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The Emergence Process of Construction Project Resilience: A Social Network Analysis Approach

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Abstract: For construction projects, resilience is the process of resisting and recovering from adversity. With the global economic and social environment constantly changing, improving the resilience of construction projects has become a research hotspot in the field of project management. On the basis of social capital theory, this study constructs a construction project organization resilience evaluation system from two dimensions of bonding and bridging social capitals. Then, a new theoretical framework is proposed: the network dynamic evaluation model of project resilience based on the resource conservation strategy. Using survey data of 247 construction engineering practitioners, this study considers the emergence of organization resilience in the three phases of adversity. The results reveal that when the construction project is hit by adversity, the investment capital will increase but decrease in the recovery phase. Protective capital demonstrates the opposite. However, both types of capital finally reach a higher level than before the adversity, thus forming an emergence curve of project resilience. This study helps to understand the emergence process of the construction project resilience, provides a feasible method to calculate the resilience and social capital of construction projects in different phases of disasters, and improves the risk response ability of construction projects.

Keywords: project resilience; construction project; social capital; organization behavior; social network

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1. Introduction

Affected by adverse events that are difficult to predict or prepare for in advance, such as the outbreak of COVID-19 and the consequent global political and economic turbulence, organizations often suffer disruptive shocks such as business process disruption and loss of performance [1,2]. These outcomes have quickly led to efforts to understand the trend that organizations are more effective at responding to and recovering from adversity, that is, showing resilience [3,4]. At a time of increasing uncertainty, understanding the resilience of project-based organizations in complex and changing internal and external environments has become a core issue in project management [5]. The present study focuses on the organization resilience of temporary projects represented by construction projects, which are highly likely to be affected by external events and are of great importance to socio-economic development [6–8].

In the field of management, research on resilience is generally divided into three levels: individual resilience, team resilience, and organizational resilience [9–11]. In more regular and stable environments, resilience at different levels has been observed to help improve one's own performance, promote collaboration, enhance cohesion, and achieve performance recovery and maintenance [12]. However, we know little about how it operates in a project-based environment and what mechanisms might contribute to such a valuable project state. This is because the construction project could not be simply regarded as a work team or organization; it often involves the collaboration of multiple participants, and is a temporary system composed of multiple teams or organizations for specific construction tasks, with the characteristics of heterogeneity and loose coupling [13,14]. Despite this, the study of resilience in construction projects needs to be further expanded. To fully consider the characteristics of the project system itself, it is necessary to consider both the integrity of the project system and the coordination of all participating units within the project. Therefore, one of the tasks of this study is to explore how resilience changes when project systems encounter a crisis within a comprehensive theoretical framework.

Social capital theory makes it possible to study resilience in the context of construction projects [15]. Social capital refers to the value of an individual's or social unit's position in an organizational structure [16]. It refers to the accumulation of behaviors and norms that make members of a group support each other. In projects, social capital exists in the interpersonal structure of the project life cycle [17]. It brings additional benefits to the project through constant, positive interaction between members [18]. Therefore, understanding project system social capital helps us to better define and discuss resilience. Of course, social capital such as cohesion and trust are not exactly the same as resilience, but they are certainly some manifestations of resilience. As described in the study of [19], resilience is largely a social process that is fundamentally shaped by the relationships between the components of an organization. Therefore, according to the social capital theory, we propose that the resilience of construction projects is based on the process of resisting adverse impact and realizing recovery reflected by the accumulation of project social capital, which can be described through the measurement of social capital. Under this concept, project resilience is broken down into the different effects of social capital. Therefore, in this study, we hope to explain the mechanism of project resilience by investigating several key social capitals and establish a project resilience measurement system under the theoretical framework of social capital.

To solve the above problems, we use social network analysis (SNA), because SNA provides a tool for measuring social capital that results from connections between subjects embedded in social networks [20,21]. In this model, we refer to the research of Cui [22] and take the network topology index as a reflection of the social capital of construction projects. We establish a network model of construction project participants at different phases of a disaster's impact to investigate the changes in social capital at different phases. Finally, through the normalization of social capital, the resilience process of the project is summarized.

Our paper contributes to the project management literature in at least three respects. First, we provide a definition of project resilience based on social capital theory, in which resilience can arise in project-based social capital. Secondly, our paper focuses on the evolution of project networks before and after disasters, providing a methodological basis for understanding the evolutionary process of project resilience, and complements the process perspective that has dominated research on resilience in the project management literature [23]. Third, we explore a social capital indicator system that can be used to describe project resilience quantitatively, reducing the difficult-to-measure resilience to an observable social capital framework. On the basis of these theoretical insights, we discuss how to improve project management practices.

In the next section, we provide a literature review, followed by the research design and methods. Then, on the basis of the construction projects that were in progress during COVID-19, the data are analyzed from two levels of bonding and bridging social capital in three phases: preparation, coping, and post-disaster recovery. The emergence of project resilience is identified, and the theoretical and practical significance of the development of resilience in construction project governance is discussed. Finally, the conclusions and limitations are given.

2. Literature Review

2.1. Construction Project Resilience

As COVID-19 brings about the sustained development of global economic, political, and social instability, studies on the resilience of various social systems are gaining popularity and attention [24]. Existing conceptualization studies suggest that resilience can be defined by adopting a process or capacity perspective [25,26], focusing on resilience-related coordination activities or states and resources that resilient organizations can develop, respectively. Similarly, scholars have distinguished different manifestations of resilience, including predicting adverse events, reducing the perturbation of adverse events, or recovering from failure [27,28]. Therefore, a comprehensive understanding of resilience should include the processes and capacity that enable organizations to anticipate and manage adversity, which can be combined into four complementary dimensions: crisis prediction, crisis management, rebound recovery, and reverse improvement [29].

At present, a systematic research system on resilience has been formed, which can be divided into individual resilience, team resilience, and organizational resilience at the research level. The research objects include the antecedents, processes, and results of resilience [30]. However, project resilience is still a relatively new concept, and although publications on it are increasing, there is still conceptual debate as to whether project resilience should be considered as a capacity or a process [31].

From the perspective of capacity, Turner and Kutsch [32] proposed an interpretation of project resilience, defining it as the art of detecting changes in the project environment, understanding these changes, planning answers, minimizing damage when changes occur, and adapting to new realities. Giezen [33] put forward the concepts of prevention, response, and adaptation in their definition of project resilience, and also mentioned two types of project resilience: Passive resilience and active resilience. In all of these studies, project resilience takes a capacity perspective.

The process perspective sees project resilience as a long-term strategy to deal with complexity and risk. Williams et al. [26] believed that resilience is a process in which individuals or groups avoid the tendency to react negatively to challenging situations and maintain positive adjustment or coping. Similarly, Crosby [34] points out that resilience is the process of managing risk, crisis, or contingencies. Another group of studies, starting with project teams, views resilience as a collective construct, including "an interactive, coordinated, and collaborative team interaction process that describes the actual behavior of teams in coping with adversity" [35,36].

Due to different research objects and focuses, and different research methods [37], empirical studies rarely integrate the process perspective and capacity perspective into the same research. Researchers select one of the perspectives according to the research purpose and the theoretical contribution they are trying to make [38]. In this study, we use a process perspective (i.e., project resilience as the whole process of recovery from disaster) to construct meaningful theories and conduct reasonable in-depth research. As Kahn's research shows, resilience stems from the relationships between the components of a system and is a social process. Therefore, we define project resilience as the whole process in which the positive interaction between component units enables the project collective to withstand shocks, cope with challenges, and recover.

