

Resilience for construction project-based organizations: definition, critical factors and improvement strategies

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Abstract: Organizational resilience has been a research hotspot recently. However, studies concentrated on construct project areas are rather limited. Therefore, this study aims to define and identify the critical factors affecting organizational resilience in construction projects. Firstly, comprehensive literature review was conducted to give a definition and to select potential factors in organizational resilience analysis. Secondly, prove the rationality behind the selected critical factors, based on which construct interview outline. Thirdly, the definition and critical factors were further corrected against the interviewing results and thereby propose management strategies on improving resilience for construction project-based organizations. As a result, there were 15 critical factors and 3 major improvement strategies were identified in total. This article enriches the organizational resilience theory and provides decision-makers with a better understanding to develop strategies to enhance resilience in construction projects.

Key words: organizational resilience; construction project; definition; critical factors; interview.

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1 Introduction

Construction projects are characterized as long-periodic, large-scale, complicated from conceptual stage to final delivery. During the whole construction period, these projects do not only encompass plenty of workers, materials, machines are involved, but some disruptions and negative impacts including natural (earthquake, hurricane etc.) and manmade (political turmoil, terrorism etc.). Even more, the advanced technology increases the complexity of projects and poses threats to the realization of project goals, like quality decline, cost overruns, and even cease of the construction^[1]. Therefore, increasing number of researchers begin to consider, in such a dynamic, turbulent and unpredictable environment, how can construction projects minimize the negative impacts?

Resilience originates from the Latin word *Resiliere*, it was first introduced into the realm of ecology by C.S Holling who also defined it as a measure of “the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables^[2]”. Resilience is indeed important to construction project itself. Faced with disruptions and discontinuities, some projects fail and never recover while others overcome quickly and even capitalize on disruptive events to accelerate the construction process. The fundamental reason lies in the difference in organizational resilience of construction projects: highly resilient projects are capable of coping with perturbations caused by uncertainty, but projects with low resilience usually lag in response, unable to adapt^[3]. However, existing studies on organizational resilience in construction project realm are lagging far behind when compared with other’s such as enterprise resilience etc.^[4], no matter in theory and in practice.

Therefore, this study aims to investigate organizational resilience in construction project area and present promising suggestions for further improvement. Admittedly, it is rather difficult to adequately summarize practices all around the world as the economic level and management regulations vary substantially across different countries. Thus, this paper determines to carry out a study in mainland China. And to be specific, the research objects include (1) to make a definition, identify critical factors for resilience in organizational-level in construction projects; (2) to examine and revise the definition and critical factors via in-depth interview; (3) to propose improvement strategies for a higher resilience in future practice. The research path is illustrated in Fig 1.

2 Research methodology

A combined research strategy is adopted to conduct this study, including reviews of related literature, brain storming and semi-structured interviews. Publications cited in authoritative academic databases, including Web of Science, Scopus and the most widespread Chinese academic database CNKI, which enables authors gain comprehensive understanding of studies on resilience, especially in organizational resilience. Based on the above understanding, brain storming was conducted on 25 May, 2017 and lasted around 30 minutes with the purpose of objectivity of all critical factors identified from existing papers. The five experts consist of two professors and three senior construction project managers who all have sufficient understanding and construction project experience. Afterwards, semi-structured interviews were performed from 27 May from 6 July, 2017 with 10 experts (including four project managers from consultant company, two from the owner, three site engineers from the contractor and one from supervisory company), who have fruitful experience of construction project management. In each interview, a series of questions in terms of

three main parts, namely basic understandings, critical factors, status-quo and improvement strategies of resilience for construction project-based organizations. Each interview lasts from 30 to 40 minutes, depending on the interviewee's actual response.

