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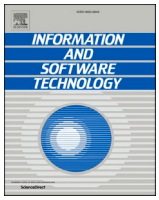

What helps Agile remote teams to be successful in developing software? Empirical evidence

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ABSTRACT

Software development firms have specific goals but today's dynamic business environment, especially regarding the use of remote teams, presents great challenges due to uncertainties and multiple risks. This study investigates the facilitators of the success of Agile software development projects delivered by remote teams. We employ a conceptual research model founded on the technology-organization-environment (TOE) framework. The study contributes to the literature by exploring how remote teams affect the success of Agile software development projects. Partial least squares structural equation modeling (PLS-SEM) analysis of the data collected from 198 IT professionals revealed that perceived pressure from government, job performance, and team satisfaction are significant in explaining these projects' success.

1. Introduction

Projects are a way for organizations to achieve specific goals and objectives and to stay competitive in a changing business environment. Agile methodologies have surged in popularity in recent years, becoming a central focus in project management and organizational development. The 17th State of Agile Report [1] highlights this trend, noting that business leaders and executives are leading Agile transformations (32%), followed closely by technical teams (31%), and CIO/CTOs (20%). This widespread adoption demonstrates the pervasive role of Agile in modern business strategies.

Research underscores Agile's effectiveness in achieving project success. Agile methodologies are increasingly favored by software development teams, as shown by Persson et al. [2], who noted that Agile contributes significantly to meeting project goals. Denning [3] supports this, stating that Agile allows for rapid response to changing requirements and focuses on delivering software that meets customer needs. Recent studies further validate Agile's benefits. Balijepally et al. [4] found that Agile practices enhance team performance and project outcomes by promoting a collaborative work environment. Similarly, Dikert et al. [5] reported improvements in communication, customer satisfaction, and productivity due to Agile transformations. Various studies throughout the years highlight the relevance of Agile.

Even though using Agile practices has several benefits, it is not a silver bullet. Agile must be accompanied by effective people management, as "individuals" is the most problematic of the four core pillars of Agile and is the most common failure point for projects [6]. Managing teams is crucial also because the understanding of "normal" has recently changed. Several years ago a standard Agile software development project team would normally be working in a shared office location, in some cases even in the same room to facilitate teamwork. However, the Covid-19 pandemic changed the way work is organized. Due to stay-at-home regulations, companies had to adopt the remote work concept, distributing development teams into remote locations and eliminating daily face-to-face contact. The lack of personal interaction among colleagues remains a challenge to communication, collaboration, and knowledge sharing.

There are numerous studies regarding the influence that remote work has on Agile teams and Agile software development projects (ASDP) success criteria. For instance, Polish researchers studied the development teams' approaches toward remote work during the Covid-19 pandemic [7]. Portuguese researchers have investigated factors influencing the success of on-going Agile software development [8]. To the best of our knowledge, there are no published studies that investigate ASDP success criteria and remote work in combination through the lens of the TOE framework. To fill that gap, we propose the following

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research questions (RQs):

RQ 1. *What are the main technological, organizational, and environmental factors that influence remote teams' success in Agile software development projects?*

RQ 2. *What role does team satisfaction play as a moderators?*

To answer these RQs, we must identify criteria for a successful ASDP to understand how an organizational work model affects the utilization of Agile methodology and to determine whether particular success criteria are influenced by remote work, and if so, how? Adapting to changing environments is crucial, as history shows that major adjustments can become necessary quickly. Organizations must respond to change without compromising work quality.

The goals of this study are to conduct a literature review to revisit the conclusions of earlier studies and build a conceptual model that will allow us to understand the facilitators of ASDP success carried out by remote teams. Our model is built using a thoroughly researched IS theory, namely, the technology-organization-environment (TOE) framework [9]. We expect to gain a deeper understanding of how the technological, organizational, and environmental contexts (among other factors) can influence remote team performance in ASDP by applying this framework. Below you can see Fig. 1 which illustrates the problem definition.

The study seeks to identify the facilitators of success when projects are assigned to remote teams. Resorting to remote teams has the potential to reduce costs for businesses due to the ability to leverage remote work, which enables the recruitment of specialized personnel from different geographical locations (thereby potentially utilizing more cost-effective resources), as well as holding down office space expenses and other overhead business costs.

We contribute to the literature by analyzing the impact of remote work and team member isolation on ASDP success. Moreover, we highlight the importance of considering both individual and team-related factors (technological, organizational, and environmental) when assigning projects to remote-working teams. As remote work becomes more common, understanding how the distribution and isolation of team members affect Agile practices and project outcomes is valuable for organizations to effectively manage their remote teams. This research also offers practical recommendations to organizations considering the adoption of Agile principles in project delivery to gain valuable insights and make informed decisions. Lastly, the study offers suggestions to organizations regarding the potential benefits of remote work.

The literature review addresses project success criteria, explains what the Agile methodology is, covers the concept of remote work, and discusses its effect on Agile teams. We then present the research framework and define the study's hypotheses. Following that, the methodology is described along with the analysis and results. The last section discusses limitations and directions for possible further research, and concludes.

2. Literature review

2.1. Project success criteria

Defining project success criteria is challenging due to the conceptual complexity of a project. One of the ways to assess the success of project delivery is the iron triangle concept, also known as the triple constraint [10]. This model describes the three constraints that exist in every project: quality (project deliverables, features, and goals), time (the timeline for project completion), and cost (the budget available for the project). However, the iron triangle model is rather generic, and extensive research has sought to identify the critical success factors (CSF) for software development projects specifically. This has included empirical investigations or related literature reviews or both methods simultaneously [11]. Table 1 summarizes the relationships between project success criteria and the later described concept – CSF.

Agile Project Success Criteria (APSC) differ from traditional Project Success Criteria (PSC) in that APSC emphasize flexibility, continuous delivery of value, and customer collaboration. While traditional PSC focus on rigid constraints like time, cost, and quality, APSC prioritize the ability to respond to change, customer satisfaction, and delivering functional increments throughout the project's life cycle [22]. APSC also shift the focus from meeting predefined requirements to maximizing value and adaptability in a dynamic environment [23].

Authors have different classifications for CSFs that result in rather similar groups. For example, Venczel et al. [25] propose the following subsets: the end-users, the dynamics of users' interactions within a social context, the adept administration of project tasks, the application of an established framework, the effective handling of transformative processes, and the intricate properties inherent in the organizational structure. Mohd et al. [26] suggest different groups: kick-off preparations, quality management, progress tracking, decision making, institutionalizing post-mortem analyses. Even though the wording and level of granularity differs, users are identified among CFSs by most researchers. For example, Alvertis et al. [27] state that project success depends greatly on fulfilment of solution users; for Ahimbisibwe et al. [6] user support, experience, and education are considered to be individual CSFs; while Berssaneti et al. [28] merge everything into one – the user.

