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The Impact of Organizational Learning on Organizational Resilience in Construction Projects

Piaoyi Jiao and Weiwei Bu *

School of Architecture and Planning, Yunnan University, Kunming 650091, China; jiaopiaoyi@itc.ynu.edu.cn
* Correspondence: bww@ynu.edu.cn

Abstract: In an increasingly volatile environment, organizational learning plays a crucial role in helping organizations turn crises into opportunities and enhance organizational resilience. However, the existing research remains unclear on how organizational learning affects the formation of organizational resilience. The aim of this study is to explore the pathways by which organizational learning impacts organizational resilience. An in-depth understanding of the learning within project organizations was initially obtained through field research and interviews. This investigation identified two distinct methods of learning within these organizations: acquisitive learning and experimental learning. A significant impact of managerial cognition on the process of organizational learning was also discovered. Subsequently, building upon the existing literature and research, a cognitive measurement scale for project managers was developed and validated through two iterations of questionnaire collection. Lastly, data pertaining to various variables were gathered via designed questionnaires, and a structural equation model was established to explore the interplay between organizational learning, managerial cognition, and organizational resilience. The findings reveal that organizational learning can enrich the cognition of managers, thereby enhancing the resilience of the organization. Managerial cognition plays a mediating role in the relationship between organizational learning and organizational resilience. In practice, it is recommended that organizations attach importance to the establishment of a learning-oriented organizational culture and foster a habit of proactive learning among their members. They should also strengthen the management of internal knowledge resources and pay attention to the iterative refinement of organizational management norms.

Keywords: organizational learning; organizational resilience; managerial cognition; acquisitive learning; experimental learning; ability scripts; willingness scripts

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1. Introduction

The ever-changing and turbulent external environment constantly presents various internal and external challenges to organizations. If organizations continue to operate according to past management models and systems without actively acquiring external information to adapt to the environment, they are likely to fall into a stagnant and regressive deadlock. Construction projects play a crucial role in economic development, yet social and economic issues triggered by these projects are frequently encountered [1,2]. Therefore, enhancing the ability to respond to crises and disruptive factors has become a key issue in construction projects. Project organizations are temporarily established to achieve specific construction goals, involving numerous stakeholders, and have a high degree of complexity due to the strong interdependencies between tasks at different nodes. Why can certain project organizations effectively navigate the crises and challenges precipitated by unpredictable changes, and proactively accomplish their project objectives? How can project organizations grow robustly in adversity and provide a reference direction for development in a changing and turbulent environment? These are pressing questions to be answered.

Resilience stems from adversity. Organizational resilience refers to the ability of an organization to quickly adapt, recover, and improve when facing external shocks and changes [3]. Organizational resilience is identified as a pivotal element for the enduring, stable development of an organization [4]. It constitutes the organization's core capacity for crisis management and enables the organization to effectively navigate the crises and challenges precipitated by unpredictable changes [5]. The capacity of project organizations to realize "rapid recovery" and "bounce back beyond" adversity largely depends on the learning orientation at the strategic level [6]. Organizational learning encompasses the behaviors of creating, acquiring, transferring, and integrating knowledge [7]. Following adversity or crisis, construction project organizations enter a phase of recovery and improvement, during which learning becomes imperative for the organization. This learning process helps organizations draw lessons from adversity and losses, thereby acquiring adaptability. It is through this process that organizations recover and reposition their organizational paths. Organizational learning allows the organization to continuously generate new ideas and absorb new knowledge from the outside world, injecting core strength into the organization. Current research by many scholars shows that organizational learning has a positive and active impact on organizational resilience [8–10].

Learning, in and of itself, does not generate knowledge; instead, it necessitates the exercise of individual subjectivity to enable effective learning. The strategic decisions made by managers are recognized as being integral to an organization's development, with these decisions being grounded in a specific cognitive basis. Consensus among scholars posits cognition as a structured process of thought and learning [11]. Managerial cognition refers to the belief or mental model possessed by enterprise strategic decision-makers about the external environment, strategy, business portfolio, or the state of the organization. It forms the knowledge structure adopted and utilized by these decision-makers during strategic selection and decision-making [12]. Managerial cognition, characterized by stability and path dependence, is progressively shaped in practice by the strategic decision-makers within an organization [13,14]. Managers play the roles of information selectors and strategy arrangers in the operational process of organizations. They use their unique cognitive structure to identify opportunities and threats in the environment, to form an effective interpretation of the organizational situation, and to seize all available opportunities to integrate resources to allow the organization to quickly adapt to the changing environment [15]. An individual's cognitive ability or mental models largely come from prior knowledge and experience [16]. The key to prior knowledge and experience affecting cognitive ability lies in converting them into cognitive schemas and scripts that match business characteristics [17]. This requires a learning mechanism. Thus, to cope with the external dynamic environment, managers must form and enrich management cognition that matches organizational business characteristics through learning to make effective strategic decisions.

In light of this, this study aims to empirically examine the impact of organizational learning on the resilience of construction project organizations from the perspective of managerial cognition. The research not only enriches the theoretical research on the impact of organizational learning on organizational resilience but also deepens the intrinsic connection between organizational learning and organizational resilience from a cognitive perspective. It provides effective theoretical guidance for the management of crises within engineering construction projects.

2. Literature Review and Hypothesis Development

2.1. Organizational Learning and Organizational Resilience

Organizations can enrich their knowledge resources and enhance the cognition of organizational members towards crises through learning. Organizational learning aids in tracking external business requirements, thereby fostering the development of an organization's adaptive capacity [18]. Construction project organizations exhibit two types of learning behaviors in their long-term practices: acquisitive learning and experimental

learning. Acquisitive learning is characterized as the process through which organizations garner and assimilate new knowledge and technology from other entities and the external environment. Through the act of learning, external knowledge is internalized, thereby enhancing the organization's capabilities. This process often results in the obsolescence, forgetfulness, or replacement of pre-existing knowledge by the newly acquired knowledge [19,20]. Acquisitive learning enables the organization to draw management experience and theoretical resources from the outside, applying them internally in a "borrowed" manner based on its own needs and current situation for knowledge re-creation [21]. It can quickly address the organization's limitations in technical capabilities, upgrade existing technologies, and restructure current capabilities, reducing uncertainties in the application of new technologies and lowering the risks of seeking alternative solutions. This helps the organization avoid detours, prevent the ossification of existing knowledge, and rapidly respond to changes in the external environment.