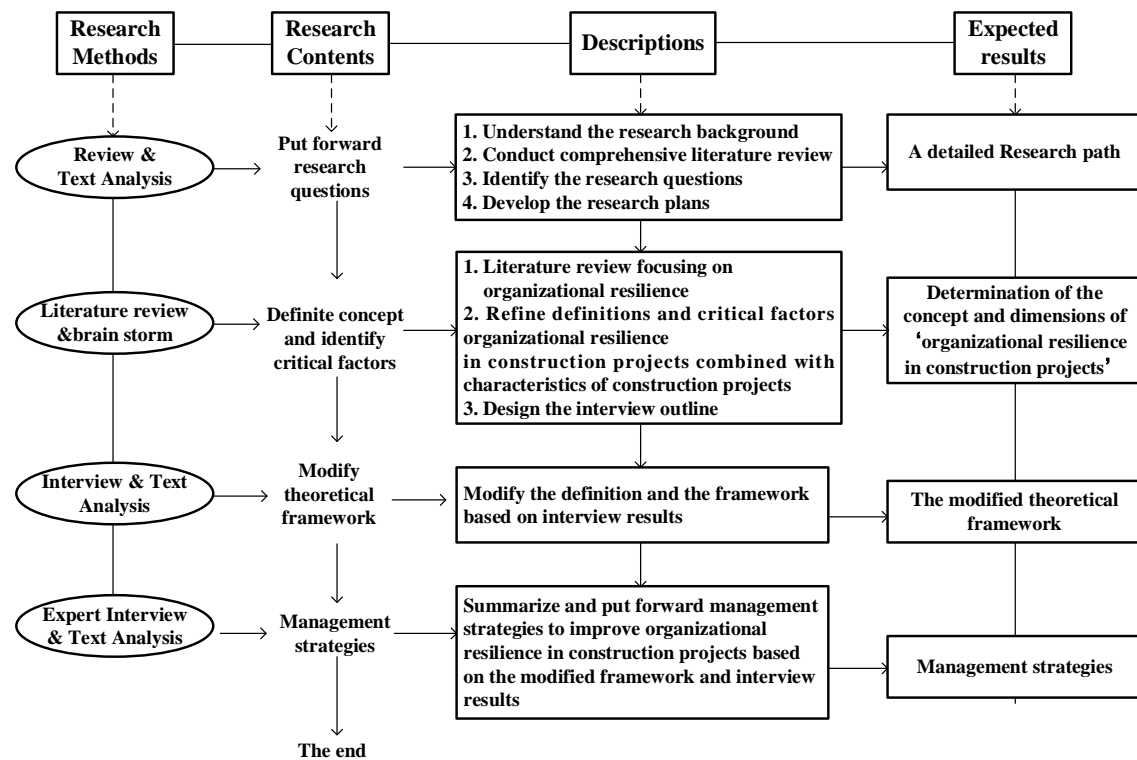


Fig 1. The research path of this paper

3 Definition and critical factors

3.1 the definition and critical factors of organizational resilience

In 1973, the concept of resilience is first introduced, since then, two typical types of definitions of resilience in ecological areas have been distinguished. One of the definitions can be summarized as “ecological resilience”, which emphasizes on the capacity of one system to absorb changes and still persist after a shock. And the other one is called “engineering resilience”, which defined as resistance to disruption and quick return to the pre-existing equilibrium^[5].

Over past few years, the concept of resilience applied to organizations has taken on a wider meaning in management literature. Organizational resilience was firstly illustrated as the capacity to resist and recover from shocks and disasters that could affect an organization or a system either in internal or external^[4]. Recently, increasing number of scholars have pointed out that organizational resilience is a cross-level concept, and should be viewed as a ‘whole-system’ response to change^[3], which means the directed actions of the organization as a whole as enacted by its members working in concert with each other. Representative definitions of organizational resilience can be divided into two parts. On one hand, some perspectives of organizational resilience focus on how organizations can absorb the impacts of external extreme events and quickly restore their performance to a more favorable or pre-impact state in case of any disruptions^[6]. On the other hand, organizational resilience has been developed by borrowing form the concept of resilience in ecology, focusing on the persistence of organizations when encountering adverse impacts instead of

recovery^[7]. The more detailed definitions in existing studies are shown in Table 1.

