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Factors affecting Agile adoption: An industry research study of the mobile app sector in Saudi Arabia ☆

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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 have been widely researched. However, most of these studies have been conducted in developed countries, particularly Europe and North America, with only a handful carried out in developing countries, including 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 heavy investment in this industry in recent years to diversify its oil-dependent economy. Therefore, this study empirically investigates the factors influencing Agile adoption by Saudi Arabian software small and medium-sized enterprises (SMEs). To this end, in-depth interviews were conducted with 12 software practitioners from three software SMEs. Our findings reveal that human factors, such as customer involvement, team capability, organisational culture and national culture, are considered the most impactful factors affecting the adoption of Agile as opposed to technical ones, such as the availability of specific tools or techniques.

1. Introduction

Agile software development has been widely adopted in both the industry and research as it helps reduce time to market and costs of software products, and improve customer satisfaction. In particular, Agile has brought a significant change to software development by providing adaptive, iterative, incremental and people-oriented approaches, where demands and solutions evolve through the collaboration of self-organising cross-functional teams (Abbas et al., 2008; Beck et al., 2001; Highsmith, 2002; Larman and Basili, 2003). Agile also offers different methods, such as Scrum, Crystal and Extreme Programming, which respond to customers' changing needs rapidly and flexibly (Sommerville, 2016).

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 homogeneous 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 its 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).

Research shows that the adoption and implementation of Agile methods are affected by several aspects, including social and technical factors (Begel and Nagappan, 2007; Chow and Cao, 2008; Tam et al., 2020; Salo and Abrahamsson, 2008; Rodríguez et al., 2012; Sheffield and Lemétayer, 2013; Santos et al., 2016; Chiyangwa and Mnkandla, 2017; Vithana et al., 2018; Stankovic et al., 2013). 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; Tam et al., 2020; Salo and Abrahamsson, 2008; Rodríguez et al., 2012; Sheffield and Lemétayer, 2013; Santos et al., 2016), with only a handful being carried out in developing countries (Chiyangwa and Mnkandla, 2017; Vithana et al., 2018; Stankovic et al., 2013; Salinas et al., 2018), particularly in the Middle East. This is problematic, specifically in the case of Saudi Arabia, which has been heavily investing in the software industry

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in recent years, as it is seen as a strategic sector for diversifying its oil-dependent economy (Vision2030, 2017; Moshashai et al., 2020; Vision2030NTP, 2018), but where the adoption of Agile is still low (Altuwaijri and Ferrario, 2021). As reported above, Agile is a values-based and principled approach to software development that emanated from a rather homogeneous Western worldview. In contrast, 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 wider society and in the workplace (Idris, 2007; Abdullah et al., 2006; Al-Saggaf, 2004).

Therefore, the purpose of this study is to gain deeper insight into the enablers and barriers of Agile adoption in Saudi Arabia. Specifically, it focuses on software development companies in the small and medium-sized enterprise (SME) sector. Within this context, we focus on mobile development practice, one of the fastest-growing sectors of the software industry both worldwide (Ahmad et al., 2018; Statista, 2020b,a) and in Saudi Arabia (Ernst & Young Global Limited, 2019). The Saudi government and businesses are heavily investing in the Saudi mobile app market (Vision2030NTP, 2018), which is expected to provide significant opportunities for the market's growth. Forecast to achieve sales and profits exceeding 10 billion SR (Saudi Riyals) by 2030 to contribute effectively to the national economy, it has become one of the main pillars of Saudi's Vision 2030 (Vision2030, 2017; Mobile Apps Market, 2018). However, designing and developing mobile apps requires effective project management and this is a particularly competitive, uncertain and dynamic market environment (Corral et al., 2015), hence researchers have started to investigate the best ways to manage mobile app development, with a number of studies finding Agile one of the most suitable approaches for the purpose (Santos et al., 2016; Ahmad et al., 2018; Wasserman, 2010; Rahimian and Ramsin, 2008; Kaleel and Harishankar, 2013; Corral et al., 2013).