Experimental learning refers to the organization's development and utilization of internal knowledge, where organizational members continuously summarize lessons learned from their technical knowledge [22]. It creates new knowledge through information sharing or trial-and-error learning among members. Compared to acquisitive learning, which obtains knowledge through low-cost methods such as imitation or copying, experimental learning emphasizes the summary of practical experience of internal knowledge in an organization. This process, characterized by its complexity and longevity, demands a more substantial commitment of organizational resources and capabilities. In the process of experimental learning, the awareness and abilities of members in dealing with changes or crisis events are improved through problem-solving and experience-sharing among organization members. Concurrently, the organization fortifies the collective strength derived from these interactions. Effective organizational learning can enable the organization to better adapt to environmental changes. In circumstances where external environments alter or crisis events transpire, organizations lacking in adaptability are prone to decline. Conversely, organizations that can effectively learn transform crises into opportunities through enhancing organizational resilience, achieving the organization's continuous vitality [23]. Therefore, this article proposes the following hypotheses:

H1. *In construction project organizations, organizational learning is positively related to organizational resilience.*

H1a. *In construction project organizations, acquisitive learning is positively related to organizational resilience.*

H1b. *In construction project organizations, experimental learning is positively related to organizational resilience.*

2.2. Organizational Learning and Managerial Cognition

The concept of "cognitive scripts" was first proposed in the context of innovation and entrepreneurship by Mitchell and others. It is pointed out that repeated cognition is organized within long-term memory as scripts or action-based knowledge structures. "Scripts possess the characteristics of being highly developed, sequentially ordered information in a specific field that is utilized according to discipline-specific norms or processes" [24]. Cognition is a structured process of thinking and learning, and therefore, the term "cognitive scripts" appeared as a description of those processes that take place in individuals' mindsets [11]. Cognitive scripts were found to consist of information about both the situation itself and the sequentially ordered knowledge required for performance within that situation. This situational information, ordered knowledge, and structured way of thinking enables managers to determine which cues are important so that they can take the right action [24].

In the context of entrepreneurship, Mitchell et al. divided cognitive scripts into ability scripts and willingness scripts. Venture ability scripts are concerned with the possession and masterful deployment of the capabilities, skills, knowledge, norms, and attitudes required to be successful in new venture development. Venture willingness scripts are concerned with commitment to venturing and receptivity to the idea of starting a venture [25].

In the context of a construction project, cognitive scripts can also be divided into ability scripts and willingness scripts. The ability scripts are conceptualized as the knowledge structures that individuals possess, encompassing the abilities, skills, knowledge, norms, and attitudes required to manage construction projects. They enable project managers to find effective solutions in disruptive situations. The main features include the ability to assess the conditions and feasibility for opportunity realization, the ability to draw lessons from past experiences and apply them to specific situations, and the ability to integrate information and resources to create value and opportunity [25,26].

On the other hand, willingness scripts are a set of knowledge structures representing the commitment of project managers to achieving project goals and their level of acceptance of new methods. Willingness scripts can be manifested in opportunity seeking (actively seeking new information and potential opportunities or risks for organizational development both internally and externally), commitment tolerance (the willingness to fulfill responsibilities proactively and take actions for organizational goal development), and opportunity pursuit (the belief that one must seize every opportunity) [25,27].

Some scholars have proposed an organizational learning framework that emphasizes the interplay between learning at an individual level and learning at an organizational level in shaping managers' cognition [28]. In dynamic, complex, and uncertain environments, managers need to acquire, integrate, and apply knowledge through organizational learning to support effective decision-making and problem-solving [29]. Managers' ability scripts depend on their skills and knowledge structures. By acquiring external knowledge and techniques through acquisitive learning, managers obtain the latest managerial perspectives and insights, enhancing their strategic vision and judgment abilities, thereby enriching their ability scripts. On the other hand, through experimental learning, managers can better understand the knowledge and technology within the organization, reflect on and summarize past experiences, continuously optimize and improve management methods and strategies, and enhance managers' situational awareness.

Through the process of acquisition learning, managers' ability to identify opportunities is enhanced, facilitating the attainment of additional resources to reach loftier objectives [30]. Furthermore, acquisition learning influences managers' anticipations and behaviors, thereby enriching their willingness scripts. Through experimental learning, the exchange of knowledge between organizational members can generate more experiences and awaken emotions. Organizational members with successful examples can also encourage other members to learn by imitation, enriching their willingness scripts [31]. Based on this, the following hypotheses can be proposed:

H2. *In construction project organizations, organizational learning is positively related to managerial cognition.*

H2a. *In construction project organizations, acquisitive learning is positively related to ability scripts.*

H2b. *In construction project organizations, acquisitive learning is positively related to willingness scripts.*

H2c. *In construction project organizations, experimental learning is positively related to ability scripts.*

H2d. *In construction project organizations, experimental learning is positively related to willingness scripts.*

2.3. Managerial Cognition and Organizational Resilience

In line with the theory of bounded rationality, the time and energy of managers are finite, therefore precluding the possibility of focusing on all aspects. Consequently, the directions an organization pursues for strategic transformations and resource allocation hinge on which factors managers prioritize in their allocation of attention [32]. The tacit cognitive characteristics of top management teams exert a profound influence on their organizations. The allocation of attention by top management teams to the external environment influences their organizational decision-making, optimizing organizational behavior, and thereby enhancing the organization's adaptability to the environment and strengthening its resilience [33,34]. Moreover, research has found that managers' cognitive abilities are crucial for an organization's capacity for adaptation and innovation [35]. Managers' cognition determines their understanding and perception of changes in the external environment, which then dictates the type of behavioral responses the organization will make.

Existing research generally acknowledges that cognitive factors have a significant impact on organizational resilience [36]. Ability scripts significantly influence an organization's ability to implement forward-looking strategic changes [37]. Managers with rich willingness scripts believe in achieving organizational goals and are more willing to initiate new development opportunities and resources and avoid organizational rigidity to promote the improvement of organizational resilience. Therefore, this article proposes the following hypotheses:

H3. *In construction project organizations, managerial cognition is positively related to organizational resilience.*

H3a. *In construction project organizations, ability scripts are positively related to organizational resilience.*

H3b. *In construction project organizations, willingness scripts are positively related to organizational resilience.*

2.4. The Mediating Role of Managerial Cognition

Managers use cognition as a foundation to understand and filter a variety of information, reflecting the process of the senior management team observing environmental changes and dealing with uncertainty and complexity. Managerial cognition is a prime factor in promoting the formation of organizational capabilities. Managerial cognition forms the domineering logic and cognitive inertia of the organization, leading to a trend of reinforced routines, which in turn catalyzes the agglomeration of capabilities [38,39]. According to cognitive development theory, managerial cognition continues to expand and deepen as managers' knowledge, experience, and information accumulate, thereby promoting the growth of managerial cognitive levels [40]. By broadening and deepening their knowledge structures, managers can enhance their cognition levels and improve their ability to perceive environmental changes and interpret relevant information [41]. To improve organizational resilience, managers must expand their horizons and improve their understanding of uncertainty and complexity, thinking critically and engaging in continuous learning [42–44]. Only when managers have these abilities can the organization become more resilient. Organizational learning assists in the development of future managers' problem-solving abilities and critical thinking, applying valuable learning experiences to reality [45]. Organizational learning affects the efficiency and quality of information sharing and experience transmission, which helps integrate individual experiences and knowledge into organizational resources. Through learning and understanding of project contexts, managers can more effectively identify, analyze, and resolve project-related issues. These knowledge resources will help managers make appropriate decisions in management practices, thereby enhancing organizational resilience.

