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Agile Software Development in Yemen: Exploring Challenges and Gaining Benefits

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***Abstract* - Agile is a philosophy that uses organizational models based on people, collaboration, and shared values. While there is a significant body of research on Agile practices globally, there is a lack of research specifically focusing on Agile implementation challenges and benefits in the Yemeni context. Therefore, the objective of this study was to investigate the challenges and benefits of implementing Agile methodologies in Yemeni software development companies. The study followed a two-step approach, consisting of a literature review and interviews. The literature review involved a comprehensive search for relevant studies on Agile methodology adoption, focusing on recent publications. A total of 39 accredited studies were included, and challenges and benefits related to Agile adoption were extracted. Interviews were conducted with professionals experienced in Agile methodology adoption in Yemeni software development companies. The challenges identified include organizational culture, lack of executive sponsorship, inadequate skill set, ill-defined project scope, and technological challenges. On the other hand, the main benefits were: Agile flexibility, delivery speed/time to market, cost reduction, and improved team communication. The results provide insights to assist Yemeni software development companies in making informed decisions and developing effective strategies for implementing Agile methodologies.**

Keywords: Agile methodology; agile software development; Software development; Agile methods; agile software development challenges; agile software development benefits.

I. INTRODUCTION

Agile methodology, since its introduction about 20 years ago, has been widely implemented for software development. Agile approaches help organizations act with speed and flexibility to quickly adapt and react to changing situations (Hoy & Xu, 2023).when a group of software practitioners came together to discuss and document a new approach to software development. The adoption of Agile practices in software development projects has gained significant attention in recent years due to its potential to enhance project management and delivery processes. According to the 10th Annual State of Agile Report, the top benefits of agile include managing changing priorities (87%), team productivity (85%), and project visibility (84%) ((Fitriani et al., 2016). While there is a significant body of research on Agile practices globally, there is a lack of research specifically focusing on Agile adoption and challenges in the Yemeni context. Therefore, the objective of this study is to investigate the challenges and benefits of implementing Agile methodologies in Yemeni software development companies.

This study takes a two-step approach, consisting of a literature review and interviews, to investigate the challenges and benefits of Agile software development. The literature review involved a comprehensive search for relevant studies on Agile methodology adoption. A total of 39 accredited studies were selected, with a focus on those published in the last five years. These studies were carefully reviewed, and challenges and benefits related to Agile adoption were extracted. The literature review provided a foundation for identifying common themes and factors influencing Agile implementation. Following the literature review, interviews were conducted with professionals experienced in Agile methodology adoption, including individuals with up to 16 years of experience. The interviews followed a structured approach, covering basic information about the interviewees and their organizations, as well as exploring the challenges and benefits of implementing Agile methodologies in software development companies based in Yemen.

The findings will assist in making informed decisions and developing effective strategies, ultimately leading to the growth and development of software development companies in Yemeni Companies.

II. METHODOLOGY

This study took a two-step approach to address the research questions. The first is a literature review and the second is the interview. In the first stage, previous studies were searched for all studies similar to the topic of the current study. The process of study selection was done by using keywords related to the research topic such as: “agile, agile

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methodology, agile approach, agile software development," and the words "challenges" and "benefits" were included with all the previous keywords. The most important and famous research databases were searched, as shown in Table 1:

Table 1: Selected databases

N0.	Database
1	Acm Digital Library (www.acm.org)
2	IEEE Xplore (www. ieee.org/ieeexplore)
3	ScienceDirect (www. sciencedirect.org)
4	Scopus (www.scopus.com)
5	Proquest (www.proquest.com)
6	Open Access Library (www.oalib.com)
7	Academia (www.academia.edu)
8	Springer (www.springer.com)
9	Clarivate (www.clarivate.com)
10	MDPI (https://www.mdpi.com/)

2.1 Literature Search Strategy

About 39 studies were selected to extract the challenges and benefits of agile methodology in software development companies. All studies were accredited and published in the English language. 30% of the studies were published in the last five years, between 2019 and 2023. Studies that did not discuss the basic idea of the research and studies that only mentioned the Agile methodology without mentioning the challenges and benefits of adopting the Agile methodology were excluded. These studies were published in several scientific journals, as shown in the following table.