To achieve the aim of this study, we conducted an empirical investigation of Agile adoption factors in a real-life context, to provide a better understanding of them and their influence on the adoption of Agile within the Saudi Arabian software industry. This investigation was conducted through semi-structured interviews with 12 Agile experts from three software SMEs to explore their viewpoints about the influential factors. Empirical research can provide data to guide the future direction of software engineering and enhance the depth of scientific knowledge in the field.

This study contributes to Agile adoption literature, by providing insights into the enablers and barriers influencing Agile adoption in Saudi software SMEs. From a software engineering practice standpoint, the findings can be used to support around decision making Agile adoption in Saudi Arabia, and in the wider Middle Eastern context—particularly Gulf Cooperation Council nations. From software engineering research perspective, these findings can inform and shape the design and development of an Agile adoption framework better tailored to Middle Eastern software development industry, which can be used by Agile researchers in the future.

The remainder of the paper is organised as follows. In the next section, the related literature is reviewed, and the enablers and barriers of Agile adoption currently investigated are identified and summarised. Next, the research methods and context are described. Subsequently, the findings are presented and the discussion ensues. The paper concludes with limitations and suggestions for future work.

2. Related work

This section aims to understand the enablers of and barriers to the adoption of Agile and how they influence its adoption, since there is a need to investigate these factors for different cultures, organisations and environments. It is essential to study the influential factors related to the adoption of Agile in developing software projects. This is because such understanding will help determine to what extent Agile can be adopted and how it influences the success of projects.

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 Hoda et al. (2011), Iivari and Iivari (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; Ozawa and Zhang, 2013; Misra et al., 2009). 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 influential 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 experience are critical factors for Agile adoption (Javdani Gandomani and Ziaei Nafchi, 2016; Ayed et al., 2017; Lindvall et al., 2002). These include the ability of team members to work together efficiently and effectively to develop Agile software projects and to work with uncertain objectives (Sheffield and Lemétayer, 2013; Chagas et al., 2015; Conboy et al., 2011; Cockburn and Highsmith, 2001; Asnawi et al., 2012). 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 the 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 Chow and Cao (2008), Misra et al. (2009) and Vithana et al. (2018). Furthermore, Sheffield and Lemétayer (2013) who conducted a mixed-method approach to investigate the factors associated with the success of Agile projects in the context of developed countries (USA, New Zealand and Australia) found that clients' involvement influences the success of Agile practice and adoption. In addition, the results of another study carried out by Stankovic et al. (2013) revealed that customer involvement had an impact on the Agile approach and adoption within software organisations in the former Yugoslavian countries.

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 early adopters (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 Altuwaijri and Ferrario (2021), Wan and Wang (2010), Misra et al. (2009) and Livermore (2008). Our previous study (Altuwaijri and Ferrario, 2021), conducted among mobile app practitioners to investigate the awareness, current usage and perceptions of Agile, found that there was currently little awareness of Agile

among practitioners, as its adoption is in the early stages in the country. These studies outlined above 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, according to Robinson and Sharp (2005a), Tolfo and Wazlawick (2008), Strode et al. (2009), and Iivari and Iivari (2011) organisational culture and environment are critical success factors in the adoption and use of Agile. A collaborative culture and an appropriate reward system have been found to support an Agile-friendly environment, as has 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, 2005a). A study conducted by Sheffield and Lemétayer (2013) established organisational culture as critical in Agile software development, as a significant force propelling Agile forward.

The support of senior management, good communication flow and collaboration also play a significant role in achieving a 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 the success of 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 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 social skills and collaboration (Robinson and Sharp, 2005b).

As previously mentioned, 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. Begel and Nagappan, 2007; Chow and Cao, 2008; Tam et al., 2020; Salo and Abrahamsson, 2008; Rodríguez et al., 2012; Sheffield and Lemétayer, 2013; Santos et al., 2016) and only a handful conducted in developing countries, in particular, Asian nations (e.g. Vithana et al., 2018; Wan and Wang, 2010; Nanthaamornphong and Wetprasit, 2016). None of these 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. 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, according to Lindvall et al. "*Agile methods need cultural support otherwise they will not succeed*" (Idris, 2007, p. 206). This means that Agile may not necessarily be suitable for all cultures. Therefore, one of the objectives of this research is to re-orientate the focus of the Agile studies towards emerging economies, using Saudi Arabia as a case study, to investigate the influential factors impacting Agile adoption within software development companies there.