In view of this, this article proposes the following hypotheses:

H4. *In construction project organizations, managerial cognition plays a mediating role in the relationship between organizational learning and organizational resilience.*

H4a. *In construction project organizations, ability scripts play a mediating role in the relationship between acquisitive learning and organizational resilience.*

H4b. *In construction project organizations, willingness scripts play a mediating role in the relationship between acquisitive learning and organizational resilience.*

H4c. *In construction project organizations, ability scripts play a mediating role in the relationship between experimental learning and organizational resilience.*

H4d. *In construction project organizations, willingness scripts play a mediating role in the relationship between experimental learning and organizational resilience.*

Based on the above hypotheses, the theoretical model constructed in this study is shown in Figure 1.

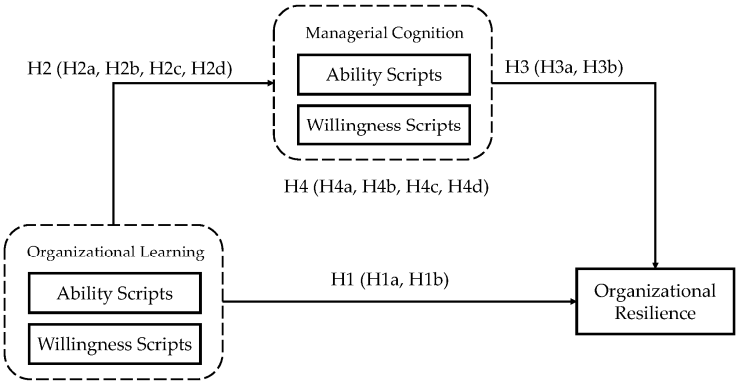

Figure 1. The theoretical model and hypotheses.

3. Methods

3.1. Development and Validation of a Manager's Cognitive Scale

Existing research on managers' cognitive scales is mostly applied in innovative environments and businesses, whereas construction project organizations have distinct industry characteristics compared to general business organizations. Project organizations are temporary, defining the relationships, resources, and assets required to achieve organizational goals at the project preparation stage. During project execution, collaboration involves multiple stakeholders, and there are no competitive relationships with other organizations. The parent company authorizes the purchasing of proprietary technology needed during project implementation, making it challenging for project managers to leverage their unique social network resources to gain additional labor, funds, and other resources for the organization. This makes the items of the manager's cognitive scale inapplicable or inconsistent with the industry reality in construction project organizations. Therefore, it is necessary to develop a manager's cognitive scale that fits the characteristics of construction project organizations.

3.1.1. Item Generation

This study employed both deductive and inductive approaches. Through in-depth field research in construction project organizations, semi-structured deep interviews were conducted with department managers such as project managers, chief engineers, and business managers. An interview outline was prepared before the interview, questions were

flexibly adjusted according to the interviewee's description, and further questions were asked in a timely manner to further explore the behavior characteristics of the managers. A total of 21 project managers with more than ten years of work experience were interviewed.

This study bifurcates the cognition of managers into two dimensions, ability scripts and willingness scripts, basing this division on the confluence of relevant studies and the established context of construction project organizations. A series of management experts were invited to review, amend, and integrate the literature-based items and the interview-derived insights, thereby evaluating the relevance, lucidity, and redundancy of the measurement items, leading to enhanced scale precision and relevance.

After the initial questionnaire was designed, in order to test the validity of the initial questions and ensure that they could be easily understood by the respondents, a pretest was conducted on the questionnaire. Any necessary modifications to the wording of the questionnaire items were made during this pretest phase. This study invited 14 middle and senior managers in the construction industry to collect opinions, sought their views on the design of the questionnaire, and accordingly revised the wording of the items. The initial measurement scale for the cognition of construction project managers was finally formed, and included the 13 items outlined in Table 1.

Table 1. Preliminary measurement scale for cognitive abilities in project managers.

Potential Dimension	Item Coding	Item	Source
Ability Scripts	AS1	I find myself automatically incorporating past valuable experiences and applying them to specific situations	Haynie and Shepherd (2009) [46]
	AS2	I am capable of promptly identifying potential issues in advance	Barrales-Molina et al. (2010) [47]
	AS3	I can discern pivotal information from complex environments and pay sufficient attention to them	Qiannan Wang and Yuhui Ge (2021) [48]
	AS4	When faced with multiple considerations or plans, I am proficient at making suitable and effective decisions	Haynie and Shepherd (2009) [46]
	AS5	I can effectively allocate and use the resources obtained	Lin Yang and Anping Yu [37]
	AS6	In response to changes in the external environment, I can swiftly integrate internal and external resources and make predictive judgments	Qiannan Wang and Yuhui Ge (2021) [48]
	AS7	I am skilled at reasonably arranging the priority of events when facing multiple issues and dealing with them sequentially	Research and interview
Willingness Scripts	WS1	I actively seek more scientific and efficient techniques or methods in my work	Research and interview
	WS2	I enthusiastically implement new techniques or methods in management work	Research and interview
	WS3	I anticipate potential emergencies in advance and consider countermeasures	Research and interview
	WS4	I have a clear notion of the objectives that the project organization needs to achieve	Lin Yang and Anping Yu [37]
	WS5	I steadfastly preserve my commitment to achieving project goals and take action	Lin Yang and Anping Yu [37]
	WS6	I am actively exploring the possibilities of achieving higher goals for projects	Lin Yang and Anping Yu [37]

3.1.2. Participants and Procedure

The research objects were managers of construction project organizations in China, including but not limited to project managers, chief engineers, deputy project managers, quality and safety department managers, business department managers, engineering department managers, and other senior and middle management staff in construction projects. The scale development adopted a cross-validation method, and questionnaires

were distributed both online and offline twice from March to August 2023. The first questionnaire was used for project analysis and exploratory factor analysis (EFA), and the scale refined after this step was used for the second round of questionnaire distribution to carry out confirmatory factor analysis (CFA).