Despite the fact that the number of ASDP CSFs studies is limited [23, 29], research on this topic is still important, as more recent literature digs deeper into CSFs and introduces sub-categorization while highlighting project methodology and top management support as key CSFs [30]. The importance of CSFs in project management is underscored by both the Project Management Institute's PMBOK Guide [31] and PRINCE2 [32], which highlight crucial elements like stakeholder engagement and effective communication.

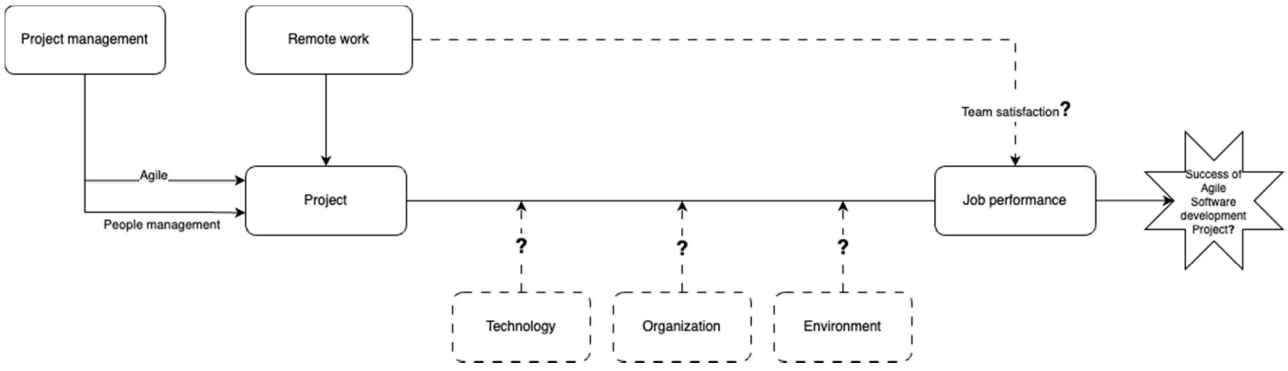

Fig. 1. Problem illustration for your problem definition.

Table 1
Project success criteria mapping to CSFs.

Success Criteria	Description	Critical Success Factors (CSFs)	Refs.
Project Completion on Time	Finishing the project within the scheduled timeline	Effective scheduling, resource allocation, proactive risk management	Podgórska et al. [12]
Budget Adherence	Staying within the financial limits set for the project	Accurate cost estimation, financial oversight, efficient resource use	Ika et al. [13]; Ofori [14]
Quality of Output	Delivering outputs that meet or exceed quality standards	Robust quality assurance processes, skilled personnel, continuous improvement	Tabassi et al. [15],Tengan et al. [16]
Stakeholder Satisfaction	Ensuring that stakeholders' needs and expectations are met	Effective stakeholder communication, engagement strategies, responsiveness	Mossalam et al. [17]
Team Satisfaction and Performance	Maintaining high levels of team morale and productivity	Strong leadership, clear role definitions, team-building activities	Jamil et al. [18]
Innovation and Learning	Fostering a culture of innovation and continuous learning	Supportive culture, ongoing training, knowledge sharing practices	Müller et al. [19]
Market Performance	Achieving desired market share and customer satisfaction	Market analysis, customer feedback mechanisms, strategic marketing	Kopmann et al. [20], Garengo et al. [21]
Agile Value Delivery (APSC)	Delivering continuous value to customers in iterations	Continuous customer feedback, adaptability, incremental progress	Conforto et al. [22], Serrador et al. [23]
Agile Adaptability (APSC)	Responding effectively to changes in requirements and environment	Agile methodology adoption, dynamic reprioritization, iterative planning	Gemino et al. [24], Serrador et al. [23]

2.2. Agile software development

Agile is a methodology created by leading software process methodologists. It aims to reveal better ways to develop software including expeditious adaptability to evolving circumstances [33,34]. Agile is a response to traditional software development methodologies that offer a linear approach – starting with a complete requirement documentation, followed by solution design, development, and inspection. It is worth mentioning that contrary to a popular belief, Agile is not a set of rules, it is a philosophy – "true agility is more than a collection of practices" [35]. The latest research confirms that projects employing an Agile management approach have yielded significantly more favorable outcomes of individual project success, exceeding the successes using the conventional waterfall methodology [33,36].

Agile manifesto creators describe Agile as a way to develop software while responding to change [37]. Agile development relies on feedback loops and frequent communication as it facilitates the ability to rapidly adapt to changes. According to Highsmith et al. [38], teams that are Agile can deliver quickly, change quickly, and change often. Such a principle of delivery allows catering to changing business needs by prioritizing the most value-adding developments [3].

There are numerous Agile methodologies and while differing in emphasis and practices, they share a number of key characteristics – iterative design, focus on interaction, communication, and the reduction of resource intensive intermediate artifacts [39]. According to Campanelli et al. [40], SCRUM, Feature Driven Development (FDD), Extreme Programming (XP), Crystal, Dynamic System Development Method (DSDM), and Adaptive Software Development (ASD) are the most adopted Agile methods in the IT market. All Agile methodologies are based on four core values: individuals and interactions over processes and tools, working software over comprehensive documentation, customer collaboration over contract negotiation, responding to change over following a plan [37]. The selection of the methodology as well as its implementation are both influenced by the organizational structure and management decisions [41].

Agile is designed to cater to individuals. It adjusts and molds the process to embrace the teams' individuality and accommodates customers' feedback. Agile teams enable the communication and mutual awareness that lay the groundwork for essential features of the Agile approach, namely collaborative endeavors, consistent delivery of functional software, and expeditious adaptability to evolving circumstances [42]. As teams play such an important role in the Agile implementation, people are recognized as primary drivers of ASDP success [43].

The focus of Agile teams is response to change, which is facilitated by decision making. Two main factors play important roles in decision-making and immediate action: (a) working in close proximity and (b) prioritizing communication [39]. Therefore, the Agile teams strive to have close physical location for the team members, focus on talking in person and at white boards rather than building documentation, and improve the team's amicability in order to encourage people to relay valuable information quickly [43]. Even though there are clearly many benefits of Agile, organizations struggle to operationalize it due to lack of adoption frameworks, lack of management support, change resistance, and organizational culture [34,44,45]. The PMBOK [31] and PRINCE2 [32] also highlight the importance of adaptability and iterative processes (which are central to Agile methodologies) as key elements in successful project management.