2.1. The key factors of Agile adoption

Some empirical studies have investigated significant factors in adopting and using Agile in different contexts, which were discussed in the previous section. For example, a survey study conducted by Chow and Cao (2008) identified the most impactful factors in Agile software projects from 109 Agile professionals' perspectives, mainly from the Americas and Europe. They identified six factors, from the many identified in the literature, affecting the success of Agile, namely delivery strategy, Agile software techniques, team capability, project management process, team environment, and customer involvement. Another empirical study (Misra et al., 2009) utilised a mixed-method approach using a survey with software practitioners worldwide to explore influential factors on Agile adoption. The results revealed that customer satisfaction, collaboration and commitment, decision time, corporate culture, control, personal characteristics, societal culture, and training and learning are critical factors influencing Agile adoption. Similarly, Wan and Wang (2010) argued that organisational culture, education and training and tool and technology are the essential factors that may affect Agile adoption, its usage and the success of software projects from the software practitioners' perspective in Hong Kong.

Before focusing our empirical study on the Saudi context, we review the factors impacting Agile adoption as reported in the literature and categorise them as shown in Table 1. We group these factors into four broad categories to support a more systematic and structured approach to data capture and analysis: people factors, organisational factors, environmental factors, and technical factors. We did so also the following literature, although we 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 also been classified as 'people factors' (Stankovic et al., 2013) or 'organisational factors' (Misra et al., 2009). The researchers do not consider this as an issue, since the categories (or types) have been used as a guide rather than as rigid classification criteria. Besides, studies have used different terms to explain and discuss similar factors. Thus, a uniform term was used to specify a particular factor. Due to the large set of factors discussed in the literature, this study only cited the influential ones mentioned in at least two studies.

Drawing on these factors identified in Table 1, a framework was designed for Agile adoption, as shown in Fig. 1. 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.

3. Research method

Dybåand Dingsøyr (2008) argue that there is a need for more empirical, evidence-based investigation of Agile software development in real-life contexts, as this enhances the depth of scientific knowledge in the field and helps to bridge the gap between

Table 1
Summary of the significant factors.

Category	Influential Factors	Literature
People Factors	Team capability	Chow and Cao (2008); Lindsjørn et al. (2016); Vithana et al. (2018); Sheffield and Lemétayer (2013); Misra et al. (2009)
	Customer involvement	Chow and Cao (2008); Vithana et al. (2018); Sheffield and Lemétayer (2013); Lindvall et al. (2002); Sheffield and Lemétayer (2013); Misra et al. (2009); Hoda et al. (2011)
	Training and learning	Livermore (2008); Wan and Wang (2010); Misra et al. (2009)
Organisational factors	Organisational culture	Robinson and Sharp (2005a); Tolfo and Wazlawick (2008); Strode et al. (2009); Iivari and Iivari (2011); Wan and Wang (2010); Sheffield and Lemétayer (2013); Misra et al. (2009)
	Management support	Dyck and Majchrzak (2012); Sheffield and Lemétayer (2013)
	Communication and collaboration	Wan and Wang (2010); Vithana et al. (2018); Dyck and Majchrzak (2012); Cockburn and Highsmith (2001); Sheffield and Lemétayer (2013)
Environmental Factors	Organisational environment	Chow and Cao (2008); Robinson and Sharp (2005a); Sheffield and Lemétayer (2013)
	Physical environment	Robinson and Sharp (2005a); Chow and Cao (2008)
	National culture	Ozawa and Zhang (2013); Misra et al. (2009); Ayed et al. (2017)
Technical Factors	Tools and technologies	Wan and Wang (2010); Vithana et al. (2018)
	Delivery strategy	Chow and Cao (2008); Stelzmann et al. (2010)
	Agile software techniques	Chow and Cao (2008); Stelzmann et al. (2010)