In addition, organizational resilience is a complicated and multi-dimensional concept. Therefore, how to establish a comprehensive framework of organizational resilience which covers as many dimensions as possible, to accurately describe the resilience of an organization, is one of the most important research topics. Mallak summarized seven characteristics of organizational resilience: perceive experiences constructively, perform positive adaptive behaviors, ensure adequate external resources, expand decision-making boundaries, practice bricolage, develop tolerance for uncertainty, and build virtual role system^[8]. Vogus & Sutcliffe emphasized the importance of slack resources, learning and diverse perspectives to organizational resilience, the idea of redundancy is essential to resilience because maintaining adequate redundancies is necessary for responding to unexpected events and operating beyond a comfortable redundancies for too long invites disaster^[9]. Lengnick-Hall pointed out three dimensions of organizational resilience: cognitive, behavioral and contextual, and described them from the perspective of human resource management^[7]. Norris et al. identified economic development, social capital, community competence, and information & communication as four basic capacities contributing to community resilience^[10]. Pal et al. set up a theoretical framework of organizational resilience consisting of four key factors: assets & resourcefulness, dynamic competitiveness, learning and culture^[11].

Table 1. Representative definitions in existing papers

Author	Year	Definition
Sutcliffe & Vogus ^[9]	2003	A characteristic or capacity of individuals or organizations, or more specifically (1) the ability to absorb strain and preserve (or improve) functioning despite the presence of adversity (both internal adversity-such as rapid change, lousy leadership, performance and production pressure-and external adversity-such as increasing competition and demands from stakeholders), or (2) an ability to recover or bounce back from untoward events.
Starr ^[6]	2003	The ability and capacity to withstand systemic discontinuities and adapt to new risk environments; the ability to effectively align its strategy, operations, management systems, governance structure, and decision-support capabilities so that it can uncover and adjust to continually changing risks, endure disruptions to its primary earnings drivers, and create advantages over less adaptive competitors.
McManus ^[12]	2008	A function of an organization's overall situation awareness, management of keystone vulnerabilities, and adaptive capacity in a complex, dynamic, and interconnected environment.
Lengnick-Hall ^[7]	2011	The firm's ability to effectively absorb, develop situation-specific responses to, and ultimately engage in transformative activities to capitalize on disruptive surprises that potentially threaten organization survival.
Pal ^[11]	2011	The system's ability to maintain a growing or constant healthy state over time, despite being subjected to negative and/or destructive events, or to make a quick positive turnaround from one state to the other to finally enter the healthy state.
British Standard ^[13]	2014	The ability of an organization to anticipate, prepare for, respond and adapt to incremental change and sudden disruptions in order to survive and prosper.

3.2 Critical factors of resilience for construction project-based organizations

Construction projects are typical project-based organizations, even though there are few studies of organizational resilience focusing on construction project areas. The general characteristics of organizational resilience, especially of those organizations that belong to complex systems, are usually applicable to organizational resilience of construction projects as well. Therefore, we propose the following definition: **the capacity of an organization of construction project to absorb pressure, develop positive adaptive behaviors, and quickly recover from adverse impacts in order to preserve functions to achieve expected targets despite of being subjected to disruptive events in a complex and dynamic environment.**

Although existing papers regarding resilience studies differ in research objects, research backgrounds, research methods or data quality etc. which could influence dimensions or factors identified. It is recognized by most scholars that resilience is a set of capacities consisting of critical factors. Eventually, the three-dimension framework made up of absorptive, adaptive and restorative capacity was developed in this study after the brain storming to identify critical factors and experts were invited to attend the discussion on 25 May, 2017. Each factor is carefully analyzed under the background of construction projects and with consideration of characteristics of construction projects. A total of 15 critical factors of resilience for construction project-based organizations are identified, including four for absorptive capacity (slack resources, hazard awareness, planning strategies, organizational learning), six for adaptive capacity (organizing capacity, leadership, coordination, communication, information and knowledge, innovation), and five for restorative capacity (acceleration capacity, external resources, recovery priorities, loss assessment, insurance awareness).

