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Unpacking the "Black Box": Understanding the Effect of Strength of Ties on Inter-Team Conflict and Project Success in Megaprojects

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Abstract: Megaprojects have been redefined as dynamic collaboration networks, which are characterized by the strength of the ties between teams. In China, megaprojects have long been criticized for low productivity, poor project implementation processes, and inter-team confrontation. Few studies in the construction domain have explored the relationship between the strength of ties, inter-team conflict, and project success. This research aims to investigate the relationship between the strength of ties, inter-team conflict, and project success in megaprojects. Strong ties and weak ties reflect the strength of ties. Inter-team conflict is measured by task-related conflict and relationship-related conflict. A questionnaire survey was conducted on Chinese megaprojects, and 306 questionnaires were collected. The data were analyzed by a structural equation model. The results indicate that strong ties positively impact task-related conflict while negatively impacting relationship-related conflict. Weak ties positively impact inter-team conflict. Task-related conflict and relationship-related conflict have positive and negative effects on project success, respectively. The effect of the strength of the ties on a project's success is mediated by conflict. This study adds to existing research on the strength of ties and emphasizes the significance of megaproject network governance. The results reveal the constructive effects of the strength of ties and task-related conflict, as well as the non-constructive effects of relationship-related conflict. This provides a reference for megaproject managers to implement project governance.

Keywords: strength of ties; inter-team conflict; project success; megaprojects

1. Introduction

Over the last two decades, with the rapid development of the world economy and the increase of global infrastructure investment, the number of megaprojects has increased dramatically [1]. According to existing studies, no less than US $50 trillion will be invested in megaprojects around the world between 2010 and 2030 [2,3]. Megaprojects involve more than US $1 bn in investments and have significant social, economic, and environmental impacts [4]. Typical megaprojects include airports, bridges, railways, tunnels, dams, hydropower plants, and Olympic venues [5]. Megaprojects involve a long construction period, a variety of technologies, and numerous participating teams (e.g., the owner team, the contractor team, the design team, the supervision team, and the consulting team) [6]. The participating teams of megaprojects have various disciplinary backgrounds and capabilities. No single team possesses all of the knowledge and capabilities required to complete a megaproject [2]. As a result, to achieve the successful delivery of megaprojects, different teams establish cooperative ties and form a large cooperative network (i.e., a megaproject network) [7].

The megaproject network is critical to the implementation and delivery of megaprojects [2,7]. The tie between the nodes in the megaproject network is an important channel

through which the team can obtain information, knowledge, and resources [8]. However, according to social capital theory, ties of varying strength (e.g., strong ties and weak ties) have varying effects on the team's acquisition of information, knowledge, and resources [9]. Strong ties in megaproject networks may help to promote communication and interaction between teams, improving the efficiency and effectiveness of inter-team cooperation [10]. Weak ties may bring non-redundant and diverse knowledge, information, and resources to the team, facilitating project task implementation [11]. As a result, in the context of megaproject networks, strong and weak ties may have an impact on project task implementation and project success.

Megaprojects are characterized by high complexity, changing environments, and incomplete contracts [4]. The participating teams of megaprojects have different professional knowledge, core capabilities, and interest demands [7]. Therefore, inter-team conflicts are frequently unavoidable. Failure to address or resolve conflicts on time may impede inter-team cooperation. This has a negative impact on project task completion and the realization of project objectives (i.e., quality, duration, and cost) and ultimately interferes with megaproject success [12]. To mitigate this negative impact, it is necessary to investigate the relationship between inter-team conflict and project success in the context of megaprojects. Furthermore, the strength of ties in a megaproject network may influence conflict and project success. Strong ties aid in the establishment of shared values and action norms, as well as high levels of trust and efficient communication [8]. This facilitates the exchange of information and knowledge between teams, increases task-related conflicts between teams, while decreasing relationship-related conflicts, and ultimately promotes project task implementation and project success [11].