2.3. Remote work

In March 2020 stay-at-home orders were issued by governments as a response to the Covid-19 pandemic. Organizations were forced to transition from an on-site to a remote work model. Remote work refers to the practice of performing work duties from a location that is neither an office space nor a co-located worksite. The conditions for remote work locations are minimal – the only requirements are access to the necessary resources and technology to complete work. As social distancing orders took full effect people were working from a home environment. It had both benefits and negative effects on Agile teams.

Numerous researchers (e.g., [46,47]) suggest that remote work is less distractive compared to the office environment, and teams' productivity increases as a result. Moreover, research shows that virtual meetings increase team efficiency. However, Agile teams experienced not only benefits but also challenges, the most significant of which was the reduced communication bandwidth. Agile serves to increase communication and feedback. Distribution amplifies the drawbacks that non-compliance to the timely and clear communication requirements can cause [48]. Narrowed down communication also has a negative impact on relationship quality among remote team members. Research implies that interactions mediated by devices rarely become non-superficial human relationships, and therefore the team members struggle to find a sense of belonging [47].

Regarding the effects of remote work on the core Agile components and principles, research suggests that the risks can be mitigated by establishing remote-work guidelines [49]. Introducing and defining communication tools for different purposes diminishes the impact of the greatest risk – limited communication. Regarding the team relationships, research shows that transitioning to a fully remote environment had no significant effect on high-performing teams, while the interpersonal friction was exacerbated in teams that were suffering from it prior to changing the work model [46]. Both the PMBOK Guide [31] and PRINCE2 [32] stress the significance of effective communication and stakeholder engagement. These elements are especially challenging in a remote work environment, yet they remain pivotal for ensuring project success.

2.4. The technology–organization–environment (TOE) framework

To increase the perception of remote work's impact on CSFs for ASDP, we apply the TOE framework, which is a segment of innovation process that explains how the firm context influences the adoption and implementation of innovations [9]. The three TOE contexts are the following:

1. The technological context encompasses the array of technologies currently utilized or accessible in the market that are relevant to the organization.
2. The organizational context, i.e., the characteristics and resources of the firm, including communication processes. It is important to mention that decentralization provides fluidity for teams and is associated with adoption [50]. Communication processes have the power to promote or inhibit innovation.
3. The environmental context encompasses the structural composition of the industry, the existence or absence of technology service providers, and the regulatory framework. Government regulations can have either stimulating or inhibiting effects on innovation endeavours [9].

Various studies in many research fields are based on the TOE framework. For example, blockchain and supply chain technology [51], warehousing [52], and robots in hotels [53]. To the best of our knowledge, there are no studies that use the TOE framework and focus on the CSF of projects executed by remote Agile teams. Driven by the gap in existing research, we seek to gain insights on effects that remote work has on ASDP success criteria. The ambition of this study is to utilize TOE to understand the technological, organizational, and environmental factors that influence the success of Agile software development projects.

3. Research framework and hypotheses

The suggested model (Fig. 2) combines the TOE framework and two additional constructs (job performance and team satisfaction) to explore Agile software development project success. The control variables used in the research model to evaluate their effect on the dependent variable are age and gender [54].

3.1. Team satisfaction

Team satisfaction is a fundamental aspect of HR management in organizational contexts. With the work model shifting to remote work, the perception of team satisfaction has also adjusted. The importance of collaboration, communication, and work-life balance has increased, resulting in unique challenges that are not relevant in on-site teams, i.e., social isolation and the requirement for effective coordination and communication across various time zones and cultures. Therefore, team leaders must develop tactics to encourage team satisfaction given the fact that one of the greatest strengths of the organization is the relationship among team members and managers [55]. A continuous focus on team satisfaction within organizations is critically important as it influences the corporate culture, increases tenure and job performance, and encourages loyalty to the company [56]. Based on this, team satisfaction might improve or impair the delivery of the project, and we therefore hypothesize:

H1a. Team satisfaction positively impacts job performance.

H2a. Team satisfaction moderates the effects of job performance on Agile software development project success, such that the ASDP is greater among people with greater team satisfaction.

H2b. Team satisfaction positively impacts Agile software development project success.

3.2. Job performance

Job performance has been acknowledged as a pivotal aspect of describing organizational outcomes and success [57]. The manner in which employees execute their work activities directly influences a company's results; hence, promoting effective work is crucial [58]. Moreover, job performance is heavily reliant on the proficiency with which tasks are accomplished, especially when the utilization of new technologies is important in the work environment [59]. The time needed to fulfil job responsibilities, adherence to schedules, and concentration and approach are among the factors that measure the level of proficiency that employees attain, which in turn influences their job performance [60]. Considering the benefits derived from job performance and the context of the research, we posit:

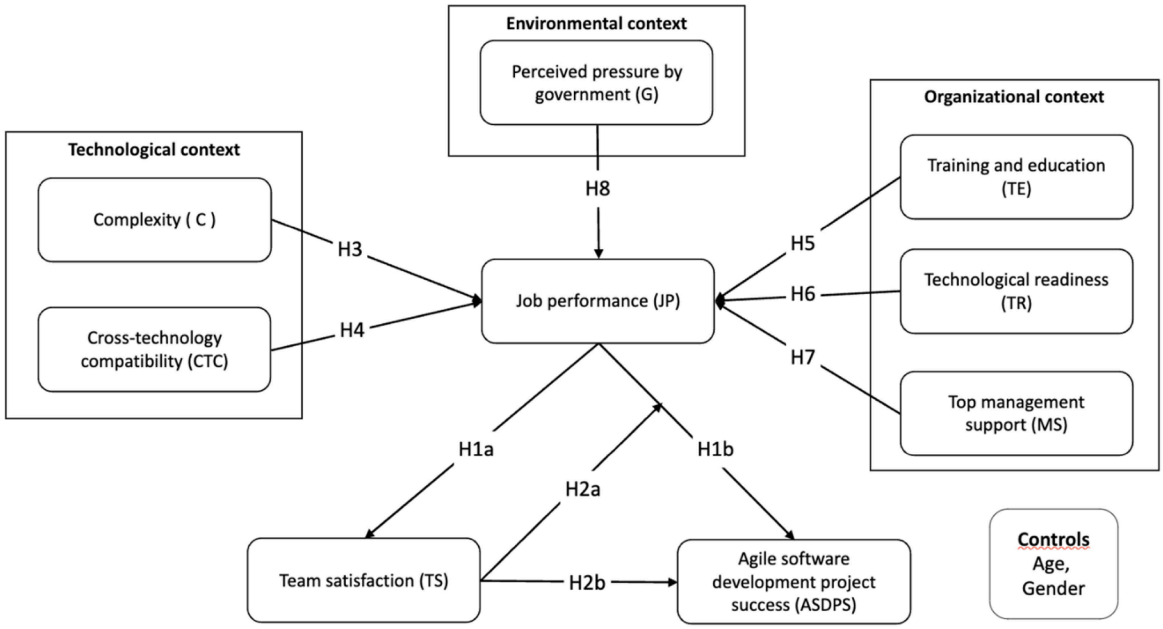

Fig. 2. Research model.

