Optimising Project Outcomes in Complex Environments: Empirical Insights on Agile Practices and Stakeholder Dynamics

Abstract:

Purpose – This study delves into the dynamics between Agile Response to Change (AR), Adaptive Scoping (AS), Stakeholder Engagement (SE), and Project Performance (PP), with a special focus on the moderating influence of Project Complexity (PC). The research, grounded in a thorough literature review, identifies critical gaps in these areas and examines the extent to which PC moderates the effects of AR, AS, and SE on PP, offering new perspectives for managing complex projects

Design/methodology/approach – The research develops a conceptual model based on a critical analysis of existing literature. A comprehensive questionnaire was designed, incorporating 28 items to measure AR, AS, SE, PP, and PC. Data was collected from 136 project managers across various industries, and the responses were analysed using structural equation modelling (SEM) to explore the complex interplay between these variables.

Findings – The analysis revealed that internal AR (AR_{int}) significantly enhances both quantitative (PP_{qt}) and qualitative aspects of PP (PP_{ql}). AS and SE were found to positively influence PPql, but their impact on PP_{ql} was not significant. Interestingly, PC was observed to negatively moderate the relationship between AR_{int} and PP_{ql}, while its moderating effect on the relationship between AR_{int} and PPql was not significant. The study also notes that PC does not significantly alter the positive correlations between AS, SE, and PP_{ql}.

Originality/value – This research contributes to the existing body of knowledge by elucidating the relationships between AR_{int}, AS, SE, and different dimensions of PP. It uniquely explores the role of PC as a moderating variable in these relationships, offering valuable insights for practitioners and researchers in the field of complex project management.

Keywords: Agile response to change; Adaptive scoping; Stakeholder engagement; Project performance; Project complexity.

Paper type: Research paper.

Introduction

In the evolving landscape of project management, the completion of projects, particularly complex ones, remains a pervasive challenge, as evidenced by a substantial proportion of projects failing to meet their intended objectives (KPMG, 2022). This persistent dilemma, marked by escalating project costs and heightened public scrutiny, underscores the imperative for more efficacious management strategies in complex project environments. The central research issue this paper addresses is the gap in understanding and effectiveness of various project management practices, specifically Agile Response (AR), Agile Strategy (AS), and Stakeholder Engagement (SE), in enhancing Project Performance (PP) amidst the intricacies of complex projects.

The genesis of this problem lies in the multifaceted nature of project complexity, which complicates the achievement of project objectives and often results in project failures or underperformance (Dao et al., 2017). In this context, complexity is not merely a characteristic but a significant impediment, altering the dynamics of project management and necessitating a reevaluation of conventional management strategies. This paper seeks to bridge this knowledge gap by providing empirical insights into the efficacy of AR, AS, and SE in the realm of complex project management.

To contextualise this study, a comprehensive review of the existing literature is undertaken. Studies like those by Floricel et al. (2016) and Brozovic (2018) highlight the evolving nature of project management strategies and their variable impact on PP. However, these studies often yield mixed results, particularly in the context of complex projects. For instance, Magazinius et al. (2012) found no significant differences in success metrics when comparing companies employing agile methodologies against those that do not, whereas Serrador and Pinto (2015) and Malik et al. (2021) identified a positive correlation between agile practices and PP. These divergent findings point to a need for further empirical investigation, particularly in dissecting the roles of AR, AS, and SE within complex project environments.

The study's novelty lies in its empirical approach to examining the specific roles and impacts of AR, AS, and SE on PP, with a particular focus on projects characterised by high degrees of complexity. AR is posited as a critical capability for project management teams to adapt to internal and external changes effectively. AS is hypothesised to play a pivotal role in managing project scope and strategising in response to stakeholder interests. SE is anticipated to be a key factor in involving stakeholders positively in project management activities, a practice underscored by Bear (2015) as essential for overcoming communication challenges among project participants.

This research also endeavours to contribute to the discourse on project complexity (PC) by examining its moderating role in the relationship between AR, AS, SE, and PP. Studies such as those by Floricel et al. (2016) and Malik et al. (2021) have explored various facets of PC, yet the specific moderating effects of PC in the context of AR, AS, and SE's impact on PP remain underexplored.

Therefore, this study is designed to empirically investigate (i) the relationships between AR, AS, SE, and PP in complex project environments and (ii) the extent to which PC moderates these relationships. In doing so, it aims to fill a critical gap in the literature and provide actionable insights that could significantly enhance the management and outcomes of complex projects. The research questions guiding this study are: (1) What correlations exist between AR, AS, SE, and PP in the context of complex projects? and (2) To what extent does PC moderate these relationships? By addressing these questions, the study seeks to contribute significantly to both academic research and practical applications in the field of project management.

Literature review and hypothesis development

In the evolving domain of project management, the interplay of various practices and their influence on project outcomes remains a critical area of scholarly inquiry. This section presents an in-depth analysis of pivotal concepts such as Project Performance (PP), Agile Response to Change (AR), Adaptive Scoping (AS), Stakeholder Engagement (SE), and Project Complexity (PC), rooted in a comprehensive survey of extant literature. The aim is to dissect and synthesise the intricate relationships between these elements, providing a nuanced understanding that transcends conventional wisdom. We endeavour to bridge theoretical frameworks with empirical observations, leading to the formulation of hypotheses that challenge existing paradigms and extend our understanding of project management dynamics in complex environments. This scholarly pursuit not only contributes to the theoretical corpus but also has profound implications for practical applications in the field.

