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Analysis of the Role of Experts' Characteristics in Prioritizing the Three Categories of Delay Factors (Planning, Risk Management, and the Ripple Effect) in Industrial Projects

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ABSTRACT

The present study aimed to analyze the relationship between experts' demographic characteristics and their prioritization of three categories of factors influencing delay claims in industrial projects. These factors include planning, risk management, and the ripple effect, each of which is recognized as a key component of project management. Data collected from 80 industrial experts included demographic information (gender, age, educational attainment, work experience, and marital status) as well as the prioritization of 48 delay factors across the three aforementioned dimensions. Data were analyzed using the independent-samples t-test, analysis of variance (ANOVA), and Pearson's correlation coefficient. The findings indicated a positive and statistically significant relationship between experts' work experience and their attention to the ripple effect ($r = .342$, $p < .01$), whereas the relationship between work experience and planning was not statistically significant ($r = .092$, $p > .05$). A statistically significant difference was observed among educational groups in their perception of the importance of risk management ($F = 3.87$, $p < .05$); similarly, a significant difference was found between educational attainment and the perception of the ripple effect ($F = 3.12$, $p < .05$). No statistically significant differences were identified between male and female respondents in the prioritization of any of the three categories of factors ($p > .05$). These findings suggest that experts' characteristics, particularly work experience and educational attainment, may influence how the three principal categories of delay factors are prioritized. Accordingly, it is recommended that industrial project decision-making and risk assessment processes incorporate the diverse perspectives of experts with different professional and demographic characteristics in order to achieve more comprehensive coverage of delay-related factors.

Keywords: experts' characteristics, project planning, risk management, ripple effect, correlation analysis, industrial projects

Introduction

Industrial projects are inherently complex undertakings characterized by multiple stakeholders, interdependent activities, substantial capital investment, technological uncertainty, contractual obligations, and strict time and cost constraints. Within such environments, project delay is one of the most persistent challenges affecting organizational performance, contractor profitability, client satisfaction, and the overall realization of project objectives. Delays can disrupt planned sequences of work, increase direct and indirect costs, generate resource inefficiencies, and contribute to contractual disputes and claims. Accordingly, contemporary project management

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places considerable emphasis on identifying and controlling the factors that influence schedule performance and on developing managerial mechanisms capable of preventing delays before they escalate into formal claims. From a broader management perspective, successful project delivery depends not only on technical planning but also on effective decision making, managerial empowerment, communication, collaborative governance, and the systematic integration of organizational knowledge into project processes (1, 2).

Project performance is generally evaluated through multiple dimensions, including time, cost, quality, productivity, stakeholder satisfaction, safety, and achievement of strategic objectives. However, the successful realization of these dimensions depends heavily on the quality of project management practices implemented throughout the project life cycle. Evidence from the construction industry indicates that systematic management practices are closely associated with improved project performance and that deficiencies in planning, monitoring, coordination, and control can produce substantial performance deterioration (3). This issue becomes particularly significant in large industrial and engineering projects in which complex procurement systems, multiple contractual interfaces, geographically dispersed project teams, sophisticated technologies, and extensive subcontracting arrangements can amplify minor disruptions. Effective project management therefore requires an integrated approach in which scheduling, risk analysis, claims management, knowledge management, and organizational decision processes are treated as mutually reinforcing mechanisms rather than isolated functions (2, 4).

Among the most important foundations of project success is project planning and control. Planning provides the formal structure through which project objectives are translated into defined activities, resource requirements, schedules, responsibilities, milestones, and monitoring mechanisms. Inadequate planning may create unrealistic schedules, insufficient resource allocation, sequencing problems, poor coordination among contractors, and delays in decision making. Effective project planning also provides the baseline against which deviations can be identified and corrective actions initiated. For this reason, the planning and control process is not merely an administrative requirement but a strategic mechanism for managing uncertainty and maintaining alignment between operational execution and project objectives (5). In increasingly complex project environments, conventional planning approaches are also being supplemented by more adaptive, data-driven, and agile management systems that enable organizations to respond more quickly to changing requirements and implementation constraints (6).

Despite the central role of planning, industrial projects frequently experience schedule deviations that cannot be explained solely by deficiencies in the initial plan. Risk is an inherent component of project activity because future conditions cannot be predicted with complete certainty. Risks may arise from financial instability, design changes, technical complexity, procurement failures, regulatory requirements, safety issues, contractor performance, market conditions, environmental factors, and stakeholder behavior. Consequently, risk management has become a core component of contemporary project governance. It involves the systematic identification, assessment, prioritization, response planning, monitoring, and control of uncertainties that may affect project objectives. Studies of major industrial and construction projects demonstrate that systematic risk identification and assessment can improve managerial awareness of potential disruptions and facilitate more effective resource allocation and preventive action (7, 8).