The questionnaire survey comprised four basic information items (gender, education level, years of work experience, position) and thirteen cognitive measurement items for managers, for a total of seventeen questions. All items were rated using the Likert 5-point scoring method, where 1 = strongly disagree, 2 = disagree, 3 = uncertain, 4 = agree, and 5 = strongly agree. Both samples eliminated invalid questionnaires with too short filling time, too strong patterns, and polarized responses. Additionally, the standard deviation of the scores submitted by the same respondent was calculated. Valid data were subsequently identified by applying the criterion of a standard deviation exceeding 0.5.

Sample one: a total of 160 valid questionnaires, which met the sample size required for exploratory factor analysis (more than 5 times or at least 150), were finally obtained. Of these, 134 were male (83.8%) and 26 were female (16.3%). The distribution of education was as follows: high school or below (12 persons, 7.5%), college (56 persons, 35%), and Bachelor's degree or above (92 persons, 57.5%). The distribution of work experience was as follows: 5 years or below (36 persons, 22.5%), 6~10 years (67 persons, 41.88%), 11~20 years (49 persons, 30.63%), and more than 20 years (8 persons, 5%). The position distribution was as follows: middle managers (83 persons, 51.9%) and senior managers (77 persons, 48.1%).

Sample two: a total of 188 valid questionnaires, which met the sample size required for confirmatory factor analysis (at least 10 times the number of questions), were finally obtained. Of these, 161 were male (85.6%) and 27 were female (14.4%). The distribution of education was as follows: high school or below (17 persons, 9%), college (62 persons, 33%), and Bachelor's or above (109 persons, 58%). The distribution of work experience was as follows: 5 years or below (46 persons, 24.5%), 6~10 years (81 persons, 43%), 11~20 years (52 persons, 27.7%), and more than 20 years (9 persons, 4.8%). The position distribution was as follows: middle managers (86 persons, 45.7%) and senior managers (102 persons, 54.3%).

The sample population exhibits a high level of education, with a substantial proportion possessing over five years of work experience. This suggests that most respondents have a solid understanding of construction projects and can make persuasive judgments.

3.1.3. Item Filtering

In the item selection process for scales, common methods include the discrimination coefficient method, the critical ratio method, the internal consistency coefficient, and correlations between items and dimension scores. This study integrates these methods to explore the discrimination, relevance, and homogeneity of each item in the managers' cognitive scale. If an item meets two or more elimination criteria, it is considered for removal.

The discriminant coefficient of each item is calculated. The t-test p-value for the AS2 item is greater than 0.05, and the critical ratio (also known as the t-statistic) is less than 3, indicating poor discrimination for this item. All other items meet the criteria of $p < 0.05$ and $t > 3$, indicating that they have distinguishing power.

Subsequently, an analysis is conducted using the Spearman rank correlation to compute the correlation coefficients between the scores of each item and the aggregate score of the scale. The analysis results indicate that all correlation coefficients, except for the AS2 item, range between 0.531 and 0.693, all of which are statistically significant ($p < 0.0001$). The discrimination of the items meets the standard.

Finally, the variation in the reliability coefficient of the overall scale following the deletion of test items was assessed. The results indicated that, with the exception of AS2, the corrected item–total correlation (CITC) for all other items surpasses 0.35 and the overall Cronbach's α for the scale stands at 0.840. An improvement in Cronbach's α was observed following the removal of AS2. Thus, based on these findings, item AS2 was eliminated.

3.1.4. Scale Dimension Exploration and Verification

An EFA was performed on data from the 160 subjects in Sample 1 using SPSS26.0. The Kaiser–Meyer–Olkin measure of sampling adequacy (KMO) was 0.883, indicating a good fit for factor analysis, and the significance of Bartlett's test of sphericity ($p < 0.001$) suggested the presence of correlations among the variables, further confirming the appropriateness of factor analysis.

Principal component analysis and varimax rotation were performed in the EFA. Based on the criterion of initial eigenvalues exceeding 1, two common factors could be extracted. The cumulative variance contribution rate of these two factors surpassed 60%, effectively reflecting the theoretical conception [49]. Hence, the decision was made to extract two factors. Upon examination of the factor loadings of each item, no issues with cross-loading were identified, negating the need for item elimination.

Sample 2 used AMOS26.0 for 188 sample data to conduct confirmatory factor analysis using the maximum likelihood method. The standardized path coefficient values are neither greater than 1 nor negative, so there are no Heywood cases. Factor loadings reached a statistically significant level ($p < 0.05$), with standardized loadings ranging from 0.50 to 0.95 for all items; the influence between each item was positive, in line with the hypotheses. Overall, the fit indices for the measurement model met the standards of measurement (see Table 2), confirming the stability of the corresponding measurement indicators. No items needed to be deleted in this phase of confirmatory factor analysis, subsequently verifying that the managerial cognition scale possesses good structural validity.

Table 2. Fitting index of confirmatory factor analysis.

Index	χ^2	χ^2/df	GFI	RMSEA	RMR	CFI	NFI	IFI	TLI	SRMR
Standard		<3	>0.9	<0.08	<0.05	>0.9	>0.9	>0.9	>0.9	<0.08
Value	86.894	1.640	0.927	0.058	0.070	0.967	0.920	0.967	0.959	0.0532

3.1.5. Reliability and Validity Test of Scale

The overall Cronbach's α for the scale is 0.851, with the ability script showing a Cronbach's α of 0.875 and the willingness script a Cronbach's α of 0.878 (see Table 3). The inability to enhance Cronbach's α upon the deletion of any item-related dimensions signifies good internal consistency and reliability of the scale.

Table 3. Reliability and validity test data for the scale.

Variable	Index	Factor Load	Cronbach's α	AVE	Square Root of AVE	CR	Correlations
Ability Scripts	AS1	0.722	0.875	0.541	0.735	0.876	0.273
	AS3	0.778					
	AS4	0.672					
	AS5	0.748					
	AS6	0.696					
	AS7	0.788					
Willingness Scripts	WS1	0.699	0.878	0.547	0.740	0.878	
	WS2	0.789					
	WS3	0.755					
	WS4	0.656					
	WS5	0.799					
	WS6	0.731					

The results derived from the CFA reveal a correlation coefficient of 0.273 between the ability script and the willingness script. The square roots of the average variance extracted (AVE) for both factor constructs surpassed the correlation coefficient between the constructs, indicating satisfactory discriminant validity between the ability and willingness scripts.

