I don't consent to take part in this survey

← →

Appendix B

Chapter 5: Investigation of Agile Adoption Factors

B.1 Interview Protocol

STUDY AIM

- The study aims to investigate the significant factors (e.g. social, organisational, environmental and technical) that can support or challenge the adoption of Agile in the Kingdom of Saudi Arabia. Specifically, this study focuses on software development companies in the small and medium-sized enterprises sector, with the specific focus on mobile app development projects.

STUDY OBJECTIVES

- Gain deeper insight into the enablers and barriers of Agile adoption in the Kingdom of Saudi Arabia.
- Refine the Agile adoption framework deigned and developed drawing from state of the art.

DATA COLLECTION METHOD

- **Online semi-structured interviews:** include closed- and open-ended questions. The closed-ended questions are designed using a five-point Likert scale to assess the importance of each factor; open questions help to investigate the factors in detail.

DATA ANALYSIS

- The data collected will be captured using digital recorders and from notes that I will take during the interviews. Audio content will be transcribed and compared with my notes and they will be analysed using NVivo software. In addition, the data will be thematically analysed in order to identify themes and patterns from the data collected.

- Closed-ended questions (quantitative data) will be analysed using a statistical software (i.e. SPSS).

RESEARCH SETTINGS

- Three software small and medium-sized organisations in Saudi Arabia that adopt Agile methods in their mobile app development projects.

PARTICIPANT TARGET

- Mobile app practitioners in Saudi Arabia who are working in the organisations under study and with 1) at least four years' industrial experience of mobile app development, 2) two years' industrial experience of Agile software development, and 3) they had to be from different software SMEs in Saudi Arabia.

PARTICIPANTS' NUMBER

- Targeting 12 participants; 4 from each organisation.

SESSION TIME

- Interview session lasting 30-60 minutes each.

ONLINE PLATFORMS

- **Microsoft Team:** A video-conferencing platform used for meeting.

BEFORE THE INTERVIEW COMMENCES:

- Ask participants to read the *'Participant Information Sheet'* to ensure that they have a full understanding of the study and what they are volunteering for.

- Ask participants to sign the *'Consent Form'*, and we have only recruited participants who can give their full informed consent to participate in this study.

SEMI-STRUCTURED INTERVIEW DESIGN:

Section A: Demographic Information about Organisations
(This part will be asked for just one participant of each organisation (i.e. CEO, CTO, Project manager, or Scrum master))

- Q1. How long has Agile been adopted in mobile app teams in your organisation?
- Q2. What Agile methods are used in your Agile teams?
- Q3. What types of mobile apps do you develop?
- Q4. What types of mobile platforms do you use?
- Q5. How many mobile-Agile teams do you have in your organisation?
- Q6. What size are the teams?
- Q7. Are the teams co-located or distributed?
- Q8. How many employees work in your organisation?

Section B: Opportunities and Challenges of Agile Adoption

- Q9. What motivated your team (organisation) to adopt Agile?
- Q10. What are the challenges your team faced with adopting Agile, and how did you overcome them?

Section C: Influential Factors on Agile Adoption

- Q11. Could you rate how important each *people* factor (i.e. Team capability; Training and learning; Customer involvement) was in influencing the adoption of Agile in your team using the five-point Likert scale? And can you say how each aspect is going to influence the adoption?
  ight

Factors	**5**	**4**	**3**	**2**	**1**
Team capability					
Training and learning					
Customer involvement					

- Q12. Could you rate how important each *organisational* factor (i.e. Organisational culture; Management support; Communication and collaboration) was in influencing the adoption of Agile in your team using the five-point Likert scale? And can you say how each aspect is going to influence the adoption?
  ight

Factors	**5**	**4**	**3**	**2**	**1**

Organisational culture					
Management support					
Communication and collaboration					

- Q13. Could you rate how important each *environmental* factor (i.e. Organisational environment; Physical environment; National culture) was in influencing the adoption of Agile in your team using the five-point Likert scale? And can you say how each aspect is going to influence the adoption?
  ight

Factors	**5**	**4**	**3**	**2**	**1**
Organisational environment					
Physical environment					
National culture					

- Q14. Could you rate how important each *technical* factor (i.e. Agile software techniques; Delivery strategy; Tools and technologies) was in influencing the adoption of Agile in your team using the five-point Likert scale? And can you say how each aspect is going to influence the adoption?
  ight

Factors	**5**	**4**	**3**	**2**	**1**
Tools and technologies					
Delivery strategy					
Agile software techniques					

- Q15. Are there any other important factors (not mentioned) that need to be considered when adopting Agile in Saudi software organisations?

Section D: Demographic Information about Participants

- Q16. What is your role in the team?
- Q17. How many years of experience do you have in mobile app development?
- Q18. How many years of experience do you have in Agile software development?

AFTER THE INTERVIEW ENDING:

- Send the *'Debriefing Sheet'* to all participants.

B.2 Focus Group Protocol

Note: It is important to ensure that participants have been provided with *'Participant Information Sheet'* and signed on the *'Consent Form'* before the group begins. Additionally, make sure to send *'Participant Debrief Sheet'* to all participants after the group finishes.

STUDY AIM

- The study aims to critically review the influential factors identified in the Agile adoption framework that can support or challenge the adoption of Agile in small and medium-size software companies in Saudi Arabia by actively engaging the participants in a structured feedback process.

STUDY OBJECTIVES

- Critically review the influential factors listed in the framework and to what extent they impact on the adoption of Agile in software development SMEs in Saudi Arabia.
- Discuss the classification of the influential factors in the framework.
- Discuss the most challenging factors on the adoption.

DATA COLLECTION METHOD

- **Online focus group:** includes open-ended questions and designs based on the interviews' outcome to review the factors included in the Agile adoption framework.