Table 2: The distribution of the selected studies among different publication sources

N0.	Publisher
1	ACM International Conference Proceeding Series
2	Agile Conference
3	Annual IEEE International Conference and Workshop on the Engineering of Computer Based Systems
4	IEEE Computer Society
5	IEEE Xplore
6	IEEE/ACM 39th International Conference on Software Engineering: Software Engineering in Practice Track
7	Information /MDPI
8	Information for Business and Management–Software Development for Data Processing and Management
9	Information Systems Journal
10	International Conference on Advanced Computing and Communication Technologies
11	International Conference on computer science and engineering
12	International Conference on Computing Communication and Automation (ICA)
13	International Conference on Research and Education in Mechatronics (REM)
14	International Journal of Applied Science & Engineering
15	International Journal of Project Management
16	Journal of Software: Evolution and Process
17	Journal of Systems and Software
18	Plos One
19	Proceedings of the Agile Development Conference
20	ProQuest
21	Sciedu Press
22	Science Direct/Journal of Systems and Software
23	Springer
24	The Journal of Systems and Software
25	ACM International Conference Proceeding Series
26	Agile Conference

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III. FINDINGS

3.1 Findings from the Literature Review

After performing an intensive review of our primary studies to discover all of the challenges and benefits of agile methodology in software development companies. As a result, in our review, 23 challenges and 13 benefits were identified from different contexts as shown in Tables 3 and 4 below.

Table 3: Challenges of Agile Implementation

NO	Challenge	Freq	Related Studies
Technical			
1	**Lack of requirements for traceability**	16	(Hoy & Xu, 2023)(Chandrachooodan et al., 2021)(Shameem, 2018)(Litchmore, 2016)(Fitriani et al., 2016)(Inayat et al., 2015)(Ramesh et al., 2010)(Boehm & Turner, 2005)(Chow & Cao, 2008)
2	**Inadequacy of existing technologies and tools**	8	(Altuwaijri& Ferrario, 2022)(Chandrachooodan et al., 2021)(Fontana & Marczak, 2020)(Chow & Cao, 2008)(Dac- Buu Cao, 2006)
3	**Minimal documentation**	5	(Hoy & Xu, 2023)(Litchmore, 2016)(Fitriani et al., 2016)(Inayat et al., 2015)(Boehm & Turner, 2005)
4	**Inappropriate architecture**	4	(Hoy & Xu, 2023)(Litchmore, 2016)(Fitriani et al., 2016)(Ramesh et al., 2010)
Organizational			
1	**Lack of management commitment**	7	(Altuwaijri& Ferrario, 2022)(Chandrachooodan et al., 2021)(Fontana & Marczak, 2020)(Shameem, 2018)(Fitriani et al., 2016)(Chow & Cao, 2008)(Dac- Buu Cao, 2006)
2	**Organizational size**	5	((Fitriani et al., 2016)(Stankovic et al., 2013) (Chow & Cao, 2008)(Dac- Buu Cao, 2006)
3	**Budget and schedule estimation**	4	(Fitriani et al., 2016)(Litchmore, 2016)(Boehm & Turner, 2005)(Ramesh et al., 2010)
4	**Organizational culture**	3	(Altuwaijri& Ferrario, 2022)(Fontana & Marczak, 2020)(Chow & Cao, 2008)(Sridhar Nerur et al., 2005)
5	**Lack of roles and responsibilities**	3	(Shameem, 2018)(Boehm & Turner, 2005)(Chow & Cao, 2008)
6	**Contractual issues**	3	(Fontana & Marczak, 2020)(Inayat et al., 2015)
Environment			
1	**Distributed team**	5	(Almashhadani et al, 2023)(Kalenda, 2018)(Kahya, 2018)(Fitriani et al., 2016)(Misra et al., 2009)
2	**Organizational environment**	4	(Almashhadani et al, 2023)(Sheffield &Lemétayer, 2013)(Chow & Cao, 2008)(Robinson & Sharp, 2005)
3	**National culture**	3	(Almashhadani et al, 2023)(Ayed et al., 2017)(Ozawa & Zhang, 2013)
4	**Physical environment**	3	(Almashhadani et al, 2023)(Chow & Cao, 2008)(Robinson & Sharp, 2005)
People			
1	**Team capability**	10	(Hoy & Xu, 2023)(Altuwaijri& Ferrario, 2022)(Chandrachooodan et al., 2021)(Fontana & Marczak, 2020)(Kahya, 2018)(Shameem, 2018)(Fitriani et al., 2016)(Chow & Cao, 2008)
2	**Lack of customer involvement**	10	(Almashhadani et al., 2023)(Hoy & Xu, 2023)(Altuwaijri& Ferrario, 2022)(Rahy, 2021)(Shameem, 2018)(Litchmore, 2016)(Inayat et al., 2015)(Ramesh et al., 2010)(Chow & Cao, 2008)(Dac- Buu Cao, 2006)
3	**Limited face-to-face communication**	8	(Almashhadani et al., 2023)(Altuwaijri& Ferrario, 2022)(Fontana & Marczak, 2020)(Kahya, 2018)(Shameem, 2018)(Kahya, 2018)(Fitriani et al., 2016)
4	**Lack of training and learning**	7	(Altuwaijri& Ferrario, 2022)(Fontana & Marczak, 2020)(Shameem, 2018)(Fitriani et al., 2016)
5	**Resistance to change**	7	(Fontana & Marczak, 2020)(Conboy, 2019)(Kalenda, 2018)(Obrutsky& Erturk,