The standardized factor loadings for the ability script and willingness script measurement variables range from 0.656 to 0.799, all meeting the minimum standard of being greater than 0.5 [50]. The AVE values of the factors are all greater than 0.5, and the composite reliability (CR) values are above 0.7. Therefore, this scale has good convergent validity [51].

3.2. Measurement

Acquisitive learning measurements adopt the scale of Xueling Li [52], combined with project scenarios, containing six items in total. Experimental learning measurements use the scale of Easterby [53], combined with project scenarios, encompassing seven items. Organization resilience is measured across four dimensions, namely, anticipated ability, adaptation ability, recovery and enhancement ability, and contextual cognitive ability, featuring 18 items in total [54,55]. Managerial cognition was measured using the scale developed in this study. All variables were gauged using a 5-point Likert scale, with measurement items provided in Appendix A.

A total of 613 questionnaires were collected, and 458 valid questionnaires were obtained. The effective recovery rate of the questionnaire was 74.7% and the sample size met the research needs. As can be seen in Table 4, the sample quality has good representativeness and reliability.

Table 4. Demographic characteristics of the samples.

Basic Information	Category	Frequency	Percentage
Gender	Male	403	88.00%
	Female	55	12.00%
Education	High School or Below	27	5.90%
	Junior College	84	18.34%
	Bachelor's Degree or Above	357	77.95%
Years of Work	<5 Years	78	17.03%
	6–10 Years	189	41.27%
	11–20 Years	153	33.41%
	>20 Years	38	8.30%
Position/Title	Middle Managers	205	44.76%
	Senior Managers	253	55.24%

4. Research Procedure and Results Analysis

4.1. Common Method Bias Test

The Harman single-factor test was used to test the common method bias of the 458 samples through exploratory factor analysis and confirmatory factor analysis. When conducting exploratory factor analysis, the main component analysis method in SPSS 26.0 was used. The results show that there are five factors with eigenvalues greater than 1 without rotation, and the first factor explains 32.242% of the total variance (less than 40%) [56]. This indicates that the common method bias does not significantly impact the research results.

In the confirmatory factor analysis, all measurement items were allowed to load solely on one common factor, constructing a single-factor structural equation model. This model was then subjected to an examination of its fit status [49]. By executing this operation, the results conveyed the following statistics: $\chi^2 = 5375.746$ ($p = 0.000$); df = 860; $\chi^2/df = 6.251$; GFI = 0.536; AGFl = 0.489; NFI = 0.547; IFI = 0.589; TLl = 0.567; CFI = 0.588; RFI = 0.524; RMSEA = 0.107. These data suggest that the model exhibits a poor fit, further indicating that the common method bias within the sample data is not substantial.

4.2. Reliability and Validity Analysis

4.2.1. Reliability

The reliability of the scale is checked through internal consistency and composite reliability (CR). The results show that all variables' Cronbach's α coefficients are above

the threshold value of 0.7 (see Table 5) and the CR values are all above 0.8 (see Table 6), indicating that each measurement scale has high reliability.

Table 5. Analysis of the reliability of each dimension.

Variable	Number of Items	Cronbach's α Value
Acquisitive Learning	6	0.886
Experimental Learning	7	0.898
Ability Scripts	6	0.876
Willingness Scripts	6	0.876
Organizational Resilience	18	0.951

Table 6. Confirmatory factor analysis (CFA).

Constructs	Items	Significance Estimation				Std.	SMC	CR	AVE
		UnStd.	S.E.	t-Value	*p*				
Acquisitive Learning	AL1	0.789	0.047	16.789	***	0.768	0.590	0.888	0.569
	AL2	0.779	0.046	17.005	***	0.776	0.602		
	AL3	0.921	0.054	16.897	***	0.772	0.596		
	AL4	0.797	0.051	15.604	***	0.720	0.518		
	AL5	0.731	0.047	15.425	***	0.712	0.507		
	AL6	1.000				0.775	0.601		
Experimental Learning	EL1	0.830	0.048	17.361	***	0.805	0.648	0.903	0.570
	EL2	0.708	0.043	16.320	***	0.761	0.579		
	EL3	0.870	0.054	16.115	***	0.752	0.566		
	EL4	0.855	0.056	15.388	***	0.721	0.520		
	EL5	0.789	0.050	15.908	***	0.744	0.554		
	EL6	1.000				0.751	0.564		
	EL7	0.695	0.043	16.055	***	0.75	0.563		
Ability Scripts	AS1	0.936	0.060	15.671	***	0.731	0.534	0.879	0.547
	AS2	1.027	0.061	16.894	***	0.783	0.613		
	AS3	0.665	0.045	14.851	***	0.697	0.486		
	AS4	0.861	0.056	15.281	***	0.715	0.511		
	AS5	0.800	0.050	15.969	***	0.744	0.554		
	AS6	1.000				0.765	0.585		
Willingness Scripts	WS1	0.730	0.048	15.179	***	0.728	0.530	0.880	0.550
	WS2	0.685	0.046	14.928	***	0.716	0.513		
	WS3	0.865	0.053	16.337	***	0.781	0.610		
	WS4	0.983	0.062	15.868	***	0.759	0.576		
	WS5	0.738	0.049	14.911	***	0.715	0.511		
	WS6	1.000				0.750	0.563		
Organizational Resilience	OR01	1.000				0.743	0.552	0.952	0.527
	OR02	0.700	0.047	14.784	***	0.678	0.460		
	OR03	0.851	0.058	14.728	***	0.676	0.457		
	OR04	0.946	0.060	15.791	***	0.720	0.518		
	OR05	0.688	0.044	15.554	***	0.710	0.504		
	OR06	1.005	0.059	17.042	***	0.772	0.596		
	OR07	0.752	0.047	16.117	***	0.734	0.539		
	OR08	1.034	0.063	16.315	***	0.742	0.551		
	OR09	0.822	0.051	16.191	***	0.737	0.543		
	OR10	0.766	0.050	15.400	***	0.704	0.496		
	OR11	0.772	0.047	16.363	***	0.744	0.554		
	OR12	1.069	0.064	16.706	***	0.758	0.575		
	OR13	0.730	0.046	15.871	***	0.724	0.524		
	OR14	0.736	0.047	15.574	***	0.711	0.506		
	OR15	0.838	0.051	16.314	***	0.742	0.551		
	OR16	0.719	0.047	15.398	***	0.704	0.496		
	OR17	0.851	0.052	16.205	***	0.737	0.543		
	OR18	0.856	0.054	15.855	***	0.723	0.523		

Note: *** Significance level is $p < 0.001$.