H1b. Job performance positively impacts Agile software development project success.

3.3. Complexity

Adopting information technology (IT) innovations is more likely to occur if they are considered straightforward to use [61]. The shift to remote work presents challenges due to its modern nature and the need to utilize a variety of online collaboration, work organization, communication, and other tools. This shift calls for managing multiple new technologies, each potentially with its own learning curve and integration challenges. To promote the adoption of these new technologies, they must be easy to handle and simple enough to use [62]. Introducing several online tools simultaneously can increase the overall complexity of the way a job is performed, making it harder for employees to adapt. Therefore, it is important to ensure that all tools used meet the criteria of simplicity and ease of use. Given the context of the research and the statements above, we posit:

H3. Complexity has a negative influence on job performance.

3.4. Cross-technology compatibility

According to Rogers [61], compatibility refers to the extent to which an innovation is perceived to align with an organization's values and needs, in light of previous experiences. For remote work to be adopted smoothly, it is imperative for the organization to acknowledge it. As a result, companies often try to replicate their traditional way of working in the digital realm, making the transition less jarring for employees, and preserving the sense of compatibility. This increases the likelihood that employees will be more accepting of the new setup. The background above gives support to the following hypothesis:

H4. Cross-technology compatibility positively impacts job performance.

3.5. Training and education

The concept of training and education lies within the organizational context of the TOE framework. It covers increasing employees' proficiency in technology necessary for remote work utilization. This can involve educating organization members in the use of new technology for communication, teamwork, and task organization, as well as providing guidance on successful remote work practices, such as time management, goal setting, and teamwork. With adequate training and education organizations can enhance the chances of successful technology adoption for remote work and ensure that employees are able to work effectively from a remote location. We posit the following:

H5. Training and education have a direct positive impact on job performance.

3.6. Technological readiness

Technological readiness within the organization influences management's decisions to adjust the firm's daily operations by adopting remote work [63]. Organizations require robust IT systems for implementing remote work, as they need to have team-sharing tools for quick connectivity. The use of cutting-edge digitalization and communication tools and technology can enhance internal and external connections [64]. This enables organizations to create information-sharing platforms that enable work from home. To make sure employees are comfortable with remote work, organizations should take advantage of government support and have comprehensive technological infrastructure. Additionally, employees must enhance their technical skills. Established IT systems can improve technology investments' efficiency, leading to better business outcomes and success. Given the preceding considerations and the background of our study, we posit:

H6. Technological readiness positively impacts job performance.

3.7. Top management support

Organizational context refers to various factors that define the organization, such as its size, capacity, centralization, technology readiness, management structure intricacy, quality of personnel, organizational readiness (in terms of technology and staff), innovativeness, and level of top management support [65,66]. To create a competitive environment the support of top management is crucial for organizations, especially for those simultaneously providing the necessary resources to adopt a remote work organization model. This support helps organizations overcome organizational impediments and resistance toward organizational change. Senior managers play a pivotal role, as the implementation of work-from-home initiatives may necessitate resource integration, activity alignment, and process reengineering. It has been established that the awareness and commitment of top management to the potential benefits of innovations is essential for effectively managing organizational change and instilling confidence in the technology among all employees [67]. Thus, we state the following hypothesis:

H7. Top management support positively impacts job performance.

3.8. Perceived pressure from government

Government pressure refers to the impact that government policies, regulations, and initiatives have on the adoption and use of new technologies within an organization. This type of pressure can change the environment in which the organization operates, affecting factors such as technological readiness, market demand, and access to resources and support for technology adoption [68]. Government pressure can take the form of mandatory remote work due to extraordinary circumstances, such as the Covid-19 pandemic. Regulations can either support, limit, or prohibit the use of certain technologies [69]. Understanding the level of government pressure is essential to the success of technology adoption in an organization and is therefore an important aspect of the TOE framework. The background above gives support to the following hypothesis:

H8. Perceived pressure from government positively impacts job performance.

4. Methodology

To collect data a survey questionnaire was built on a web-based tool (Qualtrics), which allows researchers to build and distribute various surveys and offers a robust data analysis capability. The questionnaire consisted of a series of interrogative statements designed to elicit responses and gather information regarding each construct of the research and asked respondents to assess their agreement levels using a Likert Scale ranging from 1 (strongly disagree) to 7 (strongly agree). The statements are in Appendix 1.

The measurement items employed in the current study are grounded in relevant academic research. The constructs have been derived from reputable authors, and minor adjustments were made to align them with the specific research context. Complexity (C) was based on Cagliano et al. [70], cross technology compatibility (CTC) was adapted from Nguyen et al. [71], technological readiness (TR) was drawn from Ng et al. [72] and Nguyen et al. [71], top management support (MS) was adapted from Nguyen et al. [71], Soliman et al. [73], and Wu et al. [74]. Perceived pressure by government (G) and job performance (JP) are both based on Ng et al. [72] while training and education (TE) come from Abdekhoda et al. [75]. Team satisfaction (TS) was drawn from García-Buades et al. [76]. Agile software development project success

(ASDPS) was adapted from Alvertis et al. [27] and Atkinson [10].

Participation in the study called for individuals who satisfied the following prerequisites: possessing a professional background in information technology, having been engaged in a delivery of an Agile software delivery project, and having previous exposure to remote working environment(s). There was no geographical limitation for the participation. The questionnaire was in English. Prior to distribution to a large sample of participants, a pre-test was conducted to assess the validity of the survey, obtaining 36 responses that were analysed. The pre-test did not reveal any need for changes in the questionnaire, and the instrument was therefore distributed to the final research population in its original form. The data collected in the pre-test were not included in the final analysis. The final survey was distributed via numerous channels – a public post in the professional social network LinkedIn, an entry to NOVA IMS students' forum, and direct messages in the internal communication channels of two independent international software development companies.

Data were collected from 11 April to 3 May 2023. The survey was opened online 280 times, and 82 responses were eliminated due to incompleteness, resulting in a total of 198 valid responses. To evaluate if any potential bias was influencing the data, two tests were performed on the final dataset. The first was the marker variable technique [77]. The low value of 0.03572 indicated a lack of bias in the data. Also, Harman's single-factor test [78] was applied, yielding 22.9%, which is lower than the threshold of 50%, also indicating no presence of significant bias in the data. Given the fact that both bias tests failed to confirm data bias, the dataset was deemed suitable for subsequent analysis.