2.2. Social Capital: A Theoretical Framework

Consistent with previous studies based on organizational relationships and structure [39], we propose the use of social capital theory to study the resilience of building projects. Social capital has been studied in different areas of social, economic, and political science, creating a wealth of definitions and characterizations of its characteristics [40]. Different researchers distinguish social capital by the context, form, possible use, and group of interactions. Bourdieu [41] proposed the most widely accepted and applied concept of social capital, believing that social capital is the total amount of actual or potential resources obtained through the relationship network, that is, social network is social capital. Coleman [42] defined social capital as a kind of social structural resource from a macroperspective, which is the relationship of responsibility, expectation, trust, and power between individuals or groups. He believed that various exchanges based on the interests of different actors in the social network form a continuous social relationship, which is social resource and social capital. Portes [43] also proposed that social capital is a special connection attached to social relations and an expression of ability. Burt [44] believes that structural hole is social capital and the ultimate competitive advantage of enterprises and other economic activity subjects. Finally, Lin's [45] discussion on social capital represents the general consensus of theoretical research on social capital. In his view, social capital is the investment of rewarding resources embedded in social networks.

In addition, there are many research angles on social capital theory. In sociology, Carrillo et al. [46] argue that social capital is the most important indicator of family health. In terms of enterprise management, Harris et al. [47] tested the effect of coordination between human capital and social capital on enterprise performance. In the field of policy research, Muringani et al. [48] found that different types of social capital have different incentive effects on European economic development, thus adjusting economic policies.

Of course, there are contradictions between different schools of study on social capital theory. One of the principal contradictions is that between the individual and the collective. Burt and Lin regard social capital as individual capital, which is acquired based on people's action network. However, in Bourdieu and Coleman's study, social capital can be acquired in groups. The two views are not completely opposite fundamentally. The individual is embedded in the collective, and the collective is embedded in the larger social network. Therefore, this study is based on Bourdieu's view to identify collective social capital at the project level but also combines Burt's network-based analysis method. Based on the view that resilience emerges due to the interaction of each unit of the system, we believe that the process of project resilience can be represented by the change in social capital, and try to summarize the process of project resilience by measuring the change in social capital in each phase of the project network under adversity.

2.3. Social Network Analysis: A Computing System

Social network analysis (SNA) is a quantitative analysis method based on graph theory and mathematical symbols [49]. In SNA, a social network is a collection of social actors as nodes and relationships between nodes as edges [50]. Its essence provides a mathematical method to evaluate the impact of the embeddedness of nodes and related actors in the social network on their behavior and decision-making results [51,52].

The social capital available to actors of a group is integrated into their social networks [53]. In other words, social capital lies in actors' social relationships and network positions. Therefore, using SNA to research social capital is a feasible method. One dominant view is that the connections made between network actors form the basis of social capital [54]. This view is strongly influenced by network theory.

Some progress has been made in the measurement of social capital based on SNA [53]. On the one hand, some researchers have constructed social network capital measurement scales and considered the measurement results as social capital [55]. These scales have been used in a large number of surveys, using surveys or questionnaires as data collection tools. On the other hand, some researchers use SNA to measure social capital, which is measured by the description of network genus [22]. These studies provide us with the possibility to review the resilience capital of construction projects.

For a long time, construction projects have been considered as temporary organizations involving multiple participants [56]. One theoretical bridge to using SNA in construction is to view a construction project as a set of networks [57]. By taking the key actors in the construction project as nodes and the relationship between actors as connections, we can quantitatively analyze the cooperation ability of the project organization and implement effective project network management [58–60].

3. Method

To construct a social capital system to assess the resilience of construction projects and measure the resilience process within a system framework, this study designed a construction project resilience measurement method based on SNA and social capital theory, including the following four steps: (1) Establish a social network model for construction projects; (2) through a systematic literature review (SLR) and keyword frequency statistics, identify the key social capital of construction projects, and establish the project resilience evaluation framework based on social capital theory; (3) use the SNA method to calculate the different types of social capital of construction projects to establish the evaluation model of project resilience; and (4) use the data from the construction industry in China, which had experienced the impact of COVID-19, to analyze the changes in construction projects' resilience in the preparation, coping, and post-disaster recovery stages (hereinafter, the three stages are represented by 1, 2, and 3, respectively), which provides a benchmark for engineering projects to withstand impact.

3.1. Establishing a Network of Construction Projects

The identification of network nodes was the first step of SNA. In the research on construction projects from the perspective of the network, the network construction method regards all stakeholders of construction projects as network nodes. This method can be used to analyze the impact of the relationship structure between participants in the project from a macroperspective, but it cannot accurately and in detail describe the specific structure of the project. Another method is to focus on a specific construction project case and regard each project actor as a node to build a complete network of the project [61]. This method can accurately and in detail describe the structural characteristics and relationship composition of the project. However, it is also limited to only conclusions within. In addition, the method is difficult to extend for applications to a larger field. Therefore, in this study, we abstracted the actors with the same function in the project into one node, so that the construction project network not only fully describes the project relationship structure but also has higher universality and is not limited to a single project. The network constructed in this way allows the conclusions of this study to characterize the commonness of different construction projects to a certain extent.

Through reading and combing of the relevant literature, including papers, laws, and regulations from China, combined with the actual situation of most construction projects in China, we determined the main composition of construction projects in China [62]. In-depth interviews were conducted with 18 project practitioners, experts, and scholars in the construction field. The respondents were asked to prepare a list of the main project participation roles in their own unit as the basis for constructing network nodes. We also asked respondents to briefly describe the functions and main contacts of the participating roles they provided, and to identify the final node list through mutual screening. As shown in Table 1, although not all construction projects had the same personnel composition, the participating roles provided in the list cover almost all the functions required for the operation of construction projects and could represent the network structure of construction projects to a certain extent.

The second step was to establish connections between nodes. All respondents were asked to rate their own relationships with others. The 5-point scoring system was adopted, that is, {very high, high, medium, low, very low} = {5, 4, 3, 2, 1}. On the basis of the assignment undirected network model, the relationship matrix was transformed into a 0–1 binary matrix. The edge with score {0, 1, 2} was set to 0, and the edge with score {3, 4, 5} was set to 1. More detailed questionnaires are described in the data collection section. Thirdly, UCINET software was used to draw the social network diagram and calculate the social network indicators of the social capital of construction projects.

Table 1. List of relationship network nodes.

Project Actors	Agents (Network Nodes)	Node Codes
Owner unit	Project construction management personnel Business operation management personnel Quality inspection and safety management personnel	S1 S2 S3
Design unit	Unit leader	S4
Construction unit	Construction director Business director Safety director Material director	S5 S6 S7 S8
Construction control unit	Chief supervisory engineer Professional supervisory engineer Safety supervisory engineer	S9 S10 S11
Subcontractor	Professional subcontracting director Labor subcontracting director	S12 S13
Material supplier	Supply manager	S14
Government sector	Personnel of urban and rural construction department Audit department personnel	S15 S16
Consulting unit	Consulting engineer	S17
Financial institution	Accounting personnel	S18

3.2. Selecting the Key Social Capitals Using SLR

In this study, a systematic literature review (SLR) was used to select the most appropriate social capital indicators for project resilience. The SLR was used to conduct a quantitative analysis of the literature and reduce subjective factors and errors in literature selection and evaluation [63]. Two electronic databases were selected to collect the literature, including Science Direct and Web of Science. In the subject category covering the title, abstract, and keywords, two keywords, including resilience and social capital, were set as search protocols. In addition, the article type was set as review papers, and the publication time was set between 2000 and 2021. Then, the obtained results were filtered to remove irrelevant articles, including the following steps: duplication, attribute filtering, title and summary filtering, and full-text relevance filtering [64]. Finally, 110 articles on the project resilience or the social capital of construction projects were determined. Instead of filtering articles based on the field of construction project, we selected keywords from all articles on social capital research to avoid artificial disciplinary boundaries.