DATA ANALYSIS

- The data collected will be captured using digital recorders and from notes that I will take during the session. Audio content will be transcribed and compared with my notes and they will be analysed with the support of NVivo software. In addition, the data will be thematically analysed in order to identify themes and patterns from the data collected.

RESEARCH SETTINGS

- Three software SMEs (A; B; C) in Saudi Arabia with different size that adopt Agile methods in their mobile app development projects.

PARTICIPANT TARGET

- Mobile app practitioners in Saudi Arabia who are working in the organisations under study and have wide experience in mobile app development and Agile methods.

PARTICIPANTS' NUMBER

- Five participants (two from organisation A; two from organisation B; one from organisation C)

SESSION TIME

- Focus group session lasting 120 minutes.

ONLINE PLATFORMS

- **Microsoft Team:** A video-conferencing platform used for meeting.
- **Miro:** An online collaboration platform used for doing some exercises with the participants during the session

FOCUS GROUP AGENDA

- **Section 1: Introduction and Purpose of Group:** the session starts with an introduction of the group participants, an overview of the research and the purpose and motivation of the session.
- **Section 2: The Agile Adoption Framework:** the results obtained from the previous individual interviews are briefly discussed, and the classificatory developed framework is presented.
- **Section 3: Main Discussion:** the discussion is divided into three parts as each one achieves an objective:
  - Part 1: The impact of listed factors in the framework on the adoption. (Break after this part for 10 mins)
  - Part 2: The classification of the framework.
  - Part 3: The importance level of factors on the adoption.
- **Section 4: Conclusion and Future Work:** the session ends with a conclusion of the discussion and future work planning as well as thanks all participants for participating.

B.3 Ethics Approval

Lancaster University

Applicant: Fahad Altuwairji
Supervisor: Dr Maria Angela Ferrario
Department: School of Computing and Communications
FSTREC Reference: FST20028

09 December 2020

Re: FST20028 (amendment to FST19120)
Investigating Agile Adoption in Saudi Arabian Mobile Application Development

Dear Fahad,

Thank you for submitting your research ethics amendment application for the above project for review by the **Faculty of Science and Technology Ethics Committee (FSTREC)**. The application was recommended for approval by FSTREC, and on behalf of the Chair of the Committee, I can confirm that approval has been granted for the amendment to this research project.

As principal investigator your responsibilities include:

- ensuring that (where applicable) all the necessary legal and regulatory requirements in order to conduct the research are met, and the necessary licenses and approvals have been obtained;
- reporting any ethics-related issues that occur during the course of the research or arising from the research to the Research Ethics Officer at the email address below (e.g. unforeseen ethical issues, complaints about the conduct of the research, adverse reactions such as extreme distress);
- submitting details of proposed substantive amendments to the protocol to the Research Ethics Officer for approval.

Please contact me if you have any queries or require further information.

Email: fst-ethics@lancaster.ac.uk

Yours sincerely,

Annie Beauchamp,
Research Ethics Officer, Secretary to FSTREC.

B.4 Personal Information Sheet

Lancaster University

Faculty of Science and Technology
School of Computing and Communications

For further information about how Lancaster University processes personal data for research purposes and your data rights please visit our webpage: www.lancaster.ac.uk/research/data-protection

I am Fahad Altuwaijri, a PhD student at Lancaster University. I would like to invite you to take part in this study investigating the adoption of Agile in Saudi Arabian software industry.

Please take time to read the following information carefully before you decide whether or not you wish to take part.

What is the study about?
This study aims to investigate the significant factors (e.g. social, organisational, environmental and technical) that may support or challenge the adoption of Agile in small and medium-sized software companies in Saudi Arabia, with the specific focus on mobile application development projects.

Why have I been invited?
You have been approached to participant because you are an member of a mobile app development team who adopt Agile and work in software organisation in Saudi Arabia so that this study reflects the point of view of participants which will be used to achieve the study's aim and to shape the sequential studies of my project research. For this reason, we would like to interview you or invite you to a focus group to discuss this.

What will I be asked to do if I take part?
If you decide to take part in the interview, you will be interviewed online by me, the researcher, at your convenient time and will last for about 30-60 minutes. While if you decide to take part in the focus group, you will be interviewed online by me, the researcher, with a group of 5 participants at a convenient time for all and will last for about 2 hours. The interview and the focus group will be held by Microsoft

Teams. I will send you the link of consent form before the interview or the focus group commences, and you will be asked to sign on it. This form is to confirm that you have read and received this information sheet and that you are willing to volunteer in this research.

What are the possible benefits from taking part?
This research will not benefit you directly, but our participation will be helpful and contributed to a better understanding of Agile adoption in Saudi Arabia mobile development market.

Do I have to take part?
No. It's completely up to you to decide whether or not you take part. Your participation is voluntary, and you are free to withdraw at any time during the interview or the focus group, without giving any reason.

What if I change my mind?
As explained above, you are free to withdraw at any time during the interview or the focus group and if you want to withdraw, I will extract any data you contributed to the study and destroy it. However, if you wish to withdraw after the interview or the focus group is completed, it is difficult and often impossible to take out data from one specific participant when this has already been anonymised or pooled together with other people's data. Therefore, you can only withdraw up to one week after taking part in the study.

Will my data be identifiable?
No, all data will be anonymised. After the interview or the focus group, the researcher conducting this study will have access to the information you share with me. I will keep all your personal information and your organisation's name confidential, that is I will not share it with others. Pseudonyms will be used for publications, presentations or any discussion with other researchers. Any personal information that can identify you will be removed.

How will my data be stored?
Your data will be stored in encrypted files and on a password-protected laptop. No-one other than me, the researcher, will be able to access them.