The sociodemographic analysis indicated a nearly balanced gender distribution, with 55% of participants self-identifying as male. Regarding age, 45% of the participants are between 25 and 30 years old. In terms of educational qualifications, the vast majority of the participants (90%) report holding a Bachelor's degree or higher (see Table 2). Almost half of the participants work in a technical role (developers, designers, quality assurance specialists), over 20% are project managers and PMOs, another 20% are SCRUM masters. We can thus assume an almost even distribution between technical and managerial roles representation in the survey.

The present study examines a sample of individuals who are employed in organizations of diverse characteristics. With respect to the operational period, 41% of the respondents indicated working in organizations that have been operational for fewer than 3 years, while an equal percentage (41%) reported being employed in organizations that have been active for a period ranging from 3 to 12 years. The remaining 18% of respondents work in firms that have been in existence for more than 13 years. Over half (58%) of the participants reported being employed in organizations that have implemented remote work models in response to government regulations and have been utilizing remote work for 2 to 5 years. A notable proportion of the participants (30%) indicated working in organizations that have been utilizing remote work models for more than 5 years. Company size is diverse, with a relatively even distribution across the various categories. The smallest proportion of participants (20%) represents organizations with fewer than 50 employees, while the largest percentage (29%) represents companies with more than 501 employees (see Table 3).

Table 2
Sample sociodemographic characteristics.

Distribution (n = 198)					
Gender			**Education**		
Male	108	55%	Lower than Bachelor's degree	19	10%
Female	90	45%	Bachelor's degree	114	58%
			Master's degree or higher	65	33%
Age			**Position**		
<25	24	12%	Technical (developer, QA, BA, UX/UI designer)	98	50%
25–30	90	45%	Project manager/PMO	43	21%
31–35	58	29%	SCRUM master	41	20%
>35	26	13%	Other	13	8%
			CTO	3	1%

5. Results

The data were analyzed to understand the relationships within a proposed conceptual model. The analysis technique was the partial least squares structural equation modeling (PLS-SEM) [79]. The industry standard application that supports PLS-SEM analysis is SmartPLS 4.0.9.0 [79], and was used to test the hypotheses. The two aspects that are analyzed in PSL-SEM are (1) a measurement model and (2) a structural model.

5.1. Measurement model

The robustness of the measurement model becomes evident upon evaluation of internal consistency, convergent validity, and discriminant validity. Internal consistency is described by composite reliability (CR) and Cronbach's alpha (CA). The CR and CA values should be above 0.7 [80]. Table 4 shows that both values are above 0.7. Convergent validity was assessed using the average variance extracted (AVE). The reference values considered were above 0.5 [81].

To analyze the discriminant validity, cross loadings, the Fornell-Larcker criterion, and Heterotrait-monotrait (HMTM) ratio were evaluated. The first of these requires item loading to exceed the values of all cross-loadings [82]. The items C2, G1, G4, TR3, MS1, MS2, S2, TS4, and TS5 were excluded from the PLS model estimation in order to meet the cross-loading criteria. Table 5 reports the results of cross loading, which make it evident that the results meet the expected result. With regard to the Fornell-Larcker criterion, the square roots of AVEs should exceed the correlations between the construct [81]. The results of the final discriminant validity test, HTMT ratio, are in Table 6. All values are below 0.9, indicating discriminant validity [83]. Based on the positive outcomes of measurement model analysis, it can be concluded that the constructs can be used in further tests to assess the conceptual model.

5.2. Structural model

The structural model was estimated using R^2 values and path coefficients' level of significance. To approximate the sampling distribution and its standard deviation, a bootstrapping with 5000 resamples was performed [80]. The model was assessed using the t-statistics, which allows for confirming or failing to confirm the hypotheses. Fig. 3 presents analysis results.

Results suggest that the research model explains 63% of the variation of Agile software development project success. Two constructs that are statistically significant in explaining Agile software development project success are (1) job performance ($\widehat{\beta}$=0.191, $p < .001$) and (2) team satisfaction ($\widehat{\beta}$=0.643, $p < .001$), thus confirming H1b and H2b.

Table 3
Sample organizational characteristics.

Distribution (n = 198)					
Operation period			**Organization size**		
< 3 years	81	41%	< 50 employees	39	20%
3–12 years	82	41%	51–200 employees	54	27%
13 + years	35	18%	201–500 employees	48	24%
			501 + employees	57	29%
Remote work utilization period					
< 1 years (after governmental regulations)			25	13%	
2–5 years (because of governmental regulations)			114	58%	
> 5 years (before governmental regulations)			59	30%	

Table 4
Means, standard deviations, correlations, and reliability and validity measures (CR, CA, and AVE) of latent variables.

Constructs	Mean	SD	CA	CR	1	2	3	4	5	6	7	8	9
[1] Complexity	5.315	1.332	.850	.930	.932								
[2] Compatibility	5.305	1.321	.815	.889	.692	.853							
[3] Train.education	4.889	1.359	.806	.864	.246	.340	.827						
[4] Techn.readiness	5.531	1.051	.692	.824	.640	.666	.249	.783					
[5] Top manag.sup.	5.013	1.117	.645	.804	.317	.412	.251	.410	.761				
[6] Perc.pres.government	4.332	1.395	.711	.810	.080	.138	.002	.058	.164	.770			
[7] Job performance	5.558	1.008	.794	.866	.152	.231	.103	.251	.270	.313	.786		
[8] Team satisfaction	5.517	1.062	.815	.879	.212	.322	.061	.356	.266	.203	.657	.803	
[9] Agile success	5.701	1.134	.826	.897	.287	.356	.160	.380	.215	.124	.624	.761	.862

Table 5
PLS loadings and cross-loading.