4.2.2. Validity

The validity is examined via CFA using structural validity, convergent validity, and discriminant validity. Model fit index $\chi^2/df = 1.488 < 3$, RMSEA = 0.033 < 0.05, SRMR = 0.034 < 0.05,

CFI = 0.962, TLI = 0.960, NFI = 0.893, IFI = 0.962. All fit indicators meet the fitting criteria, and the model fit is good [57–59]; hence, the structural validity of the scale is sound.

From Table 6, it can be observed that the standardized factor loadings for the items corresponding to each variable exceed 0.6. Additionally, the average variance extracted (AVE) for each latent variable surpasses 0.5, suggesting ideal convergent validity. As depicted in Table 7, the numbers on the diagonal represent the square roots of the AVE, each of which is greater than all the other values in its respective column. Thus, the discriminant validity of the measurement model employed in this study is commendable.

Table 7. The square root of AVE and correlation coefficients between other variables.

	AVE	OR	WS	AS	EL	AL
OR	0.527	0.726				
WS	0.550	0.433	0.742			
AS	0.547	0.666	0.337	0.740		
EL	0.570	0.393	0.180	0.327	0.755	
AL	0.569	0.335	0.098	0.267	0.170	0.754

Note: AL = acquisitive learning, EL = experimental learning, AS = ability scripts, WS = willingness scripts, OR = organizational resilience.

4.3. Results

4.3.1. Hypotheses Testing

The structural equation model was adopted to test the relevant assumptions by performing a path analysis. Acquisitive learning and experimental learning were independent variables, organizational resilience was the dependent variable, and ability scripts and willingness scripts were the mediating variables. Figure 2 shows the non-standardized path coefficients between these variables.

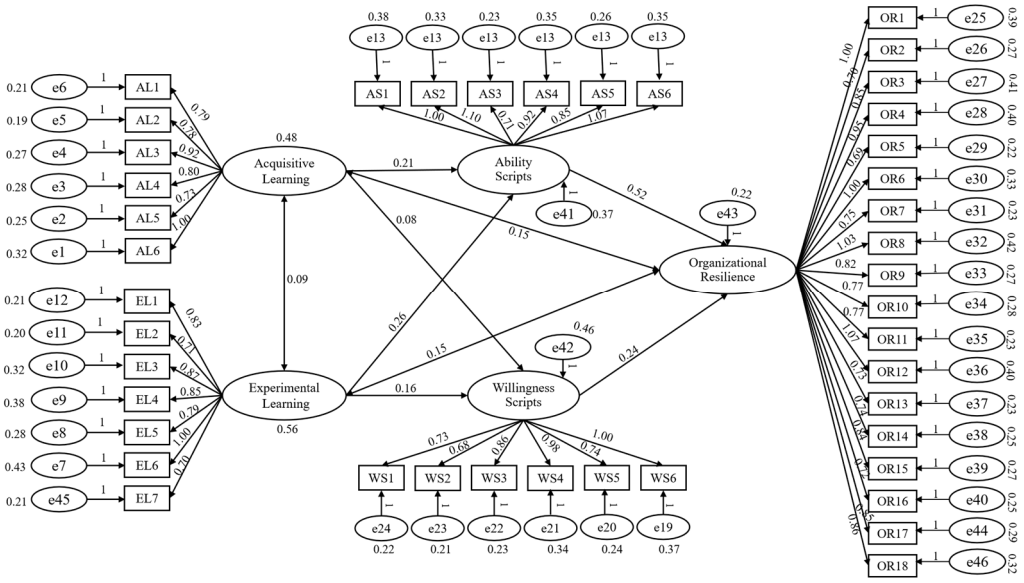

Figure 2. Structural equation model.

As shown in Table 8, the path coefficient of acquisitive learning on willingness scripts is 0.075 (z = 1.412, $p > 0.05$), so hypothesis H2b is not supported. The path coefficient of acquisitive learning on ability scripts is 0.210 (z = 4.230, $p < 0.001$), so hypothesis H2a is supported, and acquisitive learning has a positive effect on ability scripts. The path coefficient of experimental learning on ability scripts is 0.259 (z = 5.553, $p < 0.001$), so hypothesis H2c is supported, and experimental learning has a positive effect on ability scripts. The same is true for H1a, H1b, H2d, H3a, and H3b. In summary, hypotheses H1a,

H1b, H2a, H2c, H2d, H3a, and H3b were tested and the relationships were all significant, which provides the basis for further testing of the mediating hypotheses.

Table 8. Results of model path analysis.

Hypothesis	Path	UnStd.	S.E.	z-Value	*p*	Std. (β)	R^2
H2a	AL → AS	0.210	0.050	4.230	***	0.220	0.157
H2c	EL → AS	0.259	0.047	5.553	***	0.294	
H2b	AL → WS	0.075	0.053	1.412	0.158	0.075	0.041
H2d	EL → WS	0.162	0.049	3.283	0.001	0.176	
H1a	AL → OR	0.151	0.040	3.798	***	0.155	0.521
H1b	EL → OR	0.148	0.038	3.929	***	0.164	
H3a	AS → OR	0.524	0.055	9.520	***	0.512	
H3b	WS → OR	0.237	0.042	5.688	***	0.242	

Note: *** $p < 0.001$.

4.3.2. Mediating Effect Testing

The examination of the mediating effect was carried out by utilizing the Bootstrap method and analyzed via the Process plugin in SPSS, a tool developed by Hayes [60]. Model 4 was chosen, followed by resampling conducted 5000 times within a 95% confidence interval, to scrutinize the mediating effects among the variables. The results of this examination are presented in Table 9.

Table 9. Results of mediation analysis.