Risk management is particularly important because the effects of project risks are rarely isolated. A single event may affect several project objectives simultaneously and may generate secondary consequences through interactions with other project activities. Construction and infrastructure projects are especially exposed to such interconnected risks because of the dependence of one activity on the timely completion of preceding activities.

Research has therefore increasingly emphasized the need to rank and prioritize project risks rather than treat all risks as equally important (9). Similarly, knowledge-based approaches to risk management highlight the value of accumulated organizational and professional experience in identifying risk patterns, interpreting uncertainty, and selecting appropriate mitigation strategies (10). Risk management can also contribute to the success of construction and urban projects when risk-related criteria are systematically incorporated into managerial decision processes (11). These findings indicate that effective risk governance depends not only on formal tools but also on the expertise and interpretive capabilities of decision makers.

The rapid development of digital project-management technologies has further transformed risk analysis. Building Information Modelling, for example, can support schedule risk management by integrating project information, identifying potential conflicts, visualizing construction sequences, and improving the anticipation of schedule disruptions (12). At a broader organizational level, advances in analytics and machine-learning-based risk management illustrate how complex datasets can be used to support prediction, classification, and managerial decision making under uncertainty (13). Similarly, contemporary approaches to smart and sustainable governance emphasize the interaction between technology, organizational capabilities, and external environmental conditions in determining the effectiveness of risk-management systems (14). Although the technologies and contexts differ across sectors, these developments reinforce the principle that risk management is increasingly dependent on both structured analytical systems and expert interpretation.

One of the most significant consequences of inadequate planning and insufficient risk management is the emergence of contractual claims. Claims are common in industrial and construction projects because project implementation occurs within contractual frameworks that allocate responsibilities, obligations, rights, and risks among clients, contractors, consultants, and subcontractors. When project conditions differ from contractual assumptions, when obligations are not fulfilled as scheduled, or when changes affect cost and time, parties may seek compensation or extensions of time. Claim management therefore encompasses the identification, documentation, evaluation, negotiation, and resolution of claims throughout the project life cycle. Effective claim management can contribute to improved project performance by reducing conflict escalation, preserving contractual relationships, and facilitating timely resolution of disagreements (15, 16).

A substantial proportion of construction claims are directly or indirectly related to delays. Delayed access to work areas, late design information, changes in scope, delayed payments, inadequate coordination, resource shortages, procurement problems, and contractor or employer-related disruptions can all generate entitlement disputes. Research has therefore sought to identify and prioritize the factors contributing to construction claims and to develop preventive strategies that reduce their occurrence (17, 18). The management of claims is particularly important in Engineering, Procurement, and Construction projects, where the contractor commonly assumes extensive responsibilities and where delays may produce substantial financial consequences. Evidence suggests that integrating risk management with claims management can influence contractor revenue and improve the management of contractual exposure in EPC settings (19).

The contractual complexity of EPC and turnkey projects further demonstrates the importance of understanding the mechanisms through which delays evolve into disputes. Experience from major infrastructure projects shows that claims may result from differing interpretations of contractual provisions, scope changes, delays, payment issues, and disagreements concerning responsibility for project impacts (20). When such claims cannot be resolved through ordinary project-management mechanisms, they may progress into formal disputes requiring alternative dispute resolution or litigation. Research on construction claims and payment disputes consequently emphasizes the value of early dispute avoidance, structured negotiation, mediation, arbitration, and other alternative dispute-resolution mechanisms as means of reducing the cost and disruption associated with litigation (21). Claims and disputes therefore represent not merely legal outcomes but indicators of weaknesses in project planning, risk allocation, communication, documentation, and coordination.

The organizational capacity to manage claims also varies significantly across project-oriented organizations. The development of claim-management maturity models reflects growing recognition that claim management should be institutionalized through defined processes, competent personnel, documentation systems, organizational learning, and clear managerial responsibilities (22). Studies of construction project contracts have similarly shown that claims and disputes are recurrent features of project implementation and require systematic managerial attention rather than ad hoc responses after problems occur (23). This institutional perspective is consistent with the broader view that organizational knowledge should be captured and transferred across projects so that lessons from previous delays and claims can inform future planning and decision making (2).

A particularly important but comparatively less examined dimension of project delay is the ripple effect. In complex project networks, a delay originating in one activity may propagate through subsequent activities, affect parallel work packages, disrupt resource allocations, alter critical paths, and generate cumulative consequences that exceed the magnitude of the initial event. The ripple effect is therefore conceptually distinct from a simple isolated delay because it emphasizes the interconnected and cascading nature of schedule disruption. Its importance is especially evident in industrial projects characterized by tightly coupled activities and extensive dependencies between design, procurement, construction, commissioning, and subcontracted work. The propagation of delay can also complicate the determination of responsibility because the final project impact may reflect interactions among multiple events rather than a single attributable cause.