Constructs		1	2	3	4	5	6	7	8	9
[1] Complexity	C1	**.938**	.609	.258	.565	.238	.008	.147	.171	.265
	C3	**.927**	.684	.199	.632	.358	.146	.136	.226	.271
[2] Compatibility	CTC1	.493	**.868**	.235	.467	.392	.210	.226	.266	.302
	CTC2	.679	**.811**	.282	.639	.287	.066	.155	.296	.313
	CTC3	.638	**.877**	.362	.634	.360	.055	.198	.270	.302
[3] Training and education	TE1	.408	.509	**.681**	.433	.368	.021	.018	.096	.209
	TE2	.163	.259	**.907**	.170	.220	.011	.107	.029	.095
	TE3	.242	.301	**.874**	.232	.185	−0.014	.082	.077	.184
[4] Technological readiness	TR1	.479	.465	.145	**.704**	.245	.085	.104	.240	.206
	TR2	.563	.520	.199	**.912**	.284	.093	.261	.306	.312
	TR4	.472	.610	.237	**.714**	.455	−0.045	.173	.290	.362
[5] Top management support	MS3	.171	.257	.055	.215	**.729**	.093	.139	.133	.157
	MS4	.125	.278	.263	.357	**.720**	.235	.208	.168	.114
	MS5	.384	.383	.210	.335	**.829**	.052	.245	.275	.213
[6] Perceived pressure from government	G2	.014	.088	−0.070	.035	.111	**.766**	.188	.183	.155
	G3	.075	.094	−0.134	.056	.176	**.601**	.072	.153	.087
	G5	.093	.133	.071	.054	.142	**.911**	.338	.162	.077
[7] Job performance	JP1	.096	.150	.114	.171	.132	.176	**.777**	.500	.477
	JP2	.096	.072	.116	.183	.126	.094	**.737**	.439	.424
	JP3	.186	.279	.099	.285	.338	.345	**.842**	.644	.574
	JP4	.078	.186	−0.007	.123	.209	.327	**.784**	.448	.466
[8] Team satisfaction	TS1	.189	.251	.026	.340	.250	.190	.607	**.831**	.643
	TS2	.217	.359	.087	.348	.181	.119	.474	**.841**	.664
	TS3	.115	.247	.070	.243	.193	.101	.482	**.829**	.637
	TS6	.155	.170	.012	.202	.230	.246	.547	**.704**	.491
[9] Agile software development project success	ASDPS1	.250	.313	.034	.336	.154	.177	.431	.647	**.843**
	ASDPS3	.269	.353	.250	.322	.228	.098	.578	.654	**.915**
	ASDPS4	.223	.256	.124	.325	.172	.052	.596	.665	**.825**

Table 6
Heterotrait-Monotrait Ratio of correlations (HTMT).

Constructs	1	2	3	4	5	6	7	8	9
[1] Complexity									
[2] Compatibility	.851								
[3] Train.education	.384	.522							
[4] Techn.readiness	.839	.817	.437						
[5] Top manag.sup.	.404	.540	.420	.603					
[6] Perc.pres.government	.161	.164	.141	.137	.275				
[7] Job performance	.176	.266	.142	.296	.342	.364			
[8] Team satisfaction	.255	.396	.103	.467	.347	.278	.802		
[9] Agile success	.343	.437	.233	.493	.288	.178	.757	.825	

Moreover, 47.5% of variation of job performance is explained, with the statistically significant variables being the perceived pressure by government ($\widehat{\beta}$=0.182, $p < .001$) and team satisfaction ($\widehat{\beta}$=0.608, $p < .001$). Therefore, H8 and H1a are supported.

The hypotheses H3, H4, H5, H6, and H7 are not confirmed, as complexity, cross-technology compatibility, training and education, technological readiness, and top management support are not statistically significant in explaining job performance.

An analysis of the moderation effect of team satisfaction on the relationship between job performance and Agile software development project success was also performed. The results confirmed hypothesis H2a. However, it must be noted that due to a negative path value ($\widehat{\beta}$=−0.164, $p < .001$), the team satisfaction in fact weakens the effect that job performance has on Agile software development project success. The control variables age and gender were included in the model tests. The results indicate that neither of them is significant in explaining the relationships between the variables.

6. Discussion

Our study investigated the main facilitators for remote teams that drive success of the ASDP. A research model was built using the findings of the literature review and applying a contextual TOE framework. Two additional constructs outside of the TOE framework's suggested contexts

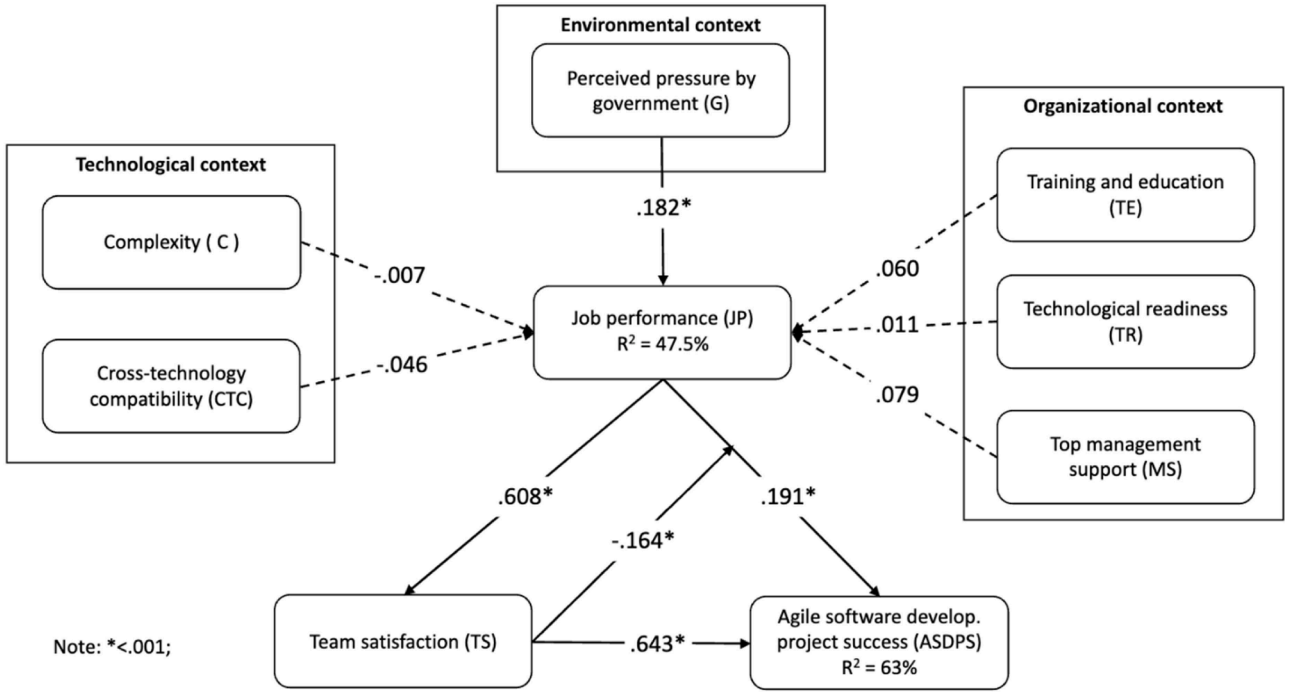

Fig. 3. Research model with results.

– team satisfaction and job performance – were investigated in the conceptual model. Data were collected by surveying a group of IT professionals (i.e., technical staff, project managers, CTOs, etc.) who have been engaged in remote-work-based delivery of Agile software development projects. To summarize the findings and link them to our research questions, in our research, as the first RQ we asked: What are the main technological, organizational, and environmental factors that influence remote teams driving the success of Agile software development projects, and what role does team satisfaction play as a moderator?