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			2017)(Stankovic et al., 2013)(Chow & Cao, 2008)(Dac- Buu Cao, 2006)
6	**Lack of Agile awareness**	**5**	(Hoy & Xu, 2023)(Shameem, 2018)(Fitriani et al., 2016)(Boehm & Turner, 2005)
Process			
1	**Lack of planning**	**6**	(Obrutsky& Erturk, 2017)(Fitriani et al., 2016)(Stankovic et al., 2013)(Chow & Cao, 2008)(Dac- Buu Cao, 2006)(Boehm & Turner, 2005)
2	**Lack of agile progress tracking mechanism**	**4**	(Stankovic et al., 2013)(Dac- Buu Cao, 2006) (Boehm & Turner, 2005)(Cohn, 2003)
3	**QA/standard processes**	**3**	(Conboy, 2019)(Boehm & Turner, 2005)

Subsequently, building upon our findings, we classified these challenges into five broad dimensions: technological, organizational, environment, people, and process. The table above shows this classification. In addition, the conceptual model of the study is presented in Figure 1 below.

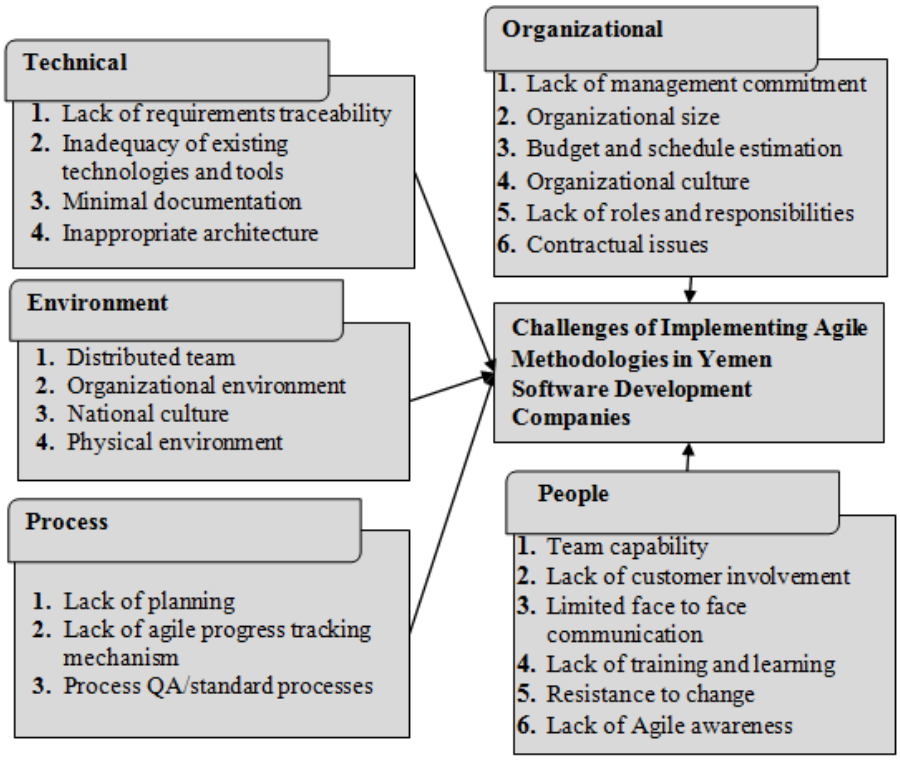

Figure 1: The Challenges of Agile Implementation

Table 4: Benefits of Agile Implementation

NO	Benefits	Freq	References
1	Agile is a flexible model	**8**	(Soundararajan & Arthur, 2009)(Mishra, 2023)(Alam et al., 2022)(Agrawal et al., 2016)(Kaur et al., 2015)(Kumar & Bhatia, 2014)(Soundararajan & Arthur, 2009)
2	Delivery speed/time to market	**7**	(Feldmüller, 2018)(Chiyangwa & Mnkandla, 2017)(Chow & Cao, 2008)(Dac- Buu Cao, 2006)
3	Reduction in the overall schedule	**7**	(Chiyangwa & Mnkandla, 2017)(Kaur et al., 2015)(Bird et al., 2010)(Chow & Cao, 2008)