Understanding the ripple effect is essential for both risk management and delay-claim analysis. When project participants assess only the immediate effects of an event, they may underestimate its downstream consequences. Conversely, experienced experts may be better able to recognize how an early disruption can create subsequent productivity losses, re-sequencing, resource congestion, delayed handovers, and secondary claims. Such judgments depend on the ability to interpret complex causal relationships among project events. Research on constraints affecting project performance supports the broader proposition that project outcomes are shaped by interacting organizational, managerial, and operational factors rather than by isolated variables (24). Consequently, analyzing cascading delay mechanisms requires not only quantitative project-control information but also expert judgment capable of integrating technical, contractual, and organizational knowledge.

The importance of expert judgment raises a further management question: whether experts with different demographic and professional characteristics evaluate project factors in the same way. Many project-management studies implicitly treat expert assessments as homogeneous, even though experts differ in work experience, education, age, gender, professional background, organizational role, and exposure to previous projects. Such characteristics may affect how individuals perceive uncertainty, assign importance to different risks, and interpret project performance problems. Research on construction safety risk assessment has demonstrated that sociodemographic characteristics can influence fieldworkers' perceptions and evaluation of risk (25). This finding is particularly relevant to expert-based project research because ranking methods, questionnaires, Delphi techniques, and managerial surveys depend on subjective judgments that may reflect both technical knowledge and individual experience.

Professional experience may be especially influential in assessments of complex project phenomena. Experts who have participated in multiple large projects are more likely to have encountered diverse delay scenarios, contractual disputes, cascading schedule effects, and risk-response strategies. Such accumulated experience may facilitate pattern recognition and improve the ability to anticipate indirect consequences. Conversely, less experienced experts may place greater emphasis on explicit planning procedures and readily observable project events. From a knowledge-management perspective, individual experience constitutes a form of tacit knowledge that can be transformed into organizational knowledge through structured learning and project-based knowledge-management processes (2). The relationship between experience and expert judgment therefore warrants empirical examination rather than being assumed.

Educational attainment may also affect the evaluation of project risks and delays because formal education can influence familiarity with analytical frameworks, quantitative techniques, systems thinking, risk assessment, and contractual principles. Risk-management research emphasizes structured methods for identifying the probability and consequences of project risks, suggesting that analytical knowledge can contribute to more systematic evaluation of uncertainty (26). Similarly, studies examining the role of risk management in organizational and municipal settings underscore the importance of institutional knowledge and managerial competence in improving risk-related decisions (27). Experts with advanced education may consequently attach greater importance to systematic risk management and complex delay-propagation mechanisms than experts whose judgments are based predominantly on operational experience.

At the same time, expert assessments may be influenced by the organizational and cognitive diversity present within project teams. Contemporary research on construction performance increasingly recognizes that individuals differ in cognition, decision behavior, and problem interpretation, and that such differences may affect collective project outcomes (28). Managerial empowerment and collaborative decision making can enhance project success when organizations enable diverse expertise to contribute effectively to project decisions (1). This perspective suggests that demographic diversity should not simply be treated as a descriptive characteristic of the sample but may represent a substantive factor influencing the prioritization of project-management issues. Evaluating whether men and women, experts with different levels of education, or professionals with different lengths of experience assign similar priorities to planning, risk management, and ripple effects can therefore provide useful insights for the design of expert panels and decision-support mechanisms.

The relevance of these issues is heightened in industrial projects where delays can have extensive economic and contractual consequences. Industrial construction is commonly characterized by large-scale investments, sophisticated engineering systems, extensive procurement chains, high levels of specialization, and strict integration requirements. The complexity of such projects makes effective construction management and intelligent resource coordination increasingly important (4). At the same time, disputes arising from contractual relationships can continue into formal legal proceedings, illustrating the broader legal and organizational implications of unresolved claims (29). Although the legal context of disputes may vary, the underlying management implication remains clear: early identification and management of delay-generating factors is preferable to resolving conflicts after they have escalated.

In the Iranian project environment, several studies have examined claims, risk management, planning, project control, and the causes of disputes independently (5, 15-17). Other studies have focused on ranking risk-management factors, evaluating risk occurrence, or investigating organizational approaches to claims management (9, 22, 26). However, relatively limited attention has been given to the possibility that experts' demographic and professional characteristics may systematically influence the way they prioritize different categories of delay-related factors. This gap is important because expert-based prioritization is frequently used to support managerial decisions, yet differences among experts may affect the resulting rankings.

Moreover, the three dimensions of planning, risk management, and the ripple effect represent different levels of managerial interpretation. Planning concerns the formal organization and control of project activities; risk management concerns the anticipation and treatment of uncertainty; and the ripple effect concerns the recognition of indirect and cascading consequences across interconnected project activities. It is therefore plausible that different forms of expertise contribute differently to the assessment of each dimension. For example, fundamental planning principles may be widely recognized across experts, whereas understanding cascading effects may depend more heavily on practical experience. Likewise, advanced education may strengthen familiarity with formal risk-management frameworks. Examining such differences can improve the methodological rigor of expert-based project research and help organizations construct more balanced decision-making groups.