The weak ties between teams in megaproject networks indicate that the teams are unfamiliar with each other [2]. This makes it difficult for teams to develop a high level of trust, as well as shared values and rules [7]. Furthermore, there is less interaction and communication between teams in weakly connected networks [8]. Miscommunication, tension, and hostility between teams are more likely in this situation [5]. This may increase inter-team relationship-related conflict and impede project task implementation and project success [13]. As a result, it is of great significance to investigate the influence of the strength of ties on inter-team conflict and project success in the context of megaprojects. Previous research has primarily focused on the impact of network positions and network structure characteristics on project performance in megaproject networks [2,7,9]. However, research on the impacting mechanism of the strength of ties on inter-team conflict and project success in megaproject networks is still limited. This research explores the impact of the strength of ties on inter-team conflict and project success. This research adds to existing research on the relationship between the strength of ties, conflict, and project success and emphasizes the importance of network governance. The research findings can help megaproject managers develop effective project management strategies from the standpoint of network and conflict, thereby promoting megaproject success.

2. Research Background

2.1. Strength of Ties

The strength of ties is an important network indicator that reflects the degree of connection between two network nodes [14,15]. Previous research found that: (1) the duration and frequency of the interaction between nodes reflect the strength of ties [16]; and (2) the interaction history and previous cooperation experience affect the strength of ties [17]. The strength of ties in the context of megaprojects is reflected by a "combination of the closeness of contact, frequency of interaction, level of input resources, and reciprocal services" [16]. The strength of ties is divided into two dimensions in this study, i.e., strong ties and weak ties [11]. Teams with strong ties have close emotional relationships, frequent interactions, and previous cooperative relationships. Weak ties reflect the teams' infrequent interaction and estrangement [14]. Teams in a strong-connected network are familiar with one another. This aids in the formation of shared values and rules, as well

as the improvement of efficiency and effectiveness of team communication [2]. From the perspective of intimacy, strong ties facilitate the integration of information, knowledge, and resources. Weak ties are distinguished by a lack of prior collaboration and low trust [8]. Weak ties provide access to novel and non-repetitive information and knowledge by connecting otherwise disjointed nodes [7]. In general, strong ties aid in the establishment of common concepts, values, and norms, as well as the development of high-level trust and efficient communication between teams in the context of megaproject networks. Weak ties aid teams in acquiring diverse and non-repetitive information, knowledge, and resources.

2.2. Inter-Team Conflict

Inter-team conflict refers to incompatible states or confrontational behaviors between teams [18]. Megaprojects are complex, time-consuming, and fraught with risk [10]. Megaproject teams (e.g., the owner team, the contractor team, the design team, the consulting team, the supervision team, and the supplier team) have varying knowledge backgrounds and interest demands [2]. This frequently results in divergent interpretations of the project plan, disparities in project task priorities and implementation methods, and contradictions in project process arrangements, all of which lead to inter-team conflicts [7]. Furthermore, a one-time construction process, a constantly changing project environment, and unforeseeable difficulties can lead to inter-team conflicts [6]. There are two types of conflict in megaprojects: task-related conflict involving task implementation and relationship-related conflict involving emotion [19]. Task-related conflict is associated with rational behavior, whereas relationship-related conflict is associated with perceptual behavior [13]. These two types of inter-team conflicts are common during the implementation of megaprojects. Task-related conflict involves the team's differing perspectives, ideas, or judgments on project task implementation methods and solutions, as well as the team's disagreement on the project process arrangement (e.g., construction period, project plan, and resource allocation) [20]. Task-related conflict is concerned with what a task is and how it is accomplished. The relationship-related conflict reflects inter-team incompatibility and hostile behaviors [21].