How will we use the information you have shared with us and what will happen to the results of the research study?
I will use the data you have shared with only in the following ways: I will use it for academic purposes only. This will include (e.g. my PhD thesis and other

publications). I may also present the results of my study at academic conferences. When writing up the findings from this study, I will only use anonymised quotes.

Who has reviewed the project?
This study has been reviewed and approved by the Faculty of Science and Technology Research Ethics Committee.

What if I have a question or concern?
If you have any queries or if you are unhappy with anything that happens concerning your participation in the study, please contact the researchers as follows:
Researcher: Fahad Altuwaijri
f.altuwaijri@lancaster.ac.uk
Supervisor: Dr Maria Angela Ferrario
m.a.ferrario@lancaster.ac.uk

If you have any concerns or complaints that you wish to discuss with a person who is not directly involved in the research, you can also contact:

Professor Adrian Friday
Head of Department, School of Computing and Communications
a.friday@lancaster.ac.uk

Thank you for considering your participation in this project.

B.5 Consent Form

I understand that any information given by me may be used in future reports, academic articles, publications or presentations by the researcher, but my personal information will not be included and I will not be identifiable.

Yes | No

I understand that my name/my organisation's name will not appear in any reports, articles or presentation without my consent.

Yes | No

I understand that any interviews or focus group will be audio-recorded and transcribed and that data will be protected on encrypted devices and kept secure.

Yes | No

I understand that data will be kept until the researcher finishes his course and will be completed destroyed by him.

Yes | No

I agree to take part in the above study.

Yes | No

By providing contact details, I understand that I will be contacted further by the researcher with updates about the study and participate in the subsequent studies.

Yes | No

Please type your name in the box below to indicate agreement to participate in this study.

Submit

B.6 Participant Debrief Sheet

Project Title: Investigating Agile Adoption in Saudi Arabian Software SMEs

Thank you for participating in the online interview/focus group which aims to investigate Agile adoption in mobile app development in Saudi Arabia. We hope that you have found it interesting and have not been upset by any of the topics discussed.

Personal data collected from you during this study will be treated as confidential; non-personal data will be used for research and cannot be confidential. Only I, the researcher, will have access to any data that may personally identify you, and pseudonyms will be used to protect your identity. Any personal data that needs to be retained will be kept securely.

As a reminder, you are free to withdraw your data from this study without any explanation up to one week after the date of the interview. You can do so by contacting the researcher, Fahad Altuwaijri. If you do so, your data will not be used in the study. Please note that it will not be possible to withdraw your data after one week has passed, as the data may already be integrated with other data and be impossible to identify and extract.

If you would like further information about the study or would like to know about what findings are when all the data have been collected and analysed, please do not hesitate to contact:

Fahad Altuwaijri, PhD student, School of Computing and Communications
Room B36, InfoLab21, Lancaster University, Lancaster, LA1 4WA, UK,
f.altuwaijri@lancaster.ac.uk

Fahad Altuwaijri, PhD student, School of Computing and CommunicationsDr Maria Angela Ferrario, Lecturer, School of Computing and Communications
Room C19, InfoLab21, Lancaster University, Lancaster, LA1 4WA, UK,
m.a.ferrario@lancaster.ac.uk

Alternatively, if you have any concern about this study and wish to speak to someone outside the study, you may contact:

Professor Adrian Friday, Head of Department, School of Computing and Communications
Room C57, InfoLab21, Lancaster University, Lancaster, LA1 4WA, UK,
a.friday@lancaster.ac.uk

Thank you for your cooperation.

Appendix C

Chapter 6: Evaluation of Agile Adoption Factors

C.1 Questionnaire Design (English Version)

Section 1: Demographics Information

Part 1.1: Participants' Information

- **Q1. Your gender:**
  - Male
  - Female
  - Prefer not to say
- **Q2. Your age:**
  - Below 23 years
  - 23 - 30 years
  - 31 - 39 years
  - Above 40 years
- **Q3. Your role: (Multiple Answers Allowed)**
  - Project manager (Scrum Master)
  - CEO
  - CIO/CTO
  - Developer

  - Tester
  - Designer
  - Other (please specify. . . . . .)

- **Q4. Years of experience in software development:**
  - Less than a year
  - 1 - 4 years
  - 5 - 10 years
  - More than 10 years
- **Q5. Years of experience in Agile software development:**
  - Less than a year
  - 1 - 4 years
  - 5 - 10 years
  - More than 10 years

Part 1.2: Work's Information

- **Q6. Number of employees in your organisation:**
  - 1 - 5 employees
  - 6 - 49 employees
  - 50 - 249 employees
  - More than 249 employees
- **Q7. Number of development teams you are working with:**
  - 1 team
  - 2 teams
  - 3 teams
  - More than 3 teams
- **Q8. Number of members in your development teams, in average:**
  - 1 - 5 members
  - 6 - 10 members
  - 11 - 20 members

  - More than 20 members

- **Q9. Market scope of your organisation:**
  - International
  - National
  - Local

Section 2: Influential Factors of Agile Adoption

To what extent do you agree with the following statements?
(strongly agree = 5; agree = 4; Neutral = 3; disagree = 2 and strongly disagree = 1)

Part 2.1: People Factors

Q9. Team capability	5	4	3	2	1
TeamCap1: Most of our team members have strong professional skills (i.e. interpersonal skills, communication skills, problem-solving skills).					
TeamCap2: Most of our team members have collaborative attitude.					
TeamCap3: Most of our team members have sense of responsibility.					
TeamCap4: Most of our team members have readiness to learn.					
TeamCap5: Most of our team members have great motivation.					
TeamCap6: Most of our team members are honest.					