Project Performance. PP criteria are well-defined including time, budget, and performance. It can be measured by time, cost, quality, scope, and customer satisfaction (Nguyen and Mohamed, 2021). PP can be evaluated on the completion of project scopes within the constraints of time, cost, and quality, as well as on other achievements such as client satisfaction and achieving strategic objectives. To evaluate stakeholder satisfaction, Serrador and Pinto (2015) measured the satisfaction of the project team, the client, and the end users. Thus, to evaluate PP, time, cost, quality, project objectives, and stakeholder satisfaction may be used.

PP measurement items may be classified into various categories. In Serrador and Pinto (2015) study, PP measurement criteria were divided into two sub-factors, including efficiency factors and stakeholder success factors. Efficiency factors include project budget, project time, and project scope. Stakeholder success factors include client satisfaction, end-users satisfaction, project team satisfaction, and project success rated by sponsors and stakeholders. Obviously, efficiency factors include both quantitative PP (time and budget) and qualitative PP (project scope). Grouping qualitative and quantitative PP criteria together may be problematic because project scope is a subjective criterion, while project time and budget are objective criteria (Nguyen and Mohamed, 2021). Nguyen and Mohamed (2021) suggested that PP criteria should be classified into quantitative and qualitative sub-factors, namely quantitative PP (PP_{qt}) and qualitative PP (PP_{ql}). PP_{qt} includes project time and project budget, while PP_{ql} includes project quality, project scope, and stakeholder satisfaction.

Key project team practices

Agile response to change. Agile methodologies are developed to overcome challenges of changing conditions in projects by increasing flexibility and responsiveness to the changes. In changing environments, agile methods have proved their abilities in dealing with dynamic situations (Serrador and Pinto, 2015). Project managers often apply agile methods to manage complex projects (Lappi and Aaltonen, 2017). The greater the effort put into agile planning, the higher the project's success (Serrador and Pinto, 2015). There are internal and/or external changes in the project environment. Internal changes involve, but are not limited to, technological changes and changing tasks. External changes involve political, economic, policy, and social value changes that may affect projects (Park *et al.*, 2017). Thus, the ability of a project manager to effectively respond to these changing conditions plays a critical function to manage project success.

Adaptive scoping. Nguyen and Mohamed (2021) defined AS as “the abilities of the project manager/team to manage the project scope and it refers to the ability to adjust and prepare project strategies in response to various attempts by key stakeholders to revisit the project mission to suit their interests” (page, 104). To improve PP for long-term complex projects, Park *et al.* (2017) developed a project management framework, in which AS was part of the framework. Formulation of strategies and preparation of alternatives for project missions were two elements regarding AS. Park *et al.* (2017) suggested that a project management team should prepare alternative options for project missions to ensure the project mission is properly revisited in an uncertain environment. Additionally, Nguyen and Mohamed (2018) emphasised that a clear definition of the project mission may assist the project management team to understand what should be done and whether their requirements will be met. To develop a clear project definition, preparing alternative options for the project mission as well as SE play a significant role (Nguyen *et al.*, 2018). Thus, project team members should engage with the main project stakeholders.

Stakeholder engagement. SE involves communicating and involving stakeholders to establish relationships with them and allowing them to participate in the project’s decision-making process (Nguyen *et al.*, 2021, Cascetta *et al.*, 2015). This process enables stakeholders to express their opinions, influence project plans, and stay informed about project decisions (Turner and Zolin, 2012), leading to a transparent decision-making process and improved input from stakeholders to reach a consensus (Cascetta *et al.*, 2015). Both internal and external stakeholders' contributions are crucial in the early stages of a project to avoid or reduce negative effects from certain stakeholders (Nguyen *et al.*, 2021). Many studies have emphasised the importance of SE, such as its ability to increase PP by reducing costs, its critical success factor in early engagement, and its positive prediction of project success (Nguyen *et al.*, 2021). The involvement of stakeholders in a project can result in the development of creative solutions and sustainable practices, ultimately leading to decreased costs in both the short and long term (Khan *et al.*, 2021). The satisfaction of stakeholders is critical in achieving project success, particularly in complex projects like mega infrastructure projects (Erkul *et al.*, 2019). SE activities such as meetings, interviews, workshops, and surveys can help in achieving this satisfaction.

The literature review emphasises the importance of AR, which plays a critical role in the success or failure of projects (Nguyen and Mohamed, 2021). AS is related to the capabilities of project managers or teams to manage project scope and develop strategies (Nguyen and Mohamed, 2021). SE is a platform for stakeholders to express their expectations and contribute to project progress. Nguyen and Mohamed (2021) found that the latent construct that is measured by AR, AS, and SE mediates relationships 1) between stakeholder power (stakeholder legitimate behaviour, opposing behaviour, and supportive behaviour) and stakeholder interests and 2) PP_{ql}. Thus, further investigation is needed to clearly understand the relationships between individuals AR, AS, SE, and PP. Therefore, the following hypotheses were developed:

H_1: The abilities of the project management team to respond to changes positively affect PP.

H_2: The abilities of the project management team to embrace AS positively affect PP.