A better understanding of the relationship between experts' characteristics and their project-related judgments can also contribute to more effective governance of industrial projects. If particular demographic or professional characteristics are associated with stronger recognition of certain delay factors, project organizations can deliberately diversify expert panels, risk committees, claims-management teams, and planning groups. Such diversity can reduce the likelihood that important project risks are overlooked because of homogeneous professional perspectives. It can also complement formal risk-management systems by incorporating experiential knowledge into structured decision processes. Accordingly, the integration of planning, risk management, claims management, and expert diversity can provide a more comprehensive framework for preventing delay disputes and improving project performance (7, 8, 19).

In this context, the present study aimed to analyze the relationship between experts' demographic characteristics—particularly work experience, educational attainment, age, and gender—and their prioritization of planning, risk management, and the ripple effect as three major categories of factors associated with delay claims in industrial projects.

Methods and Materials

The present study is applied in terms of its objective and survey-correlational in terms of data collection. It is classified as a descriptive-analytical study examining the relationship between experts' demographic characteristics and their prioritization of three categories of factors influencing delay claims, namely planning, risk management, and the ripple effect. The correlational approach was selected because the study sought to identify relationships between the independent variables (demographic characteristics) and the dependent variables (prioritization of delay factors).

The statistical population consisted of 80 managers and experts from owner organizations, main contractors, and subcontractors operating in Phases 12, 13, 14, 19, 20, 21, 22, and 24 of the South Pars Gas Field. Sampling was conducted using an availability-based random sampling method. The data collection instrument was a researcher-developed questionnaire comprising two main sections. The first section collected demographic information, including gender, age, educational attainment, work experience, and marital status, while the second section addressed the prioritization of 48 identified delay factors across the three dimensions of planning, risk management, and the ripple effect. Each factor was assessed using a five-point Likert scale ranging from “very low” to “very high.” The content validity of the questionnaire was confirmed through evaluations by subject-matter experts and university faculty members, and its reliability was assessed using Cronbach’s alpha coefficient. The obtained reliability coefficients were .804 for the planning dimension, .769 for risk management, and .593 for the ripple-effect dimension.

Data analysis was performed at both descriptive and inferential levels using SPSS version 26. At the descriptive level, frequency distributions, percentages, means, and standard deviations were used to characterize the sample and the study variables. At the inferential level, Pearson’s correlation coefficient was employed to examine the relationship between experts’ work experience and their prioritization of the three categories of delay factors. One-way analysis of variance (ANOVA) was used to examine differences in perspectives across educational groups, while an independent-samples t-test was applied to compare the views of male and female participants. In addition, stepwise multiple regression analysis was conducted to identify the strongest demographic predictors of the prioritization of the three categories of delay factors. The significance level for all statistical tests was set at .05.

Findings and Results

Of the 80 experts who participated in the study, 57 (71.2%) were men and 23 (28.8%) were women. Regarding educational attainment, 14 participants (17.5%) held an associate degree, 34 (42.5%) held a bachelor’s degree, 23 (28.7%) held a master’s degree, and 9 (11.3%) held a doctoral degree or higher. In terms of age, 6 participants (7.5%) were between 20 and 25 years old, 28 (35.0%) were between 25 and 35 years old, 34 (42.5%) were between 35 and 45 years old, and 12 (15.0%) were older than 45 years. Regarding marital status, 54 participants (67.5%) were single and 26 (32.5%) were married. With respect to work experience, 12 participants (15.0%) had between 5 and 10 years of experience, 19 (23.7%) had between 10 and 15 years, 20 (25.0%) had between 15 and 20 years, 21 (26.2%) had between 20 and 25 years, and 8 (10.0%) had more than 25 years of professional experience. Overall, the largest proportions of the sample were male, held a bachelor’s degree, were between 35 and 45 years of age, were single, and had between 20 and 25 years of work experience.

Table 1. Descriptive Statistics for the Three Delay-Related Dimensions and Their Correlations With Work Experience

Dimension	Number of Factors	Minimum	Maximum	*M*	*SD*	*r* With Work Experience	*p*
Planning	10	3.78	4.33	4.062	0.138	.092	.214
Risk management	15	3.94	4.22	4.073	0.078	.187	.048
Ripple effect	23	3.61	4.17	3.931	0.126	.342	.001

As shown in Table 1, the mean scores for all three dimensions were relatively high. Risk management received the highest average score (M = 4.073, SD = 0.078), followed closely by planning (M = 4.062, SD = 0.138), whereas the ripple effect had a comparatively lower, although still high, mean score (M = 3.931, SD = 0.126). Pearson’s correlation analysis showed a positive and statistically significant association between experts’ work experience and their prioritization of the ripple effect, r = .342, p = .001. Thus, experts with greater professional experience tended to assign greater importance to the indirect, cumulative, and cascading consequences of project delays. A weaker but statistically significant positive correlation was also observed between work experience and risk management, $r = .187$, $p = .048$. In contrast, the relationship between work experience and planning was not statistically significant, $r = .092$, $p = .214$. These findings suggest that accumulated professional experience is more strongly associated with experts' recognition of complex and cascading delay effects than with their assessment of basic project-planning considerations.