Q10. Customer involvement	5	4	3	2	1
CusInv1: Our customers closely collaborate with our team members and commit to the project, i.e. they are motivated, active, and consider themselves to be responsible elements of the project.					
CusInv2: Our customers had full authority and knowledge to make decisions on-site, such as approving, disapproving, and prioritising project requirements and changes.					

Part 2.2: Knowledge Factors

Q11. Training and learning	5	4	3	2	1
TrainLearn1: Training events are conducted in our country to practitioners, customers and senior managers.					
TrainLearn2: Training events are conducted in our organisation to practitioners, customers and senior managers.					
TrainLearn3: Learning resources are available to us to get more knowledge of Agile.					

Q12. Awareness and knowledge	5	4	3	2	1
AwareKnow1: Our team members are aware and knowledgeable of Agile.					
AwareKnow2: Our management is aware and knowledgeable of Agile.					
AwareKnow3: Our customers are aware and knowledgeable of Agile.					

Part 2.3: Cultural Factors

Q13. Organisational culture	5	4	3	2	1
OrgCult1: Our organisation culture is flexible and participative, values teamwork, feedback and learning, and encourages social interaction.					
OrgCult2: The management style of our organisation does not have a hierarchical structure.					
OrgCult3: Our organisation is based on loyalty, mutual trust, and commitment.					
OrgCult4: Our organisation enables empowerment of people and teams.					

Q14. National culture	5	4	3	2	1
NationCult1: Saudi culture is based on flat structures and equality in power.					
NationCult2: Saudi People are in general communicative and collaborative.					
NationCult3: Saudi People are in general tend to avoid uncertainty and risk.					

Part 2.4: Organisational Factors

Q15. Management support	5	4	3	2	1
MangSupp1: Our team receives strong executive support. "Executive" may mean the whole Board of Directors or the CEO, CFO, CIO, etc. who influenced the decision-making.					
MangSupp2: Our team has committed sponsors or a committed organisation manager. An example of a committed sponsor/manager is one who would stand up to critics and vouch for the Agile method in a non-agile organizational environment.					
MangSupp3: Our management team provides us with the time for training that we needed in order to use Agile methods effectively.					

MangSupp4: Our management team provides us with funding for training that we needed in order to use Agile methods effectively.					

Q16. Communication and collaboration	**5**	**4**	**3**	**2**	**1**
CommColl1: Our organisation has mechanisms that enable us to communicate and collaborate quickly and effectively with each other, operations, support, customers, management, and business areas.					
CommColl2: Normally (e.g. pre-covid), communication and collaboration in our team is face-to-face.					
CommColl3: Normally (e.g. pre-covid), communication and collaboration in our team happen between people who were physically close to one another.					
CommColl4: Most people in our team are amicable to each other to such an extent that they communicate and collaborate with each other with trust and good will.					

Part 2.5: Environmental Factors

Q17. Organisational environment	**5**	**4**	**3**	**2**	**1**
OrgEnv1: Our organisation has a reward system appreciative of Agile behaviour.					
OrgEnv2: Our organisational environment encourages us to be more confident to share our opinions openly without fear of judgment.					

Q18. Physical environment	**5**	**4**	**3**	**2**	**1**
PhyEnv1: Our team is collocated, i.e. all team members worked in the same location for ease of communication and casual					
PhyEnv2: Our team works in a facility with proper Agile-style work environment, e.g. a dedicated office with pair programming workstations, social spaces, ample wall spaces for postings, no separate cubicles or offices.					

Part 2.6: Technical Factors

Q19. Tools and Technologies	**5**	**4**	**3**	**2**	**1**
ToolTech1: Appropriate tools and technologies are available to us to support our teamwork.					
CMB: Please, answer this question by clicking ‘disagree’.					

Part 2.7: Process Factors

Q20. Delivery Strategy	5	4	3	2	1
DelStr1: In my experience, the regular delivery of working software has encouraged our team to adopt Agile.					
DelStr2: The strategy of delivering most important features first encourages our team to adopt Agile.					

Q21. Agile Software Techniques	5	4	3	2	1
AgileTech1: Agile techniques (e.g. regular and short meetings; simple design; right amount of documentation) encourage our team to adopt Agile.					
AgileTech2: Techniques practiced in Agile are compatible with our working style.					

Section 3: Relative Advantage of Agile Adoption

To what extent do you agree with the following statements?

Q23. Agile Adoption (Relative advantage)	5	4	3	2	1
AgileAdopt1: Agile Adoption in our organisation has enhanced our team to improve software quality.					
AgileAdopt2: Agile Adoption in our organisation has enabled our team to reduce development costs.					
AgileAdopt3: Agile Adoption in our organisation has accomplished our team to reduce time to delivery.					
AgileAdopt4: Adoption in our organisation has improved our team productivity and morale.					
AgileAdopt5: Agile Adoption in our organisation has achieved our customers' needs and requirements.					

Thank you for participating in this study.

C.2 Questionnaire Design (Arabic Version)

السلام عليكم ورحمة الله وبركاته...
أولا أعرفك بنفسي، أنا فهد التويجري ، طالب دكتوراه في جامعة لانكستر في قسم علوم الحاسب. أود أن أدعوك للمشاركة في هذه الدراسة التي تبحث في العوامل التي تؤثر على اعتماد الأجايل في صناعة البرمجيات في المملكة العربية السعودية.

فضلا وليس أمراً، أرجوا قراءة المعلومات التالية بعناية قبل اتخاذك القرار بالمشاركة.

تهدف هذه الدراسة إلى التحقيق في العوامل المؤثرة (مثل الأشخاص والمعرفة والتنظيمية والثقافية والبيئية والعملية والتقنية) التي قد تدعم أو تتحدى اعتماد الأجايل في شركات البرمجيات الصغيرة والمتوسطة في المملكة العربية السعودية.

