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Facing barriers to unlock large-scale agile benefits: exploring the mediating role of organizational readiness

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Abstract

Purpose – This aims to explore the relationship between the agile methods barriers in large-scale contexts and the benefits for business, team and product and process, exploring the organizational readiness (OR) mediating role.

Design/methodology/approach – We propose a theoretical model through survey-based research, applying partial least square structural equation modelling.

Findings – We confirmed that OR mediating effect on the relationship between agile methods barriers and team benefits. We operationalized OR in a broader context that embeds the strategic alignment of large-scale agile implementation, considering variables such as organizational structure and culture.

Research limitations/implications – The data are cross-sectional rather than longitudinal, which limits temporal interpretations of the associations between agile methods and organizational issues.

Practical implications – The findings offer a way forward for organizations already using or planning to implement agile management to understand the pathway towards achieving the expected benefits. Our study also unveils the importance of looking at OR when implementing such a complex change in management from traditional to large-scale contexts.

Originality/value – Our results show the significant and positive influence of agile method on all three benefit variables (team, business, product and processes). Furthermore, we identified the significant and positive mediating role of OR on the relationship between agile method and team benefits.

Keywords Agile project management, Agile at scale, Large-scale agile, Scaled agile, Survey-based research, Partial least square structural equation modelling

Paper type Research paper

1. Introduction

The organizational environment is in the midst of evolutionary changing scenarios, requiring organizations to adapt (Bredillet *et al.*, 2018). In this way, agile project management (APM) was embraced as an approach aligned with dynamic environments (Conforto *et al.*, 2016). APM's influence has transcended its origins in the software development sector, gaining adepts in other business contexts and in large-scale context, multi-team settings and large organizations. The existing literature highlights a lack of consensus regarding the concept of "large-scale" within the APM context (Dingsøyr *et al.*, 2018). The term large-scale can refer to product or project complexity in terms of project size (Dingsøyr *et al.*, 2018; Khalid *et al.*, 2020; Qureshi and Hussain, 2008; Shameem *et al.*, 2020), budget (Berger and Beynon-Davies, 2009), duration and the number of stakeholders involved, including customers, users and developers (Dikert *et al.*, 2016; Šmite *et al.*, 2017).

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Parameters related to team size are the most commonly considered aspects, followed by coordinated teams, the geographic dispersion (Boehm and Turner, 2005; Khalid *et al.*, 2020; Lindvall *et al.*, 2004; Saeeda *et al.*, 2015; Šmite *et al.*, 2017) and team multidisciplinary. Furthermore, large-scale can also refer to large organizations engaging different areas, with multiple business units, multiple clients and large portfolio (Hobbs and Petit, 2017). The interest in APM within a large-scale context is growing significantly due to its emerging research focus, driven by both the challenges and complexities inherent in scaling APM and the potential benefits it offers in innovative projects (Moyano *et al.*, 2022). In this way, we address two research gaps.

Firstly, several characteristics of APM pose challenges for scalability, including the emphasis on minimal documentation and its team-centric approach within the agile toolkit (Santos and Carvalho, 2021). APM does not support the degree of documentation and infrastructure required for lower-level certification (Boehm and Turner, 2005), presenting a significant hurdle to scaling. Furthermore, large-scale agile extends beyond the team level of analysis, demanding a modular approach that integrates three components, customer experience teams, business process teams and technology systems teams (Rigby and Sutherland, 2018). We define large-scale agile projects as those that refer to the application of agile principles and methodologies to projects that involve a substantial number of team members, multiple teams or complex and extensive work. These projects require coordination and integration between different teams, departments or even organizations (Hüllmann *et al.*, 2024). Large-scale agile projects require careful preparation and committed leadership, which demands a clear understanding of how the transformation process will impact people (e.g. team structures, networks and relationships), processes (e.g. team coordination, customer engagement, performance monitoring and productivity metrics) and practices (e.g. agile methods and organizational culture). Therefore, these projects span a large number of teams, roles and personalities; abstract and knowledge-intensive work processes; diverse and often competing agendas between teams; in addition to final results and objectives that are often abstract, complex and unknown (Carroll *et al.*, 2023).

In this sense, we address the first gap in the literature by arguing that there are potential benefits related to the team, the business and the product and processes that should be explored when associating APM with organizational readiness (OR) in large-scale agile projects. For the team, implementing agile practices can promote greater engagement, autonomy and responsibility. In business terms, agility can result in faster and more frequent deliveries of customer value, increasing customer satisfaction and loyalty, as well as improving responsiveness to market changes. As for products and processes, the adoption of agile methodologies allows an iterative and adaptive approach that favours continuous innovation, reducing development time and mitigating risks through faster and more effective feedback. However, these benefits may be conditioned on OR to adapt to rapid changes, which involve cultural and structural aspects, the approach adopted, transition and strategic management. Previous studies have delved into challenges in APM at scale (Eickhoff *et al.*, 2018; Faisal *et al.*, 2020), identifying barriers to agile methods (Hobbs and Petit, 2017; Shameem *et al.*, 2020) and benefits to the adoption of this approach (Heikkilä *et al.*, 2015; Hobbs and Petit, 2017; Sahid *et al.*, 2018). Regrettably, there exists a lack of studies demonstrating positive outcomes when extending the methodology's scope (Hobbs and Petit, 2017) and elucidating how organizations should structure themselves for agility (Meier and Kock, 2022). To date, only a limited number of studies discuss the relationship between APM and benefits in a large-scale context, with even fewer employing quantitative approaches (Meier and Kock, 2022; Santos and Carvalho, 2021).

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In this way, further research is essential to understand better the benefits, challenges and specific practices that contribute to success in agile methodologies (van Wessel *et al.*, 2022). Thus, this study addresses this gap by exploring the relationship between agile methods and the associated benefits for businesses, teams and products and processes in large-scale contexts.

The second gap in the literature identified in this research refers to the correlation between OR and agility in large-scale projects. Our argument is that an organization's ability to adopt, sustain and overcome the barriers of agile management depends on OR. Specifically in the context of barriers, barriers for large-scale agile that stood out include leadership, a receptive culture, experienced agile practitioners and a high tolerance for risk (Rigby and Sutherland, 2018). In the R&D context, the culture showed the highest correlations with agility (Meier and Kock, 2022). Additionally, there are demotivating factors in the large-scale agile context, such as difficulties related to the necessary knowledge and proficiency in agile methodologies for applying agile tools across various types of activities, along with the challenge of fostering acceptance of agile principles and values (Faisal *et al.*, 2020).

Also, OR refers to the organization's state of readiness to implement significant changes, including the adoption of agile methodologies on a large scale. This readiness involves several factors, such as organizational culture, willingness to change, leadership structure and the ability to learn and adapt (Hussain and Papastathopoulos, 2022). However, the empirical testing of OR theory in operations and innovation management is limited. OR theory can provide valuable theoretical support for evaluating an organization's preparedness to overcome potential barriers in large-scale agile projects (Santos and Carvalho, 2021). Implementing the agile approach at a large-scale poses a significant challenge for many organizations, often leading to demotivation in the implementation process (Hobbs and Petit, 2017). Santos and Carvalho (2021)'s review indicates that the majority of the literature predominantly focuses on large projects or multi-projects (72%), with a smaller proportion (28%) addressing the concept of scaling within the broader organizational environment. This distribution underscores the pressing need for a more comprehensive examination of the role of organizational issues in the large-scale context. Thus, there is a second gap in comprehending the role of OR within the context of barriers in large-scale agile. In order to narrow this gap, this study investigates the OR mediating role in the relationship between the agile methods barriers and the benefits in a large-scale context.

Thus, considering these two research gaps, this paper aims to explore the relationship between the agile methods barriers in large-scale contexts and the benefits for business, team and product and process, exploring the OR mediating role. To achieve this goal, a theoretical model has been developed and analysed using structural equation modelling (SEM). Data were collected through a survey questionnaire administered to Brazilian agile project managers with prior experience in large-scale settings. We also seek to answer the following research questions:

RQ1. How does OR impact the relationship between AM and benefits in large-scale agile projects?