H_3: The abilities of the project management team to effectively engage stakeholders positively affect PP.

Project Complexity. Complexity theory and its application are important subjects in many fields, including mathematics, philosophy, physics, chemistry, biology, computer science, technology, engineering, and project management. PC can be defined as 'the property of a project which makes it difficult to understand, foresee and keep under control its overall behaviour, even when given reasonably complete information about the project system' (Vidal *et al.*, 2011) (p. 719). Nguyen *et al.* (2018) emphasised that, in theoretical terms, PC is based both on a project's characteristics, such as its technical, organisational, and environmental complexity, as well as the ability of project managers to manage the varied elements that affect project outputs. Projects are at risk of failure because of their complexity (Nguyen *et al.*, 2021). As suggested by other scholars, in the dynamic and uncertain environment of complex projects, core solutions to address unforeseen events can be AR, AS, and SE (Serrador and Pinto, 2015, Lappi and Aaltonen, 2017, Park *et al.*, 2017).

Further, scholars have investigated the influence of the interactions between management strategies and PC on PP to discover appropriate management strategies for complex projects. However, these studies have also had mixed results. Serrador and Pinto (2015) found no statistically significant correlation between 1) the interaction of the degree of effort in agile planning and PC and 2) agile-project success. However, Floricel *et al.* (2016) found that there is a significant positive influence of interactions between technical complexity and existing knowledge, technical complexity and new knowledge, organisational complexity and new knowledge, and market complexity and new knowledge on completion performance. PC often acts as a moderator in the relationship between management strategies and PP (Açıkgöz *et al.*, 2016). In a study conducted by Zhu *et al.* (2021), it was discovered that as project complexity levels increase, the relationship between emotional intelligence and project success weakens. The researchers emphasised the importance of management teams giving greater attention to the dynamics between project managers and the organisations involved in complex projects. This finding highlights the need for specific strategies and support systems to effectively navigate the challenges posed by complex projects.

Thus, to investigate the potential influence of PC on the relationships between AR, AS, SE, and PP, the current study was conducted to examine its moderating effect. The following hypotheses were developed:

$H_{4.1}$: PC moderates the relationship between the abilities of the project management team to respond to changes and PP.

$H_{4.2}$: PC moderates the relationship between the abilities of the project management team to embrace AS and PP.

$H_{4.3}$: PC moderates the relationship between the abilities of the project management team to effectively engage stakeholders and PP.

Research Methodology

Design

This study aims to examine the correlation between 1) AR, AS, and SE and 2) PP, as well as the moderating effects of PC on these relationships. The study uses a quantitative approach to test these relationships, as it involves the quantification of data collection and analysis to test theories (Bryman and Bell, 2015).

Data collection instrument

Project performance. The PP was evaluated based on time, cost, scope, quality, and stakeholder satisfaction (Narasimman *et al.*, 2023). The PP was divided into two sub-criteria, PP_{qn} and PP_{ql}, which included quantitative and qualitative performance indicators, respectively (see Table 1). The quantitative performance indicators were project time and cost, while the qualitative performance indicators were project quality, scope, and stakeholder satisfaction. A 5-point Likert scale was used for each item, where higher scores indicated better PP.

Table 1. Measurement items

Agile response to change, adaptive scoping, and stakeholder engagement. To measure AR, this study used six items, four of which were taken from Park *et al.* (2017), while the other two were developed based on the characteristics of complex projects (Floricel *et al.*, 2016). AS was measured using four items from Park *et al.* (2017), while SE was measured using nine indicators. Six of these indicators were adopted from a previous study conducted by Park *et al.* (2017), and the remaining three were developed considering the level of SE, including information, consultation, collaboration, co-decision, and empowerment (Nguyen *et al.*, 2018). Respondents used a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) to provide their answers.

Project complexity. To assess the level of PC, this study used CIFTER (Aitken and Crawford, 2007). Each CIFTER factor was compared to a baseline from an "average" project, and participants rated their responses using a 5-point Likert scale (very low, moderately low, similar level/number, moderately high, very high). Participants were asked to compare their recently completed project with average projects based on CIFTER's seven factors. The total score of these factors determined the level of PC, with higher scores indicating a higher level of PC.

Pilot studies. A pilot study was conducted to test the content and reliability of an instrument. The study involved two rounds. In the first round, a preliminary questionnaire was sent to three academic experts in the field. These experts were asked to review the questionnaire and provide feedback on its clarity, comprehensibility, and any potential additions or improvements. The feedback received included suggestions to revise certain statements and questions, change the order of measurement scales, and provide explanations for certain terms. Based on this feedback, the preliminary questionnaire was revised for the second round of the pilot study. In this round, the revised questionnaire was sent to two industrial experts, who provided feedback on the instructions and measurement scales for PP and PC indicators. One of the suggestions was to rescale a four-point Likert scale to a five-point Likert scale in the PC measurement section.

Sample. To collect data, an online survey was conducted and distributed to project managers or team members through email, social media, and professional networks such as the Australian Institute of Project Management and the Project Management Institute. The research was randomised and cross-sectional, similar to other studies where the overall population sample pool could not be identified (Francisco and Rabechini, 2019). Participants were instructed to reflect upon a project that had been recently completed by their organization and provide responses to the survey questionnaires on PP, complexity, and three key project team practices: AR, AS, and SE. A total of 436 respondents accessed the survey over five months, with 234 surveys answered and 159 submitted. A total of 136 data entries were deemed valid for analysis as they were found to be free of any missing information.