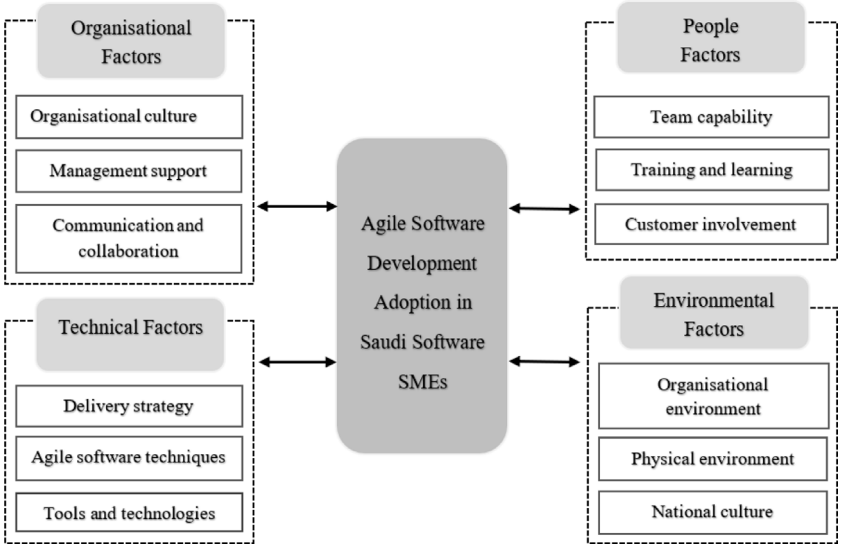

Fig. 1. The Proposed framework for Agile adoption factors.

research and practice. This study utilises empirical research and expands on the existing empirical studies carried out in the context of the enablers and barriers of Agile adoption (Chow and Cao, 2008; Sheffield and Lemétayer, 2013; Stankovic et al., 2013; Misra et al., 2009). Semi-structured interviews with 12 Agile experts were conducted to achieve the study's aim. Ethical approval was sought and obtained from the authors' institution following adherence to its rigorous procedures.

3.1. Research design

This study is explorative in nature and adopts a mixed-method design approach using semi-structured interviews which contained closed- and open-ended questions so to collect quantitative data in addition to qualitative data (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).

Interview questions were developed based on the reviewed literature, and complemented by our recent empirical research on awareness and perception of Agile in the Saudi software industry (Altuwaijri and Ferrario, 2021). The interviews were conducted online over six weeks with mobile app practitioners from three software SMEs. Each interview lasted about 40 to 70 min, resulting in a total of approximately 650 min of recorded material. A mixture of closed- and open-ended questions was used. The closed-ended questions were designed using the five-point Likert scale (i.e. very important = 5; important = 4; neutral = 3; slightly important = 2 and not important = 1), while the open-ended questions helped the researchers 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

Table 2
Overview of the companies.

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 apps types developed	Native, Hybrid, Web	Native, Hybrid	Native
Mobile platforms used	IOS, Android	IOS, Android	IOS, Android
Agile adopted (in years)	3	4	2

factors, environmental factors and technical factors), as well as prompting for any other additional factors. The last section focused on the interviewees' professional background. The interview guide of our study is provided in Appendix. 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.

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 Dybåand Dingsøyr (Turner, 2010), the pilot interviews' participants should be selected based on similar criteria to the group of participants for the main study. Thus, the pilot interviews were conducted with two mobile app practitioners of different positions (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, we reduced the recruitment criteria 'years of experience' from four 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.

3.2. Research context

The authors 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. Table 3 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 (according to Ministry of Commerce, 2016), 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 when, according to the project manager, its benefits elsewhere were noticed. He stated, *"We decided to adopt Agile in our mobile app teams when we noticed the benefits of Agile in other teams in the company"*.

The second company, **B**, is a local, small-sized software development company, specialising in web and mobile app development. 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, as it is more suited to the dynamic environment of the mobile app industry.

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, uses the Scrum method. Currently, there are 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"*.

3.3. Data analysis

The data collected from the interviews were captured using digital recorders, and notes were taken during the interviews. Audio content was transcribed verbatim by the researchers and compared with their notes. Analysis involved a deductive coding approach (Braun and Clarke, 2006; Boyatzis, 1998; Miles et al., 2014); first, the data was labelled with the four factor types identified from the literature, then their sub-themes. 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 (Field, 2017). Table 2 illustrates the themes and sub-themes of the interview data.