RQ2. What is the effect to be considered regarding the agile method (AM) barriers for benefits and OR?

Our paper specifically focuses on professionals who are actively involved in large-scale agile projects. It investigates the actual large-scale agile scaling process, focusing on elements related to Organizational Readiness Issues, AM Barriers, Business Benefits (BB), Product and Process Benefits (PPB) and Team Benefits (TB). This research contributes to the theory by proposing and validating a research model that demonstrates the significant influence of the AM on benefits (team, product and process and business) in a large-scale context.

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This study applies the concept of OR in a broader context, incorporating strategic alignment within the implementation of large-scale agile. This broader perspective takes into account critical variables like organizational structure and culture. The proposed model further investigates the mediating pathway of OR, linking AM to benefits.

2. Theoretical background

2.1 Large-scale agile

The literature shows different labels for large-scale agile such as large-scale development and organization-wide transformation (Edison *et al.*, 2022). Previous literature has provided varying explanations for the concept of large-scale agile, considering factors such as the size of teams, codebase, project budget and duration (Dingsøyr *et al.*, 2014), showing the contextual nature of the term (Dingsøyr *et al.*, 2018).

The debate on large-scale agile focuses on the people involved and number of simultaneous teams. Some authors argue that large-scale is suitable for up to 50 people (Berger and Beynon-Davies, 2009; Paasivaara *et al.*, 2014). Paasivaara *et al.* (2014) consider a project with 7 development teams and 40 people as large-scale. Some authors consider large-scale configuration when a team size has more than 50 members (Berger and Beynon-Davies, 2009; Dikert *et al.*, 2016). Another driving factor for the concept of large-scale is the number of simultaneous agile teams. Marinho *et al.* (2021) argue that a project with 2–9 teams (or more) and will need agile-scaled approaches for coordination, while Dikert *et al.* (2016) suggest at least six collaborating teams.

However, other variables are used to classify large-scale. Berger and Beynon-Davies (2009) argue that projects exceeding 10 million GBP are large-scale. Petersen and Wohlin (2010) highlight the coding structure, suggesting that projects with codebases surpassing 5 million lines of code are large scale. Bjarnason *et al.* (2012) look at schedule and features, suggesting that projects spanning 2 years with a scope of 60–80 features are large-scale.

Large-scale agile initiatives necessitate an organizational-level analysis, as discussed in the literature. Some authors point out differences in the structure adopted compared to the existing organizational setup, deficiencies in motivation strategies and the organization's overall commitment (Conboy and Carroll, 2019; Shameem *et al.*, 2020; Sweetman and Conboy, 2018). Scaling agile introduces many challenges stemming from organizational issues, including coordination among multiple agile teams and the lack of initial architecture and requirements analysis (Marinho *et al.*, 2021). Addressing these organizational challenges in large-scale agile is complex, and the existing literature provides limited guidance on effectively handling scaling and complexity factors (Alqudah and Razali, 2016; Hobbs and Petit, 2017).

Several frameworks for large-scale share principles, practices and artefacts aligned with agile, offering valuable insights on different levels of adoption, standing out as widely adopted the Scaled Agile Framework (SAFe) and Scrum@Scale (Khoza and Marnewick, 2021). Some large-scale approaches are Crystal methodology, SAFe (Leffingwell, 2011), Scrum@Scale/Scrum of Scrums (SoS) (Rigby and Sutherland, 2018), Large-Scale Scrum (LeSS), Disciplined Agile Delivery (DAD) and Spotify.

2.2 Organizational readiness

Organizations need to be ready for challenging changes (Alves and de Carvalho, 2023; Hussain and Papastathopoulos, 2022). Weiner (2020) presents a multi-level and multi-faceted readiness theory for change, which emphasizes a shared state where members feel committed to implementing changes. The theory of OR has been used to understand complex organizational changes, such as readiness for digital innovation (Lokuge *et al.*, 2019) and

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defense sector (Hutapea *et al.*, 2021; Johnson *et al.*, 2007). However, empirical testing of the OR theory in the field of operations and innovation management remains limited (Vaishnavi *et al.*, 2019).

OR is a multi-level of an analysis construct that can be theorized at "individual, group, unit, department, or organizational level" [45, p. 2]. Thus, it can mean and encompass different variables across levels of analysis from broader contextual conditions to the individual perspective. It can involve organizational culture, flexible organizational policies and procedures, positive organizational climate (Eby *et al.*, 2000), organization's financial, material, human and informational resources (Bloom *et al.*, 2000) and collective and coordinating action, shared beliefs, collective capabilities, promoting organizational learning (Weiner, 2009).

The OR theory consists of change valence (employee commitment), change efficacy and contextual factors (Lokuge *et al.*, 2019; Weiner, 2020). Change valence links positive perception with implementation effort, while change efficacy assesses the resources for change execution, aiding readiness. OR is essential for adapting to new technologies and enhancing innovation (Jun *et al.*, 2022). It involves both psychological and structural elements (Keramati *et al.*, 2011; Sharma *et al.*, 2022; Su *et al.*, 2023; Tsou and Hsu, 2015).

For Santos and Carvalho (2021), several aspects influence the OR for scaling APM, including organizational culture, organizational structure and organizational approach and transition from traditional to agile and strategic management. Scaling APM tends to provide various benefits when the organization is mature enough to promote transitions in an appropriate, gradual and aligned way to business strategies (Santos and Carvalho, 2021). Thus, conflicts with organizational culture and relationship with the client (Berger and Beynon-Davies, 2009; Faisal *et al.*, 2020; Hobbs and Petit, 2017; Nerur *et al.*, 2005; Shameem *et al.*, 2020) become challenging to overcome when it seeks the APM on a large-scale context. Moreover, there is a need to develop an appropriate structure when scaling agile to the organization.

When scaling agile, the organizational structure needs to adapt to the new reality, which may require a transition structure between methods (Eickhoff *et al.*, 2018; Faisal *et al.*, 2020; Petersen and Wohlin, 2010). In companies that have scaled up agile, the organization charts often have fewer management layers and broader spans of control (Rigby and Sutherland, 2018).

The effect on organizational culture and approach is relevant (Hobbs and Petit, 2017; Lindvall *et al.*, 2004; Riaz *et al.*, 2018) since when scaling APM, the changes go beyond team level, reaching managerial, customer, multi-teams, approaches, processes and product issues (Santos and Carvalho, 2021). This concept refers to the organization members' commitment as implementation is often a "team sport", such as agile methodologies, issues arise when some feel committed to implementation but others do not (Berntzen *et al.*, 2023; Weiner, 2009). The challenges of adopting agile practices in a large-scale context can be related to the size of the organization and its readiness to respond to challenges (Uludağ *et al.*, 2022).

Finally, OR for APM scaling has to consider the strategic management perspective (Hobbs and Petit, 2017; Riaz *et al.*, 2018) setting strategic priorities aligned with corporate strategies and build the organizational capabilities to achieve those goals (Rigby and Sutherland, 2018).

2.3 APM in the large-scale context

When implementing large-scale agile, some characteristics of the APM can lead to different results from those found in small and dedicated projects. Along with the broadening of the agile approach, new issues were raised, such as team involvement, the need for certifications and training and the relationship with organizational practices (Alqudah and Razali, 2016).

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The lack of knowledge about the AM generates doubts about how to proceed and move forward with project activities (Hobbs and Petit, 2017), demanding experienced agile practitioners and providing highly prescriptive guidelines to align staff hundreds (Rigby and Sutherland, 2018). In consequence, the large dissemination and on-the-job training can result in training deficiencies and distortions related to a lack of proper understanding (Eickhoff *et al.*, 2018; Faisal *et al.*, 2020). The focus on processes or products, commonly adopted in large organizations, needs balancing with teams or entire areas that focus on people (Nerur *et al.*, 2005), demanding adjustments and challenges for dealing with such differences within the same environment. Iterative and evolutionary development cycles, which require greater contact and communication, with less focus on long-term planning and predictability (Nerur *et al.*, 2005).