Table 2. One-Way Analysis of Variance for Differences in the Three Dimensions by Educational Attainment

Dimension	*F*	*p*	Result
Planning	1.45	.234	Not significant
Risk management	3.87	.021	Significant
Ripple effect	3.12	.038	Significant

The results of the one-way analysis of variance presented in Table 2 indicated that experts' evaluations of risk management differed significantly according to educational attainment, $F = 3.87$, $p = .021$. Experts holding doctoral and master's degrees assigned higher mean scores to risk management ($M = 4.32$ and $M = 4.18$, respectively) than those holding bachelor's and associate degrees ($M = 3.95$ and $M = 3.84$, respectively). A statistically significant difference was also observed among educational groups in the prioritization of the ripple effect, $F = 3.12$, $p = .038$, with experts possessing higher levels of education assigning greater importance to this dimension. In contrast, no statistically significant difference was found among educational groups regarding planning, $F = 1.45$, $p = .234$. The results therefore indicate that educational attainment is associated with experts' evaluations of risk management and the ripple effect, whereas the perceived importance of project planning appears to be relatively consistent across educational levels.

Table 3. Independent-Samples t-Test Comparing Male and Female Experts on the Three Dimensions

Dimension	Male *M*	Female *M*	*t*	*p*
Planning	4.05	4.08	−0.42	.672
Risk management	4.06	4.09	−0.25	.803
Ripple effect	3.92	3.95	−0.18	.854

As presented in Table 3, the independent-samples *t*-test revealed no statistically significant gender differences in any of the three delay-related dimensions. The mean planning score was 4.05 for male experts and 4.08 for female experts, with the difference being nonsignificant, $t = -0.42$, $p = .672$. Similarly, no significant gender difference was observed for risk management, with mean scores of 4.06 for men and 4.09 for women, $t = -0.25$, $p = .803$. The ripple-effect scores were also highly similar between male ($M = 3.92$) and female ($M = 3.95$) experts, $t = -0.18$, $p = .854$. Therefore, gender was not significantly associated with the prioritization of planning, risk management, or the ripple effect. The similarity of the scores suggests that male and female experts within the investigated industrial context held broadly comparable assessments of the three principal categories of factors associated with delay claims.

Table 4. Multiple Regression Analysis Predicting the Prioritization of the Three Delay-Related Dimensions From Experts' Characteristics

Dependent Variable	Predictor(s)	R^2	β	*p*
Ripple effect	Work experience	.117	.342	.001
Ripple effect	Work experience + education	.153	.342, .198	.001, .032
Risk management	Education	.082	.287	.008

Risk management	Education + work experience	.124	.287, .165	.008, .048
Planning	No significant predictor retained	.021	—	.214

As shown in Table 4, the regression analyses further clarified the predictive contribution of experts' demographic characteristics to the prioritization of the three dimensions. For the ripple effect, work experience emerged as the strongest predictor, β = .342, p = .001, accounting for 11.7% of the variance in ripple-effect prioritization (R^2 = .117). When educational attainment was added to the model, the proportion of explained variance increased to 15.3% (R^2 = .153). In this model, work experience remained a significant predictor (β = .342, p = .001), while educational attainment also made a significant contribution (β = .198, p = .032). For risk management, educational attainment was identified as the strongest predictor, β = .287, p = .008, explaining 8.2% of the variance (R^2 = .082). The addition of work experience increased the explained variance to 12.4% (R^2 = .124), with education (β = .287, p = .008) and work experience (β = .165, p = .048) both contributing significantly to the model. In contrast, none of the demographic variables significantly predicted the prioritization of planning, and the corresponding model explained only 2.1% of the variance (R^2 = .021, p = .214). Taken together, the regression findings indicate that professional experience is particularly relevant to experts' recognition of ripple effects, whereas educational attainment plays a more prominent role in their prioritization of risk management. Planning, however, appears to be evaluated relatively consistently irrespective of the demographic characteristics examined.