Fig. 4 summarizes the findings of our study.

6.1. Theoretical implications

The suggested model justifies the relationship between perceived pressure from government and team satisfaction over the job performance. 47.5% of variation of the job performance is explained in the research model, thereby supporting hypotheses H1a and H8. Moreover, the model investigates and explains 63% of the variation in Agile software development project success in line with job performance and team satisfaction, thus confirming H1b and H2b. Our results are in alignment with the earlier research of Salman et al. [84] and Ciric Lalic et al. [36].

Our results fail to explain relationships between the TOE framework technological and organizational contexts and job performance. The technological domain consists of complexity and cross-technology compatibility constructs, neither of which are significant in explaining job performance in our analysis. This might be due to the fact that adopting digital remote work tools was essential when the work from home regulations were in place and the technological aspect was perceived as a necessity rather than a choice [85], hence the lack of impact on job performance and therefore ASDP success. Therefore, we find no support for H3 or H4.

In terms of organizational context, none of our three constructs were significant in explaining the job performance, even though the literature suggests that training and education significantly boost job performance if the training program is designed specifically for the case and is well prepared ([86]; C. [87]). The research outcome reveals a different result – it fails to support the hypothesis H5. Consequently, we suspect that the training programs received by survey participants were disappointing. The training programs might have been prepared without a specific goal in mind and/or the materials might have been low quality. To further assess this construct and give evidence-based insights, additional research is needed.

Our results reveal that technological readiness does not explain job performance – H6 is not supported. The findings contrast with earlier

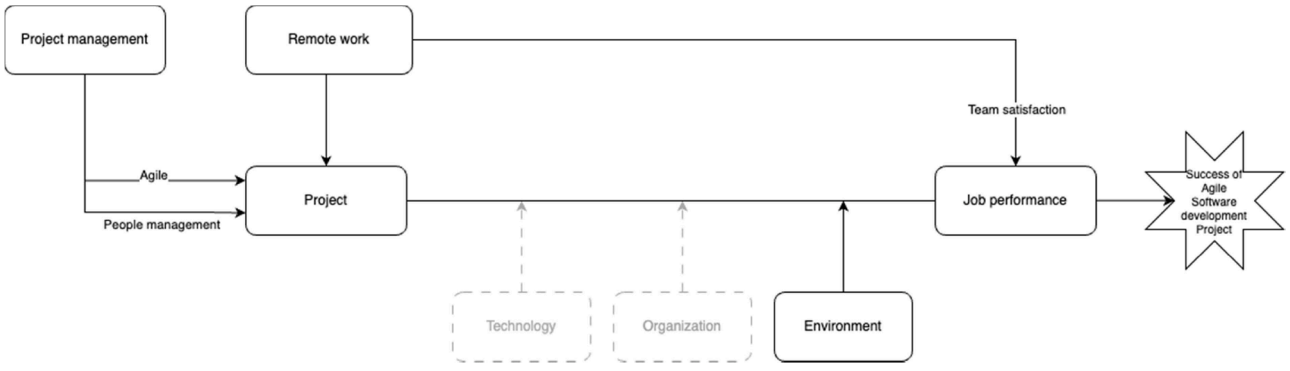

Fig. 4. illustration of the research findings.

research reporting that technological readiness does in fact impact job performance [88–90]. Our results to the contrary invite further research on organization maturity in the technological readiness domain in light of remote work adoption during recent years.

Our study suggests that managerial support does not affect employee job performance, as H7 is not supported. Literature findings are non-consensual when it comes to management support impact on job performance. Diamantidis et al. [91] report a significant relationship between supportive behavior and employee job productivity. However, other researchers suggest that only a specific – transformational – leadership style results in increased performance [92].

Fig. 5 depicts a significant moderator, team satisfaction, and highlights the influence on the success of ASDP in terms of job performance. The results illustrated in the graph reveal that project success is influenced by job performance, especially when team satisfaction is low. The team satisfaction moderator suggests the major impact of job performance over Agile success among people with low team satisfaction. For people with high team satisfaction, job performance is not important in explaining the Agile success. As the constructs that were demonstrated to be significant are a part of the human resources (HR) field, our research contributes to the literature that highlights the importance of HR management [93].

6.2. Practical implications

Our research reveals the contributors to ASDP success. While perceived pressure by government is beyond the scope of organizational management, the other two of the three significant constructs (job performance and team satisfaction) can be controlled by the project stakeholders – team leaders, managers, department heads, CTOs, and other IT practitioners in leadership positions. First, the leaders of organizations that are considering to apply Agile principles to delivery processes should consider remote team setup. It significantly increases the flexibility of the team organization because the location becomes irrelevant. Moreover, remote work expands the talent pool to wider geographies without affecting the project success, given the fact that the team satisfaction is achieved. Finally, remote work provides cost reduction opportunities. The working-from-home regime reduces direct business costs and eliminates overhead, such as office-space rent.

Second, the team leaders should strengthen and prioritize people management. As elevated team satisfaction ultimately results in successful projects, it is important for managers to pay close attention to people management and to ensure that team members are properly supported, motivated, and equipped with the necessary skills and resources. This includes fostering effective communication, collaboration, and knowledge sharing among team members. Keeping the satisfaction levels high is a challenging task that involves various levels and departments of the organization(s). The motivators are strongly dependent on the individual preferences as well as the cultural aspect, economic well-being, and other factors. To understand the motivators for IT professionals, further research should be undertaken.

Third, managers should cultivate an environment that supports and promotes effective work execution. This includes providing necessary resources, setting clear expectations, and promoting a culture of continuous improvement and learning.

6.3. Limitations

Although this research offers valuable insights into the topic, it must be noted that there are certain limitations to it. First, the study was carried out without geographic limits, which exerts a greater level of difficulty to capture the impact of cultural aspects. A suggested direction for future studies in this area is to assess the influence that culture has on job performance and ASDP success. Second, the questionnaire was responded to by persons with a range of internal project roles, which limits the generalizability of the results. In future studies it would be interesting to compare the perception of internal and external stakeholders. Third, the survey was shared with two specific companies that cannot be named due to nondisclosure agreement. In future research on the topic, we suggest sharing the survey with organizations whose names can be disclosed in order to make further conclusions. Furthermore, a limited number of items were evaluated in the study. While the significant variables were tested, the study could be improved by expanding the scope of dimensions. For example, a construct “teamwork” could be added to assess criteria such as collaboration and communication and its limitations (influence of time zone differences, for example) as well as “team satisfaction” to understand whether the remote teams were more satisfied. Moreover, the data we collected cover only the post-pandemic period. To assess the ASDP in different time periods (pre-pandemic, during pandemic, and post-pandemic) we recommend collecting data concerning those periods in future research.