Studies also point out that in the large-scale context, regulatory issues and portfolio control reports collide with the APM proposal for minimal documentation, which encompasses different sectors of the company (Alsaqaf *et al.*, 2019; Lebdeh *et al.*, 2020; Lindvall *et al.*, 2004; Santos and Carvalho, 2021). In addition, there is some criticism related to excessive optimism (Heikkilä *et al.*, 2015) and negligence of risks (Qureshi, 2012) in small isolated and self-managed projects, which generate concerns in the large-scale context.

Another challenge in large organizations is the coordination and communication between multiple teams and different organizational units that often do not work in an agile way (Berntzen *et al.*, 2023). Although traditional agile methods mostly focus on intra-team practices that work well in small organizations, agile methods do not provide enough guidance on how agile teams should interact in large environments (Uludağ *et al.*, 2022). Thus, large organizations must adapt practices to their specific needs.

2.4 Benefits of scaling APM

Large-scale agile projects involve multiple teams working in a coordinated and integrated manner, which requires the adoption of work structures focused on communication and synchronization (e.g. SAFe, LeSS or Scrum@Scale). The complexity and breadth of these projects require efficient management of dependencies and a clear definition of responsibilities between teams that may be from different organizational contexts. However, we recognize that simply adopting the agile approach in large-scale projects may not generate satisfactory results, as it involves overcoming a series of complex challenges. These challenges include effective coordination between multiple teams, maintaining clear and continuous communication and managing dependencies and interdependencies between different project components (related to the TB dimension). Furthermore, it is necessary to ensure alignment between the project goals and the organization's strategic objectives, which requires greater effort from leadership (which influences BB). Finally, the complexity of large-scale agile processes, when poorly implemented, can influence the quality and reliability of the product, reduce team productivity due to lack of motivation and communication and make prototyping and experimentation difficult (which would affect the PPB) (Carroll *et al.*, 2023; Hüllmann *et al.*, 2024; Santos and Carvalho, 2021).

However, when implementing agile methodologies is supported by comprehensive training and effective leadership from senior management, we argue that potential benefits emerge across dimensions such as project teams, business outcomes and organizational products and processes. Some studies pointed out greater customer involvement and stakeholder satisfaction in large-scale agile, promoting constant interactions, prototyping and validations that allow customers and stakeholders engagement and, consequently, more influence in the project progress, counteracting the difficulties faced in dealing with people-oriented approaches and the principles and values of the method (Sahid *et al.*, 2018; Serrador and Pinto, 2015).

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The potential benefits of this large-scale agile include the perception of greater efficiency, improved productivity, adaptation to changes in the business environment (Rigby and Sutherland, 2018), quicker development timelines, easier fault detection, enhanced customer involvement (Lebdeh *et al.*, 2020) better inter-team communication (Dabney and Arthur, 2019) and improved responsiveness to changes (Bass, 2019).

Moreover, in agile at scale, some benefits can cascade among projects (Sweetman and Conboy, 2018), which can culminate in faster development cycles (Hoeren and Pinelli, 2018; Lebdeh *et al.*, 2020; Sahid *et al.*, 2018) and better resource management (Heikkilä *et al.*, 2015; Sahid *et al.*, 2018).

The perception of these benefits relates to the optimization of information and resources, increasing presence in organizational and market demands. Therefore, there is an alignment between the AM and business processes (Hannay *et al.*, 2017; Sahid *et al.*, 2018), benefiting financial and performance indicators (Petersen and Wohlin, 2010; Sahid *et al.*, 2018; Serrador and Pinto, 2015).

Santos and Carvalho (2021) clustered various benefits related to processes and products, particularly, those related to productivity and improvement in the requirement management stand out. Despite the difficulties faced with minimal documentation, the amount of documentation is perceived in some cases as a benefit (Petersen and Wohlin, 2010) coherent with lean methodology characteristics and benefits (Saltz and Heckman, 2018; Sweetman and Conboy, 2018).

Some studies report that large-scale agile brings improvements in process compliance and reliability (Sahid *et al.*, 2018; Siqueira *et al.*, 2018), increasing the quality of products and better risk and failure management (Heikkilä *et al.*, 2015; Hobbs and Petit, 2017; Lebdeh *et al.*, 2020; Lindvall *et al.*, 2004; Sahid *et al.*, 2018).

The final benefit category proposed by Santos and Carvalho (2021) relates to TB. Some studies point out benefits of learning and community of practice (Eickhoff *et al.*, 2018; Šmite *et al.*, 2017).

In addition, studies report advantages related to frequent feedback and improvements in communication and transparency (Eickhoff *et al.*, 2018; Heikkilä *et al.*, 2015; Lebdeh *et al.*, 2020; Petersen and Wohlin, 2010). Organizations apply agile methods to increase their productivity and ensure delivery of products according to customer requirements. However, in some environments (e.g. global software development) they face barriers, as development activities can be employed beyond the organization's national geographic boundaries, which makes it difficult to implement agile methods. Coordination and communication difficulties increase the need for successful implementation of agile methods, which can influence product benefits (Šmite *et al.*, 2021; van Wessel *et al.*, 2022). Thus, we suggest the following hypotheses:

3. Research model and hypotheses

The research model (see Figure 1) explores the causal chain among three constructs: agile method, OR and benefits in large-scaled contexts. There are two causal paths feeding into the benefits variable. There is a path from the independent variable AM issues to the mediator, OR (H1) and the impact of the mediator on the benefits (H2). The second path is the direct impact of the AM on the benefits (H3). Thus, we explore the mediation role of OR between AM and benefits for business, product and process and team (H4).

The theory of OR for change provides the overarching theoretical framework for developing an assessment of OR. This is reflected in reactionary factors such as a sense of urgency, support and the commitment employees have to change (Lokuge *et al.*, 2019). We hypothesize following the theoretical lens of OR role (Haque *et al.*, 2016; Hussain and Papastathopoulos, 2022; Jun *et al.*, 2022; Lokuge *et al.*, 2019). In this previous literature, the

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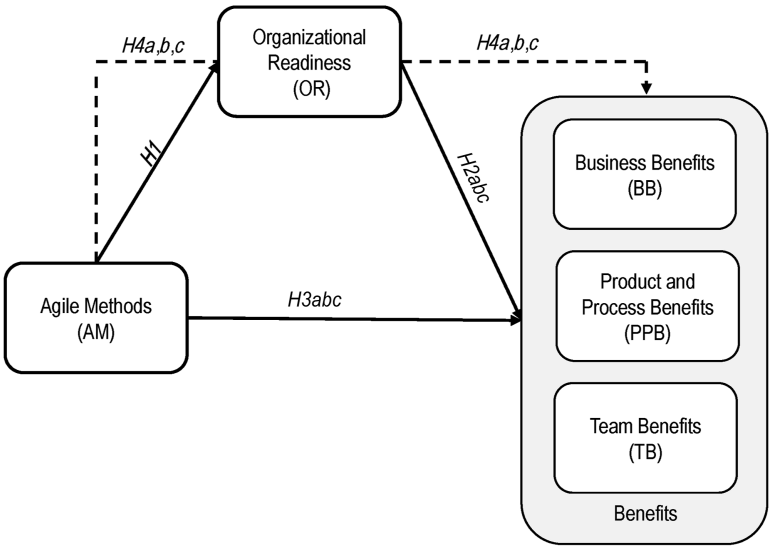

Source(s): Authors' own creation

Figure 1.
Research model

OR helps mediate the typical effects of the agile methods on benefits. Facing the perceived research gap on the relationship between AM and OR issues in the large-scale context, the following research hypothesis emerged:

H1. There is a significant relationship between AM barriers and OR

Understanding the relationship between OR and benefits obtained through large-scale agile is crucial (Santos and Carvalho, 2021). In this sense, organizations must be promptly prepared to implement changes, avoiding problems that are harmful to the success of the business. OR can be a precursor to the successful implementation of complex changes in large organizations looking for effectiveness to implement new organizational arrangements. Previous studies with OR theoretical lenses in other contexts, such as digital transformation, show the discrepancy between current performance levels and the creation of an attractive vision of the future, promoting confidence that this future state can be achieved (Jun *et al.*, 2022; Weiner, 2009). According to (Lokuge *et al.*, 2019), the OR is essential to acquire technology and implement new methodologies, which must be adequate to the human resources, infrastructure and capabilities of the company leading to successful implementations. The organization's readiness to accept changes can be related to the benefits of new product development as well as increased productivity (Lokuge *et al.*, 2019). Thus, extending this previous literature to large-scale agile contexts can bring contributions to theory (Santos and Carvalho, 2021), leading to the following hypothesis:

H2. There is a significant relationship between OR and Benefits (BB, PPB, TB) in large-scale contexts.