3.4. Participants and sampling

A purposive sampling approach was adopted in this study to select the interview participants (Saunders et al., 2018; Creswell and Creswell, 2018). 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. 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 participants number, 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 to 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 (Saunders et al., 2018; Ness and Fusch, 2015; Guest et al., 2020). We utilised the data saturation approach (Saunders et al., 2018) which refers to the point of redundancy in the data. By applying this approach, saturation was reached at 12 interviews.

Table 4 summarises the demographic information of each interviewee. Each interviewee was given a pseudonym. Thy were working in different roles, with the majority working as Developers (five participants). Two were Scrum Masters, and there

Table 3
The themes of the interview data.

Factor Type	Description	sub-themes
People	People factors relate to individuals and teams, such as mobile app practitioners and customers.	Team capability; Customer involvement; Training and learning; Awareness and knowledge
Organisational	Organisational factors relate to the firm level and the way organisations operate.	Organisational culture; Management support; Communication and collaboration.
Environmental	Environmental factors relate to the context in which organisations, and teams operate.	Organisational environment; Physical environment; National culture.
Technical	Technical factors relate to the process, tools and technologies that support Agile work.	Tools and technologies; Delivery strategy; Agile software techniques.

Table 4
The demographic information of interviewees.

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

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.

4. Findings

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

4.1. Opportunities and challenges of Agile adoption

A previous smaller pilot study (Altuwaijri and Ferrario, 2021), interviewed four experts on the reasons and challenges for Agile adoption in Saudi Arabia. This paper 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).

4.1.1. 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 *"the nature of developing mobile apps is highly competitive and dynamic"*. In this case, Agile was introduced to support and manage the dynamic and competitive nature of mobile app development. As discussed by the CEO of company B, *"there is stiff 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.

4.1.2. 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 adopting Agile. In this section we outline these challenges and further explore them in Section 3.3 to Section 2.1.

Culture of Organisations - The main challenge reported by this study 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 is 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.

4.2. 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 (Fig. 1), 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 below, 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 (Saunders et al., 2016; Jamieson, 2004).

Based on the descriptive analysis in the above table, the results indicate that all the investigated factors have a median of greater than three, except for two factors (i.e. delivery strategy and Agile software techniques). As illustrated in the above Figure, 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' was the third most important people factor with most of the interviewees (83.3%) agreeing with it.

Table 5
Median and range 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

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 has the largest percentage of agreement from the participants on its importance, as 25% of them said 'very important' while 66.7% said 'important'. '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' is considered the third most important environmental factor, as most of the participants (58.30%) agreed on its importance, while a quarter of them considered it neutral.

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 development SMEs are 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.

4.3. People factors

4.3.1. 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-mind 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.

4.3.2. 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 to 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.

4.3.3. 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.

4.4. Organisational factors

4.4.1. 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"*.

4.4.2. Management support

Senior management support has been also 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.

4.4.3. Communication and collaboration

Regarding the influence of communication and collaboration factor, 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 impact on the success of the adoption and practising of Agile.

4.5. Environmental factors

4.5.1. Organisational environment

Another factor that can influence the adoption of Agile is the organisational atmosphere and cultural environment. According to the frequency table above, 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 judgement from colleagues or repercussions from management, for example 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.

4.5.2. 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"*.

4.5.3. 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 said 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. 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"*. The results of these changes have been noticed in the daily life. On the other hand, P10 notes that some aspect of Saudi culture can actually encourage the adoption, as a collective society is valued.

4.6. Technical factors

4.6.1. 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 on 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 impact on the adoption of Agile 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.

4.6.2. 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 considering 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 sometime 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. 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.

4.6.3. 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.

4.7. 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 4.1.2). 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 previous empirical study (Altuwaijri and Ferrario, 2021), 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 towards 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. Discussion

This research investigates the enablers and barriers to the adoption of Agile in Saudi software development SMEs through in-depth interviews with 12 Agile experts from different software organisations. In this section, we discuss the interviews findings and summarise contributions to SE practice and research.