The most concerned social capital index in the study of resilience was screened by antconc3.5.9 software. Referring to the screening characterization proposed by Zhang et al. [65], only the indicators that appeared in more than three pieces of literature and whose relevance was in the forefront were selected. Then, the author discussed and analyzed these indicators from the theoretical perspective of the type of social network connection. In this process, seven kinds of social capital (Ci, $i = 1, 2, 3, \ldots, 7$) were selected, including cohesion (C1), trust and reciprocity (C2), information sharing (C3), information superiority (C4), social identity (C5), social influence (C6), and interpersonal relationship (C7) [66,67].

Finally, we referred to Putnam's classification of social capital and divided social capital into two types: bonding and bridging social capital. Bonding social capital originates from the interactions of actors within the system and emphasizes cohesiveness. On the other hand, bridging social capital originates from external network relationships, emphasizing the role of brokerage. A construction project is a unified whole, which needs the maintenance of bonding social capital. However, there are many heterogeneous actors from different teams inside the project, which needs the development of bridging social capital. Therefore, on the basis of the types of social capital, we discussed the identified social capital and built an evaluation system for the emergence process of project resilience, as shown in Table 2.

Table 2. Calculation system of Resilience Social Capital for construction projects based on SNA.

Level	Social Capital	SNA Indicators	Parameter
Bonding	Cohesion Trust and reciprocity Information sharing	Cohesion	Density Subgroup Average distance
Bridging	Information superiority Social identity Social influence Interpersonal relationship	Structural hole Cohesion Centrality	Efficiency Clustering Degree centrality Betweenness centrality

3.3. Calculating the Social Capitals Using SNA

In terms of the calculation of social capital, this study used [68]'s calculation system for reference and established a resilience social capital calculation system for construction projects based on network indicators, as shown in Table 2.

3.3.1. Bonding Social Capital Computing

Cohesion refers to the ability to keep actors of a social network together by sharing common standards, values, ideas, and beliefs. According to Sanchez's research [69], the concept of group cohesion can be measured by the network density. In SNA, network density refers to the ratio of actual connections to potential connections. The more connections between each group actor and other group actors, the greater the density of the network. At the project level, the project network density corresponds to the average number of contacts per actor. From the perspective of social network analysis, network density is equivalent to group cohesion, which as a tightly connected network is considered to be more cohesive.

Trust and reciprocity represent one of the first indicators of social capital research. According to Sun et al. [70], trust and reciprocity are informal norms that promote cooperation between multiple individuals. The SNA subgroup refers to the closeness of the association among actors of a social network, who have a reciprocal relationship with each other and combine to form a substantial subgroup. Therefore, we used subgroup analysis in the social networks to measure the levels of trust and reciprocity.

Information sharing is defined as revealing the existence of relevant information and knowledge without the need for overall dissemination. If the construction project is regarded as a network, the information sharing ability of the project is closely related to the communication distance between network actors [71]. Therefore, we used the average network distance of SNA to measure the information sharing level of projects.

3.3.2. Bridging Social Capital Computing

Information superiority refers to the ability of actors to obtain non-redundant information, which is of high quality and conducive to decision making. In SNA, structural holes are used to analyze non-redundant links between any two nodes. From this point of view, we used the structural hole efficiency to measure actors' information superiority ability, that is, to what extent they possessed and used the structural hole superiority ability.

Social identity is the definition of one's own attributes and those shared with others when identifying oneself and comparing oneself with the group to which one belongs. Therefore, we used cluster analysis to measure the level of social identity. A higher clustering coefficient means that the node had a more united relationship with its neighbors, that is, a high sense of identity to its network membership.

Social influence is used to measure the ability of actors to directly or indirectly influence the emotions and actions of others. High social influence means that actors are able to interact with more other actors or with a higher frequency. Therefore, we used degree centrality to describe social influence, measuring the degree to which one node in a network is related to other nodes.

Interpersonal relationships represent the process by which actors connect indirectly or directly, establish connections, and allow the access and exchange of resources. Strong interpersonal skills mean that they are at the hub of network communication and could contact other actors directly or indirectly through this actor. Thus, betweenness centrality was used to measure interpersonal competence.

3.4. Establishing the Construction Project Resilience Evaluation Model

After the establishment of the social capital measurement system, social capital needs to be normalized to form a measure of project resilience. This study established an evaluation model of project resilience. The model referred to the RL model in the resilience evaluation of large-scale systems and estimated the resilience as the ratio of recovery to loss (Shen et al. 2020). The model is shown in Formula (1), where t = 1, 2, and 3 represent different phases of disaster impact, including pre-disaster, during the disaster, and post-disaster. $R(t)$ represents community resilience in phase t; i = 1, 2, . . . , 9 represent different types of social capital in the construction project organization; and Ci is the value of social capital in phase t. The specific value was obtained in the case study according to the method described in the method section:

$$R(t) = \sum_{i=1}^{n} \frac{C_i(t) - C_i(t_{min})}{C_i(t_{max}) - C_i(t_{min})} \tag{1}$$

3.5. Data Collection

To clearly express the changes in the construction project network before and after the disaster, this study selected the organization leaders, managers, and experienced employees and scholars of each participating subject of 9 construction projects in Hubei Province of China as the main sample sources. Because Hubei province was the first province in China to be affected by COVID-19, respondents from Hubei province clearly felt the impact of the disaster. The principles for selecting these respondents adhered to the following rules: (1) The selected respondents covered all 18 categories of construction project actors mentioned in the network node identification section; and (2) the working years of the respondents had to be greater than 5 years (to ensure that the respondents not only have a certain understanding of their work but also have experienced the impact of epidemic disasters). In other words, the selected respondents can include all participating organizations of construction projects in terms of categories and have a rich theoretical basis and practical experience in terms of individuals.

The researchers conducted a questionnaire survey based on the network actors identified above to measure their relationship network. Before the questionnaire, respondents were asked to review the impact of the epidemic on the project before answering. Thereafter, respondents were asked to evaluate how their relationship with others changed during different stages of a disaster from three dimensions: trust, communication frequency, and communication quality, as shown in Table 3. This table was adapted from the SNA questionnaire proposed by Wang et al. [72] to infer structural changes in the construction project relationship network.

The following measures were taken to ensure the return rate and validity of the questionnaire. First, during the questionnaire distribution process, we assured respondents that their information would be kept strictly confidential and that the results would be used for scientific purposes only. Second, we used a dual incentive mechanism in which respondents were not only rewarded for their participation but also for recruiting a reliable new respondent. A total of 391 questionnaires were distributed through online surveys, and construction site interviews. Then, 247 valid questionnaires were recovered, with an effective response rate of 63.2%, as shown in Table 4. After that, we interviewed 18 project managers with 5 years of project management experience, who were asked to validate the authenticity and validity of the networks constructed in different phases of our study and supplemented the data with specific interviews with specific project actors. Finally, the valid scores of the respondents were averaged as the result of the final relationship strength matrix.

Table 3. Data Collection Form.

1. Please briefly describe your position and work in the project. 2. Please list the other members of the project with whom you work or exchange information frequently. 3. The position of the member in the project and the main work content.
Please provide your evaluation on the following questions about the quality of your relationship (The evaluation is based on a 5-point scale, 1 = very low, 2 = low, 3 = medium, 4 = very high, 5 = high).
4. Please evaluate your level of trust in the pre-disaster phase. 5. Please evaluate your level of trust during the disaster phase. 6. Please evaluate your level of trust in the post-disaster phase.
7. Please evaluate the frequency of your communication in the pre-disaster phase. 8. Please evaluate the frequency of your communication during the disaster phase. 9. Please evaluate the frequency of your communication in the post-disaster phase.
10. Please evaluate the quality of your communication in the pre-disaster phase. 11. Please evaluate the quality of your communication during the disaster phase. 12. Please evaluate the quality of your communication in the post-disaster phase.
13. Would you like to help us contact the member to receive the questionnaire?