Furthermore, the participants offered valuable information regarding the project's location, total budget, duration, and the industry sectors to which the projects belonged. The projects were spread across more than 20 countries. Approximately 70% of the projects had a budget exceeding US$1 million, with a few (4%) surpassing US$1 billion. Nearly half of the projects (46%) were completed within a two to five-year time frame, while around 20% were finished within five years, and a small percentage (2%) took over a decade to complete. The projects encompassed a wide range of industries, with the majority (31%) belonging to the construction, infrastructure, or engineering sectors, followed by information technology or telecommunications (16%). Additionally, the study revealed that non-complex projects had smaller budgets and shorter durations compared to complex projects. Non-complex projects reported an average budget of approximately $104 million with a duration of 24 months, while complex projects reported an average budget of around $244 million with a duration of 45 months.

Data analysis method

For data analysis, the present study used exploratory factor analysis (EFA), confirmatory factor analysis (CFA), and structural equation modelling (SEM). Factor analysis (George and Mallery, 2021) was conducted to explore the underlying structure of PP, AR, AS, and SE. CFA was used to validate the reliability and fitness of the factor structures of latent variables in the measurement model (Collier, 2020). SEM was then used to examine the structural model, including the relationship between 1) AR, AS, and SE, and 2) PP, as well as the moderating effect of PC. SEM is a commonly used method in social sciences to test moderating effects (Trinh *et al.,* 2019). The model fit was assessed using several indicators, including the chi-squared test ($\chi 2$), the Tucker-Lewis index (TLI), the standardised root mean square residual (SRMR), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA).

Results

Validity and reliability analyses

To explore the underlying structure of AR, AS, SE, and PP the study used factor analysis. Principal factor analysis with promax rotation was applied to the factors analysis. The number of sub-constructs in the data set was determined by eigenvalues higher than 1, as recommended by Allen *et al.* (2014). Two sub-constructs were explored for PP (PP_{qt} and PP_{ql}) and AR (internal AR [AR_{int}] and external AR [AR_{ext}]), while no sub-constructs were identified for AS and SE (See Table 1).

To evaluate each item's reliability, standardised regression weights were assessed using AMOS software (Kline, 2015). Items AR1, AR3, SE4 and SE5 (see Table 1) were eliminated during measurement scale analysis as a result of low factor loading to improve scale reliability. Thus, all loadings, except those for items PC3 and PC7, were above 0.4, the threshold recommended by Hair *et al.* (2014). PC3 and PC7 were retained because PC was measured using CIFTER (Aitken and Crawford, 2007), which has been previously used to measure PC (Dao *et al.*, 2017).

Validity refers to whether the items or indicators devised to make judgements about a concept measure that concept (Bryman and Bell, 2015). One way of establishing validity is to measure convergent and discriminant validity. Convergent validity is gauged by comparing measures to other measures of the same concept (Bryman and Bell, 2015). The convergent validity of measured constructs was assessed using composite reliability (CR) and average variance extracted (AVE) tests. The results of testing convergent and discriminant validity are shown in Table 2.

Table 2. Convergent validity of constructs

Results of the convergent validity analysis indicate that all calculated CR scores were either above or close to 0.7, as recommended by Bryman and Bell (2015). The AVE scores for of AR_{int},

AR_{ext}, and SE were higher than 0.5, which meets the threshold suggested by Hu and Bentler (1999). Although the AVE scores for AS, PP_{ql}, and PC were close to or below 0.5, this is still considered acceptable according to Malhotra (2010), who argued that relying on CR alone is sufficient for establishing reliability as AVE can be too strict.

Discriminant validity may be assessed by measuring the correlation coefficients of each pair of variables (Kline, 2015). If the correlation coefficient is greater than 0.85, the variables may represent the same concept and should be combined into a single construct (Kline, 2015). Discriminant validity was further evaluated by comparing the square root of AVE scores and correlation coefficients between the latent constructs. The square root of the AVE of each construct should be higher than its largest correlation with any other construct (Hair *et al.*, 2014). The results in Table 2 indicate that discriminant validity was satisfactory, except for AS and SE. Combining AS and SE into a single construct was not considered because they measured two distinct concepts.

Hypothesis Testing

SEM was used to examine the relationships between latent variables. Table 3 presents the unstandardised coefficients of the estimated relationships and the indicators of model fit. The results demonstrate that all three structural models were a good fit with CFI > .95 and RMSEA < .05.

Table 3. Model fitting indexes and correlation regression weights

As can be seen from Table 3, AR_{int} had a significant positive correlation with both PP_{qt} ($\beta = .559$, t-value = 2.743, $p < .05$) and PP_{ql} ($\beta = .322$, t-value = 2.462, $p < .05$). However, no significant association was observed between AR_{ext} and both PP_{qn} and PP_{ql}. Therefore, H_1 should be revised to:

H_1: The abilities of the project management team to respond to internal changes positively affect both PP_{qt} and PP_{ql}.