Hypothesis	Path	Effect	β	Boot SE	95% Bootstrap CI	Result
H4	OL → MC → OR	Indirect effect	0.215	0.035	0.151~0.285	Supported
		Direct effect	0.336	0.045	0.248~0.424	
		Total effect	0.551	0.052	0.449~0.653	
H4a	AL → AS → OR	Indirect effect	0.128	0.026	0.077~0.180	Supported
		Direct effect	0.171	0.036	0.100~0.243	
		Total effect	0.300	0.043	0.214~0.385	
H4b	AL → WS → OR	Indirect effect	0.030	0.018	−0.004~0.066	Not Supported
		Direct effect	0.270	0.040	0.191~0.349	
		Total effect	0.300	0.043	0.214~0.385	
H4c	EL → AS → OR	Indirect effect	0.148	0.026	0.097~0.200	Supported
		Direct effect	0.191	0.035	0.123~0.260	
		Total effect	0.339	0.040	0.260~0.418	
H4d	EL → WS → OR	Indirect effect	0.050	0.016	0.023~0.082	Supported
		Direct effect	0.288	0.038	0.214~0.363	
		Total effect	0.339	0.040	0.260~0.418	

The effect of organizational learning on organizational resilience is significant (B = 0.551, t = 10.641, $p = 0 < 0.01$), and when the mediating variable is included, the direct effect of organizational learning on organizational resilience remains significant (B = 0.336, t = 7.486, $p = 0 < 0.01$). The positive effect of organizational learning on managerial cognition is significant (B = 0.342, t = 7.251, $p = 0 < 0.01$), and the positive effect of managerial cognition on organizational resilience is also significant (B = 0.629, t = 14.916, $p = 0 < 0.01$). In addition, the upper and lower limits of the bootstrap 95% confidence interval for the direct and mediating effects of organizational learning on organizational resilience do not include 0, indicating that organizational learning can not only directly affect organizational resilience but also affect organizational resilience through the mediating effect of managers' cognition. Therefore, hypothesis H4 is accepted; similarly, hypotheses H4a, H4c, and H4d are also confirmed.

In hypothesis H4b, the total effect value of acquisitive learning on organizational resilience is 0.300, the confidence interval does not include 0, and it is significant under the condition of $p < 0.01$. Next, the effect value of the independent variable acquisitive learning on the mediating variable willingness script is 0.082, the confidence interval includes 0,

and $p = 0.079$ is not significant. After controlling the impact of the independent variable acquisitive learning, the effect value of the mediating variable willingness script on the dependent variable organizational resilience is 0.362, the confidence interval does not include 0, and it is significant under the condition of $p < 0.01$. Finally, if the confidence interval of the indirect effect includes 0, then the mediating effect is not significant; that is, hypothesis H4b is not valid.

5. Discussion and Conclusions

5.1. The Relationship between Organizational Learning and Organizational Resilience

Organizational learning (acquisitive learning and experimental learning) has a positive impact on organizational resilience. The theory of the knowledge-based view posits knowledge as the central resource of an organization, and an important method for an organization to acquire knowledge is organizational learning [29]. Organizational resilience is cultivated and developed through effective learning. Acquisitive learning can increase the heterogeneity of organizational knowledge resources and quickly help the organization upgrade its capabilities, for example, by hiring external experts for training, or visiting and learning from peer technical experiences. Experimental learning is the organization's redevelopment and utilization of existing knowledge based on practical experience. This method is conducive to the formation of knowledge resources that conform to the actual development situation of the organization, and it explores a path suitable for the dynamic development of the organization in the process of continuous integration and iteration of knowledge.

Field studies have found that in organizations adept at effectively managing crises and unforeseen events, a synergistic model is observed where acquisition learning and practice-based learning mutually supplement each other in practice (as shown in Figure 3). On the one hand, the inductive and summarizing experiences of organizational members enhance their knowledge application and mining capabilities, which help organizations more effectively select and internalize external knowledge. Such specialization allows organizations to effectively identify coping strategies during crises, enhances their stability, and facilitates recovery. On the other hand, acquisitive learning provides new insights, diversifies the organization's knowledge resources, and boosts its flexibility, aiding the organization's improvement and growth during a crisis.

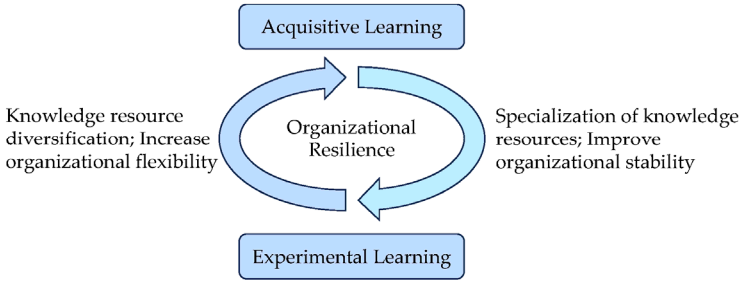

Figure 3. The relationship between acquisitive learning and experimental learning in organizational resilience.

5.2. The Relationship between Organizational Learning and Managerial Cognition

Organizational learning has a positive impact on managerial cognition. Through organizational learning, project managers can enhance their judgment and resource consolidation abilities, affecting their perception and evaluation of the internal and external environments. Acquisitive learning positively affects ability scripts. Managers broaden and acquire knowledge in fields the organization has not yet approached through acquisitive learning. In this process, they continuously break through the boundaries of existing knowledge, deny, forget, or replace the existing knowledge structure, and obtain new management thinking. Acquisitive learning does not significantly impact willingness

scripts. While it can provide managers with certain references and inspirations, it seldom significantly benefits or influences project managers due to the differing work contexts of individuals. These contexts fail to meet everyone's specific needs, and in most cases, the knowledge acquired from them does not bring substantial individual advancement or project gains in the short term. This limitation hinders the stimulation of managers' belief in achieving organizational goals and their enthusiasm for exploring new methods to facilitate organizational growth.

Experimental learning positively influences both the ability scripts and willingness scripts of managers. Practice-based learning is problem-oriented. Through this approach, managers within engineering project organizations can extract the utmost value from their pre-existing experiences. They can also gain a sense of behavioral control, thereby stimulating their willingness to work [61].

Both experimental learning and acquisitive learning have a positive impact on ability scripts. Research comparison reveals that the relatively weak impact of acquisitive learning on ability scripts is due to a mismatch between external management experience and internal organizational context. If managers do not internalize the acquired knowledge, they may mechanically copy and imitate it, falling into a state of knowing the "what" but not understanding the "why", thereby struggling to genuinely address problems. Consequently, managers should continuously explore during practice, adjust externally acquired management schemes based on real-world feedback, and effectively bridge the gap between theory and current reality.

5.3. The Relationship between Managerial Cognition and Organizational Resilience

Managerial cognition has a positive impact on organizational resilience, with ability scripts and willingness scripts both significantly affecting organizational resilience. Cognitive schemas govern the selection and interpretation of information by managers. When managers of construction project organizations perceive external changes based on their cognitive structure, they will predict the organizational situation and adjust organizational behavior. From the perspective of strategic change, every decision and action taken by managers depends on the current cognitive structure.