لقد تم التواصل معك بسبب أنك من ممارسي البرمجيات الذين يستخدمون الأجايل ويعملون في الشركات البرمجية الصغيرة والمتوسطة الحجم في المملكة العربية السعودية ، وهو محور هذه الدراسة.

تمت مراجعة هذه الدراسة والموافقة عليها من قبل لجنة أخلاقيات البحث بكلية العلوم والتكنولوجيا بجامعة لانكستر.

إذا كان لديك أي استفسارات أو إذا لم تكن راضيًا عن أي شيء يحدث فيما يتعلق بمشاركتك في الدراسة ، فيرجى الاتصال بالباحثين على النحو التالي:
الباحث: فهد التويجري
f.altuwaijri@lancaster.ac.uk
المشرفة: الدكتورة ماريا أنجيلا فيراريو
m.a.ferrario@lancaster.ac.uk

القسم الأول: المعلومات العامة

الجزء 1.1: معلومات عامة عن المشاركين

1. الجنس:
- ○ ذكر
- ○ أنثى
- ○ غير محدد

2. العمر:
- ○ أقل من 23 عام
- ○ 23 – 30 عام
- ○ 31 – 39 عام
- ○ أكبر من 40 عام
- □ غير ذلك (أرجو التوضيح .....)

3. دورك في فريق العمل: (يمكنك اختيار أكثر من إجابة)

- ☐ مدير مشروع
- ☐ CEO
- ☐ CIO/CTO
- ☐ مطور
- ☐ Tester
- ☐ مصمم
- ☐ غير ذلك (أرجو التوضيح .....)

4. خبرة العمل في مجال تطوير البرمجيات:

- ○ أقل من سنة
- ○ 1 – 4 سنوات
- ○ 5 – 10 سنوات
- ○ أكثر من 10 سنوات

5. خبرة العمل في مجال تطوير الأجايل:

- ○ أقل من سنة
- ○ 1 – 4 سنوات
- ○ 5 – 10 سنوات
- ○ أكثر من 10 سنوات

الجزء 1.2: معلومات عامة عن الشركات

6. عدد الموظفين في الشركة التي تعمل لديها:

- ○ 1 – 5 موظف
- ○ 6 – 49 موظف
- ○ 50 – 249 موظف
- ○ أكثر من 249 موظف

7. عدد فرق العمل التي تعمل فيها:

- ○ فريق عمل واحد
- ○ فريقين عمل
- ○ 3 فرق
- ○ أكثر من 3 فرق

8. متوسط عدد الأعضاء في فرق التطوير التي تعمل فيها:

- ○ 1 – 5 عضو
- ○ 6 – 10 عضو
- ○ 11 – 20 عضو
- ○ أكثر من 20 عضو

9. نطاق عمل الشركة:

- ○ عالمي
- ○ وطني
- ○ محلي

القسم الثاني: العوامل المؤثرة على تبني الأجايل

إلى أي مدى تتفق مع العبارات التالية في جميع الأسئلة في هذا القسم؟
(أوافق بشدة = 5 ؛ أوافق = 4 ؛ محايد = 3 ؛ أعترض = 2 ؛ أعارض بشدة = 1)

الجزء 2.1: العوامل المتعلقة بالناس

10. قدرات فريق العمل	5	4	3	2	1
يتمتع معظم أعضاء فريقنا يتمتع بمهارات مهنية عالية (مثل: مهارات التعامل مع الآخرين ، ومهارات الاتصال ، ومهارات حل المشكلات).					
يتمتع معظم أعضاء فريقنا بسلوك تعاوني.					
يشعر معظم أعضاء فريقنا بالمسؤولية.					
معظم أعضاء فريقنا لديهم استعداد للتعلم.					
معظم أعضاء فريقنا لديهم دافع كبير.					
معظم أعضاء فريقنا صادقون.					
11. مشاركة العملاء في فريق العمل	**5**	**4**	**3**	**2**	**1**
عملاؤنا يتعاونون بشكل وثيق مع أعضاء فريقنا و يلتزمون بالمشروع، أي أنهم متحمسون ونشطون ويعتبرون أنفسهم عناصر مسؤولة في المشروع.					
يتمتع عملاؤنا بالسلطة والمعرفة الكاملة لاتخاذ القرارات في الموقع، مثل الموافقة على متطلبات وتغييرات المشروع ورفضها وتحديد أولوياتها.					

الجزء 2.2: العوامل المتعلقة بالمعرفة

12. التدريب والتعلم	5	4	3	2	1
يتم تقديم الأحداث التدريبية للممارسين والعملاء وأعضاء الإدارة في السعودية					
يتم تقديم الأحداث التدريبية للممارسين والعملاء وأعضاء الإدارة في مؤسستنا.					
مصادر التعلم متاحة لنا للحصول على مزيد من المعرفة عن الأجايل.					
13. الوعي والمعرفة	**5**	**4**	**3**	**2**	**1**
أعضاء فريقنا على علم ومعرفة بمنهجية الأجايل.					
فريق الإدارة العليا في شركتنا على دراية ومعرفة بمنهجية الأجايل.					
عملاؤنا على علم ومعرفة بمنهجية الأجايل.					