2.3. Project Success

Scholars have shown a keen interest in the topic of project success over the last two decades [22,23]. Many studies have focused on the success criteria for megaprojects [13,24]. The "golden triangle" indicator system establishes key project success criteria: duration, cost, and quality [22,25]. As technology has rapidly developed, megaprojects have become increasingly complex, with longer duration, more dynamic environments, and wider social impacts [1,12]. As such, overemphasizing the "golden triangle" may lead to too much focus on short-term goals, rather than longer-term impacts [13]. As a result, researchers reassessed the success criteria for megaprojects. In addition to the "golden triangle", other factors are used to evaluate megaproject success [24,25]. Examples of hard factors are safety, resource utilization efficiency, and social impact. Examples of soft factors are trust, collaborative efficiency, and owner and user satisfaction. These factors highlight the multidimensional evaluation of success [22]. From a time perspective, megaproject success should be assessed over the long term [26,27]. From a stakeholder perspective, project success should be assessed from the perspective of the project participants, users, and the public [28]. This research divides the success criteria for megaprojects into two categories: soft factors and hard factors. Hard factors include quality, cost, duration, and safety. Soft factors include the growth of knowledge and experience, trust, satisfaction, and the intent of teams to collaborate in the future.

3. Theoretical Model and Hypotheses
3.1. Theoretical Model

The input/mediation/output model was used in this study to investigate the relationship between the strength of ties, inter-team conflict, and project success in the context

of megaprojects [29]. According to the connotation of the strength of ties, conflict, and project success, as well as the characteristics of megaprojects, the theoretical model of this study (see Figure 1) has been established. First, the theoretical model proposes that strong ties positively impact task-related conflict while negatively impacting relationship-related conflict. Weak ties positively impact task-related conflict and relationship-related conflict. Second, the theoretical model proposes that both strong ties and weak ties have a positive impact on project success. Third, the theoretical model proposes that task-related conflict has a positive impact on project success, whereas relationship-related conflict has a negative impact on project success.
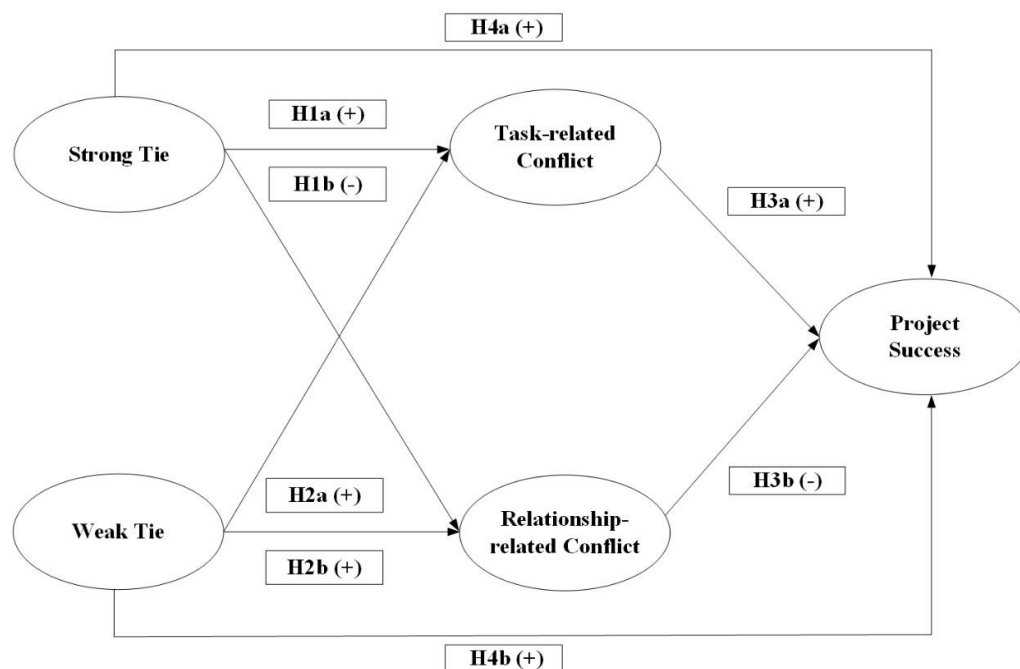

Figure 1. Theoretical model.