Table 4. Descriptive statistical analysis of the respondents.

Classifications		Actors	Percentage
Sex	Male	139	56
	Female	108	44
Working years	5–10	145	59
	11–15	65	26
	>15	37	15
Stakeholder party	Project construction management personnel	22	9
	Business operation management personnel	17	7
	Quality inspection and safety management personnel	23	9
	Unit leader	19	8
	Construction director	20	8
	Business director	19	8
	Safety director	15	6
	Material engineer	13	5
	Chief supervision engineer	11	4
	Professional supervision engineer	8	3
	Safety supervision engineer	14	6
	Professional subcontractor	11	4
	Labor subcontractor	12	5
	Supply manager	10	4
	Personnel of urban and rural construction department	9	4
	Audit department personnel	8	3
	Consulting engineer	9	4
	Accounting personnel	7	3

4. Result and Analysis

4.1. Social Network Description

UCINET 6.0 software was used to draw a social network diagram showing the stakeholder relations in three different phases, as shown in Figure 1. Obviously, S1 and S9 were the most connected nodes in the whole social network in phase 1 (the pre-disaster period). Intuitively, at the beginning of the disaster, the number of edges between the network nodes of the project organization, especially S1, decreased significantly, which meant that the relationship and interconnection among project actors loosened due to the impact of the disaster. After the disaster, the social network became type 3, which was closer than when the disaster occurred, and even stronger than before the disaster to a certain extent. Some possible reasons might have included the following: First, in phase 2, the connection between the project actors was weakened by the impact of the disaster.

However, the connections that enabled the project to exhibit resilience were retained, so the project system could resist or even survive the impact of a disaster. Second, by drawing lessons from disasters, the project organization accumulated more experience in dealing with disasters. An organizational network with more redundant connections was formed to enhance the resilience of the project.

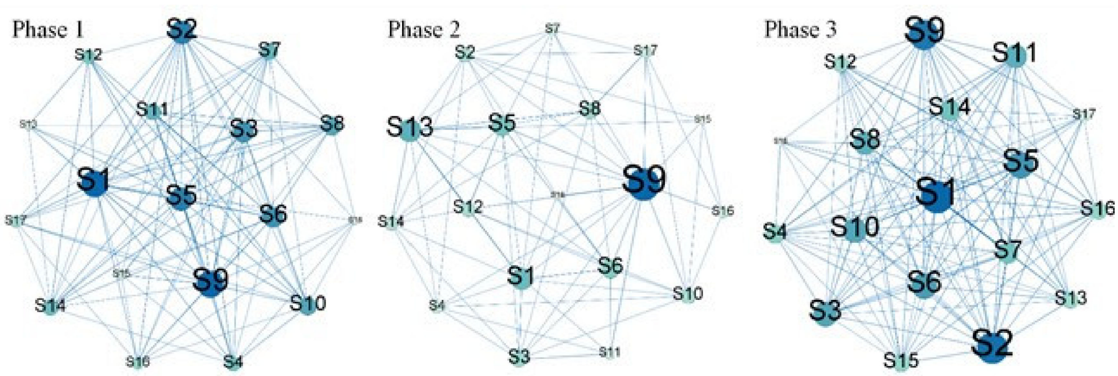

Figure 1. Social network graphs of the construction project before, during, and after the disaster.

4.2. Bonding Social Capital of the Whole Project

The bonding social capital of the project in the three phases of the epidemic is shown in Figure 2. In general, compared with phase 1, the social capital index basically showed a downward trend first and then an upward trend (the rise in the distance indicators represents a decline of the level of information sharing).

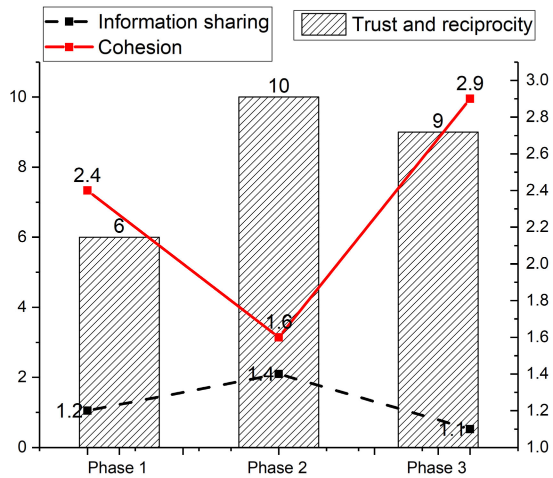

Figure 2. Bonding social capital during different phases of the disaster.

Based on the changes in the network indicators, when the disaster occurred, the project network became sparse and loose. Project actors were uncertain whether the project could successfully deal with the crisis, and the cohesion of the project was weakened. The communication bridge between project actors that could be directly contacted in the past was broken, and the communication distance between different nodes to achieve cooperation was lengthened, which compromised the ability to share information within the project. However, the number of small groups increased from 6 to 10, and the trust and reciprocity between the actors of the common group were improved, thereby increasing the level of trust throughout the project. When the project successfully overcame difficulties, the cohesion of the project was restored to a higher level than phase 1. The number of factions decreased from 10 to 9. Part of the temporary small groups that formed to deal with the impact of disasters was retained, the resources of reciprocity and trust were developed, and a higher level of information sharing was formed.

Table 5 describes the major subgroups and their major actors that existed at each phase of the disaster impact. As the social network diagram shows, actors of a small group were connected to each other without structural holes. As a result, information could be transferred directly between them, point-to-point, without mediation. This meant that the trust levels within these four subgroups were high, were less affected by the impact of the disaster, and played an important role in maintaining the normal function of the project. It is worth noting that node S13 did not appear in any subgroup at any phase, which meant that its relationship with other nodes should be improved. Other subgroups were flexibly combined based on the different needs of the disaster response. For example, the subgroups with S1, S4, and S9 as actors appeared in stage 2 but disappeared in stage 3, indicating that the project management personnel of the construction unit, the leader of the design unit, and the chief supervisory engineer played the role of a temporary emergency response team in the case of the impact on the project.

Table 5. Construction project subgroup analysis.

Subgroup	T1	T2	T3	T4
Actor	S1 S2 S3 S4 S5 S6	S7 S8 S9 S10	S11 S12 S14	S15 S16 S17

4.3. Bridging Social Capital of Actors

In the previous section, the project was regarded as a cohesive whole, and the bonding social capital of the project was calculated through the network's overall indicator. However, the normal operation of a construction project involves the cooperation of multiple actors, and bridging social capital also plays an important role for each actor. Therefore, this section calculated the node indicators of the network to obtain the changes in the four bridging social capitals: information superiority, social identity, social influence, and interpersonal relationship, of the actors in the three periods, as shown in Figure 3. It is part of the project resilience assessment framework.

In Figure 3, in the bridging social capital of the project actors, information superiority and interpersonal ability showed a similar trend: rising in phase 2 and then declining in phase 3 but higher than phase 1. This suggests that information superiority and interpersonal relationships were even more important to keeping projects running during a disaster impact. However, the interpersonal relationship of S4, S11, and S15 declined in phase 2, indicating that the quality of their relationship with other actors needs to be further improved.

The social capital of project actors, social identity and social influence, showed a downward trend in phase 2 but recovered to a higher level in phase 3. This meant that for construction projects, actors' social identity and social influence were the bridging social capital that was most vulnerable to damage when experiencing the disaster's impact. To ensure the project survives the crisis, it is necessary to take measures to protect actors' social identity and social influence ability.