As can be seen from Table 3, AS had a significant positive correlation with PP_{ql} ($\beta = .418$, t-value = 4.785, $p < .001$), but no significant association was observed between AS and PP_{qt}. Therefore, H_2 should be revised to:

H_2: The abilities of the project management team to embrace AS positively affects PP_{ql}.

As can be seen from Table 3, SE had a significant positive correlation with PP_{ql} ($\beta = .178$, t-value = 3.843, $p < .001$), but no significant association was observed between SE and PP_{qt}. Therefore, the H_3 should be revised to:

H_3: The abilities of the project management team to effectively engage stakeholders positively affect PP_{ql}.

Moderating effects

SEM was used to test moderating effects. In this study, two-way interaction (Dawson, 2014) was tested. It should be noted that the moderation hypothesis is accepted if the interaction (for instance, the interaction of AR_{int} and PC) is significant (Dawson, 2014). Table 4 presents the unstandardised coefficients of the estimated relationships and the model fit indicators of the moderation testing results. The results demonstrate that all three models were a good fit.

Table 4. Moderator testing results.

The results in Table 4 indicate that there were significant negative correlations between (1) moderating effect of ($PC*AR_{int}$) on PP_{qt} ($\beta = -.135$ t-value = −1.697, p = .090) (2) moderating effect of (PC*AS) on PP_{qt} ($\beta = -.184$, t-value = − 1.901, p = .057) and (3) moderating effect of (PC*SE) on PP_{qt} ($\beta = -.226$, t-value = −2.837, p = .005). However, there were no significant correlations observed between the same moderating factors and PP_{ql} ($p > .10$). The results of moderation analysis show that the influence of AR_{int}, AS, and SE on PP_{qt} were negatively moderated by PC; therefore, hypotheses $H_{4.1}$, $H_{4.2}$, and $H_{4.3}$ should be revised to:

$H_{4.1}$: PC negatively moderates the relationship between the abilities of the project management team to respond to internal changes and quantitative PP.

$H_{4.2}$: PC negatively moderates the relationship between the abilities of the project management team to embrace AS and quantitative PP.

$H_{4.3}$: PC negatively moderates the relationship between the abilities of the project management team to effectively engage stakeholders and quantitative PP.

Discussion

Effects of key project team practices on project performance

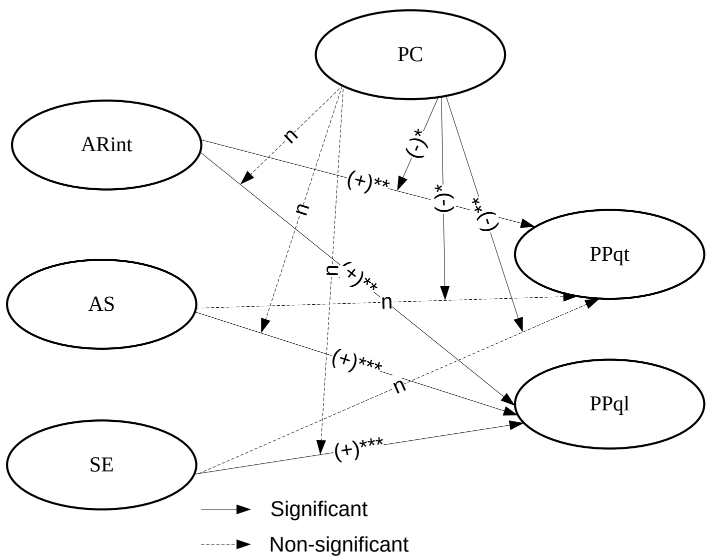
The ability of the project management team to respond to technological changes and rapidly changing tasks in projects was used to measure AR_{int} (refer to Table 1). As hypothesised in H_1, the results indicate a positive correlation between AR_{int} and both PP_{qt} ($\beta = .559$, t-value = 2.743, $p < .05$) and PP_{ql} ($\beta = .322$, t-value = 2.462, $p < .05$). This suggests that improving the project management team's ability to respond to technological changes and rapidly changing tasks may lead to better quantitative and qualitative PP. This finding is supported by previous research indicating that a higher reported agile approach leads to better PP (Serrador and Pinto, 2015). Moreover, technological changes and rapidly changing tasks are among the PC factors (Floricel *et al.*, 2016). Overcoming these factors can mitigate PC and improve PP. However, the regression weight for AR_{ext} was not significantly different in predicting PP at the 0.10 level. This suggests that the project management team should focus on improving its ability to respond to internal changes rather than external changes that are often beyond its control, such as political, economic, policy, and social value changes.

AS was measured through project mission, stakeholder satisfaction levels, and project management strategies through project execution (see Table 1). As hypothesised in H_2, the results confirm that AS positively correlates with PP_{ql} ($\beta = .418$, t-value = 4.785, $p < .001$). From the findings, AS may contribute to improving PP_{ql}, not only stakeholder satisfaction and reputation but also project quality and project scope expectations from stakeholders. However, there was no statistically significant correlation observed between AS and PP_{qt}. This finding may be explained by the fact that the relationship between AS and PP_{qt} was extensively moderated by other factors (Guo, 2014) such as PC.