5.1. Factors impacting on Agile adoption

People Factors - This study shows that people factors (team capability, training and learning and customer involvement) are important factors when considering the adoption of Agile in Saudi Arabia. Looking further into the details of these interviews' 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; Lindsjørn et al., 2016; Vithana et al., 2018; Sheffield and Lemétayer, 2013; Misra et al., 2009 and Livermore, 2008). One of the necessities of Agile adoption is to have professional team members which have skills, such as how to be self-organised and motivated. It is also they 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.

However, 'customer involvement' was considered by our participants as one of the main barriers for Agile adoption in Saudi Arabia. This primarily because of the lack of customers' knowledge of Agile as well as the lack of trust between them and Agile development teams. In addition, this study finds that Agile teams find it challenging to deal with customers from governmental bodies as their working style is based on Waterfall model, and they are usually unwilling to be involved in development teams. '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.

This study identifies a new factor affecting on the adoption of Agile in the country. This factor is the 'awareness and knowledge' of Agile held by both practitioners and customers, which, as indicated in our previous study (Altuwaijri and Ferrario, 2021), was found to be low, with few Agile training events and expert in what is still a young sector. Additionally, the participants identified that lack of awareness and knowledge of other key stakeholders, such as customers and managers, impacts on the adoption of Agile. To make Agile work, both management and the customers need to have a good understanding of Agile in order to adopt it.

Organisational Factors - based on the findings of this study, 'organisational culture' is considered one of the most important organisational factors influencing on the adoption. The results of these organisational-related factors support the findings of other empirical studies, such as those conducted by Robinson and Sharp (2005a), Tolfo and Wazlawick (2008), 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 factors in context and especially in those countries, such as Saudi Arabia, where Agile has been historically overshadowed by the Waterfall methodology. This study also indicates the importance of 'management support' and 'communication and collaboration' on the adoption of Agile in Saudi Arabia.

Environmental Factors - the findings of this study consider 'national culture' the most important environmental factor in the adoption of Agile, a finding that echoes those of Ozawa and Zhang (2013), Misra et al. (2009) and confirms the impact of Saudi culture on organisational culture. Cultural aspects related to national and organisational influence on the software development SMEs regarding the adoption of Agile and the way of software practitioners to use it. We encourage future investigation of cultural alignment in the influence of Saudi culture on Agile adoption in terms of norms, values and attitudes, e.g. surrounding gender. The participants in this current study also indicate the importance of the 'organisational environment' and 'physical environment' on the adoption of Agile in Saudi Arabia. These findings are similar to those of Robinson and Sharp (2005a) and Sheffield and Lemétayer (2013) but are in contrast to the findings of Stankovic et al. (2013).

Technical Factors - This research also reveals that technical factor, i.e. 'tools and technologies' is an influential factor on the adoption of Agile in Saudi Arabia. This is a conclusion also drawn by Vithana et al. (2018), based on the results of their Sir Lankan study. Whilst technical factors have not received much attention in the literature due to an overriding focus on social factors, the authors 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. Regarding 'Agile software techniques' and 'delivery strategy' factors, this research found that these factors are not important factors regarding Agile adoption in the country, and 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.

5.2. The refining Agile adoption framework

Related work (Section 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 1 in Section 2.1. Drawing on these factors, a framework for Agile adoption is proposed (see Fig. 1 in Section 2.1).

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, which will be conducted in the following study. In addition, a new factor (awareness and knowledge) was suggested by the interviewees. Fig. 3 shows the refining framework for Agile adoption with the new factor added under the people factors category. This framework helps explain the Agile adoption factors in Saudi Arabian software SMEs, which can serve as a research tool to provide

useful guidance for Saudi organisations wanting to adopt Agile. It can also aid decision-making on Agile adoption in other Middle Eastern countries, notably Gulf Cooperation Council member countries.

Further study will need to be conducted to review the framework and its classification by actively engaging the participants in a structured feedback process (i.e. focus group). Future research deploying statistical techniques (e.g. Structural Equation Modelling (SEM)) is also planned; the objective is to better understand and measure the impact of these factors on Agile adoption by software SMEs in Saudi Arabia.