3.2. Research Hypotheses

3.2.1. Strong Ties and Inter-Team Conflict

Teams with prior cooperative relationships are more likely to establish strong relationships, i.e., strong ties [8]. Strong ties transform the megaproject network from a loose cooperative relationship network to a close cooperative relationship network with high-level communication [10]. There are more communication frequencies and interaction times between teams in a strong-connected network [30]. Because each team has different knowledge backgrounds, core competencies, and interest demands, it is easy for the team to have different perspectives, ideas, and judgments on the project's task implementation and project process arrangement during the interaction process, resulting in more task-related conflicts [2]. Megaproject networks with strong ties tend to produce shared norms [11]. This aids in the reduction of opportunistic behavior and inter-team confrontation during project implementation. Meanwhile, megaproject networks with strong ties are associated with high levels of trust [15]. This promotes inter-team information sharing and the development of a harmonious project environment [13]. In this case, the project's participating team is more likely to avoid ambiguous behaviors, reducing relationship-related conflict. In general, strong ties are closely related to the development of effective communication and the establishment of high levels of trust. In megaprojects, effective communication, high levels of trust, and shared norms can help increase task-related conflicts while decreasing relationship-related conflicts [20].

Hypothesis 1 (H1a). *Strong ties positively impact task-related conflict.*

Hypothesis 1 (H1b). *Strong ties negatively impact relationship-related conflict.*

3.2.2. Weak Ties and Inter-Team Conflict

Megaprojects involve a large number of project participation teams with varying knowledge backgrounds and core competencies [12]. Many of these teams have never worked together. As a result, they usually have weak relationships (i.e., weak ties) in the first project. In this case, the teams' diverse experience, knowledge, and core capabilities improve the depth and breadth of information and knowledge in a megaproject [2]. This contributes to the formation of new perspectives, ideas, and judgments about task implementation and process arrangement, resulting in task-related conflicts [13]. Furthermore, unlike traditional construction projects, megaprojects involve longer construction cycles and the more frequent movement of the project's participating teams, resulting in constantly changing nodes (i.e., the project's participating teams) [6]. During the course of a megaproject's implementation, new nodes may appear in the project network, while old nodes may exit [12]. However, the cognition, knowledge, and experience of the new nodes are frequently different from those of the original node [10]. As a result, differences in the project's task implementation and project process arrangement may grow, potentially leading to task-related conflicts. There is a loose relationship between teams in the weakly connected megaproject network [14]. This makes it difficult for teams to develop shared values and norms, leading to discord and incompatibility [11]. Furthermore, weakly connected teams are less familiar with each other than closely connected teams, and it is difficult for teams to interact continuously [16]. As a result, miscommunication, tension, and hostility are more likely to occur between teams, leading to relationship-related conflicts.

Hypothesis 2 (H2a). *Weak ties have a positive impact on task-related conflict.*

Hypothesis 2 (H2b). *Weak ties have a positive impact on relationship-related conflict.*

3.2.3. Inter-Team Conflict and Project Success

Various inter-team conflicts have varying effects on megaproject success [2]. Relationship-related conflicts frequently impair inter-team cooperation, which has a detrimental effect on the success of megaprojects [13]. Specifically, the tension caused by relationship-related conflict causes teams to hide their true views and ideas, impeding inter-team communication [31]. Meanwhile, relationship-related conflict causes negative emotions in the team and shifts the team's focus away from the task at hand, harming inter-team cooperation [32]. Relationship-related conflict also erodes mutual understanding between teams and exacerbates differences and confrontation [33]. In general, relationship-related conflict impairs effective communication and cooperation between teams, negatively impacting megaproject success. Task-related conflict occurs when teams disagree on specific task content, implementation methods, and solutions [34]. Due to the different knowledge backgrounds and capabilities of different teams, task-related conflicts are common in megaprojects [35]. Previous research has shown that task-related conflict can help improve organizational performance [36]. In megaprojects, task-related conflicts increase the team's critical opinions on task objectives, content, and solutions, promoting the implementation of the tasks [2]. Furthermore, task-related conflict can improve team cohesion, improve team relationships, and encourage teams to complete challenging tasks, thereby promoting task implementation and megaproject success [13].