Previous literature support the positive relationship between agile practices and benefits (Lindvall *et al.*, 2004). However, the transition pathway for large-scale context imposes challenges for allowing companies to reap the benefits while minimizing conflicts and unnecessary efforts. Despite the lack of confirmatory studies, some authors suggest potential advantages of large-scale agile, including increased stakeholder satisfaction, enhanced team

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engagement (Sahid *et al.*, 2018; Serrador and Pinto, 2015), cascade benefits across coordinated teams (Hoeren and Pinelli, 2018; Lebdeh *et al.*, 2020; Sahid *et al.*, 2018; Sweetman and Conboy, 2018) and positively impacting financial and performance indicators (Hannay *et al.*, 2017; Sahid *et al.*, 2018). Due to the lack of quantitative research exploring this relationship, we propose the following hypothesis.

H3. There is a significant relationship between AM barriers and Benefits (BB, PPB, TB) in large-scale contexts.

The theoretical lens of OR supports the understanding of complex organizational changes (Lokuge *et al.*, 2019). We hypothesize following the theoretical lens of OR, particularly, the research exploring the mediating OR role confirmed in other fields as digital transformation (Haque *et al.*, 2016; Hussain and Papastathopoulos, 2022; Jun *et al.*, 2022; Lokuge *et al.*, 2019). Therefore, we propose the following hypothesis for extending the theory for a large-scale agile context:

H4. OR mediates the link between AM barriers and Benefits (BB, PPB, TB) in large-scale contexts.

4. Research method

4.1 Sampling process

The data were collected through a survey of a sample of Brazilian agile project managers who have previous experience in a large-scale context. We invited 300 agile project managers through direct contact by professional social networks and emails who have worked on large-scale projects in Brazil. We also published the questionnaire in specific groups of professionals in APM. As a result, we received 117 responses, indicating a 39% response rate.

To confirm if the sample size is adequate, we calculated the minimum sample size required by applying the GPower 3.0 software (Faul *et al.*, 2007). Firstly, we select the test family for "*F* tests - Linear multiple regression: Fixed model, R^2 deviation from zero". Secondly, in the analyses we select "*a priori*: Compute required sample size". Thirdly, following the literature, we perform statistical analysis to seek the internal validity of the sample size in representing the population of interest (Forza, 2002). We run a power test (Cohen, 1998), considering a statistical significance level of 5%, a power level of 90%, an effect size of 15% and a number of predictors of 2, the GPower 3.0 software recommends a sample size of 107 elements. Thus, the sample exceeds the sufficient range for partial least squares structural equation modelling (PLS-SEM) analysis (Chin, 2010). For the 117 valid questionnaires, the calculated power is 0.9674558.

4.2 Data collection

A survey questionnaire can, when well administered, reduce the variability of responses, have a wide scope and be easy to administer (Gorrell *et al.*, 2011). Our survey questionnaire has 45 closed questions related to the five latent variables of the research model, grounded in the literature discussed in the previous section, applying a seven-point Likert-type scale, as detailed in Table 1. Moreover, 10 questions explored the profile of respondents.

Ethical procedures guarantee the anonymity of respondents, and a pilot test was performed with three scholars devoted to agile methods. As independent and dependent variables are measured at the same time using the instrument (Liang *et al.*, 2014), special attention was devoted to avoiding common method bias (CMB). Thus, in the data collection

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Latent variable	Scale	Manifest variables	Code	Mean
OR	7-point Likert scale	Organizational Culture	OR_01	4.9
		Organizational Structure	OR_02	4.6
		Organizational Approach	OR_03	4.4
		Transition Framework	OR_04	4.3
		Strategic Management	OR_05	4.3
Agile method barriers (AM)	7-point Likert scale	Knowledge of Agile Methods	AM_01	4.6
		People-centric	AM_02	4.5
		Agile principles and values	AM_03	4.6
		Technologies/tools/methods	AM_04	3.9
		Development cycle	AM_05	4.1
		Minimal Documentation	AM_06	3.5
		Over-optimism	AM_07	3.8
		Lack of risk awareness	AM_08	4.4
Business benefits (BB)	7-point Likert scale	Customer Engagement	BB_01	4.6
		Stakeholders Satisfaction	BB_02	4.7
		Sharing the benefits	BB_03	4.2
		Business process integration	BB_04	4.5
		Fast cycle time	BB_05	4.6
		Better resource management	BB_06	4.5
		Stakeholders Management (Proactive engagement to ensure ongoing alignment)	BB_07	4.4
		Change Management	BB_08	4.3
		Best financial and performance results	BB_09	4.4
Product and process benefits (PPB)	7-point Likert scale	Quality	PPB_01	4.4
		Reliability	PPB_02	4.1
		Productivity	PPB_03	4.6
		Simplicity	PPB_04	4.3
		Compliance	PPB_05	3.9
		Flexibility	PPB_06	4.6
		Prototyping and experimentation	PPB_07	4.5
		Lean features	PPB_08	4.4
		Better control over risks and possible failures	PPB_09	4.2
		Documentation Amount	PPB_10	3.9
		Requirements management improvement	PPB_11	4.2
Team benefits (TB)	7-point Likert scale	Frequent Feedback	TB_01	4.8
		Learning	TB_02	4.7
		Practice Community	TB_03	4.1
		Communication	TB_04	5.0
		Transparency	TB_05	5.0
		Control	TB_06	4.0
		Responsiveness	TB_07	4.4
		Leadership	TB_08	4.7
		Work-life quality and team motivation	TB_09	4.8
		High level of trust	TB_10	4.7
		Teamwork	TB_11	4.1
		Customer Commitment	TB_12	5.0

Source(s): Authors' own creation

Table 1. Survey questionnaire structure and theoretical traceability

phase, extant analysis explores the survey questionnaire semantics and questions designed to avoid ambiguity (Podsakoff *et al.*, 2003). After data collection, CMB was tested, as detailed in the data analysis section. We screen the questionnaires looking for bias in non-engagement (same answer for all questions) and other issues. Besides, we used Little Missing Completely at Random (MCAR) test, for the missing value analysis (Li, 2013).

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4.3 Operationalization of constructs

We designed the measurement model according to the conceptual reasoning previously discussed in Figure 1. All of the latent variables were operationalized as the first-order construct, using multi-item reflective indicators, which are appropriated for the target theoretical constructs (Hair *et al.*, 2014). In the reflective type, a set of manifest variables reflect the latent variable based on the covariance between the estimate of the latent variable and the indicator variable they are measuring (Hair *et al.*, 2019). We operationalized the research constructs grounded in the literature review of (Santos and Carvalho, 2021). A seven-point Likert-type scale was selected because it provides reliable and valid scores (Preston and Colman, 2000). Table 1 summarizes the structure of the survey questionnaire.

4.4 Data analysis

Descriptive statistical analysis on all research questions was performed and mapping of the sample demographics. Then, we analysed the CMB to avoid pathological collinearity patterns (Kock, 2015), applying the blindfolding algorithm in the SmartPLS 3.0 software (Ringle *et al.*, 2015). The blindfolding algorithm omits portions of the data for a particular construct and cross-validated using the estimates obtained from the remaining data points, providing predictive validity through Q-square statistics (Chin, 2010).