4 Results and discussions

4.1 Interview results and discussions

Respondents basically agree with the definition which defined in Section 3.2 of this study, and the realization of project objectives is emphasized by most of respondents. Construction project-based organizations are typical types of temporary organizations, and the task is usually the reason why a temporary organization is set up. This characteristic determines that even if disturbed by adverse impacts, the target should not be changed easily. In addition, two respondents pointed out that recovery is possibly necessarily needed, while a certain amount of deformation should be acceptable as long as realization of project objectives. Also, critical factors have been adjusted into five factors in absorptive capacity, six in adaptive capacity and four in restorative capacity, (shown in Table 2 in details). And other major results are discussed as follow:

(1) “Redundancy” is most frequent factor mentioned in absorptive capacity

Eight of ten respondents mentioned “redundancy” in their interview. Unlike permanent organizations, a construction project organization consists of many stakeholders and a certain degree of redundancy in human resources is necessary. For example, if three staff in the same team are assigned similar tasks, when one of them is under pressure, the rest two can offer effective support. This is a type of redundancy in human resource allocation, which guarantees the project organization still be capable to achieve preset objectives despite disruptive events. In addition, financial redundancy is also essential and “insurance” is mostly mentioned during interview process. In mainland China, it is prevalent that stakeholders purchase some kinds of compulsory insurances.

(2) Good project planning is the basis of redundancy.

Project planning requires a comprehensive understandings of project requirements, difficult points, potential risks, etc. to achieve a clear and profound understanding of the project. Generally, organizations vary from characteristics of each project, thus the structure of organization can only be set up after in-depth analysis of the project characteristics in the prophase; meanwhile, redundancy mechanism should be carefully considered, which helps to make organization resilient.

(3) Risk analysis is more important than hazard awareness

There are six out of ten respondents mentioned “risk” in interviews. Of course, risk objectively exists and risk management is a core idea that throughout the whole process of construction projects.

As many risks in construction projects can be predicted to a certain extent, it is important to reasonably use of risk analysis to reach a clear understanding of potential risks and take preventive measures in advance, ensuring strong absorptive capacity against adverse risk events. In actual, hazard awareness is not likely to be very helpful for an organization to set up feasible solutions to practical problems; instead, risk analysis based on a large amount of detailed and reliable information is actually important.

(4) Centralized decision-making is important to adaptive capacity

Among the factors of adaptive capacity, organizing capacity is complicated. In construction projects, most interviewers pointed out that the horizontal structure of project organizations is not necessarily helpful to deal with crises; by contrast, decentralized decision-making mechanism is recognized to be more helpful in many cases. This is because that, in emergency, centralized decision-making model is generally more efficient to make decisions and deal with unexpected events.

(5) Loss assessment and re-planning are the two critical factors to recovery capacity

When crises occur, loss assessment should be carried out in no time to assess extent of actual losses, identifying which parts still function well, which parts need reinforcements, repair or complete reconstruction, etc. After loss assessment, re-planning is also critical. Disruptive events may lead to great adjustments for previous project plans, thus the organization needs to develop new or adjusted plans that fit new situations to help the project recover and still able to achieve targets. In re-planning, priorities of activities needed to be recovered should be consider carefully, in other words, reasonable orders of recovery activities should be done.

4.2 Management strategies of resilience for construction project-based organization

- Emphasis on preliminary planning and redundancy mechanism

Planning in pre-stage should be emphasized, with in-depth analysis of the project to determine its characteristics and requirements. Besides, redundancy mechanism should be preset in the organization to ensure that the capacities of participants can meet the requirements and fully cover the risks. For example, for a project with high structural difficulty, apart from a design group skilled in structure, a consulting group and an auditing unit may also be embodied in the project organization, so that the capacities of multiple groups can be combined to ensure the structural safety.