Hypothesis 3 (H3a). *Task-related conflict positively impacts megaproject success.*

Hypothesis 3 (H3b). *Relationship-related conflict negatively impacts megaproject success.*

3.2.4. Strength of Ties and Project Success

The network ties serve as the foundation for interaction among project teams [15]. Previous research has found that the strength of ties impacts the type, quantity, and quality of resources obtained by the organization, which in turn affects the organization's output [16,17]. Gilsing and Nooteboom (2005) proposed that strong ties help to improve the level of trust and the effect of cooperation between organizations, thereby increasing organizational performance and project performance [16]. Wu et al. (2020) pointed out that a strong tie means frequent contact, which helps the team understand each other's work content and interest demands, promoting the implementation of tasks [11]. Hu et al. (2020) pointed out that the strength of ties positively impacts project performance [10]. Megaprojects are distinguished by their high complexity, uncertainty, and risk, as well as unforeseeable difficulties and challenges [4]. Through network ties, the team embedded in the megaproject network obtains project-related information, knowledge, and resources and then implements corresponding tasks [13]. Strong ties provide more opportunities for teams to interact during the implementation of megaprojects. This allows the team to fully communicate any difficulties or problems that may arise during project implementation, promoting the smooth execution of megaprojects [8]. Furthermore, strong ties reduce opportunity risks and interaction costs and aid in the formation of alliance relationships between teams, thereby promoting team resource complementarity [10]. This contributes to the success of megaprojects. Weak ties in megaproject networks may bring more diverse viewpoints, ideas, and judgments. This contributes to a broader implementation plan for project tasks, positively impacting megaproject implementation and success.

Hypothesis 4 (H4a). *Strong ties positively impact megaproject success.*

Hypothesis 4 (H4b). *Weak ties positively impact megaproject success.*

4. Method

4.1. Questionnaire Development

To measure the research variables, a questionnaire was developed. The research variables included the strength of ties, inter-team conflict, and project success. The following steps were used to develop the measurement items for the research variables. First, this study cited items that have been shown to have high reliability in previous studies [2]. Second, the items were modified to reflect the current state of megaprojects in China [8]. Third, on-site discussions with experts were used to confirm the items [10].

4.2. Pilot Test

The initial questionnaire was tested using the pilot test [13]. The pilot test was carried out in various megaprojects in China's Guangxi, Guangdong, and Fujian provinces. A total of 300 questionnaires were distributed via email and courier, with 148 recovered. After screening the 148 questionnaires, 104 were found to be valid. The normal quantile-quantile (Q-Q) plot was used to test the normal distribution of valid data [2,19]. The results of the tests show that the sample distribution of each study variable is nearly linear (see Figure 2). As a result, the valid samples follow the normal distribution and can be tested using the pilot test.