We chose PLS because this research is focused on the prediction of dependent variables, tackles a theory-building environment (exploratory analysis), the analysis is concerned with testing a theoretical framework, and the structural model is complex (includes many constructs and indicators) (Hair *et al.*, 2014). As we applied a Likert-type scale, the method fits well because it needs neither the normality of the variables nor the normality of the residuals.

In order to validate SEM models, first we need to validate the measurement model and then the structural model (Hair *et al.*, 2014). The PLS-SEM analysis relies on composites of observed variables to represent latent variables, which facilitates the estimation of different forms of nonlinear model relationships (Basco *et al.*, 2021). The PLS-SEM indicator weighing also produces smaller biases in measurement and structural model estimates (Hair *et al.*, 2017). We use the SmartPLS 3.3.2 software for the analysis of PLS path modelling (Ringle *et al.*, 2015).

In the PLS-SEM's standard measurement and structural model evaluation criteria, the constructs are measured reflectively and their measurement models must meet all relevant criteria in terms of their internal consistency reliability, convergent validity and discriminant validity (Basco *et al.*, 2021; Hair *et al.*, 2014). In our measurement model, we describe the relationships between the manifest variables and their respective latent variables, and in the structural model, we describe the relationships between the latent variables (Crocetta *et al.*, 2021).

We used the average variance extracted (AVE) to test convergent validity, accepting values equal to or above 50% (Fornell and Larcker, 1981). Discriminant validity was also assessed where all values were lower than or equal to 0.9 (Henseler *et al.*, 2009). To assess the quadratic effect's statistical significance, we run the bootstrapping procedure with 5,000 samples. We report the f^2 effect size to indicate the interaction term's impact on the endogenous construct's R^2. The f^2 values of 0.02, 0.15 and 0.35, respectively, represent small, medium and large effect sizes. A one-tail test was performed, reporting R^2 and adjusted R^2 of the endogenous variables, the total effects, significance (p-value), Stone–Geisser's Q and endogenous constructs' variance inflation factor (VIF) (Basco *et al.*, 2021; Henseler *et al.*, 2009).

Finally, we explore mediating effects through direct and indirect effects on SmartPLS, investigating full mediation (only indirect effect is significant) and partial mediation (direct effect is significant), following the literature guidelines (Nitzl *et al.*, 2016a).

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5. Results

5.1 Sample demographics

We considered only participants with at least five years of experience with large agile projects suitable as respondents; it was a condition for fulfilling the questionnaire. The sample is composed mainly of agile project managers (45%) and 28% are team members, as shown in Table 2. Other important roles for the agile approach that make up the sample of this research are scrum master (8%), consultant (4%) and PMO (2%), as shown in Table 2. We understand that the functions mentioned by respondents, although they may have origins in traditional methodologies, are adapted and play essential roles in large-scale agile projects. While some of these roles may seem traditional, they are essential to supporting and sustaining agility in large-scale projects. Transforming to an agile environment often involves adapting and evolving existing roles to better meet the needs of an organization adopting agile methodologies.

Most of the respondents have training in agile approach courses (65%), 24% had received training in the work environment and 11% did not take courses, they acquired knowledge with the experience. About 46% of the sample applies the agile approach only to some company projects, software development projects (30%) or most company projects (17%).

The descriptive statistics of the manifest variables show that the primary AM are Knowledge of Agile Methods (AM_01, $\mu = 4.6$) and Agile principles and values (AM_03, $\mu = 4.6$). Key BB that stand out include Stakeholders Satisfaction (BB_02, $\mu = 4.7$) and Fast cycle time (BB_05, $\mu = 4.6$). Among the PPB, the most prominent are Productivity (PPB_03, $\mu = 4.6$) and Flexibility (PPB_06, $\mu = 4{,}6$). Finally, regarding team benefits, the most significant indicators are Communication (TB_04, $\mu = 5{,}0$) and Transparency (TB_05, $\mu = 5{,}0$).

5.2 Measuring model evaluation

We analysed the CMB to avoid pathological collinearity patterns, applying the path algorithm in the SmartPLS 3.0 software (Ringle *et al.*, 2015). CMB can be detected through a

Topic	Description	Number of respondents	Percentage (%)
Role in the project	Project manager	53	45
	Team member	33	28
	Project Owner	10	9
	Scrum Master	9	8
	Consultant	5	4
	PMO	2	2
	Development Manager	1	1
	Product manager	1	1
	Portfolio Management	1	1
	Head of Innovation, Technology and Agility	1	1
	Portfolio Leader	1	1
Training and experience in agile methods	Agile approach courses	76	65
	Workplace training on agile	28	24
	Practical experience on agile only	13	11
Application of the agile approach	In some company projects	54	46
	Only on software development projects	35	30
	In most of the company's projects	20	17
	Across the company	8	7

Source(s): Authors' own creation

Table 2. Sample demographics

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full Collinearity assessment approach, and in our model, all Inner VIF values of our model are less than 3.3 (Kock, 2015). Also, our Harman's single factor test is less than 50% (equal to 34.59%) (Pesämaa *et al.*, 2021). We perform the blindfolding algorithm that omits portions of the data for a particular construct and cross-validated using the estimates obtained from the remaining data points, providing predictive validity through Q-square statistics (Chin, 2010). Table 3 shows the predictive validity through Q-square statistics. We considered $0 < Q^2 < 0.25$ as small predictive accuracy; $0.25 \leq Q^2 < 0.50$: medium predictive accuracy; and $Q^2 \geq 0.50$: significant predictive accuracy. In the blindfolding algorithm, "portions of the data for a particular construct block are omitted and cross-validated using the estimates obtained from the remaining data points" [68, p. 24].

To assess the predictive relevance of a given endogenous latent variable, we calculated Stone-Geisser's Q^2. Q^2 values should be greater than 0, and predictive accuracy can be small (higher than 0), medium (larger than 0.25) or large (greater than 0.50) (Chin, 2010; Cohen, 1998; Hair *et al.*, 2014). Table 3 shows the blindfolding construct cross validation.

Q^2 is a method to evaluate the predictive relevance of the internal model. It is based on a sample reuse technique that, regardless of the data matrix, omits estimate model parameters and uses estimates to predict deleted parts. The smaller the difference between the expected value and the original value, the larger the Q^2 and the better the model's prediction accuracy. Specifically, a Q^2 value for a particular model, in this case, is greater than zero, indicating the route model's predictive relevance, particularly for the variables in the BB and TB (Chen *et al.*, 2010).

The validation of the measurement model of all first-order reflective constructs occurs in two rounds, applying the PLS algorithm in SmartPLS 3.0 software.

For convergent validity, all constructs were validated in the first round. All manifest variables show significant loading factors higher than 0.6 for the respective latent variable. The AVE analysis shows values higher than 0.5 for all latent variables (Fornell and Larcker, 1981). The composite reliability and Cronbach's alpha present values higher than 0.7 for all latent variables (Henseler *et al.*, 2009; Tenenhaus *et al.*, 2005).

However, for the discriminant validity, we needed a second round of validation. We applied the criterion of observing if the square root of the AVE is higher than the correlation among the variables. We also checked the cross-loading, analysing if the correlation is higher in the aimed construct than in any other latent variable. To achieve both criteria, the three indicators of PPB construct PPB07, PPB9 and PPB10, three indicators of TB, TB6, TB9 and TB12 and two indicators, BB04 and BB06 of BB were withdrawn.

We also calculated the Heterotrait-Monotrait Ratio of Correlations (HTMT) to attest our discriminant validity. HTMT is an estimate of the correlation between the constructs and according to (Kline, 2015) HTMT < 1 ensures that the model has discriminate validity. Our model has HTMT = 0.71. Table 4 presents the summary of the measurement model validation.