SE was measured by the sharing of information, consideration of stakeholders' views, opinions and interests, building of effective relationships, governance of communication systems, and empowerment (see Table 1). As hypothesised in H_3, the results confirm that SE positively correlates with PP_{ql} ($\beta = .178$, t-value = 3.843, $p < .001$). This implies that the aforementioned factors, which are critical in SE, may improve project quality and stakeholder satisfaction. SE has been reported as being key to improving stakeholder satisfaction and project quality (Nguyen *et al.*, 2018).

Moderating effects of project complexity

Figure 1 summarises the results of the moderating effect of PC on the relationship between 1) AR_{int}, AS, and SE and 2) both PP_{qt} and PP_{ql}.



Note: ***$p < 0.001$; **$p < 0.05$; *$p < 0.10$; n: non-significant. (+): positive relationship. (−): negative relationship. PC: project complexity. PP_{qt}: quantitative project performance. PP_{ql}: qualitative project performance. AR_{int}: internal agile response to change. AS: adaptive scoping. SE: stakeholder engagement.

Figure 1. Summary of moderating effect of project complexity

The study's results demonstrate that the impact of AR_{int}, AS, and SE on PP_{qt} are not constant across different PC levels. The moderation analysis reveals that PC has a negative moderating effect on the influence of these factors on PP_{qt}. This is consistent with previous research where PC has been found to negatively moderate the relationship between independent and dependent variables (Muller *et al.*, 2012). For instance, the complexity of fact and the complexity of interaction have been found to negatively moderate the relationship between managerial leadership competency and project success (Muller *et al.*, 2012) and PC has been found to negatively moderate the relationship between knowledge exploitation and new product success (Açıkgöz *et al.*, 2016). The finding aligns with Zhu *et al.* (2021) who revealed that as projects become more complex, the positive impact of emotional intelligence on project managers' commitment diminishes, leading to poor project performance.

However, the negative moderating role of PC differed from that found in previous studies in which PC was observed to strengthen the effects of team communication, cohesiveness, and collaboration on overall PP (Yang *et al.*, 2011). This difference may be attributed to our study's more nuanced approach of dividing PP into quantitative and qualitative aspects. It should be noted that the moderating effect of PC occurs only in the relationships 1) AR_{int}, AS, and SE and 2) PP_{qt}, not PP_{ql}. Given the dynamic and uncertain nature of complex projects, it is logical to assume that addressing these challenges requires significant investments of time and money to ensure that project quality is maintained.

Managerial implications

The study's findings have several implications for project management teams. It is recommended that project management teams prioritise AR_{int}, AS, and SE as these practices positively affect PP_{ql}. Of these practices, AR_{int} is the most critical as it positively impacts both PP_{qt} and PP_{ql}. To be agile in responding to changes, project management teams should focus on their ability to adapt to technological changes and rapidly changing tasks within their organisation. However, there was no significant impact found between being agile in response to external changes and both PP_{qt} and PP_{ql}. This implies that project management teams should focus on enhancing their capability to respond to internal changes like changes in project tasks and technology, rather than external changes such as political, economic, policy, and social value changes. Implementing agile methodologies can help break down complex projects into smaller, more manageable tasks. This approach allows for more flexibility and adaptability as the project progresses, reducing the negative impact of complexity on performance.

Regarding Adaptive Scoping (AS), it is recommended that project management teams should establish clear project scope and objectives beforehand, and prepare alternative plans and strategies. Project challenges can be addressed by setting rules, planning for flexibility, and creating problem-solving teams to handle uncertainties that may have been overlooked. Additionally, project management teams can utilise work breakdown structure techniques, maintain real-time monitoring of all activities, and implement flexible contracting. It is also important to develop a clear project mission statement that defines the project's objectives and helps stakeholders understand what needs to be accomplished and whether their needs will be met. Clearly defining the project scope and objectives from the start can help manage complexity by providing a clear direction and purpose. This can help prevent scope creep and ensure that all project activities are aligned with the overall goals. Alternatives should also be prepared to ensure that the project mission can be revised as needed.

With Stakeholder Engagement (SE), it is crucial to establish a communication system and engage stakeholders at all levels to improve the PP_{ql} of a project. Project management teams should also enable stakeholders to actively participate in projects to minimise dissatisfaction. Also, they should prioritise all five levels of stakeholder involvement - information, consultation, collaboration, empowerment, and co-decision. The initial level centres on disseminating pertinent information to stakeholders concerning the project establishing an informational foundation. The subsequent level encompasses presenting the project to stakeholders and assimilating their suggestions, which may be instrumental in the decision-making process. At the tertiary level, stakeholders are actively incorporated into the decision-making process, reflecting a more participative approach. The fourth level necessitates collaborative efforts with stakeholders to attain consensus on the project's implementation strategies. Ultimately, the co-decision level bestows stakeholders with decisive authority over the project's development and implementation, reflecting heightened stakeholder empowerment and involvement. This structured approach ensures a comprehensive and inclusive stakeholder engagement process pivotal for the project's success.

Engaging stakeholders throughout the project lifecycle can help manage complexity by ensuring their needs and expectations are understood and addressed. Regular communication and feedback loops with stakeholders can help identify and resolve potential complexities before they become major issues. Also, encouraging collaboration and communication among different teams and stakeholders can help address complexity by bringing different perspectives and expertise together. This can lead to better problem-solving, increased efficiency, and improved project delivery. Complex projects are too complex for the traditional project team as they present a series of challenges of greater magnitude than found in other projects. The project team would need to proactively identify and engage with key stakeholders in order to create and capitalise on opportunities at all stages of project's lifecycle. In doing so, the team must deal effectively with uncertainty, ambiguity and various dynamic interfaces thus reducing resource waste. Efficient project delivery would ultimately deliver a significant social value as wasted resource gets redirected and invested somewhere else thus creating value to the user and society at large.