4	Easy to identify the risks	**6**	(Feldmüller, 2018)(Agrawal et al., 2016)(Kaur et al., 2015)(Bird et al., 2010)
5	The project pursues a simple design	**4**	(Chiyangwa & Mnkandla, 2017)(Bird et al., 2010)(Chow & Cao, 2008)(Dac- Buu Cao, 2006)
6	Rigorous refactoring activities	**4**	(Kalenda, 2018)(Chiyangwa & Mnkandla, 2017)(Dac- Buu Cao, 2006)
7	The right amount of documentation	**3**	(Chiyangwa & Mnkandla, 2017)(Chow & Cao, 2008)(Dac- Buu Cao, 2006)

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8	The project scope is well-defined	**3**	(Chiyangwa & Mnkandla, 2017)
9	Correct integration testing	**2**	(Chow & Cao, 2008)(Dac- Buu Cao, 2006)
10	Agile is cost reduction	**6**	(Mishra, 2023)(Chiyangwa & Mnkandla, 2017)(Kahya, 2018)(Kahya, 2018)(Kaur et al., 2015)(Kumar & Bhatia, 2014)(Chow & Cao, 2008)
11	Coherent and self-organizing teamwork	**13**	(M, 2020)(Tam et al., 2020)(Kahya, 2018)(Chiyangwa & Mnkandla, 2017)(Chiyangwa & Mnkandla, 2017)(Bird et al., 2010)(Chiyangwa & Mnkandla, 2017)(Chow & Cao, 2008)(Dac- Buu Cao, 2006)
12	Improved team communication	**5**	(Mishra, 2023)(Chiyangwa & Mnkandla, 2017)(Chow & Cao, 2008)(Dac-Buu Cao, 2006)
13	Good customer relationship	**3**	(Chiyangwa & Mnkandla, 2017)(Chow & Cao, 2008)(Dac- Buu Cao, 2006)

3.2 Findings from the Interview

In the second activity, the qualitative research approach was applied through a series of in-depth interviews (structured interviews) conducted with8 software development experts. The targeted respondents were selected based on purposeful and snowballing sampling strategies.