	Construct cross-validated redundancy			Construct cross-validated communality		
	SSO	SSE	Q^2 (=1-SSE/SSO)	SSO	SSE	Q^2 (=1-SSE/SSO)
AM	936.000	936.000		936.000	498.222	0.468
BB	819.000	728.968	0.110	819.000	417.474	0.490
OR	585.000	487.630	0.166	585.000	400.007	0.316
PPB	936.000	886.520	0.053	936.000	484.314	0.483
TB	1.053.000	943.823	0.104	1.053.000	376.913	0.642

Table 3.
Blindfolding

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	AM	BB	OR	PPB	TB	
AM	*0.765*					
BB	0.546	*0.785*				
OR	0.591	0.446	*0.739*			
PPB	0.355	0.657	0.316	*0.783*		
TB	0.409	0.746	0.396	0.660	*0.849*	
Composite reliability (CR)	0.919	0.918	0.857	0.927	0.958	>0.7
Average variance extracted (AVE)	0.586	0.616	0.547	0.613	0.720	>0.5
Cronbach's alpha	0.900	0.895	0.793	0.909	0.951	>0.7

Note(s): The diagonal contains the AVE square root which is higher than the correlation among variables; all correlations are significant at the 1% level
Source(s): Authors' own creation

Table 4. Construct reliability and discriminant validity

5.3 Structural model validation: hypothesis testing

Once we confirmed that the construct measures were reliable and valid, the next step required evaluation of the structural model results. We proceeded with the bootstrapping simulation in the SmartPLS 3.0 to validate the structural model and hypothesis testing. The structural model is assessed by determining the relationship between path coefficients among the variables or constructs under study (Hair *et al.*, 2019). We tested the research hypothesis with 5,000 bootstrap subsamples as a conservative configuration to calculate the significance of outer weights (Hair *et al.*, 2014).

To understand the relationship among the three constructs depicting the direct and indirect effects among them, we opted to test three versions of the structural model to evaluate the increase of R^2 from the initial model to the full model (M0, M1 and M2 in Table 5).

Model	Hypothesis		Original sample (O)	Standard deviation (STDEV)	*T* statistics (|O/STDEV|)	*p* values	*R* square	*R* square adjusted
Model M0	AMB → BB	H3a	0.558	0.075	7.468	*0.000**	0.312	0.306
	AMB → PPB	H3b	0.373	0.092	4.053	*0.000**	0.139	0.132
	AMB → TB	H3c	0.420	0.105	3.993	*0.000**	0.176	0.169
Model M1	AMB → OI	H1	0.591	0.083	7.158	*0.000**	0.350	0.344
	OI → BB	H2a	0.446	0.093	4.792	*0.000**	0.199	0.192
	AMB → OI → BB	H4a	0.264	0.077	3.431	*0.001**		
	OI → PPB	H2b	0.316	0.108	2.920	*0.004***	0.100	0.092
	AMB → OI → PPB	H4b	0.187	0.074	2.519	*0.012***		
	OI → TB	H2c	0.396	0.107	3.684	*0.000**	0.157	0.149
	AMB → OI → TB	H4c	0.234	0.076	3.074	*0.002***		
Model M2	AMB → OI	H1	0.591	0.088	6.726	*0.000**	0.349	0.343
	OI → BB	H2a	0.182	0.105	1.730	0.084	0.329	0.317
	AMB → BB	H3a	0.447	0.093	4.783	*0.000**		
	AMB → OI → BB	H4a	0.107	0.064	1.687	0.092		
	OI → PPB	H2b	0.150	0.126	1.189	0.235	0.149	0.134
	AMB → PPB	H3b	0.278	0.107	2.590	*0.010***		
	AMB → OI → PPB	H4b	0.088	0.075	1.180	0.238		
	OI → TB	H2c	0.226	0.111	2.042	*0.041****	0.206	0.192
	AMB → TB	H3c	0.282	0.113	2.489	*0.013****		
	AMB → OI → TB	H4c	0.134	0.066	2.033	*0.042****		

Note(s): $^{*}p < 0.001$ Supported; $^{**}p < 0.01$ Supported; $^{***}p < 0.05$ Supported
Source(s): Authors' own creation

Table 5. Structural models validation: hypothesis testing

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The so-called model zero (M0) explores the relationship between AM and the three benefits (BB, PPB and TB). Model 1 explores the relationship between AM with OR (H1) and OR with benefits (BB, PPB and TB) (H2) and the mediating effects of OR (H4). Finally, Model 2 (M2) presents the hypotheses altogether H1 to H4, as shown in Figure 2.

We explore mediating effects in the research model, following the procedures suggested by (Nitzl *et al.*, 2016a; Zhao *et al.*, 2010), which includes the mediator into the model to investigate both partial mediation in M1 (direct effect is significant) and full mediation in M2 (only indirect effect is significant). Table 5 shows the results of the hypothesized relationships for the three models, depicting effect sizes and standardized coefficients.

5.3.1 Direct effects analysis. The coefficient of determination explained variance, or R^2 value is an essential measure in PLS-SEM since it measures the model's explanatory power. It measures the proportion of variance explained by each endogenous construct. There are different interpretations of the R^2 value, which have to consider the maturity of the theoretical field. In this research, R^2 of 0.02, 0.15 and 0.35, respectively, represent small, medium and strong effects (Cohen, 1998; Zhao *et al.*, 2010). As expected, the explanation of the influence of the independent on the dependent variable benefits increases from M_0 to M_2. The positive and significant influence of AM on OR is strong (35%) in both models (M_1 and M_2). The AM has a significant and positive effect on all three types of benefits; however, the effect size is stronger in BB, followed by TB and PPB.

Answering research question 1 (RQ1), in Model M1, it is interesting to note that the introduction of OR seems to dilute the direct impact of AM on the dependent variables PPB and TB. In Model M2, the relationship between AM and BB, PPB and TB improves substantially when compared to Model M1. The introduction of OR as a mediating variable appears to not only preserve but also amplify the explanation of the variance of the dependent variables. The variance explained by AM in BB increases to 32.9%, while for PPB and TB it increases to 14.9% and 20.6%, respectively.

In Model M_1, which explores only the direct effect of OR on the benefits, the direct effects are significant and positive but with a medium effect on BB and TB, with a small effect on PPB. However, in M_2, in which the direct effect of AM and OR are expected, only the positive and significant effect remains on TB. It is explained by the mediation effect discussed in the next section.

5.3.2 Mediation analysis. The mediating effect measures the extent to which the dependent variable changes when the independent variable is held fixed and the mediating variable changes by the amount that it would have changed if the independent variable had increased by one (Baron and Kenny, 1986; Nitzl *et al.*, 2016b; Zhao *et al.*, 2010).

Model M1 explores the path between AM and benefits (BB, PPB and TB) with the mandatory mediation of OR, i.e. in M1, there is no expected direct effect of AM on benefits. The results show the mediating role of OR between AM and benefits (BB, PPB and TB) with significant effects (see Tables 5 and 6). However, in M2, when we hypothesize the full mediation with a potential direct relationship between OR and benefits and between AM and benefits, only the OR mediation between AM and TB (path AM → OR → TB), remains significant with 95% confidence. The mediating role of OR between AM and PPB shows no significance. Finally, the mediating role of OR between AM and BB needs further investigation due to the potential relationship with 90% of confidence, which we did not consider significant but should be explored further. In consequence, we considered that OR has a partial mediation role once the direct and indirect effects are significant (Nitzl *et al.*, 2016a; Zhao *et al.*, 2010).