Furthermore, the correlation between 1) AR_{int}, AS, and SE 2) PP_{qt} is negatively moderated by the level of complexity of the project. However, the positive relationship between 1) AR_{int}, AS, and SE and 2) PP_{ql} remains consistent even as PC increases. These findings are important for both scholars and practical personnel, as the study reveals that the moderating effect of PC varies depending on whether the measurement is quantitative (e.g. time and cost) or qualitative (e.g. quality, objectives, and satisfaction). In complex projects, staying within budget and timeline constraints may be more challenging, but achieving other business values such as quality and stakeholder satisfaction may be less affected. The study suggests that project management teams should prioritise managing schedule and budget performance in complex projects and consider avoiding a combination of quantitative and qualitative measurements for evaluating PP.

Conclusion

This study embarked on an in-depth exploration into the interplay of Agile Response (AR), Adaptive Scoping (AS), and Stakeholder Engagement (SE) in the realm of complex project management. Through a comprehensive literature review, we identified critical gaps, formulated pertinent research questions, and developed hypotheses, mainly focusing on the moderating role of Project Complexity (PC) on project performance.

Our empirical findings shed light on the significant correlations between AR, AS, SE, and Project Performance (PP), with AR emerging as a notably influential factor. The study delineates that internal AR strongly correlates with both qualitative and quantitative aspects of PP, while external AR's impact is less pronounced. AS and SE demonstrated a positive effect on the qualitative aspects of PP, indicating the nuanced roles these strategies play in complex project environments. Interestingly, PC was found to negatively moderate the relationship between these management strategies and quantitative PP, adding a vital layer to our understanding of project management dynamics in complex settings.

While these insights offer substantial contributions to theory and practice, providing actionable strategies for project management professionals, it is crucial to address the study's limitations concerning generalizability. The quantitative approach, focused on specific contexts and industry sectors, may only partially capture the diverse and dynamic realities of project management practices globally. Consequently, the direct applicability of our findings across different economic sectors and geographic regions is not assured and should be approached with cautious extrapolation.

Recognising this limitation opens up exciting avenues for future research. Subsequent studies could employ a mixed-methods approach, integrating quantitative data with qualitative analyses through case studies or ethnographic methods, to better understand how AR, AS, and SE function across various cultural and economic landscapes. This expanded research approach would enable a more nuanced exploration of the global applicability of these project management strategies, potentially bridging existing gaps in international project management practices. To illustrate the practical application of our research themes, we present the example of developing a smart city infrastructure project. This type of project exemplifies the complexity of interconnected systems and diverse stakeholders, necessitating agile responses, adaptive scoping, and stakeholder engagement. Monitoring and evaluating project performance in areas such as transportation, energy, waste management, and public safety are vital to achieving the project's objectives and ensuring optimal outcomes. This practical example not only enhances the understanding of our research but also guides future case studies and explorations in similar complex project environments.

In sum, while our study contributes significantly to the field of project management, particularly in complex project environments, it also paves the way for future research to broaden the scope of our understanding. The potential of these insights to influence global project management practices, policy development, and educational frameworks remains a promising prospect, underscoring the continual evolution and relevance of project management as a critical field of study.

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List of Tables

Table 1. Measurement items

Constructs	Sub-factors	Item#	Measures	Reference
Project performance (PP)	**PP$_{qn}$**	PP1	Extent to which the project was delivered on schedule	(Shenhar et al., 2001, PMI, 2008, Bond, 2015)
		PP2	Extent to which the project was delivered on budget	
	PP$_{ql}$	PP3	Extent to which the project scope expectations were met	
		PP4	Extent to which the project's quality objectives were met	
		PP5	Extent to which my organisation achieved its desired project outcomes	
		PP6	Number of project stakeholders that achieved their desired project outcomes	
Project complexity (PC)		PC1	Number of different organisations involved in the project	(Aitken and Crawford, 2007)
		PC2	Number of distinct disciplines, methods, or approaches involved in project execution	
		PC3	Level of stakeholder agreement about the project outcomes	
		PC4	Level of importance of legal, social, or environmental implications on project execution	
		PC5	Overall financial impact (positive or negative) on the project's stakeholders	
		PC6	Level of importance of the project to my organisation	
		PC7	Level of stability of the overall project context	
Agile response to change (AR)	**AR$_{ext}$**	AR1^{R}	Project management team had the abilities to respond to **political changes** that affected the project	(Park et al., 2017)
		AR2	Project management team had the abilities to respond to **economic changes** that affected the project	
		AR3^{R}	Project management team had the abilities to respond to **policy changes** that affected the project	
		AR4	Project management team had the abilities to respond to **social value changes** (e.g. awareness of environmental issues, safety standard and climate change) that affected the project	
	AR$_{int}$	AR5	Project management team had the abilities to respond to **technology changes** that affected the project	(Baccarini, 1996, Vidal et al., 2011, Floricel et al., 2016)
		AR6	Project management team had the abilities to respond to **rapidly changing tasks** in the project	
Adaptive scoping (AS)		AS1	The project mission statement was clearly developed	(Park et al., 2017)
		AS2	Project management team's approach sought possible alternatives to project mission	
		AS3	Project management team's approach aimed to establish the target stakeholders' satisfaction level	
		AS4	Strategies were carefully formulated for executing the project	
Stakeholder engagement (SE)		SE1	Project management team explained project objectives and implications to all stakeholders	(Luyet et al., 2012, Park et al., 2017, Nguyen et al., 2018)
		SE2	Project management team carefully considered stakeholders' opinions and views	
		SE3	Project management team actively built a good relationship with stakeholders	
		SE4^{R}	Project management team aimed for a compromise whenever there was a disagreement between stakeholders	
		SE5^{R}	Project management team achieved reconciliation and offered compensation (where applicable)	
		SE6	Project management team operated an effective communication system	
		SE7	Project management team implemented a governance system for the project	
		SE8	Stakeholder interests were carefully considered throughout the project lifecycle	
		SE9	Key stakeholders were empowered to participate in the decision-making process	