The researchers chose to follow the steps proposed by (Kvale, 1996), as a guide for the interview investigation phase of this study. There are seven stages of an interview investigation as reported by (Kvale, 1996), namely: "thematizing, designing, interviewing, transcribing, analyzing, verifying and reporting" as shown in Figure 2.

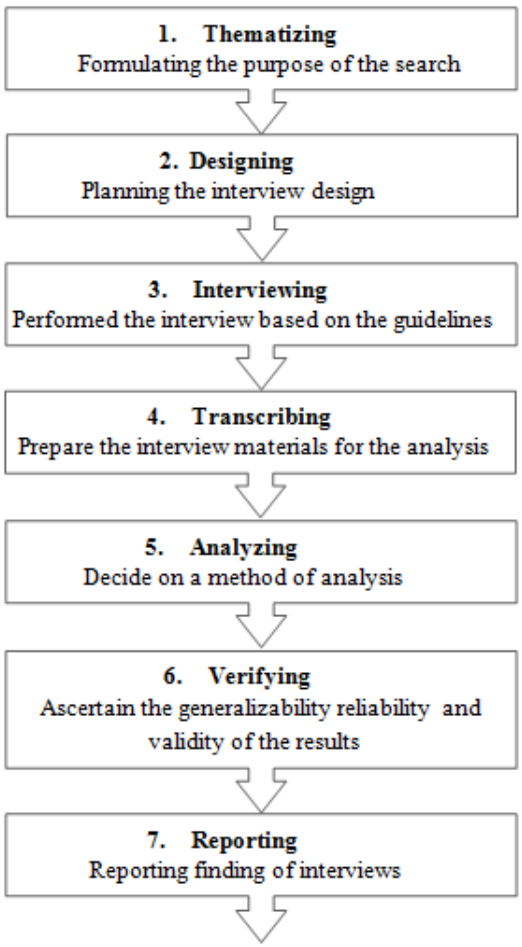

Figure 2: Interview Data Analysis Model

1. Thematizing: This stage involves clarifying the topic to be investigated and formulating the purpose of the search before starting the interviews

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2. Designing: The interview questions are divided into two sections. Section A collects basic information about the interviewees and their organizations, while Section B explores the challenges and benefits of implementing Agile methodologies in Yemeni software development organizations.

3. Interviewing: The interview was prepared by preparing questions, then communicating with the people to be interviewed, and after that, the semi-structured interview was sent. phone calls were conducted or audio recordings were sent with answers to all the interview questions.

4. Transcribing: In this stage the interview materials were carefully prepared to convert the spoken responses into text format for further analysis.

5. Analyzing: In the analyzing stage, a qualitative methodology was employed to examine the transcribed interview materials and gain insights into the challenges and benefits of implementing Agile methodologies in Yemeni software development companies.

6. Verifying: Following the interview, the obtained data was categorized, and key themes for challenges and benefits were identified. Experienced individuals then reviewed and validated these findings to ensure their accuracy.

7. Reporting: Finally, the findings were reported, providing valuable insights into the challenges and benefits of Agile implementation in Yemeni software development companies. The report was written by following the approved themes identified during the interview stages and adapting the themes.

The interview was conducted with respondents who have varying years of experience, with some having up to 16 years of experience in adopting the Agile methodology. Several factors related to the challenges and benefits of adopting the Agile methodology for software development were extracted from these interviews. It was observed that some factors mentioned in previous research studies were also identified in the interviews. However, there were also new factors that were not mentioned in previous research studies as shown in Table 5.