Despite some mediation roles not being significant for BB and PPB, OR amplifies the effect on these benefit variables, as shown in Table 6 and in importance-performance maps (see Figure 3). For instance, the direct relationship between AM → BB has the original sample value of 0.447, which equates to AM → OR → BB value (0.107), reaching the total value of

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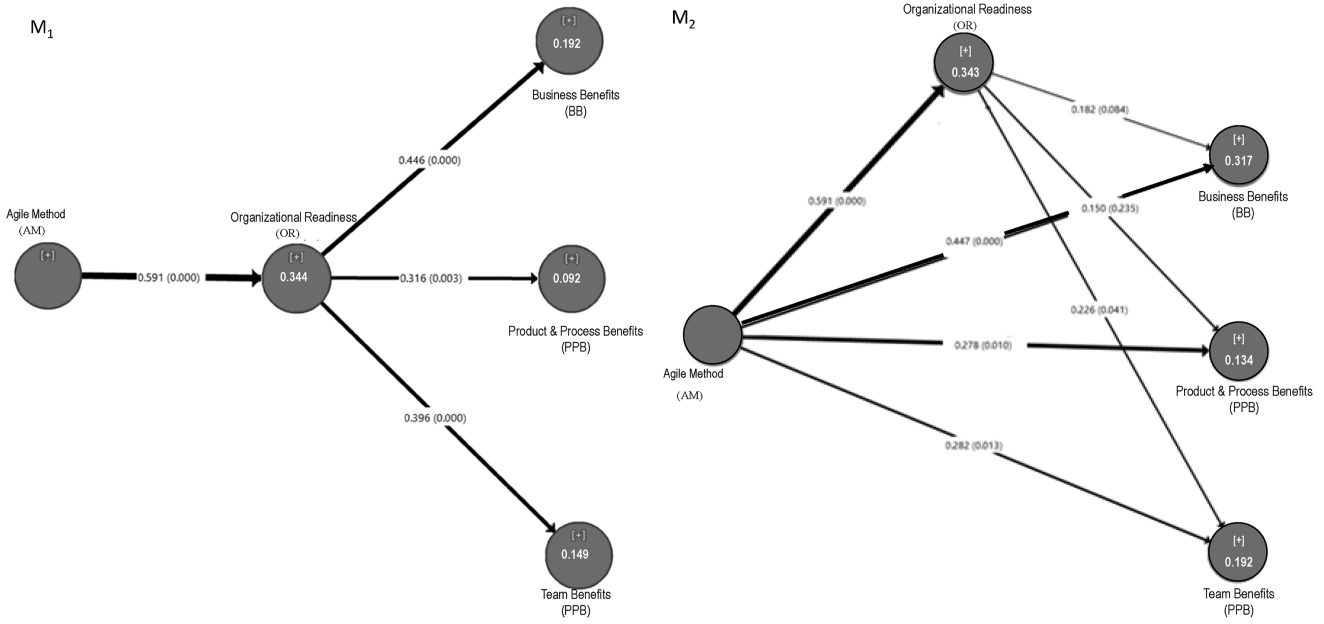

Note(s): In the arrow the value of path coefficient (*p*-value). In the circle the R Squared Adjusted
Source(s): Authors' own creation

Figure 2.
Structural model validation

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Dependent variable	Effects	Path	Original sample (O)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	p values
BB	Direct	OR → BB	0.182	0.105	1.730	0.084
		AM → BB	0.447	0.093	4.783	*0.000**
	Indirect	AM → OR → BB	0.107	0.064	1.687	0.092
	Total	AM → BB	0.554	0.077	7.195	*0.000**
		OR → BB	0.182	0.105	1.730	0.084
PPB	Direct	AM → PPB	0.278	0.107	2.590	*0.010***
		OR → PPB	0.150	0.126	1.189	0.235
	Indirect	AM → OR → PPB	0.088	0.075	1.180	0.238
	Total	AM → PPB	0.367	0.090	4.052	*0.000**
		OR → PPB	0.150	0.126	1.189	0.235
TB	Direct	AM → TB	0.282	0.113	2.489	*0.013****
		OR → TB	0.226	0.111	2.042	*0.041****
	Indirect	AM → OR → TB	0.134	0.066	2.033	*0.042****
	Total	AM → TB	0.416	0.107	3.890	*0.000**
		OR → TB	0.226	0.111	2.042	*0.041****

Table 6.
Hypothesis testing: mediation effects

Note(s): $^{*}p < 0.001$ Supported; $^{**}p < 0.01$ Supported; $^{***}p < 0.05$ Supported
Source(s): Authors' own creation

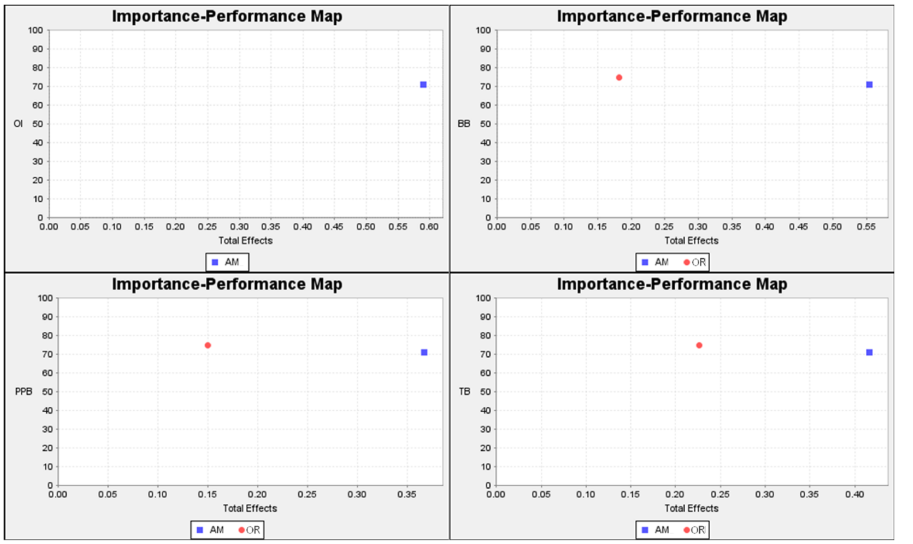

Figure 3.
Importance-performance maps

Source(s): Authors' own creation

0.554 (see Table 6 and Figure 3). As shown in Figure 3, AM has an indirect effect to be considered in OR and the potential benefits, thus answering (RQ2).

6. Discussion and conclusions

This study explores the agile methods in large-scale contexts and their influence on business, product and process and team benefits, investigating the mediating role of OR. We proposed and validated a theoretical model through SEM.

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Our results show the significant and positive influence of AM on all three benefit variables (TB, BB, PPB). The most prominent AM are people-centric (AM2) and agile principles and values (AM3). Furthermore, we identified the significant and positive mediating role of OR on the relationship between AM and TB.

Regarding research question 1 (RQ1), we understand that OR refers to an organization's level of preparation and ability to adopt and implement agile methodologies effectively. In Model M1, which examines the direct effect of OR on benefits, we find that the direct effects are significant and positive but vary in magnitude. OR has a medium impact on BB and TB, but a smaller impact on PPB. This suggests that OR is essential for maximizing the benefits of agile practices, but its influence may be limited by other contextual and project-specific factors. In Model M2, where both the direct effects of AM and OR are considered, the results indicate that the direct effect of AM is mediated by OR, resulting in a significant and positive impact only on TB.

To answer question 2, we consider the barriers mapped by Santos and Carvalho (2021). We observed that in Model M1, even with a positive and significant impact of OR, inherent barriers can dampen the expected benefits, especially in PPB. Furthermore, in Model M2, the mediated relationship between AM and benefits through OR highlights that removing barriers is crucial to unlocking the full potential of agile methodologies. OR not only prepares the company to adopt agile practices but also acts as a lever to overcome obstacles that may arise.

As such, we theorize that large-scale agile projects face unique challenges, such as the need to coordinate diverse teams, roles and personalities, deal with complex, knowledge-intensive work processes, manage competing agendas and achieve often unknown goals and end results. Thus, OR can facilitate communication and collaboration between diverse teams to align with project objectives. Furthermore, an OR can establish organizational capabilities to manage complex processes, adapt to continuous change, align divergent agendas among teams and stakeholders and face uncertainty of end results. OR in large-scale agile projects promotes greater experimentation and iteration to maximize results achieved (Carroll *et al.*, 2023; Hüllmann *et al.*, 2024; Santos and Carvalho, 2021).

6.1 Theoretical contributions

The theoretical contribution of the research model is in linking organizational issues, agile methods and benefits for the business, the product and process and the team in a large-scale context. Several scholars recognize the benefits of scaling APM in optimizing the project delivery process, making it faster and more efficient. However, our study goes further, validating a research model that shows the relationships between AM and organizational issues and the magnitude of their effects on benefits.