5.3. Contributions

This study makes both practical and theoretical contributions to software engineering and holds particular relevance for the Middle Eastern and Saudi software communities. To the best of our knowledge, this is the first study which has attempted to investigate the social and technical factors that can support or challenge the adoption of Agile in software SMEs in the Kingdom of Saudi Arabia.

5.3.1. Contributions to practise

In terms of the contributions to software engineering practice, our empirical study shows a number of contributions based on the outcomes of this research and the framework developed. In addition, the Agile adoption framework developed lists several factors that can influence the adoption of Agile in the Saudi Arabian context. These factors can guide and support software practitioners in Saudi Arabia to adopt Agile and to assess to what extent their organisations can adopt it or not. We report several main implications from the findings of this study. **First**, 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 and public in Saudi Arabia from institutions and organisations. They also have to emphasise providing Arabic resources (e.g. textbooks) to increase the self-learning about Agile by stakeholders who do not speak English.

Second, this study finds that Agile teams find it challenging to encourage customers to be involved in Agile teams. They also 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. Organisations 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.

Third, the research identified some cultural aspects that management teams and decision-makers in Saudi Arabian software SMEs should consider when intending 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. It is proposed that the smooth and successful adoption of Agile in an organisation requires changing its structure to be flat as possible as can and increasing its employees' confidence. **Fourth**, organisations should 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. Prayer rooms and social spaces, which teams can use during break times to improve productivity, comfort and socialisation would be advantageous.

Fifth, Senior managers should be particularly mindful of their organisation's 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. Top management team should select team members carefully, based on skills and knowledge, and provide them with continuous training to increase the capability of their team members to be able to adopt and use Agile methods successfully. **Finally**, 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. These too have the potential to influence and support teams.

5.3.2. Contributions to research

This study contributes to research on Agile adoption in general, and in the context of Saudi Arabia. First, this study has provided a review of the relevant literature to identify and summarise the factors affecting Agile adoption. These factors have guided this empirical research to investigate Agile adoption among software SMEs in Saudi Arabia. Thus, researchers can investigate these factors in different contexts. Secondly, this research offers the empirical investigation into the enablers and barriers affecting Saudi software SMEs' adoption of Agile and the identification of ten influential factors (Fig. 2). The third, and key contribution of this research, is the design and development of the Agile adoption framework. This is tailored to the Saudi and Middle Eastern software industry in an attempt to improve decision making around Agile adoption. This framework lays the foundation for future empirical research. As next step, we envisage the investigation of each identified factors and sub-factors with a wider survey of the Saudi context to further assess the relationships between the identified factors and intention to adopt Agile.

5.4. Limitations and 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, 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 being examined (Saunders et al., 2016; Creswell and Creswell, 2018). Thus, 'high research validity' demonstrates the consistency of the results obtained with real traits. This section discusses our study risks to validity and how these were mitigated.

5.4.1. Validity

This study examined factors influencing Agile adoption in Saudi Arabia, and the findings were derived from three Saudi Arabian software SMEs know 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 researchers 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

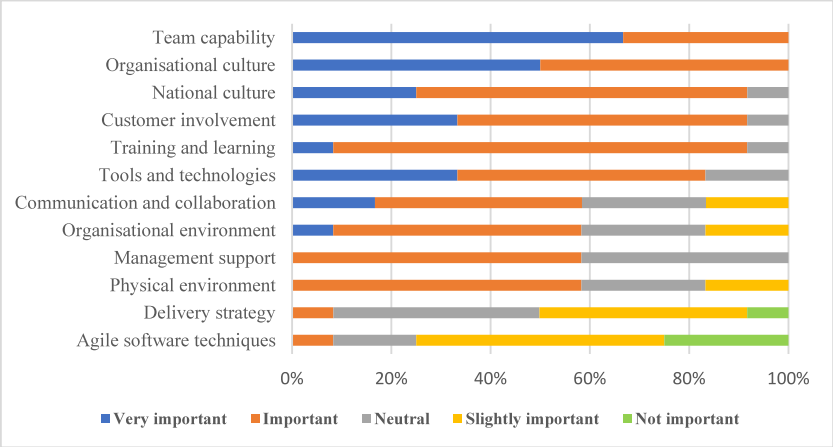

Fig. 2. Importance level of influential factors.