Table 5: Challenges of Agile implementation identified through the interview data

No	Challenges	Freq	Sample evidence from the interview
1	**Lack of Agile awareness**	5	"…There are indeed many challenges in working with Agile methodology, one of which is the lack of understanding and awareness of this approach…" [2] "…One of the biggest challenges is The team's lack of knowledge of the concept of Agile and lack of experience in working with it …" [5]
2	**Resistance to change**	3	"… Many developers and customers are not familiar with Agile and therefore may not be proficient in working with it, leading to resistance to change and reluctance to adopt Agile principles …" {2} "…Some team members may be resistant to change or find it difficult to adapt to the new way of working…." [3]
3	**Lack of requirements for traceability**	2	"…Factors deterring Agile adoption for clients with fixed timeframes is unclear and unstable requirements at the project's onset…"[4] " … It causes a lot of problems and delays in work, which leads to sitting with the client again and working again …"[6]
4	**Organizational size**	2	"…It is also possible that the project may expand, so this causes a problem ..."[1] "One of the challenges facing implementing agile methodology is large project size …"[4]
5	**Lack of customer involvement**	1	"…Engage stakeholders effectively and ensuring their alignment with Agile practices is a big challenge …" [3]
6	**Lack of management commitment**	1	"…Managers and leaders may resist or impede the implementation of Agile practices, affecting team performance…." [4]
7	**Lack of roles and responsibilities**	1	"…Roles and responsibilities of team members are not clearly defined..." [4]

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No	Challenges	Freq	Sample evidence from the interview
8	**Lack of agile progress tracking mechanism**	1	"…Failure to complete tasks creates a challenge in completing the agile implementation …"[6]
9	**Distributed team**	1	"…When we have remote teams, working in different countries and different time zones we find some challenges to keeping communication and collaboration strong…"[7]
10	**Consuming time***	1	"…Adopting the Agile methodology takes a lot of time …"[1]
11	**Lack of team commitment***	1	"…Not everyone is committed to following the Agile approach…" [4]
12	**Unwillingness to accept errors***	1	"…One of the challenges is unwillingness to accept errors…" [4]
13	**Work boundaries***	1	"…One of the challenges is the client's rigid work boundaries.…" [4]

(*) New challenges emerged from the interview data.

Table 6: Benefits of Agile implementation identified through the interview data

No	Benefits	Freq	Sample evidence from the interview
1	**Easy to identify the risks**	5	"… By continuously discovering and fixing errors at the end of each phase, Agile methodology allows for early detection and rectification, unlike traditional methods …"[2] "…This way, errors can be detected early on, saving time, effort, and cost while improving project efficiency and quality…" [5]
2	**Delivery speed/time to market**	4	"… Respond to customer changing requirements quickly. This leads to increased customer satisfaction and a higher likelihood of project success…" [3] "…It ensures customer satisfaction by enabling continuous monitoring and keeping them informed about the progress of work throughout each sprint…" [4]
3	**Good customer relationship**	3	'…These benefits collectively contribute to productivity and better collaboration with customers…" [3] "…It fosters effective communication and collaboration within the team, promoting a cohesive work environment… and ensures clarity between the development team and the customer …" [4]
4	**Agile is cost reduction**	3	"…This way, errors can be detected early on, saving time, effort, and cost while improving project efficiency and quality..." [5] "… Also adopting Agile methodology allow to effort saving, time and cost saving… "[6]
5	**Agile flexibility**	2	"The Agile methodology is considered the best choice because it offers complete flexibility and smoothness in work…" [5] "…Some of the factors that may encourage you to use Agile Methodologies Is the Flexibility…" [7]
6	**Improving project efficiency and quality ***	3	"…This way, errors can be detected early on, saving time, effort, and cost while improving project efficiency and quality..." [5] "…We're always looking for ways to improve, and we focus on quality at every step. Overall, Agile makes our teams more engaged, and our projects more successful…" [7]
7	**Customer engagement ***	3	"…Having the customer as part of the team and having an understanding of the phases the client has gone through and approved of the product output.…" [1] "… By involving the customer reviews throughout the process, we make sure we're building what they want…" [7]
8	**Reduces problems ***	2	"… Fourthly, it allows for the identification of anticipated risks and the formulation of strategies to mitigate and overcome them…" [4] "…This way, errors can be detected early on…" [5]