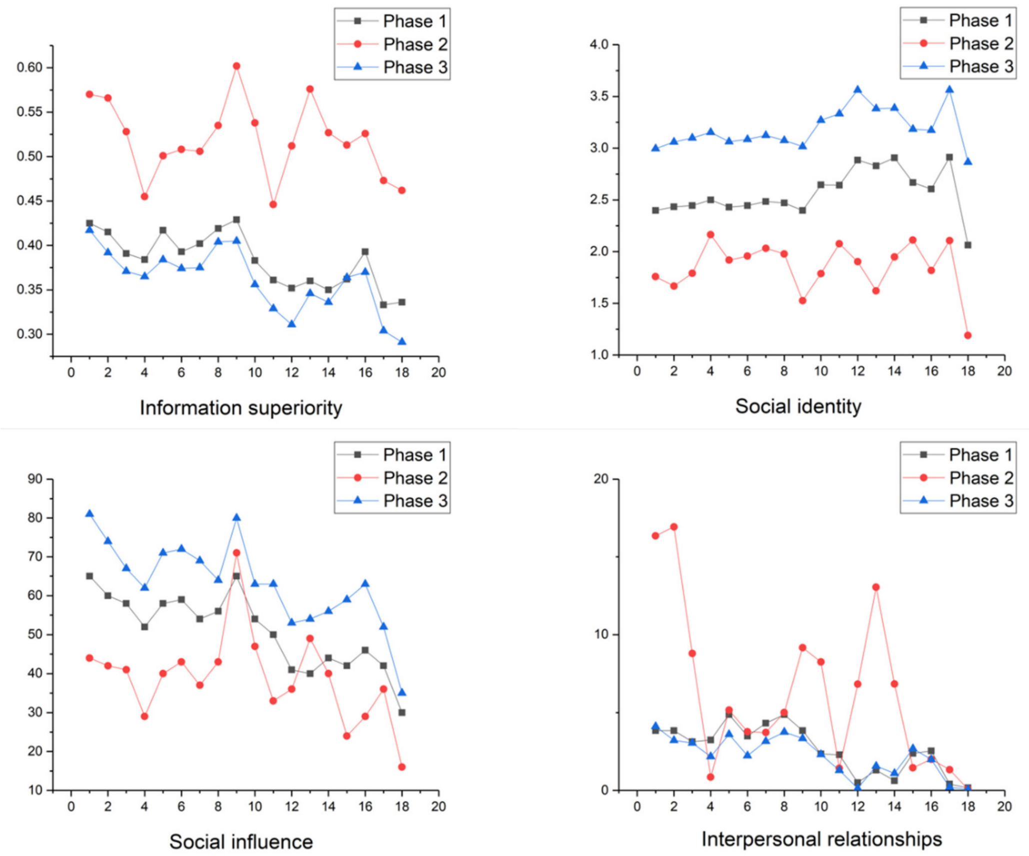

Figure 3. Bridging social capitals during different phases of the disaster.

4.4. Resilience of Construction Project

The above research demonstrates that in the social capital system, to evaluate the resilience of construction projects, the trust and reciprocity in bonding social capital and the information superiority and interpersonal relationships in bridging social capital were required, which was manifested when encountering adversity, as the project needed to protect the existing capital constantly from loss through resource investment, and ensure faster recovery from lost resources. Meanwhile, the cohesion and information sharing in bonding social capital, the social identity and social influence in bridging social capital, showed the characteristics of protective capital. In case of adversity, the project would take a series of protective measures to reduce the loss of protective capital and wait for rescue and turnaround to over difficulties. Therefore, project resilience evaluation system could be characterized from two dimensions: social capital attribute and resource conservation strategy, as shown in Table 6.

Table 6. Project resilience measurement system.

	Bonding Social Capital	**Bridging Social Capital**
Investment	Trust and reciprocity	Information superiority Interpersonal relationships
Protect	Cohesion Information sharing	Social identity Social influence

According to Formula (1), nine social capital indicators of the construction project in three phases of adversity were normalized and summarized by type to reflect the emergence of the project resilience, as shown in Figure 4. From the perspective of investment resources, the project resilience scores before, during and after the disaster were 0.89, 1.99, and 1.25

respectively. From the perspective of protective resources, project resilience was 2.79, 0.98 and 3.4 respectively. As can be seen from Figure 4, the project resilience as the result of the interaction between the construction project system and the environment had the characteristics of dynamic and repeated iteration: (1) the construction project had a certain level of investment and protective social capital in phase 1, and paid attention to the preparation and readiness capability, i.e., early warning capability, at the level of strategy, structure and resources. (2) The project paid attention to the ability of adjustment and skillful creation in phase 2, and increased the investment in investment capital when the protective capital was seriously damaged, so that the construction project could survive the emergency. (3) In phase 3, the project paid attention to recovery, learning and improvement transcendence. Although the investment capital decreased, it was still higher than the level before the adversity. The protective capital recovered after a major blow and surpassed the original level, so that the project would have more sufficient social capital when the next adversity came, thus completing the emergence of project resilience.

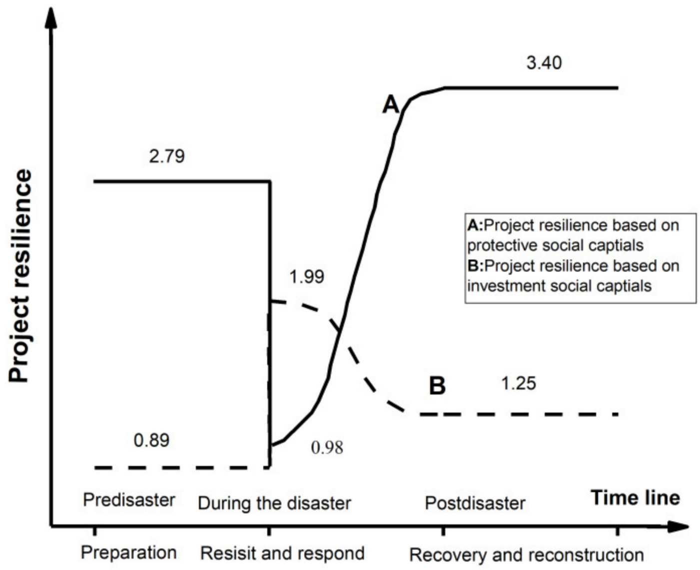

Figure 4. Construction project resilience in the three phases of the disaster.

5. Discussion

This research is based on the investigation and study of China's construction projects, which were hit by COVID-19 in 2020. Moreover, this study analyzed the relationship network and the evolution of social capital among project actors. The data demonstrates how the macrostructure of the network changes in the different phases of impact, thus allowing the present research to discuss the evolution of network social capital further, and establish a dynamic measurement system of project resilience based on the categories of social capital. The findings of this study provide insights into how construction project actors can improve the resilience and performance of complex cross-organization project teams through a structural review and intervention of relationship networks in adversity.

Previous studies have shown that complex organizational systems can actively adapt to environmental changes, dynamically coordinate different subjects, and promote project organizations to overcome adversity and achieve success, that is, show resilience; however, a detailed description of the emergence process of project resilience in the field of construction project management involving multi-department participation is lacking [73,74]. To fill this gap, this study developed a dynamic research method based on the data of three time points. The results reveal that construction projects in the three phases (e.g., before, during, and after the adversity) will adjust the network structure and the development and transfer of social capital to make the project resilient and rebound during adversity. From the changes in the network indicators, when a disaster occurs, given the uncertainty of whether the project can successfully deal with the crisis, the psychological security level within the project is reduced and the cohesion of the project is weakened. The communication bridge between project actors that can be directly contacted in the past is broken, and the communication distance to achieve cooperation between different nodes is lengthened, and the information sharing within the project becomes more difficult.