The pilot test consists of three steps. First, the coefficients of the corrected-item total correlation (CITC) and Cronbach's α were used to test the reliability of all the items [13]. The CITC value reflects the reliability of the item and should be greater than 0.5 [37]. Cronbach's α reflects the internal consistency of the items and should be greater than 0.7 [38]. Second, the Kaiser–Meyer–Olkin (KMO) test was used to determine whether an exploratory factor analysis (EFA) was feasible. Each variable's KMO value should be greater than 0.6 [39]. Third, the EFA was carried out. After the pilot test, a formal questionnaire was created (see Table 1).
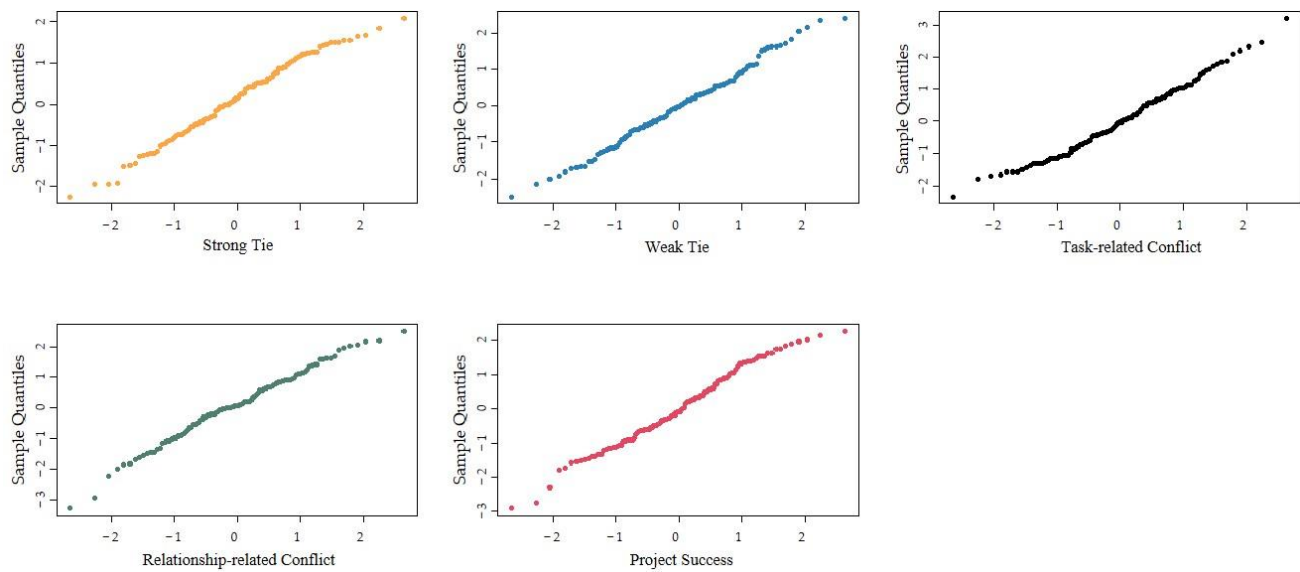
Figure 2. Normal distribution test.

Table 1. Measurement items.

Variables	Items	References
Strong Tie	Formal communication between teams lasts for many years Informal communication between teams lasts for many years Formal communication between teams is very frequent Informal communication between teams is very frequent Communication between teams involves knowledge and management Collaboration between teams is beneficial to both parties	Hu et al., 2021 [10]; Evald et al., 2006 [17]; Wu et al., 2020 [11]
Weak Tie	Formal communication between teams is uncommon Informal communication between teams is uncommon The team has invested a lot of capital resources to keep the collaborative relationship Inter-team communication is limited to technology and projects Project participating teams monitor each other's actions	
Relationship-related Conflict	There is tension between teams There is animosity between teams There is disharmony between teams There are numerous emotional clashes between teams There are numerous disagreements between teams During communication, teams do not respect each other's feelings Different teams have various management philosophies Different teams have various interest demands	Liu et al., 2022 [2]; Lu et al., 2011 [19]; De and Van, 2001 [21]; de et al., 2013 [31]
Task-related Conflict	Teams frequently disagree on the content of tasks Teams frequently disagree on how to achieve project objectives Power distribution is viewed differently by different teams Different teams have different ideas about how responsibility should be distributed Teams have differing perspectives on project resource allocation Teams have different perspectives on work difficulties	

Table 1. *Cont.*

Variables	Items	References
Project Success	The project meets three goals: quality, cost, and duration The project's resource utilization efficiency is high Project teams gain new skills and experience The level of trust between teams has increased The effectiveness and results of inter-team cooperation are favorable The project has received positive feedback from the public The project management is excellent The teams are pleased with the project's implementation process and outcomes The teams are eager to work together again in the future	Wu et al. (2019) [13]; Prabhakar (2008) [23]; Imam (2021) [24]; Angus et al., (2005) [25]