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9	**Iterative Development***	**2**	"…Some of the factors that may encourage to use of Agile methodologies is iterative development…" [7] "…The most important benefit provided by Agile is that the work process is structured into clear steps and iterations…" [8]
10	**Increase the effectiveness of the team***	**1**	"…Agile methodologies enhance the collaboration between the development team. Agile enables teams to work together more which leads to higher team morale and productivity…." [3]
11	**Promote the continuous improvement***	**1**	"… Agile methodologies promote continuous improvement. Through regular meetings, the team reflects on their performance. This approach allows us to continually refine our processes and deliver better results…" [3]
12	**Testing the product***	**1**	"…There are many reasons that contribute to working as an agile team, such as testing the product or outputs in advance …" [1]
13	**Completing tasks as required***	**1**	"The Agile methodology helps Accomplishing tasks as required …" [5]
14	**Clarity of requirements ***	**1**	"…Continuously meeting with the customer and writing down customer user stories from the beginning of the work ensures that the requirements are clearly defined …" [6]

(*) New benefits emerged from the interview data.

IV. DISCUSSION AND CONCLUSION

The literature review, as presented in Tables 3 and 4, extensively discusses the challenges and benefits associated with implementing agile methodologies in software development projects. These challenges have been categorized into five broad dimensions: technological, organizational, environmental, people, and process. Organizational challenges may arise from factors such as a lack of management commitment, organizational size, and difficulties in roles and responsibilities. Environmental challenges, such as distributed teams and cultural differences, can also have an impact on the implementation of agile methodologies. People-related challenges include team capability, limited customer involvement, resistance to change, and a lack of awareness about agile practices. However, despite these challenges, adopting agile methodologies offers significant benefits, including enhanced flexibility, faster delivery times, improved team communication, and stronger customer relationships. Consequently, agile methodologies prove to be a valuable approach for enhancing project efficiency and success.

Tables 5 and 6 further validate the common challenges and benefits associated with implementing agile methodologies in software development projects, as both the literature review and the interviewees emphasize them. The identified challenges encompass a lack of agile awareness, resistance to change, inadequate requirements traceability, organizational size, insufficient customer involvement, limited management commitment, ambiguous roles, and responsibilities, absence of an agile progress tracking mechanism, and the presence of distributed teams. Conversely, the highlighted benefits encompass the ease of identifying risks, accelerated delivery speed and time to market, fostering positive customer relationships, cost reduction, and the inherent flexibility offered by agile methodologies. Recognizing these shared challenges and benefits enables organizations to develop effective strategies to address these obstacles while capitalizing on the advantages of agile methodologies to achieve improved project outcomes.

Moreover, the insights provided by the interviewees introduce additional challenges and benefits that were not previously mentioned in the literature review. These challenges encompass time-consuming processes, lack of commitment, unwillingness to accept errors, and rigid work boundaries imposed by clients. However, the interviewees also identified benefits such as improved project efficiency and quality, considering the customer as an integral part of the team, mitigating the probability of problems within the team or organization, promoting iterative development, increasing team effectiveness, fostering continuous improvement, conducting thorough product testing, accomplishing tasks as required, and ensuring clarity of requirements.

In conclusion, both the literature review and the interviewees shed light on numerous challenges and benefits associated with implementing agile methodologies. Acknowledging these shared challenges and benefits empowers organizations to devise effective strategies to overcome obstacles and leverage the advantages of agile methodologies for enhanced project outcomes.

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