Discussion and Conclusion

The present study examined whether experts' demographic and professional characteristics were associated with their prioritization of three major categories of factors related to delay claims in industrial projects: planning, risk management, and the ripple effect. The findings showed that all three dimensions received relatively high mean scores, indicating that experts generally regarded planning, risk management, and cascading delay effects as important components of effective project management. Risk management obtained the highest mean score, closely followed by planning, while the ripple effect received a slightly lower, though still substantial, score. More importantly, the inferential findings demonstrated that experts' work experience was positively associated with the prioritization of the ripple effect and, to a lesser extent, risk management, whereas no significant relationship was found between work experience and planning. Educational attainment was significantly associated with the prioritization of both risk management and the ripple effect, but not with planning. No significant gender differences were found in any of the three dimensions. Finally, the regression analysis indicated that work experience was the strongest predictor of the ripple effect, while educational attainment was the strongest predictor of risk management; in contrast, none of the examined demographic variables significantly predicted planning.

The relatively high mean score obtained for planning confirms its fundamental position in the successful management of industrial projects. Project planning provides the framework within which activities are sequenced, resources are allocated, responsibilities are defined, and schedule deviations are monitored. Accordingly, the strong emphasis placed on planning by the participants is consistent with previous research identifying project planning and control as indispensable mechanisms for achieving project objectives and preventing schedule-related problems (5). Effective planning is particularly critical in industrial and construction projects because of the interdependence of design, procurement, execution, and commissioning activities. When project schedules are unrealistic or activities are inadequately coordinated, delays can rapidly generate cost overruns and contractual claims. Similar evidence has shown that sound project-management practices are strongly associated with better project performance, particularly where planning, coordination, monitoring, and control are systematically integrated (3). The high planning score observed in the present study can therefore be interpreted as reflecting experts' recognition of planning as a basic and universally relevant project-management capability.

The absence of a significant relationship between work experience and planning is particularly noteworthy. Experts with longer work experience did not assign substantially greater importance to planning than those with less experience. One plausible explanation is that planning represents a standardized and foundational component of professional project-management knowledge. Planning principles are routinely embedded in engineering education, organizational procedures, scheduling software, contractual requirements, and project-control systems, meaning that their importance may be recognized relatively consistently regardless of accumulated professional experience. This interpretation is consistent with the view that project planning and control involve formalized procedures that are fundamental to project execution (5). It is also compatible with contemporary approaches emphasizing structured project-management processes, whether in traditional or more agile management settings (6). Thus, while experience may improve the quality with which planning is implemented, it may not substantially alter experts' fundamental recognition of its importance.

A different pattern emerged for the ripple effect. The findings demonstrated a statistically significant positive relationship between work experience and the prioritization of cascading delay effects, and work experience alone explained 11.7% of the variance in ripple-effect scores. This suggests that experts with greater professional experience are more attentive to the way in which an initial delay may propagate through interconnected activities and generate subsequent disruptions. This result can be explained by the tacit and experiential nature of understanding delay propagation. Unlike basic scheduling principles, which can be acquired through formal training, recognizing secondary and tertiary consequences of project disruptions may depend heavily on exposure to complex project situations. More experienced professionals are more likely to have witnessed how late design information, procurement disruptions, resource shortages, or delayed handovers affect subsequent activities and create cumulative schedule and contractual consequences.

This finding is consistent with knowledge-management perspectives suggesting that professional experience generates tacit knowledge that can strengthen organizational problem solving and project decision making (2). Experienced experts are likely to possess richer mental models of project interdependencies, enabling them to anticipate downstream consequences that may not be immediately visible in formal schedules. The result also aligns with research emphasizing that project performance is influenced by interacting constraints rather than isolated events (24). In complex industrial projects, delays often interact with resource limitations, technical constraints, contractor interfaces, and organizational decisions, producing cumulative effects that require considerable practical experience to interpret. The positive relationship observed between experience and ripple-effect prioritization therefore supports the argument that experiential knowledge is particularly important when evaluating multidimensional and cascading project phenomena.

The results also indicated a weaker but statistically significant positive relationship between work experience and risk management. Although the magnitude of this association was smaller than that observed for the ripple effect, the finding suggests that more experienced experts place somewhat greater emphasis on systematic risk management. Practical exposure to project uncertainty may increase awareness of the consequences of failing to identify, assess, and respond to risk at an early stage. Previous studies have demonstrated that systematic risk-management practices can improve construction project performance by strengthening the identification, assessment, and mitigation of threats before they negatively affect project objectives (8). Similarly, research on mega industrial projects has emphasized the importance of structured risk identification and assessment in environments characterized by technical and managerial complexity (7). The current findings extend these observations by suggesting that experts' appreciation of risk management may itself be partly shaped by accumulated professional exposure.

The stronger relationship between work experience and the ripple effect than between work experience and risk management is also theoretically meaningful. Formal risk-management procedures can be learned through education, professional training, organizational standards, and structured tools, whereas detecting cascading delay patterns may require more extensive contextual experience. This distinction is supported by studies emphasizing the role of knowledge-based approaches in risk management (10) and by research showing that project risk factors must be systematically ranked and prioritized (9). Experience may therefore enhance risk perception, but the most pronounced contribution of experience may occur when experts are required to interpret complex interactions among events rather than simply apply established risk-management procedures.