الجزء 2.3: العوامل المتعلقة بالثقافة

14. الثقافة التنظيمية	5	4	3	2	1
تتسم ثقافة مؤسستنا بالمرونة والمشاركة ، وتقدر العمل الجماعي والملاحظات والتعلم ، وتشجع التفاعل الاجتماعي.					
لا يحتوي أسلوب إدارة منظمتنا على هيكل هرمي.					
تقوم منظمتنا على أساس الولاء والثقة المتبادلة والالتزام.					
تمكن منظمتنا من تمكين الأفراد والفرق.					
15. الثقافة الوطنية	**5**	**4**	**3**	**2**	**1**
تقوم الثقافة السعودية على الهياكل المسطحة والمساواة في السلطة.					
الشعب السعودي بشكل عام متواصل ومتعاون.					
يميل السعوديون بشكل عام إلى تجنب عدم اليقين والمخاطر.					

الجزء 2.4: العوامل التنظيمية

16. الدعم الاداري	5	4	3	2	1
يتلقى فريقنا دعمًا تنفيذيًا قويًا. قد تعني كلمة "تنفيذي" مجلس الإدارة بأكمله أو الرئيس التنفيذي والمدير المالي ورئيس قسم المعلومات ، وما إلى ذلك ، الذين أثروا في اتخاذ القرار.					
لقد التزم فريقنا برعاية أو مدير منظمة ملتزم. مثال على الراعي / المدير الملتزم هو الشخص الذي سيواجه النقاد ويضمن عمل الأسلوب الرشيق في بيئة تنظيمية غير رشيقة.					
يوفر لنا فريق الإدارة الوقت للتدريب الذي نحتاجه من أجل استخدام أساليب الأجايل بشكل فعال.					
يوفر لنا فريق الإدارة التمويل للتدريب الذي نحتاجه من أجل استخدام أساليب الأجايل بشكل فعال.					
17. التواصل والتعاون	**5**	**4**	**3**	**2**	**1**
تمتلك منظمتنا آليات تمكننا من التواصل والتعاون بسرعة وفعالية مع بعضنا البعض ، والعمليات ، والدعم ، والعملاء ، والإدارة ، ومجالات العمل.					
عادة (على سبيل المثال ، ما قبل كوفيد) ، يكون التواصل والتعاون في فريقنا وجهًا لوجه.					
عادة (على سبيل المثال ، ما قبل كوفيد) ، يحدث التواصل والتعاون في فريقنا بين الأشخاص الذين كانوا قريبين جسديًا من بعضهم البعض.					
معظم الأشخاص في فريقنا ودودون مع بعضهم البعض لدرجة أنهم يتواصلون ويتعاونون مع بعضهم البعض بثقة وحسن نية.					

الجزء 2.5: العوامل المتعلقة بالبيئة التنظيمية

18. البيئة التنظيمية	5	4	3	2	1
منظمتنا لديها نظام مكافأة يقدر السلوك الرشيق (الأجايل).					
تشجعنا بيئتنا التنظيمية على أن نكون أكثر ثقة في مشاركة آرائنا بصراحة دون خوف من الحكم.					
19. البيئة الفيزيائية	**5**	**4**	**3**	**2**	**1**
يتم تجميع فريقنا ، أي عمل جميع أعضاء الفريق في نفس الموقع لسهولة التواصل والاتصال غير الرسمي والمستمر.					
يعمل فريقنا في منشأة ذات بيئة عمل مناسبة لإسلوب الأجايل، على سبيل المثال: مكتب مخصص به مواقع عمل للبرمجة الإزدواجية ، ومساحات اجتماعية ، ومساحات جدارية واسعة للإعلانات ، ولا توجد مقصورات أو مكاتب منفصلة.					

الجزء 2.6: العوامل المتعلقة بالتقنية

20. الأدوات	5	4	3	2	1
تتوفر لنا الأدوات والتقنيات المناسبة لدعم العمل الجماعي لدينا ، مما يتيح لنا اعتماد أساليب الأجايل.					
من فضلك أجب على هذا السؤال بالضغط على " غير موافق."					

الجزء 2.7: العوامل المتعلقة بالعمليات

21. استراتيجية التسليم	5	4	3	2	1
من واقع خبرتي ، فإن التسليم المنتظم لبرامج العمل شجع فريقنا على اعتماد الأجايل.					
تشجع استراتيجية تقديم المميزات الأكثر أهمية أولاً، فريقنا على اعتماد الأجايل.					
22. تقنيات برمجيات الأجايل	**5**	**4**	**3**	**2**	**1**
تشجع التقنيات الرشيقة (الأجايل) (على سبيل المثال ، الاجتماعات المنتظمة والقصيرة ، والتصميم البسيط ، والكمية المناسبة من الوثائق) فريقنا على اعتماد الأجايل.					
تتوافق التقنيات التي يتم ممارستها في الأجايل مع أسلوب العمل لدينا.					

القسم الثالث: المييزات المتعلقة بتبني الأجايل

إلى أي مدى تتفق مع العبارات التالية؟

23. تبني الأجايل (المميزات المتعلقة)	5	4	3	2	1
عزز اعتماد الأجايل في مؤسستنا لفريقنا لتحسين جودة البرامج.					
سمح اعتماد الأجايل في مؤسستنا لفريقنا بتقليل تكاليف التطوير.					
حقق اعتماد الأجايل في مؤسستنا لفريقنا لتقليل الوقت المستغرق للتسليم.					
أدى اعتماد الأجايل في منظمتنا إلى تحسين إنتاجية فريقنا ومعنوياته.					
حقق تبني الأجايل في مؤسستنا إحتياجات ومتطلبات عملائنا.					

شكراً لك على المشاركة في هذه الدراسة.

C.3 Ethics Approval

Lancaster University

Applicant: Fahad Altuwaijri
Supervisor: Maria Angela Ferrario
Department: SCC
FSTREC Reference: FST20126

04 June 2021

Re: FST20126 (Amendment to FST20028)
Investigating Agile Adoption in Saudi Arabian Software industry

Dear Fahad,

Thank you for submitting your research ethics amendment application for the above project for review by the **Faculty of Science and Technology Ethics Committee (FSTREC)**. The application was recommended for approval by FSTREC, and on behalf of the Chair of the Committee, I can confirm that approval has been granted for the amendment to this research project.