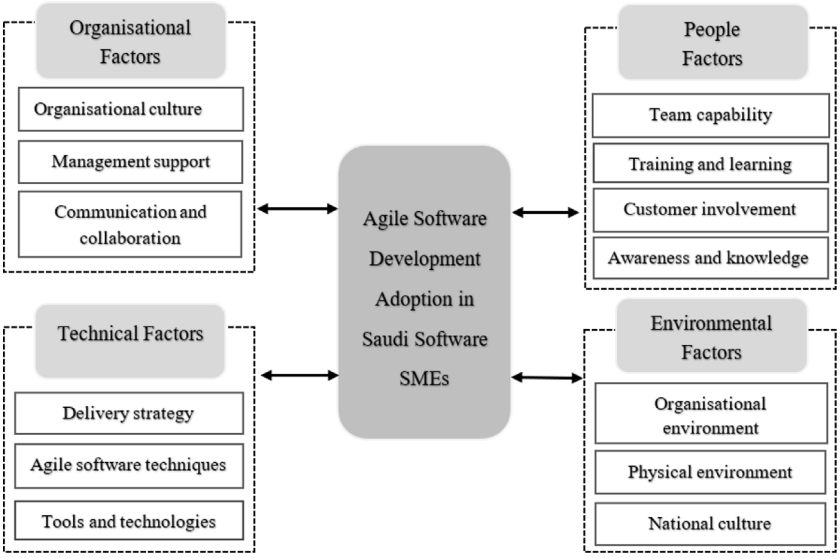

Fig. 3. The refined Agile adoption framework.

(e.g. focus group) to review and discuss the study's findings with participants is considered.

The participants were recruited mainly from mobile app developers—one 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.

5.4.2. 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.

5.4.3. Reliability

The term 'reliability' relates to the research's replicability and consistency (Saunders et al., 2016). To mitigate research bias, the first researcher conducted and analysed the data (Creswell and Creswell, 2018), whilst the second 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.

6. Conclusion and future work

The goal of this study was to investigate the enablers and barriers of Agile adoption in Saudi Arabia. This research was carried out in three Saudi software SMEs by collecting quantitative and qualitative data using semi-structured interviews. The data were gathered from 12 Agile practitioners, from each company. This research contributes to expanding the knowledge surrounding Agile adoption in the Saudi software community by identifying the factors that can support or hinder the adoption of Agile in software development SMEs. This research can also be useful

for countries in close geographical proximity such as the Gulf Cooperation Council nations.

The findings indicate there are a number of factors that impact on the adoption of Agile. The most important factor 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 software tools and technologies, especially due to COVID-19. In contrast, other technical factors, such as Agile software techniques and delivery strategy are not considered important factors. This study shows that cultural factors and customer involvement are the main barriers to adopting Agile in Saudi Arabia.

Future work should investigate the impact of Saudi cultural attitudes on the adoption and effective use of Agile. The authors would also recommend the use of more in-depth qualitative research methods, such as in-situ observations in the real-world context of the Saudi software industry; this was planned as part of this piece of research but was hampered due to COVID-19. Furthermore, future quantitative work is needed to further evaluate and measure the relationship between the identified factors and their importance in the Saudi Arabian context.

CRediT authorship contribution statement

Fahad S. Altuwaijri: Conceptualisation, Methodology, Formal analysis, Investigation, Writing – original draft, Writing – review & editing, Visualisation, Project administration. **Maria Angela Ferrario:** Conceptualisation, Methodology, Supervision, Writing – review & editing, Project administration.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix. Interview guide

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.

Sample interview questions

The interview is divided into four sections

• ***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 using the five-point Likert scale (i.e. very important = 5; important = 4; neutral = 3; slightly important = 2 and not important = 1)? 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 using the five-point Likert scale? 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 using the five-point Likert scale? 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 using the five-point Likert scale? And can you say how each aspect is going to influence the adoption?

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.

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