Educational attainment was significantly associated with risk-management prioritization. Experts with master's and doctoral degrees assigned higher scores to risk management than those with bachelor's and associate degrees. Regression analysis further showed that education was the strongest predictor of risk-management prioritization, explaining 8.2% of the variance independently and contributing to a model that explained 12.4% of the variance when combined with work experience. This finding can be explained by the analytical and conceptual nature of contemporary risk-management practice. Higher education may expose professionals to formal methods of probability assessment, uncertainty analysis, systems thinking, quantitative modeling, decision theory, and strategic management, thereby increasing their awareness of the value of systematic risk governance.

This interpretation is supported by research emphasizing the formal assessment of the probability and consequences of project risks (26). Similarly, studies examining organizational risk management have highlighted the role of managerial knowledge and structured risk processes in improving institutional decision making (27). Research on urban construction projects has likewise demonstrated the importance of incorporating risk-management criteria into project-success frameworks (11). Taken together, these studies suggest that risk management is not merely an intuitive response to uncertainty but a structured managerial discipline that may be more highly valued by individuals with greater exposure to advanced theoretical and analytical education.

Educational attainment was also significantly associated with prioritization of the ripple effect. Experts with higher academic qualifications tended to assign greater importance to cascading delay consequences. Although work experience was the strongest predictor of this dimension, adding education to the regression model increased explained variance from 11.7% to 15.3%. Thus, both experiential and formal knowledge appear relevant to the recognition of ripple effects. Higher education may promote systems thinking and encourage experts to understand project activities as components of interconnected networks rather than as independent tasks. Such a perspective is particularly useful for recognizing how disturbances propagate across schedules, organizational units, and contractual relationships. This interpretation is consistent with research showing that project performance constraints are multidimensional and interconnected (24). It is also consistent with emerging approaches to project management that rely on advanced information systems and integrated analytical tools to understand schedule and risk interactions (12).

Building Information Modelling and other digital tools provide a useful illustration of this systems-oriented perspective. BIM-supported schedule risk management makes it possible to integrate information across activities, identify conflicts, visualize sequences, and anticipate downstream project consequences (12). Similarly, data-driven approaches to risk assessment demonstrate how complex patterns can be detected through advanced analytical systems (13). Although the present study did not measure digital competencies, experts with higher educational qualifications may have had greater familiarity with such analytical frameworks, which could partly explain their stronger recognition of cascading delay effects.

The finding that education was unrelated to the prioritization of planning mirrors the non-significant association between planning and work experience. This consistency strengthens the interpretation that planning is regarded as a core professional requirement across demographic groups. It may be that the importance of planning is sufficiently established within industrial project environments that neither additional formal education nor extensive professional experience produces substantial differences in perceived priority. In contrast, risk management and ripple effects involve greater degrees of uncertainty, interpretation, and systems analysis, making them more susceptible to differences in expertise. This pattern suggests that experts converge more strongly on traditional project-management fundamentals while diverging somewhat in their assessment of more complex or indirect managerial issues.

Another important finding was the absence of statistically significant gender differences in planning, risk management, and ripple-effect prioritization. Male and female experts assigned almost identical mean scores to all three dimensions. This result indicates that gender did not meaningfully shape the evaluation of delay-related factors in the present sample. One possible explanation is that professional socialization and shared organizational contexts may reduce gender-related differences in technical project judgments. Experts working in the same industrial environment are likely to operate under comparable contractual arrangements, technical standards, organizational procedures, and project constraints, resulting in similar assessments regardless of gender.

The result can be considered alongside research showing that sociodemographic characteristics may influence risk assessments in some construction contexts (25). However, such effects are not necessarily uniform across variables or populations. While certain demographic characteristics may shape perceptions under particular conditions, the present findings indicate that gender does not appear to be a decisive factor in expert prioritization of the three project-management dimensions studied. Instead, professional experience and educational attainment appear more relevant. This distinction reinforces the need to avoid assuming that all demographic variables exert comparable effects on expert judgment.

The findings also have implications for claims management. Delays constitute a major source of construction and industrial project claims, and inadequate recognition of delay mechanisms may increase the likelihood that disagreements escalate into formal disputes. Previous research has emphasized that systematic claim management contributes to improved project performance and that project organizations should identify potential claims early rather than address them only after disputes emerge (15, 16). Studies have also identified numerous causes of construction claims and emphasized the importance of preventive strategies (17, 18). The current findings suggest that the effectiveness of these preventive processes may depend partly on the composition of expert decision-making teams. Experienced professionals may contribute greater awareness of cascading delay consequences, whereas highly educated experts may contribute stronger formal risk-analysis capabilities.