As principal investigator your responsibilities include:

- ensuring that (where applicable) all the necessary legal and regulatory requirements in order to conduct the research are met, and the necessary licenses and approvals have been obtained;
- reporting any ethics-related issues that occur during the course of the research or arising from the research to the Research Ethics Officer at the email address below (e.g. unforeseen ethical issues, complaints about the conduct of the research, adverse reactions such as extreme distress);
- submitting details of proposed substantive amendments to the protocol to the Research Ethics Officer for approval.

Please contact me if you have any queries or require further information.

Email: fst-ethics@lancaster.ac.uk

Yours sincerely,

T. Morley

Tom Morley,
Research Ethics Officer, Secretary to FSTREC.

C.4 Personal Information Sheet

Lancaster University

Faculty of Science and Technology
School of Computing and Communications

For further information about how Lancaster University processes personal data for research purposes and your data rights please visit our webpage: www.lancaster.ac.uk/research/data-protection

I am Fahad Altuwaijri, a PhD student at Lancaster University. I would like to invite you to take part in this study investigating the factors influencing the adoption of Agile in the Saudi Arabian software industry.

Please take time to read the following information carefully before you decide whether or not you wish to take part.

What is the study about?
This study aims to investigate the significant factors (e.g. people, knowledge, organisational, cultural, environmental, process and technical) that can support or challenge the adoption of Agile in small and medium-size software companies in Saudi Arabia.

Why have I been invited?
You have been approached to participate because you are a software practitioner who adopted Agile and working in a software development SME in Saudi Arabia so that this study reflects the point of view of participants which will be used to achieve the study's aim.

What will I be asked to do if I take part?
If you decided to take part, this questionnaire will take approximately 15 minutes in which you will be asked to answer a number of questions.

What are the possible benefits from taking part?
This research will not benefit you directly, but our participation will be helpful and contributed to a better understanding of the influential factors on Agile adoption in

Saudi software development organisations.

Do I have to take part?
No. It's completely up to you to decide whether or not you take part. Your participation is voluntary, and you are free to withdraw at any time during the study, without giving any reason.

What if I change my mind?
As explained above, you are free to withdraw at any time without the need to give an excuse prior to submitting your participation by simply abandoning the survey and close the browser window. To have your responses included, please click the "submit" button at the end of the survey. If you change your mind after submitting your participation, the researcher will not able to delete your data because the survey will be anonymous, and thus, it will be difficult to identify your data.

What are the possible disadvantages and risks of taking part?
There are no disadvantages and risks, completely.

Will my data be identifiable?
Certainly, no. Only I, the researcher conducting this study will have access to the data you share with me. The data will be numerically coded and kept on a password protected computer system.

How will my data be stored?
Your data will be stored in encrypted files (that is no-one other than me, the researcher will be able to access them) and on a password-protected laptop.

How will we use the information you have shared with us and what will happen to the results of the research study?
I will use the data you have shared with only in the following ways: I will use it for academic purposes only. This will include (e.g. my PhD thesis and other publications). I may also present the results of my study at academic conferences.

Who has reviewed the project?
This study has been reviewed and approved by the Faculty of Science and Technology Research Ethics Committee.

What if I have a question or concern?
If you have any queries or if you are unhappy with anything that happens concerning your participation in the study, please contact the researchers as follows:

Researcher: Fahad Altuwaijri
f.altuwaijri@lancaster.ac.uk
Supervisor: Dr Maria Angela Ferrario
m.a.ferrario@lancaster.ac.uk

If you have any concerns or complaints that you wish to discuss with a person who is not directly involved in the research, you can also contact:

Professor Adrian Friday
Head of Department, School of Computing and Communications
a.friday@lancaster.ac.uk

Thank you for considering your participation in this project.

C.5 Consent Form

English

Consent Form

Project Title: Investigating the Influential Factors of Agile Adoption in the Saudi Software Industry
Name of Researcher: Fahad Altuwaijri
Email: f.altuwaijri@lancaster.ac.uk

Before participating in this study, please read and accept the information below.

By clicking the "I consent" button below you are indicating that:

- You have read and understood the description of the study.
- You have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.
- You understand that any information given by you may be used in future reports, academic articles, publications or presentations by the researcher, but your personal information will not be included and you will not be identifiable.
- You understand that data will be protected on encrypted devices and kept secure.
- You understand that your participation is voluntary and that you are free to withdraw from the study at any time, without giving any reason prior to submitting your participation by simply abandoning the survey and close the browser window.

I consent to take part in this survey

I don't consent to take part in this survey

← →

C.6 Discriminant Validity (Cross-Loading Approach)