However, the number of subgroups increased from 6 to 10. The project actors of the same subgroups have the same goals and strive to reduce the impact of the disaster on the operation of construction projects. As a result, their trust and mutual benefit are improved. When the organization successfully overcomes the adversity, the broken communication bridge can be restored. At the same time, given the impact of the disaster, the organization may pay extra attention to the investment in the early warning, recovery, and reconstruction of disasters, thus resulting in a new communication bridge, shortening the communication distance, and restoring the cohesion and information sharing of the project to a higher level than before the disaster. The number of factions was reduced from 10 to 9, and the clustering coefficient increased to a higher level than before the disaster. Given that the project as a whole has overcome the difficulties together, the temporary subgroups formed to deal with the impact of the disaster have been retained, and the resources of reciprocity and trust have been developed, with a higher level of psychological security. Therefore, managers should fully consider the relationship dynamics among multiple subjects. On the one hand, they should pay attention to the network areas that are hardest hit by adversity, and to the organizations, teams, or individuals with the most serious decline in social capital indicators, which are often the focus of post-disaster recovery and prevention. On the other hand, they should pay attention to the new relationship connections established in adversity. These connections show a tighter network structure and higher network efficiency, which means that the growth of project investment social capital is closely related to the emergency response ability and resistance ability of the construction project.

Considering the increasing complexity of construction projects, to further identify the resilience development process of a construction project, this study established an evaluation system of seven social capital resilience factors of construction projects from the perspective of bridging and bonding social capital, and explored the emergence process of organizational resilience based on two resource strategies: investment and protection.

Based on bonding social capital, we note that the observed values of the network density and clustering coefficient dropped sharply in phase 2 and then continued to increase in phase 3. This trend means that when the construction project rebounds from adversity, it needs to develop into a more compact (less structural holes) network (phase 3), increase the concentration, reduce the dependence on external nodes, and develop more endogenous connections. In terms of initiating collective action and promoting the rapid dissemination of information/materials/services, the project's cohesion and information sharing are restored and highlighted. Meanwhile, they ensure that the project can complete this transformation depending on the investment in trust and mutual capital in adversity, that is, adopting protective strategies, which is reflected in the increase in the number of subgroups.

Based on bridging social capital, the central idea of social capital is that individuals invest, acquire, and use heterogeneous resources in social networks to achieve the desired results [75]. In this study, the effectiveness of most individuals in adversity shows a downward trend. However, those who always maintain a high level of effectiveness or show an upward trend provide help to others to the greatest extent. The impact of adversity breaks some network bridges and increases the distance for actors to obtain resources, which makes it very important to invest in the ability to maintain existing connections and establish new connections to communicate networks and integrate resources. The engineering and technical personnel, comprehensive business management personnel of the construction unit, construction management personnel, and chief supervision engineer of the construction unit are often in the central position in the network at different phases. They either have authority or occupy the information center. The combination of authority and the central position in the network may produce a better decision-making ability and positive results. In other words, more investment in information superiority and interpersonal relationships, and a decreased loss of social identity and social influence can improve a project's resilience performance.

Among the previous literature conclusions on the resilience of construction projects, they have mainly made theoretical contributions to the preliminary understanding of the positive effect of resilience on construction projects. However, most of the conclusions are still based on the use of a single performance index to characterize resilience, and this form of post feedback lacks real-time information and effectiveness. Compared with the previous literature conclusions, this study combined the actual data of China and analyzed the influence factors of project resilience and different resource changes from the perspective of sociology to promote the success of construction projects in a more targeted and real-time way. Through social capital theory and the evolution view of resource conservation, an evaluation model of the resilience of construction projects was proposed from the two dimensions of protection and investment. The research results make up for the theoretical defects in the identification of resilience in construction projects and point out the direction for the future development of construction projects.

6. Conclusions

6.1. Theoretical Significance

Based on social network theory and social capital theory, this study revealed the emergence mechanism of project resilience. The innovation of this study is that it performed a cross-level analysis of project resilience from a dynamic perspective, and makes some theoretical contributions to the project management literature. First, social capital theory is extended to the research of project management in this study. Then, this study constructs an evaluation system for project resilience, which includes seven social capital indicators based on the two types of social capital. These research results help to deepen the understanding of the emergence mechanism of project resilience, enrich the literature on construction project management, and establish the relationship between the project and sociological research. Secondly, given the structural complexity and resource diversity of construction projects, this study proposes that project resilience should be considered at both the overall and local structural levels. Bonding and bridging social capital are inherent in the overall and local relationship of the project, which provides a new understanding for the identification and measurement of project resilience. Third, this study discusses the capital integration process of the project from a dynamic perspective. This research shows that the construction project will strengthen the trust and reciprocity and information superiority, allow the development of the interpersonal relationship ability of employees, and maintain the cohesion, information sharing, social identity, and social influence at no less than a certain level, which will provide new insights into the understanding of project resilience.

6.2. Management Significance

Our results provide some practical guidelines on the resilience of construction projects to maximize organizational and project performance. First, consideration of the evolution of the relationship network will help to shift the management of the construction industry to informal institutional arrangements, including but not limited to trust, cohesion, information sharing, and social identity, etc., to enhance the sustainability of social project governance. Secondly, this study will help practitioners fully grasp the emergence process and phase of project resilience to deal with risks and adversity pertinently and strategically, especially sudden public health events. In addition, we suggest that the project should pay attention to the development of investment capital and protect the conservation of capital. In times of adversity, the project should strengthen the trust among actors, improve the quality of the relationship, develop collective efficiency, and ensure the psychological safety and sense of belonging to a certain level, which will help loose construction projects to have better resilience and achieve their objectives.

7. Limitations

This study can be regarded as the starting point for further testing of the development of resilience in the construction industry through SNA. One of the limitations is the methodological challenge of the SNA method. Drawing social network diagrams, especially vertical continuous drawing, is a costly and time-consuming process, which requires an ingenious and thorough research design and system design. Future work is encouraged to clarify the bridge between project resilience standards and network measures, and the theoretical development of resilience measures and network evolution. In addition, this study did not consider the types of relationships (such as friend relationship, task relationship, interest alliance, etc.), and it encourages further detailed research to explore the relationship between the network dynamics and project resilience of construction projects under the background of more complex relationships.

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References

1. Choi, S.; Cho, I.; Han, S.H.; Kwak, Y.H.; Chih, Y.-Y. Dynamic Capabilities of Project-Based Organization in Global Operations. *J. Manag. Eng.* **2018**, *34*, 040180275. [CrossRef]
2. Rai, S.S.; Rai, S.; Singh, N.K. Organizational resilience and social-economic sustainability: COVID-19 perspective. *Environ. Dev. Sustain.* **2021**, *23*, 8. [CrossRef] [PubMed]
3. Doern, R.; Williams, N.; Vorley, T. Special issue on entrepreneurship and crises: Business as usual? An introduction and review of the literature. *Entrep. Reg. Dev.* **2019**, *31*, 400–412. [CrossRef]
4. Sakurai, M.; Chughtai, H. Resilience against crises: COVID-19 and lessons from natural disasters. *Eur. J. Inf. Syst.* **2020**, *29*, 585–594. [CrossRef]
5. Carmeli, A.; Levi, A.; Peccei, R. Resilience and creative problem-solving capacities in project teams: A relational view. *Int. J. Proj. Manag.* **2021**, *39*, 5. [CrossRef]
6. Wang, A.; Pitsis, T.S. Identifying the antecedents of megaproject crises in China. *Int. J. Proj. Manag.* **2020**, *38*, 6. [CrossRef]
7. Siraj, N.B.; Fayek, A.R. Risk Identification and Common Risks in Construction: Literature Review and Content Analysis. *J. Constr. Eng. Manag.* **2019**, *145*, 031190049. [CrossRef]
8. Araya, F. Modeling working shifts in construction projects using an agent-based approach to minimize the spread of COVID-19. *J. Build. Eng.* **2021**, *41*, 102413. [CrossRef]
9. Chapman, M.T.; Lines, R.L.J.; Crane, M.; Ducker, K.J.; Ntoumanis, N.; Peeling, P.; Parker, S.K.; Quested, E.; Temby, P.; Thøgersen-Ntoumani, C.; et al. Team resilience: A scoping review of conceptual and empirical work. *Work Stress* **2020**, *34*, 1. [CrossRef]
10. Raetze, S.; Duchek, S.; Maynard, M.T.; Wohlgemuth, M. Resilience in organization-related research: An integrative conceptual review across disciplines and levels of analysis. *J. Appl. Psychol.* **2021**, *107*, 867–897. [CrossRef]
11. Mishra, P.; McDonald, K. Career Resilience: An Integrated Review of the Empirical Literature. *Hum. Resour. Dev. Rev.* **2017**, *16*, 3. [CrossRef]
12. Stoverink, A.C.; Kirkman, B.L.; Mistry, S.; Rosen, B. Bouncing Back Together: Toward a Theoretical Model of Work Team Resilience. *Acad. Manag. Rev.* **2020**, *45*, 2. [CrossRef]
13. Hu, Y.; Chan, A.P.C.; Le, Y.; Jin, R.-Z. From Construction Megaproject Management to Complex Project Management: Bibliographic Analysis. *J. Manag. Eng.* **2015**, *31*, 040140524. [CrossRef]
14. Turskis, Z.; Gajzler, M.; Dziadosz, A. Reliability, risk management, and contingency of construction processes and projects. *J. Civ. Eng. Manag.* **2012**, *18*, 290–298. [CrossRef]