(^{R}: item removed. $_{int}$: internal. $_{ext}$: external)

Table 2. Convergent validity of constructs

Constructs	CR	AVE	AR_{ext}	AR_{int}	AS	SE	PP_{ql}	PC
AR_{ext}	0.71	0.55	**0.742**					
AR_{int}	0.74	0.59	0.440^{***}	**0.768**				
AS	0.79	0.49	0.382^{***}	0.700^{***}	**0.701**			
SE	0.88	0.52	0.372^{***}	0.693^{***}	0.886^{***}	**0.722**		
PP_{ql}	0.73	0.40	0.087	0.348^{**}	0.592^{***}	0.437^{***}	**0.631**	
PC	0.69	0.27	0.069	0.008	0.018	0.147	-0.031	**0.516**

Note: $^{***}p < .001$, $^{**}p < .05$, $^{*}p < .10$. CR = composite reliability. AVE = average variance extracted. AR = agile response to change. AS = adaptive scoping. SE = stakeholder engagemet. PP_{ql} = qualitative project performance. PC = project complexity.

Table 3. Model fitting indexes and correlation regression weights

Model	Variables		Model Fitting Indexes				Path Indexes		
	DV	IV	ρ	χ^2/df	CFI	RMSEA		β	t-value
1	AR_{int}, AR_{ext}	PP_{Qn}, PP_{Ql}	.395	1.047	.994	.019	$AR_{int} \rightarrow PP_{Qn}$	$.559^{**}$	2.743
							$AR_{int} \rightarrow PP_{Ql}$	$.322^{**}$	2.462
2	AS	PP_{Qn}, PP_{Ql}	.847	.751	1.000	.000	$AS \rightarrow PP_{Ql}$	$.418^{***}$	4.785
3	SE	PP_{Qn}, PP_{Ql}	.281	1.187	.981	.037	$SE \rightarrow PP_{Ql}$	$.178^{***}$	3.843

Note: $^{***}p < .001$, $^{**}p < .05$, $^{*}p < .10$, none-significant paths are not shown. DV = dependent variable. IV = independent variable. AR = agile response to change. AS = adaptive scoping. SE = stakeholder engagemet. PP_{qn} = quantitative project performance. PP_{ql} = qualitative project performance. PC = project complexity.

Table 4. Moderator testing results.

Model	Variables			Model Fitting Indexes				Path Indexes		
	DV	IV	MV	ρ	χ^2/df	CFI	RMSEA		β	t-value
4	AR_{int}	PP_{Qn}, PP_{Ql}	PC	.306	1.206	.969	.039	$PC \rightarrow PP_{Qn}$	$-.217^{**}$	-2.918
								$AR_{int} \rightarrow PP_{Qn}$	$.152^{**}$	2.073
								$AR_{int} \rightarrow PP_{Ql}$	$.136^{**}$	2.285
								$PC{*}AR_{int} \rightarrow PP_{Qn}$	$-.135^{*}$	-1.697
5	AS	PP_{Qn}, PP_{Ql}	PC	.319	1.172	.984	.036	$PC \rightarrow PP_{Qn}$	$-.249^{***}$	-3.364
								$AS \rightarrow PP_{Ql}$	$.223^{***}$	3.851
								$PC{*}AS \rightarrow PP_{Qn}$	$-.184^{*}$	-1.901
6	SE	PP_{Qn}, PP_{Ql}	PC	.263	1.337	.982	.050	$PC \rightarrow PP_{Qn}$	$-.215^{**}$	-2.926
								$EC \rightarrow PP_{Ql}$	$.209^{***}$	3.608
								$PC{*}SE \rightarrow PP_{Qn}$	$-.226^{**}$	-2.837
								$PC \rightarrow PP_{Ql}$	$-.096^{*}$	-1.661

Note: $^{***}p < .001$, $^{**}p < .05$, $^{*}p < .10$, none-significant paths are not shown. DV = dependent variable. IV = independent variable. MV = moderator variable. AR_{int} = internal agile response to change. AS = adaptive scoping. SE = stakeholder engagemet. PP_{qn} = quantitative project performance. PP_{ql} = qualitative project performance. PC = project complexity.