		AA	AST	AK	CC	CI	DS	MS	NC	OE	OC	PE	TC	TT	TL
AA	AgileAdopt1	**0.649**	-0.19	-0.059	0.21	0.287	0.45	0.085	0.325	0.288	0.174	0.07	-0.382	0.175	0.113
	AgileAdopt2	**0.686**	0.242	0.395	0.235	0.344	0.179	0.201	0.081	0.389	0.333	0.074	-0.211	0.187	0.038
	AgileAdopt3	**0.812**	0.073	0.156	0.403	0.415	0.349	0.242	0.054	0.465	0.299	0.1	-0.208	0.236	0.251
	AgileAdopt4	**0.801**	0.121	0.475	0.388	0.499	0.215	0.396	0.215	0.499	0.413	0.31	-0.205	0.405	0.38
	AgileAdopt5	**0.668**	-0.13	0.399	0.48	0.379	0.418	0.372	0.127	0.491	0.432	0.202	-0.013	0.116	0.231
AST	AgileTech1	0.039	**0.952**	0.325	0.094	0.101	0.082	0.17	-0.02	0.126	0.126	0.087	0.106	0.014	0.153
	AgileTech2	0.019	**0.781**	0.405	0.266	0.057	0.043	0.239	-0.06	0.23	0.224	0.149	0.225	0.106	0.084
AK	AwareKnow1	0.341	0.303	**0.900**	0.634	0.345	0.339	0.586	0.019	0.493	0.653	-0.006	0.37	0.139	0.432
	AwareKnow2	0.414	0.225	**0.766**	0.489	0.421	0.289	0.447	0.086	0.549	0.602	0.054	0	0.251	0.151
	AwareKnow3	0.183	0.448	**0.743**	0.168	0.088	-0.01	0.313	-0.1	0.152	0.264	-0.022	0.207	0.163	0.338
CC	CommColl1	0.436	0.14	0.443	**0.889**	0.467	0.388	0.674	0.157	0.683	0.668	0.141	0.109	0.312	0.239
	CommColl4	0.411	0.158	0.555	**0.876**	0.461	0.316	0.609	0.026	0.654	0.637	0.182	0.272	0.295	0.3
CI	CusInv1	0.49	0.085	0.301	0.412	**0.888**	0.529	0.3	0.163	0.476	0.442	0.201	-0.005	0.272	0.127
	CusInv2	0.457	0.084	0.34	0.516	**0.870**	0.39	0.447	0.066	0.59	0.582	0.11	-0.06	0.127	0.139
DS	DelivStrat1	0.42	0.143	0.319	0.423	0.504	**0.946**	0.197	0.224	0.426	0.461	0.091	0.062	0.284	0.156
	DelivStrat2	0.403	0	0.199	0.329	0.487	**0.941**	0.064	0.153	0.317	0.375	0.066	-0.053	0.248	0.084
MS	ManagSup1	0.297	0.217	0.506	0.695	0.369	0.157	**0.824**	0.164	0.728	0.73	0.172	0.127	0.242	0.205
	ManagSup2	0.4	0.181	0.494	0.645	0.352	0.175	**0.805**	0.213	0.642	0.644	0.387	0.013	0.372	0.406
	ManagSup3	0.195	0.012	0.253	0.474	0.334	0.084	**0.739**	0.047	0.446	0.488	0.169	0.126	0.054	0.357
	ManagSup4	0.224	0.238	0.501	0.383	0.245	-0.03	**0.748**	0.03	0.46	0.482	0.217	0.142	0.05	0.426
NC	NationCult2	0.162	0.026	0.013	0.039	0.019	0.131	0.045	**0.801**	0.084	0.156	0.207	-0.209	0.328	0.012
	NationCult3	0.215	-0.075	0.001	0.127	0.179	0.204	0.205	**0.917**	0.216	0.259	0.352	-0.031	0.241	0.224
OE	OrgEnv1	0.57	0.195	0.423	0.714	0.572	0.446	0.684	0.204	**0.946**	0.66	0.348	0.041	0.284	0.419
	OrgEnv2	0.55	0.141	0.539	0.718	0.568	0.296	0.738	0.148	**0.941**	0.779	0.326	-0.076	0.329	0.304
OC	OrgCult1	0.499	0.16	0.619	0.655	0.469	0.407	0.716	0.272	0.644	**0.880**	0.2	0.022	0.252	0.488
	OrgCult2	0.421	0.086	0.532	0.577	0.466	0.363	0.613	0.148	0.668	**0.768**	0.003	-0.071	0.169	0.096
	OrgCult3	0.312	0.111	0.419	0.536	0.484	0.297	0.531	0.086	0.593	**0.777**	0.185	0.038	0.338	0.199
	OrgCult4	0.252	0.219	0.53	0.648	0.492	0.376	0.645	0.288	0.59	**0.849**	0.201	0.101	0.348	0.329
PE	PhyEnv1	0.094	0.085	0.01	-0.006	-0.007	-0.01	0.212	0.285	0.124	0.027	**0.888**	-0.103	0.178	0.114
	PhyEnv2	0.253	0.125	0.009	0.234	0.229	0.11	0.326	0.339	0.415	0.22	**0.989**	-0.06	0.349	0.142
TC	TeamCap2	-0.14	-0.107	0.25	0.178	-0.083	0.077	0.151	-0.32	-0.024	0.035	-0.17	**0.606**	-0.14	0.088
	TeamCap3	-0.281	0.186	0.308	0.151	-0.033	0.057	0.088	-0.16	-0.034	0.031	-0.028	**0.894**	0.082	-0.067
	TeamCap4	-0.209	0.184	0.065	0.134	-0.011	-0.1	0.07	0.098	-0.019	-0.003	-0.017	**0.686**	0.183	-0.09
	TeamCap5	-0.157	0.144	0.145	0.217	0.009	-0.01	0.089	-0.01	0.042	0.019	-0.058	**0.805**	0.048	-0.084
TT	ToolsTech1	0.322	0.05	0.221	0.344	0.23	0.282	0.258	0.316	0.324	0.331	0.319	0.082	**1.000**	0.028
TL	TrainLearn1	0.047	0.153	0.151	0.147	0.034	-0	0.195	-0.12	0.229	0.081	0.003	-0.044	-0.176	**0.622**
	TrainLearn2	0.327	0.074	0.443	0.396	0.192	0.097	0.518	0.21	0.466	0.477	0.101	-0.065	0.029	**0.936**
	TrainLearn3	0.196	0.2	0.187	0.019	0.041	0.189	0.126	0.117	0.069	0.035	0.213	-0.035	0.124	**0.735**