This observation is particularly important for EPC and turnkey projects, where complex allocations of responsibility can make delay claims difficult to assess. Research on EPC projects has shown that integrating risk management with claims management can affect contractors' financial outcomes (19), while empirical analyses of EPC and turnkey contracts illustrate how delays, changes, and contractual interpretation can lead to substantial claims (20). When these disputes are not managed effectively, they may progress to formal dispute-resolution processes (21). Consequently, improving the diversity and quality of expert input at earlier stages may contribute to more accurate identification of potential delay pathways and better documentation of their consequences.

The organizational institutionalization of such expertise is equally important. Claim-management maturity requires structured processes, qualified personnel, effective documentation, organizational learning, and defined responsibilities (22). Studies of claims and disputes in construction contracts likewise indicate that these problems should be managed systematically at the organizational level (23). The present findings suggest that organizations should not treat expert judgment as a uniform resource. Rather, they should recognize that experience and education contribute differently to particular dimensions of project assessment. This conclusion also aligns with contemporary research emphasizing cognitive diversity and different decision-making profiles in construction performance (28), as well as studies showing that collaborative decision making can improve project success in complex organizational settings (1).

More broadly, the findings support an integrated view of industrial project management in which planning, risk management, knowledge management, and claims management are mutually connected. Modern industrial projects require increasingly sophisticated systems for construction management, resource coordination, and technical integration (4). Similarly, governance frameworks for complex environments emphasize the interaction of technological, organizational, and environmental factors in effective risk management (14). The present results add a human dimension to this perspective by showing that the characteristics of those who interpret and prioritize project risks may affect the resulting judgments. Therefore, technical systems alone are insufficient; the expertise, education, and experiential knowledge of decision makers remain central to understanding and controlling project delays.

In summary, the findings demonstrate a differentiated pattern in the role of experts' characteristics. Planning was highly valued but largely independent of demographic differences, suggesting broad professional consensus regarding its importance. Risk management was more strongly associated with educational attainment, indicating the relevance of formal analytical knowledge. The ripple effect was most strongly associated with work experience, reflecting the likely importance of accumulated tacit knowledge in recognizing cascading consequences. Gender did not significantly influence any of the three dimensions. These findings reinforce the importance of combining formal education, practical experience, structured risk-management systems, and organizational learning when establishing expert panels responsible for the prevention and evaluation of delay claims in industrial projects.

A principal limitation of the present study is that the sample consisted of 80 experts drawn from a specific industrial project environment, which may limit the generalizability of the findings to other industrial sectors, geographical regions, contractual systems, or organizational settings. In addition, the use of self-report questionnaires may have introduced response bias, social desirability effects, or differences in individual interpretation of the delay factors. The cross-sectional design also limits the possibility of establishing causal relationships between experts' demographic characteristics and their prioritization patterns. Furthermore, some potentially relevant professional characteristics, such as organizational role, engineering discipline, type of employer, project size, contractual responsibility, prior claims experience, professional certifications, and familiarity with digital project-management systems, were not included in the analyses. The comparatively modest reliability coefficient for the ripple-effect dimension should also be considered when interpreting the findings related to that construct.

Future research should replicate the study with larger and more heterogeneous samples drawn from different industrial sectors, regions, project types, and contractual arrangements in order to test the robustness of the observed relationships. Longitudinal designs could examine whether experts' prioritization patterns change as they accumulate professional experience or receive additional education and training. Future studies should also include professional variables such as job position, disciplinary background, organizational affiliation, project-management certification, prior involvement in claims and disputes, and experience with EPC or turnkey contracts. Structural equation modeling or multilevel analysis could be employed to investigate the simultaneous effects of individual, organizational, and project-level characteristics. Qualitative interviews with experienced experts may also provide deeper insight into how professionals recognize cascading delay mechanisms and how experiential knowledge develops. In addition, future studies could examine whether digital competencies, BIM proficiency, risk-analysis training, and knowledge-management practices moderate the relationship between expert characteristics and delay-factor prioritization.

From a practical perspective, industrial project organizations should establish multidisciplinary expert panels that combine professionals with different levels of experience, education, and functional expertise when assessing delay risks and potential claims. More experienced experts should be particularly involved in evaluating cascading schedule effects and indirect consequences, while individuals with advanced analytical and academic training can contribute substantially to structured risk assessment and formal risk-management processes. Organizations should also document the tacit knowledge of senior professionals and transfer it through mentoring, lessons-learned systems, workshops, and knowledge-management databases. Risk registers and project schedules should explicitly incorporate possible ripple effects rather than focusing only on direct delay events. Regular integrated reviews involving planning, risk, contract, claims, procurement, and execution teams can facilitate earlier identification of cascading problems. Finally, organizations should ensure that expert selection is based primarily on relevant competence, experience, and knowledge rather than demographic assumptions, while maintaining sufficiently diverse decision-making groups to reduce blind spots in the assessment of project delays.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

All ethical principles were adheried in conducting and writing this article.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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