Our model offers valuable insights, especially in the context of scaling from traditional small-scale agile to larger environments. Through the lens of OR theory, the model unveils the pathway from AM to the intermediary role of OR, which subsequently affects the benefits (B). Our findings reveal a mediating effect wherein the OR construct bridges the AM constructs with team, business and product/process benefits. We operationalized the OR construct for large-scale agile from broader contextual conditions, bringing from the literature several variables such as culture, structure and agile approach (Alsaqaf *et al.*, 2019; Lebdeh *et al.*, 2020; Lindvall *et al.*, 2004; Santos and Carvalho, 2021). In our study, the variable related to OR that stood out is organizational culture. It corroborates previous studies that show the agile methodology requires cohesive, creative and collaborative teamwork in order to deal with rapid changes and error resolution (Boehm and Turner, 2005).

Moreover, strategic management is also important, requiring support across organizational boundaries (Sweetman and Conboy, 2018). The transition towards large-scale contexts can accommodate changes and disruptions if people are aware that

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they need to make changes. The transition from traditional to agile is a relevant variable in our model, as both the organization and individuals must distance themselves from bureaucratic structures (Eickhoff *et al.*, 2018; Hobbs and Petit, 2017). After the transition to the agile model, the structure must become more responsive to change and encourage experimentation (Lebdeh *et al.*, 2020; Lindvall *et al.*, 2004; Nerur *et al.*, 2005), in consequence, the organizational structure is centred on the understanding of customer and people needs.

Dingsøyr *et al.* (2023) elucidate that the transition to large-scale agile projects evolves in two distinct phases. In the first phase, exemplified by studies such as Batra *et al.* (2010), the need for structuring project management frameworks to deal with large, highly strategic and critical projects in terms of deadlines and geographic distribution stands out. In this context, the combination of agile methods is essential to manage unforeseen events and changes in requirements (Batra *et al.*, 2010). This initial approach combines team-level agile methods with traditional frameworks like the Project Management Body of Knowledge (PMBOK) or Prince2. Characterized by an emphasis on processes, formal communications and defined individual roles, this initial generation divides work into phases, reflecting an orientation typical of bureaucratic organizations (Dingsøyr *et al.*, 2023).

The second generation of large-scale agile development methods actively incorporates insights from digital product development and adopts approaches such as SAFe, Scrum@Scale, Disciplined Agile Delivery, LeSS and the Spotify model. In contrast to first-generation methods, these approaches embrace principles from the agile community and incorporate new learnings from Lean product development. They place greater emphasis on product over process, promoting informal communication, an evolving delivery model and a more flexible organizational structure to encourage social collaboration. Management is more collaboration-oriented, defining principles based on agile practices with a focus on organizing large projects around autonomous teams, planning and architecture released through roadmaps and guidelines, continuous collaboration with clients and involvement of end users at various levels. These methods also emphasize practices such as SoS meetings for coordination between teams and communities of practice for knowledge sharing (Dingsøyr *et al.*, 2023).

Therefore, we argue that the transition from traditional management to APM in large-scale projects requires a structured and carefully planned approach. Initially, it is essential to invest in education and training in agile methodologies for all levels of the organization. Next, a detailed assessment of existing project management practices to identify areas of opportunity for applying AM. It is essential to align the organization's processes with new agile practices by customizing an agile framework, such as SAFe, LeSS or Scrum@Scale.

Before the methodology can effectively operate throughout the organization, we recommend that it is necessary to initially implement it in pilot projects that allow the approach to be validated and the framework to be adjusted before large-scale adoption. Furthermore, it is necessary to train autonomous and multidisciplinary teams, promoting collaboration and shared responsibility, while guiding them to regular retrospective cycles that ensure continuous improvement of the process. Finally, it is essential to proactively manage organizational change, regularly communicating the benefits of the agile approach and aligning expectations for the transition.

Regarding the AM, our model reinforces that the company must thoroughly know the advantages of adopting this methodology and if it is applicable to its context. Our study reinforces the two most significant AM, people-centric and agile principles and values, corroborating some previous studies. The people-centric approach is challenging in a large-scale context since a lack of team communication, motivation and proper project documentation can lead to frustrations, skipped tasks and missed deadlines (Eickhoff *et al.*, 2018). Besides, the lack of understanding of the method can cause excessive optimism, insufficient documentation and inadequate tools, generating negligence and continuous errors (Eickhoff *et al.*, 2018; Faisal *et al.*, 2020; Petersen and Wohlin, 2010).

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Our model focuses on three benefits. The first one is the benefits for the team. In APM, iteration and testing are fundamental in project execution and when the customer is involved in the entire process, there is transparency, control and cooperation. With constant feedback, teams go through a continuous learning process that, through constant communication, can generate attributes of cooperation, trust and commitment to the project's stakeholders (Hobbs and Petit, 2017; Riaz *et al.*, 2018). The second is the benefit to the business. The product of strong collaboration is the strengthening of the company's internal and external relationships. Customer engagement and efficient stakeholder management can bring better financial results and a fast turnaround time (Hannay *et al.*, 2017; Sahid *et al.*, 2018). Change management ends up being more assertive while constant learning improves the management of project resources.

Finally, there are PPB due to the iterative approach to project management, which means that processes are improved each time an interval is repeated (Petersen and Wohlin, 2010; Sahid *et al.*, 2018; Serrador and Pinto, 2015). This consistent focus on improvement and quality control is one of the core tenets of agile and helps create superior products. There can be a reduced risk of developing products that do not align with customer expectations. Compared to traditional development cycles, solutions can be flexibly tested early and with greater requirements management. Results and optimization potential can be incorporated directly into the next sprint, ensuring compliance, simplicity and reliability. In this way, the best results are achieved step by step and risks can be minimized (Eickhoff *et al.*, 2018; Heikkilä *et al.*, 2015; Lebdeh *et al.*, 2020; Petersen and Wohlin, 2010).

6.2 Implications for practice

Companies are moving on to agile approaches, looking for advertising benefits. We identified as the key BB in large-scale agile Stakeholders Satisfaction (BB_02) and Fast cycle time (BB_05). The benefits associated with PPB that stood out were Productivity (PPB_03) and Flexibility (PPB_06), while the most significant team benefits were Communication (TB_04) and Transparency (TB_05).

However, it is crucial to acknowledge the proliferation of failures and implementation challenges, when scaling agile beyond its original software development context, designed for smaller teams and specific timeframes (Santos and Carvalho, 2021).

The findings offer a way forward for organizations already using or planning to implement agile management to understand the pathway toward achieving the expected benefits. The results underscore the importance of considering the appropriate knowledge of agile methods (AM_01) and the alignment of agile principles and values (AM_03) as the most influent on benefit, while minimal documentation (AM_06) and over-optimism demands attention.

Our model emphasizes the need to consider factors like organizational culture, cooperation and the transition from traditional to agile approaches. The validated measurement model instrument may be of interest to decision-makers seeking to evaluate how ready they are for agile at scale. Our study unveils the importance of looking at OR when implementing such a complex change in management from traditional to large-scale contexts. We employed a broader contextual perspective of OR. We argue that organizations must have a strategic alignment to adopt the agile methodology in a large-scale context, involving organizational culture and structure, looking at the appropriate large-scale approach adopted for the transition from traditional agile to large-scale, exploring hybridization approaches to mitigate the side effects of this transition.

6.3 Limitations and future directions

We recognize that this analysis is subject to some limitations that offer opportunities for future research. Firstly, the sample size of 117 respondents, considering the large number of firms applying APM in a large-scale context, may be considered small, but it attends to the

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PLS path modelling requirement. However, for confirmatory purposes, further studies with a larger sample should be developed. The data are cross-sectional rather than longitudinal, which limits temporal interpretations of the associations between agile methods and organizational issues. The interpretations of the associations among variables should be exercised with caution. Therefore, a longitudinal study should provide more insights into probable causation to establish the underlying associations more firmly. Future studies should capture longitudinal data with case studies about perceptions and observations of the role of agile methods and organizational issues on the main benefits of the approach. Furthermore, we adopted an OR perspective that explores more the firm level than the individual level of analysis. Thus, future directions should explore other dimensions of the operational readiness construct.

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