15. Di Vincenzo, F.; Mascia, D. Social capital in project-based organizations: Its role, structure, and impact on project performance. *Int. J. Proj. Manag.* **2012**, *30*, 5–14. [CrossRef]
16. Powley, E.H. Reclaiming resilience and safety: Resilience activation in the critical period of crisis. *Hum. Relat.* **2009**, *62*, 1289–1326. [CrossRef]
17. Breuer, C.; Hüffmeier, J.; Hertel, G. Does trust matter more in virtual teams? A meta-analysis of trust and team effectiveness considering virtuality and documentation as moderators. *J. Appl. Psychol.* **2016**, *101*, 1151–1177. [CrossRef]
18. Wang, G.; Locatelli, G.; Wan, J.; Li, Y.; Le, Y. Governing behavioral integration of top management team in megaprojects: A social capital perspective. *Int. J. Proj. Manag.* **2021**, *39*, 365–376. [CrossRef]
19. Kahn, W.A.; Barton, M.A.; Fisher, C.M.; Heaphy, E.D.; Reid, E.M.; Rouse, E.D. The Geography of Strain: Organizational Resilience as a Function of Intergroup Relations. *Acad. Manag. Rev.* **2018**, *43*, 509–529. [CrossRef]
20. Easton, G.S.; Rosenzweig, E.D. Team leader experience in improvement teams: A social networks perspective. *J. Oper. Manag.* **2015**, *37*, 13–30. [CrossRef]
21. Pinheiro, M.L.; Serôdio, P.; Pinho, J.C.R.; Lucas, C. The role of social capital towards resource sharing in collaborative R&D projects: Evidences from the 7th Framework Programme. *Int. J. Proj. Manag.* **2016**, *34*, 1519–1536. [CrossRef]
22. Cui, P.; Li, D. A SNA-based methodology for measuring the community resilience from the perspective of social capitals: Take Nanjing, China as an example. *Sustain. Cities Soc.* **2020**, *53*, 101880. [CrossRef]
23. Saja, A.M.A.; Teo, M.; Goonetilleke, A.; Ziyath, A.M. A Critical Review of Social Resilience Properties and Pathways in Disaster Management. *Int. J. Disaster Risk Sci.* **2021**, *12*, 790–804. [CrossRef]
24. Yang, J.; Cheng, Q. The Impact of Organisational Resilience on Construction Project Success: Evidence from Large-Scale Construction in China. *J. Civ. Eng. Manag.* **2020**, *26*, 775–788. [CrossRef]
25. Kossek, E.E.; Perrigino, M.B. Resilience: A Review Using a Grounded Integrated Occupational Approach. *Acad. Manag. Ann.* **2016**, *10*, 729–797. [CrossRef]
26. Williams, T.A.; Gruber, D.A.; Sutcliffe, K.M.; Shepherd, D.A.; Zhao, E.Y. Organizational Response to Adversity: Fusing Crisis Management and Resilience Research Streams. *Acad. Manag. Ann.* **2017**, *11*, 733–769. [CrossRef]
27. Chowdhury, M.; Prayag, G.; Orchiston, C.; Spector, S. Postdisaster Social Capital, Adaptive Resilience and Business Performance of Tourism Organizations in Christchurch, New Zealand. *J. Travel Res.* **2019**, *58*, 1209–1226. [CrossRef]
28. Santoro, G.; Messeni-Petruzzelli, A.; Del Giudice, M. Searching for resilience: The impact of employee-level and entrepreneur-level resilience on firm performance in small family firms. *Small Bus. Econ.* **2021**, *57*, 455–471. [CrossRef]
29. Pavez, I.; Gómez, H.; Laulié, L.; González, V.A. Project team resilience: The effect of group potency and interpersonal trust. *Int. J. Proj. Manag.* **2021**, *39*, 697–708. [CrossRef]
30. Gucciardi, D.F.; Crane, M.; Ntoumanis, N.; Parker, S.K.; Thogersen-Ntoumani, C.; Ducker, K.J.; Peeling, P.; Chapman, M.T.; Quested, E.; Temby, P. The emergence of team resilience: A multilevel conceptual model of facilitating factors. *J. Occup. Organ. Psychol.* **2018**, *91*, 729–768. [CrossRef]
31. Tavares Thome, A.M.; Scavarda, L.F.; Scavarda, A.; Felipe, E.S. Similarities and contrasts of complexity, uncertainty, risks, and resilience in supply chains and temporary multi-organization projects. *Int. J. Proj. Manag.* **2016**, *34*, 1328–1346. [CrossRef]
32. Turner, N.; Kutsch, E. Project Resilience: Moving beyond traditional risk management. *PM World J.* **2015**, *4*, 487–498. [CrossRef]
33. Giezen, M.; Salet, W.; Bertolini, L. Adding value to the decision-making process of mega projects: Fostering strategic ambiguity, redundancy, and resilience. *Transp. Policy* **2015**, *44*, 169–178. [CrossRef]
34. Crosby, P. Building resilience in large high-technology projects: Front end conditioning for success. *Int. J. Inf. Technol. Proj. Manag.* **2012**, *3*, 21–40. [CrossRef]
35. Furniss, D.; Back, J.; Blandford, A.; Hildebrandt, M.; Broberg, H. A resilience markers framework for small teams. *Reliab. Eng. Syst. Saf.* **2011**, *96*, 2–10. [CrossRef]
36. Meneghel, I.; Martínez, I.M.M.; Salanova, M. Job-related antecedents of team resilience and improved team performance. *Pers. Rev.* **2016**, *45*, 505–522. [CrossRef]
37. Mathieu, J.E.; Hollenbeck, J.R.; Van Knippenberg, D.L.; Ilgen, D.R. A century of work teams in the Journal of Applied Psychology. *J. Appl. Psychol.* **2017**, *102*, 452–467. [CrossRef]
38. Hartmann, S.; Weiss, M.; Newman, A.; Hoegl, M. Resilience in the Workplace: A Multilevel Review and Synthesis. *Appl. Psychol.* **2020**, *69*, 913–959. [CrossRef]
39. Scott, K.L.; Zagenczyk, T.J.; Li, S.; Gardner, W.L.; Cogliser, C.; Laverie, D. Social network ties and organizational citizenship behavior: Evidence of a curvilinear relationship. *Eur. J. Work Organ. Psychol.* **2018**, *27*, 752–763. [CrossRef]
40. Fang, R.; Duffy, M.K.; Shaw, J.D. The Organizational Socialization Process: Review and Development of a Social Capital Model. *J. Manag.* **2011**, *37*, 127–152. [CrossRef]
41. Bourdieu, P. *The Forms of Capital*; Blackwell Publishers Ltd.: Oxford, UK, 1986; pp. 280–291.
42. Coleman, J.S. *Foundations of Social Theory*; Harvard University Press: Cambridge, MA, USA, 1990.
43. Portes, A. Social Capital: Its Origins and Applications in Modern Sociology. *Annu. Rev. Sociol.* **1998**, *24*, 1–24. [CrossRef]
44. Burt, R.S. The Network Structure of Social Capital. *Res. Organ. Behav.* **2000**, *22*, 345–423. [CrossRef]
45. Lin, N. *Social Capital: A Theory of Social Structure and Action*; Cambridge University Press: Cambridge, UK, 2002.
46. Alvarez, E.C.; Kawachi, I.; Romani, J.R. Family social capital and health—A systematic review and redirection. *Sociol. Health Illn.* **2017**, *39*, 5–29. [CrossRef] [PubMed]