Managers possessing abundant ability scripts can enhance organizational resilience by identifying pertinent information in the environment, enabling them to evaluate the likelihood of risk incidents or opportunities, thereby facilitating sound decision-making. Managers with rich willingness scripts are more predisposed to invest substantial energy into the organization's development. They are inclined to explore innovative methods and solutions, thereby creating a wealth of opportunities for organizational growth.

6. Managerial Implications

6.1. Theoretical Implications

From the perspective of a construction project, organizational learning is divided into acquisitive learning and experimental learning, and the impact of different learning on organizational resilience is explored, but also expands the existing management literature on construction organizational learning, deepening our understanding of the impact of organizational learning on organizational resilience in construction projects.

Secondly, in accordance with the characteristics of construction project organizations, managers' cognition is divided into two dimensions: ability scripts and willingness scripts. Measurement Scales have been developed for each dimension, and a new perspective for subsequent research on managerial cognition in construction project organizations is provided.

Lastly, previous studies have generally believed that organizational learning has a positive impact on organizational resilience. Based on surveys and literature, this study uses managerial cognition as a mediating variable to clarify the mechanism of organizational learning's effect on organizational resilience, opening up a new perspective for organizations to conduct effective learning.

6.2. Practical Implications

Cultivating a learning organization culture is carried out to encourage employees to voluntarily engage in learning within the context of an externally volatile environment, thereby fortifying an organization's capacity to effectively manage crises. Compared to formal learning with plans at the project organization or company level, establishing a learning organization culture to cultivate the habit of continuous learning among organization members is more conducive to the progress of personal experience and capabilities. This cultural atmosphere provides a strong internal drive for the organization to achieve the development of organizational resilience.

Secondly, project organizations should strengthen the management of internal knowledge resources. Employment turnover in construction project organizations is higher than in ordinary organizations, so the risk of losing accumulated knowledge increases when a project ends or employees change. The disparity in the willingness of organizational members to share knowledge and their experiential capabilities can impede the standardization and internal dissemination of organizational knowledge. Therefore, organizations should manage internally generated knowledge assets as valuable resources, planning an internal "knowledge management platform" to control the identification, collection, transmission, and promotion of knowledge and ensure the efficient use of knowledge resources. For instance, some companies encourage project managers to summarize typical negative impact events encountered in the course of the project and their coping strategies, and compile them into reports or case studies, which are then refined into standardized and systematic knowledge, turned into the company's intellectual assets.

Finally, the organization should continuously update and iterate its management norms based on its internal knowledge resources, establishing corresponding systems to avoid uncontrollable factors during project construction. Through extensive research, it has been observed that, although numerous project organizations have established comprehensive knowledge systems, the practical application and understanding of these resources often fall short of the ideal due to variations in members' willingness to learn and their cognitive capabilities. Project organizations can convert summarized knowledge assets into the organization's internal management system by transforming complex content goals into clear standards in a simplified and systematic way. Thus, a set of operational guidelines that enables managers to implement task objectives more precisely should be developed for project organizations.

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Appendix A

(1) Organizational Learning

- Acquisitive Learning

AL1 The project organization to which I belong excels in acquiring new technologies from its partners.

AL2 The project organization to which I belong adeptly obtains management knowledge and experience from its partners.

AL3 The project organization to which I belong is proficient in securing information on technology development from its partners.

AL4 The project organization to which I belong is capable of effectively sourcing information on specific engineering requirements and preferences from its partners.

AL5 The project organization to which I belong excels in gathering relevant policy information.

AL6 The project organization I am in can pay timely attention to market environment information.

- Experimental Learning

EL1 Within the project organization to which I belong, crucial information and knowledge experiences are shared promptly among members.

EL2 A strong willingness to learn from one another is demonstrated by the members of the project organization to which I belong.

EL3 The members of the project organization to which I belong are adept at extracting knowledge and information from work experiences for decision-making purposes.

EL4 The project organization I am in encourages project members to develop and transform the knowledge, technology, and patents accumulated in their work.

EL5 Members of the project organization to which I belong actively develop and utilize technologies transferred from external sources.

EL6 Members of the project organization to which I belong actively develop and utilize technical tips and patents.

EL7 The project organization to which I belong encourages its employees to experiment with new work methodologies.

(2) Managerial Cognition

AS1 I find myself automatically incorporating past valuable experiences and applying them to specific situations.

AS2 I can discern pivotal information from complex environments and pay sufficient attention to them.

AS3 When faced with multiple considerations or plans, I am proficient at making suitable and effective decisions.

AS4 I can effectively allocate and use the resources obtained.

AS5 In response to changes in the external environment, I can swiftly integrate internal and external resources and make predictive judgments.

AS6 I am skilled at reasonably arranging the priority of events when facing multiple issues and dealing with them sequentially.

WS1 I actively seek more scientific and efficient techniques or methods in my work.

WS2 I enthusiastically implement new techniques or methods in management work.

WS3 I anticipate potential emergencies in advance and consider countermeasures.

WS4 I have a clear notion of the objectives that the project organization needs to achieve

WS5 I steadfastly preserve my commitment to achieving project goals and take action.

WS6 I am actively exploring the possibilities of achieving higher goals for projects.

(3) Organizational Resilience

OR1 Our organization proactively monitors what is happening in the industry for early warning of emerging issues.

OR2 Our organization conducts drills for emergency situations.

OR3 Our organization is prepared for emergencies and ready to take advantage of unforeseen opportunities.

OR4 Our organization is not only capable of observing and identifying tangible changes and imminent crises but also focuses on potential future developments.

OR5 To deal with the impact of crisis events or other risks, my organization has adopted a series of control measures and plans.

OR6 A swift transition from regular operations to a crisis response mode can be made by my organization.

OR7 A firm stance of acceptance is exhibited by my organization during a crisis.

OR8 My organization can quickly obtain the resources needed to deal with unexpected events when a crisis occurs.

OR9 A collective coordination mechanism can be established by my project organization during a crisis to ensure a full-system response.

OR10 During a crisis, our employees engage in frequent communication to comprehend the situation that the organization is undergoing.

OR11 Changes in the workplace and organization are accepted by our employees.

OR12 During or after a crisis event, members of my project organization can apply the lessons learned to future work.

OR13 Strategies are timely adjusted by my organization in response to changes in the external environment.

OR14 During the crisis event, there was not much impact on the project due to the effective response of my organization.

OR15 My organization realizes that the success or failure of each department is closely related.

OR16 My organization can clearly define priorities for important matters during and after the crisis.

OR17 My organization can deploy relevant personnel at any time to fill the vacancies of key employees.

OR18 A clear understanding of the risks faced by the project is demonstrated by my organization.

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