- Making plans of emergencies in advance

When risk management cannot fulfill the purpose of effective protection, or some unpredictable disastrous events occur, there should be plans in place to reduce the personal, financial and environmental losses. Emergency plans are based on safety evaluation and the conditions of specific facilities and environments, and they provide scientific and effective arrangements for agencies, personnel, equipment, facilities and conditions of emergency rescue, course and program of action, methods and procedures for controlling loss aggravation, and so on forth.

- Implement objective management and hierarchical control

Construction projects are characterized with clear and definite objectives. In order to ensure the fulfillment of the objectives despite all kinds of uncertainties, objective management and hierarchical control are indispensable. During the formulation of the objective management system, low-level objectives should be strictly controlled, while high-level objectives should be moderately easy, leaving some room for management and making the project resilient. Taking Shanghai

Disneyland construction project for instance, if the objective of government level was set on June 1st, the objective of Walt Disney company level may be scheduled on May 1st. Similarly, the project levels may be scheduled on April 1st, and the general contractor level's needs to be further controlled on March 1st. In this way, the objective system that is hierarchical controlled leaves room for adjustment in the condition that unexpected disruptive events have negative impacts on the construction schedule, so that the realization of overall objectives will not be affected.

Table 2. Critical factors adjusted based on interview results

Dimension		Factor	Descriptions
Absorptive Capacity	●	Slack resources	Reserve adequate margin in resources and rationalize the distribution of them; make sure organizational capabilities meet the requirements of the project.
	●	Risk analysis	Identify sources of risk, anticipate the probability and consequences of risk events.
	●	Planning strategies	Make careful planning in the prophase, set flexible and adjustable plans, simulate emergent situations and practice how to act.
	●	Insurance awareness	Arrange the necessary insurance cover, get the hang of the details of insurance policy including coverage, exclusions, liability identification mechanism, compensation procedures, etc.
	●	Organizational learning	Create, share and apply knowledge; transmit and share information efficiently across the organization to reach consistent recognition.
Adaptive Capacity	✓	Organizing capacity	Flexibly utilize a diversity of organizing methods and maximize the use of project resources, including setting up good authorization mechanism and emergency decision mechanism.
	✓	Leadership	Make continuous assessment on project objectives and work procedures, as well as provide reliable management and decisions in times of crises.
	✓	Coordination	Maintain good relationships among the parties inside and outside the project through communication, collaboration and cooperation, focusing on the common interest.
	✓	Communication	Wisely choose the content, object and timing to communicate, have good communication ways and channels.
	✓	Information and knowledge	Capture useful information in the environment, integrate project information, and improve the knowledge level of project personnel.
	✓	Innovation	Test, verify and apply new or improved products, services and processes, adopt new ideas and methods to solve existing or emerging problems.
Restorative Capacity	➤	Loss assessment	Investigate, count and verify the range and extent of actual losses.
	➤	Re-planning	Make new or adjusted plans that fit new situations, understand the priorities of recovery issues and make arrangements accordingly.
	➤	External resources	Obtain resources and assistance from organizations outside the project, which help solve problems that are hard to solve on its own or cost too high to solve.
	➤	Acceleration Capacity	Be able to offset the effects of disturbance on project schedule by accelerate production.

5 Conclusions

In recent years, the concepts of resilience have become very topical and popular. However, studies concentrated on construct project areas are rather limited. Therefore, with the consideration of general characteristics of construction project, this study defined the concept of organizational resilience in construction project area; and identified 15 critical factors concerning organizational resilience based on a wide literature review and brain storm. Afterwards, in-depth interviews conducted to help to revise the definition as well as critical factors. Finally, three major management strategies were put forward. As an exploratory research, this article enriches organizational resilience theory and provides decision-makers with a better understanding to develop strategies to improve resilience in construction project.

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