47. Harris, C.M.; Wright, P.M.; McMahan, G.C. The emergence of human capital: Roles of social capital and coordination that drive unit performance. *Hum. Resour. Manag. J.* **2019**, *29*, 162–180. [CrossRef]
48. Muringani, J.; Fitjar, R.D.; Rodríguez-Pose, A. Social capital and economic growth in the regions of Europe. *Environ. Plan. A Econ. Space* **2021**, *53*, 1412–1434. [CrossRef]
49. Lee, C.-Y.; Chong, H.-Y.; Liao, P.-C.; Wang, X. Critical Review of Social Network Analysis Applications in Complex Project Management. *J. Manag. Eng.* **2018**, *34*, 040170612. [CrossRef]
50. Reagans, R.; McEvily, B. Network Structure and Knowledge Transfer: The Effects of Cohesion and Range. *Adm. Sci. Q.* **2003**, *48*, 240–267. [CrossRef]
51. Carlson, E.J.; Poole, M.S.; Lambert, N.J.; Lammers, J.C. A Study of Organizational Reponses to Dilemmas in Interorganizational Emergency Management. *Commun. Res.* **2016**, *44*, 152–156. [CrossRef]
52. Granovetter, M.S. The Impact of Social Structures on Economic Outcomes. *J. Econ. Perspect.* **2005**, *19*, 33–50. [CrossRef]
53. Jack, S.L. Approaches to studying networks: Implications and outcomes. *J. Bus. Ventur.* **2010**, *25*, 120–137. [CrossRef]
54. Weiler, M.; Hinz, O. Without each other, we have nothing: A state-of-the-art analysis on how to operationalize social capital. *Rev. Manag. Sci.* **2019**, *13*, 1003–1035. [CrossRef]
55. Chen, X.; Wang, P.; Wegner, R.; Gong, J.; Fang, X.; Kaljee, L. Measuring Social Capital Investment: Scale Development and Examination of Links to Social Capital and Perceived Stress. *Soc. Indic. Res.* **2015**, *120*, 669–687. [CrossRef]
56. Sun, J.; Ren, X.; Anumba, C.J. Analysis of Knowledge-Transfer Mechanisms in Construction Project Cooperation Networks. *J. Manag. Eng.* **2019**, *35*, 32–44. [CrossRef]
57. Allee, V. Value network analysis and value conversion of tangible and intangible assets. *J. Intellect. Cap.* **2008**, *9*, 5–24. [CrossRef]
58. Pauget, B.; Wald, A. Relational competence in complex temporary organizations: The case of a French hospital construction project network. *Int. J. Proj. Manag.* **2013**, *31*, 200–211. [CrossRef]
59. Mok, K.Y.; Shen, Q.; Yang, R. Stakeholder management studies in mega construction projects: A review and future directions. *Int. J. Proj. Manag.* **2015**, *33*, 446–457. [CrossRef]
60. Wu, G.; Zheng, J.; Zhao, X.; Zuo, J. How does strength of ties influence project performance in Chinese megaprojects? *Int. J. Confl. Manag.* **2020**, *31*, 753–780. [CrossRef]
61. Herrera, R.F.; Mourgues, C.; Alarcon, L.F.; Pellicer, E. Understanding Interactions between Design Team Members of Construction Projects Using Social Network Analysis. *J. Constr. Eng. Manag.* **2020**, *146*, 040200536. [CrossRef]
62. Yuan, J.; Chen, K.; Li, W.; Ji, C.; Wang, Z.; Skibniewski, M.J. Social network analysis for social risks of construction projects in high-density urban areas in China. *J. Clean. Prod.* **2018**, *198*, 940–961. [CrossRef]
63. Sangwa, N.R.; Sangwan, K.S. Leanness assessment of organizational performance: A systematic literature review. *J. Manuf. Technol. Manag.* **2018**, *29*, 768–788. [CrossRef]
64. Dixit, S.; Mandal, S.N.; Thanikal, J.V.; Saurabh, K. Evolution of studies in construction productivity: A systematic literature review (2006–2017). *Ain Shams Eng. J.* **2019**, *10*, 555–564. [CrossRef]
65. Zhang, F.; Li, D.; Ahrentzen, S.; Feng, H. Exploring the inner relationship among neighborhood environmental factors affecting quality of life of older adults based on SLR–ISM method. *J. Hous. Built Environ.* **2019**, *35*, 5. [CrossRef]
66. He, C.; Jia, G.; McCabe, B.; Chen, Y.; Sun, J. Impact of psychological capital on construction worker safety behavior: Communication competence as a mediator. *J. Saf. Res.* **2019**, *71*, 231–241. [CrossRef]
67. Straub, A.M.; Gray, B.J.; Ritchie, L.A.; Gill, D.A. Cultivating disaster resilience in rural Oklahoma: Community disenfranchisement and relational aspects of social capital. *J. Rural Stud.* **2020**, *73*, 105–113. [CrossRef]
68. Sánchez-Arrieta, N.; González, R.; Cañabate, A.; Sabate, F. Social Capital on Social Networking Sites: A Social Network Perspective. *Sustainability* **2021**, *13*, 5147. [CrossRef]
69. Wise, S. Can a team have too much cohesion? The dark side to network density. *Eur. Manag. J.* **2014**, *32*, 703–711. [CrossRef]
70. Son, J.; Feng, Q. In Social Capital We Trust? *Soc. Indic. Res.* **2019**, *144*, 167–189. [CrossRef]
71. Lee, S.; Park, J.-G.; Lee, J. Explaining knowledge sharing with social capital theory in information systems development projects. *Ind. Manag. Data Syst.* **2015**, *115*, 883–900. [CrossRef]
72. Wang, H.; Lu, W.; Söderlund, J.; Chen, K. The Interplay Between Formal and Informal Institutions in Projects. *Proj. Manag. J.* **2018**, *49*, 20–35. [CrossRef]
73. Raetze, S.; Duchek, S.; Maynard, M.T.; Kirkman, B.L. Resilience in Organizations: An Integrative Multilevel Review and Editorial Introduction. *Group Organ. Manag.* **2021**, *46*, 607–656. [CrossRef]
74. Li, G.; Kou, C.; Wang, Y.; Yang, H. System dynamics modelling for improving urban resilience in Beijing, China. *Resour. Conserv. Recycl.* **2020**, *161*, 104954. [CrossRef]
75. Lin, N.; Fu, Y.; Hsung, R.M. *Social Capital: Theory and Research*; Aldine Transaction Publishers: Piscataway, NJ, USA, 2001.