Another metric that could provide more insights on the topic, is

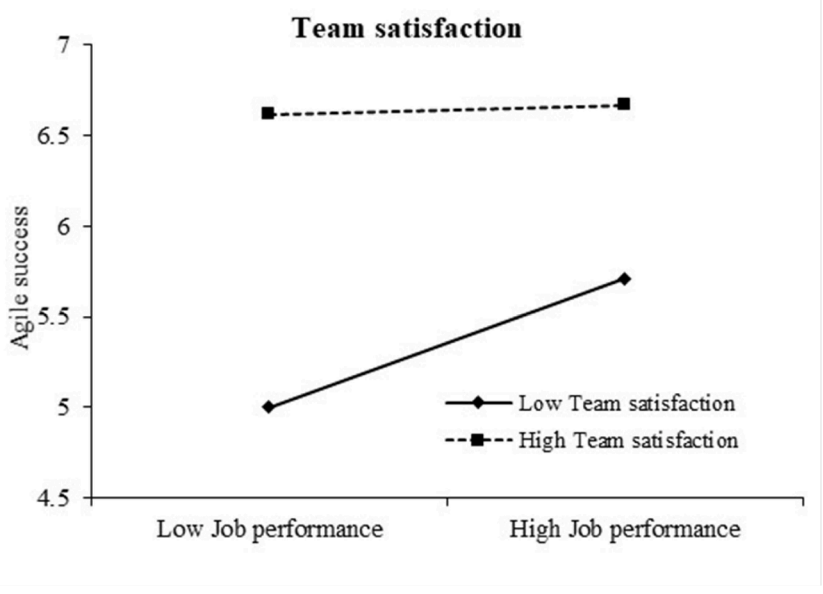

Fig. 5. Moderator effects.

whether the teams were able to choose the working location. We believe that the results might differ in the event that there was a mandate regarding the work location, and we suggest this as a topic for further research.

7. Conclusion

The study investigates the impact that remote work has on Agile software development project success criteria. A conceptual research model was built based on an extensive literature review. The model proposed utilizes a contextual TOE framework as its foundation while adding job performance and team satisfaction to the equation. The model was tested on 198 IT professionals who have participated in Agile software development projects executed by remote teams utilizing remote work. The data were analyzed using PLS-SEM, which resulted in explaining a variance in ASDP success by the perceived pressure of government, job performance, and team satisfaction. This work is of interest to IT professionals involved in remote team management in ASDP. The most significant context from the TOE framework was found to be the environmental context, which was analyzed by perceived pressure from the government construct. However, the study suggests considering team satisfaction as a top priority in project execution as it has a significant direct and indirect impact on ASDP success.

Availability of data materials

The data that support the findings of this study are available from the corresponding author upon reasonable request.

CRediT authorship contribution statement

Marta Adzgauskaite: Writing – original draft, Visualization, Methodology, Investigation, Data curation. **Carlos Tam:** Writing – review & editing, Supervision, Software, Resources, Methodology. **Ricardo Martins:** Writing – review & editing, Validation, Methodology.

Declaration of competing interest

The authors have no competing interests to declare that are relevant to the content of this article.

Data availability

Data will be made available on request.

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Appendix

Appendix 1. Items

Constructs		Item	From
Complexity	C1	It was easy for the team to understand the difference between the remote work tools.	[70]
	C2	All tools had a distinct use case, there were no overlapping features between the tools.	
	C3	Each tool was easy to use both individually and combined with other tools.	
Compatibility	CTC1	The remote work processes are the same as face-to-face work processes.	[71]
	CTC2	The shift to remote work model was easy to incorporate to the organization.	
	CTC3	Shifting to remote work allowed retaining the organization values among the team.	
Training and education	TE1	Each team member has received the training needed to understand and use remote work tools.	Abdekhoda [75]
	TE2	The team was confident in using remote work tools after the training.	
	TE3	The training makes remote work tools more useful to each team member.	
Technological readiness	TR1	The organization's infrastructure allows remote work facilitation for each employee on individual and team basis.	Ng [72]; Nguyen [71]
	TR2	The employees contain a high level of knowledge about remote work arrangement.	
	TR3	Our organization leverages cutting-edge technology for remote work development.	
	TR4	Our firm invests in building and marketing innovative remote work solutions.	
Top management support	MS1	Top management supports remote work and effectively communicates their position.	Nguyen [71]; Wu et.al. [74]; Soliman and Yanz [73]
	MS2	Top management is investing in remote work -related technologies.	
	MS3	Top management has established remote work monitoring practices and KPIs.	
	MS4	The management encourages employees to keep track of the latest remote work technology trends.	
	MS5	The top management is likely to pursue remote work as an important strategic business decision.	
Perceived pressure from government	G1	Government provides seminars, courses, conferences, and talks regarding remote work to the firms.	Nguyen [71]; Ng [72]
	G2	At the time of the project delivery stage, the government endorsed remote work arrangement.	
	G3	At the time of the project delivery stage, there were active social distancing measures in place.	
	G4	At the time of the project delivery stage, the government promoted the implementation of remote work arrangement.	

(*continued on next page*)

(*continued*)

Constructs		Item	From
	G5	At the time of the project delivery stage, the team members were able to choose preferred work model.	
Job performance	JP1	The remote team members meet formal performance requirements of the job.	Ng [72]
	JP2	Remote team members fulfil the job responsibilities specified in the job descriptions when working remotely.	
	JP3	The remote team members adequately complete assigned duties.	
	JP4	The remote team members' performance exceeds the formal requirements of the job.	
Team satisfaction	TS1	The remote team was overall satisfied with the remote work.	[76]
	TS2	The physical exhaustion of the remote work is more significant than working on-site.	
	TS3	The mental exhaustion of the remote work is more significant than working on-site.	
	TS4	The remote team members trusted each other while working on the project together.	
	TS5	A fully remote team is motivated to deliver the project in comparison to on-site team.	
	TS6	It is easy for the remote team members to collaborate on the project activity.	
Agile software development project success	ASDPS1	The project team was able to deliver the project on time.	Atkinson [10], Alvertis et al. [27], Ahimbisibwe et al. [6], McLeod et al. [94]
	ASDPS2	The project team was able to deliver the project on budget.	
	ASDPS3	The project team was able to deliver the project that met the quality standards.	
	ASDPS4	The end-users were satisfied with the delivered result.	

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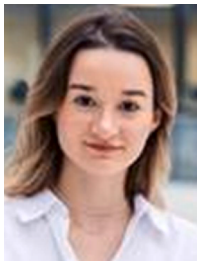

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