4.3. Data Collection

A non-probabilistic sampling technique was utilized to collect the samples [13]. The respondents were technical and management personnel from the owner team, contractor team, design team, supervision team, consulting team, and supplier team of various megaprojects in the Guangxi, Guangdong, and Fujian provinces in China. A total of 900 questionnaires were distributed via email and courier. After screening 357 returned questionnaires, 306 questionnaires were found to be valid. The valid data were used in confirmatory factor analysis (CFA) [11]. Table 2 shows the sample structure of the valid data.

Table 2. Sample structure.

Characteristic	Category	Number	%
Project type	Infrastructure project	110	35.7
	Industrial project	82	26.9
	Public project	114	37.4
Job position	Project engineer	118	38.5
	Department manager	69	22.7
	Professional manager Manager	89	29.2
	Project manager	30	9.6
Work experience	<5 years	38	12.4
	5–10 years	79	25.8
	11–15 years	101	32.6
	16–20 years	51	16.8
	>20 years	37	12.4
Project party	Owner team	65	21.2
	Contractor team	84	27.5
	Design team	61	19.8
	Consulting team	55	18.1
	Supervision team	32	10.3
	Supplier team	9	3.2

4.4. Confirmatory Factor Analysis

CFA was used to validate the items' applicability [8]. The construct reliability (CR) and average variance extraction (AVE) values were generated by the CFA. A CR value greater than 0.7 indicates that the items' overall reliability is high [40]. An AVE value greater than 0.5 indicates that the items have a high degree of convergence validity [41]. Table 3 displays the CFA results. The CR value is greater than 0.7, indicating that the items' overall reliability is high. The AVE value is greater than 0.6, indicating that the items' convergence validity is high. As a result, the theoretical model can be tested.

Table 3. SEM analysis.

Category	Coefficient	Critical Ratio	S.E.	*p* Value
ST→TC	0.172 *	2.209	0.042	0.017
ST→RC	−0.117 *	−2.271	0.037	0.013
WT→TC	0.670 *	2.332	0.029	0.016
WT→RC	0.263 ***	5.058	0.030	0.000
TC→PS	0.125 **	2.616	0.052	0.007
RC→PS	−0.261 ***	−4.820	0.064	0.000
ST→PS	0.127 *	2.586	0.051	0.004
WT→PS	0.159 *	2.194	0.036	0.025
Fit indices	GFI = 0.95; NFI = 0.93; IFI = 0.91			

Note: ST, strong tie; WT, weak tie; TC, task-related conflict; RC, relationship-related conflict; PS, project success. *, $p < 0.05$. **, $p < 0.01$. ***, $p < 0.001$.

5. Model Test

5.1. SEM Test

Structural equation modeling (SEM) is an effective tool for investigating the relationship between multiple variables [10]. The theoretical model of this study was tested using SEM. AMOS 21.0 was used to carry out the SEM analysis. Tables 3 and 4 display the fit indices and hypotheses test results, respectively. The goodness-of-fit index (GFI), normed fit index (NFI), and incremental fit index (IFI) were 0.95, 0.93, and 0.91, respectively, and they all exceeded the threshold of 0.9 [13].

Table 4. Hypotheses test results.

Hypothesis	Hypothesis Decision
H1a. Strong ties positively impact task-related conflict	H1a: Supported
H1b. Strong ties negatively impact relationship-related conflict	H1b: Supported
H2a. Weak ties have a positive impact on task-related conflict	H2a: Supported
H2b. Weak ties have a positive impact on relationship-related conflict	H2b: Supported
H3a. Task-related conflict positively impacts megaproject success	H3a: Supported
H3b. Relationship-related conflict negatively impacts megaproject success	H3b: Supported
H4a. Strong ties positively impact megaproject success	H4a: Supported
H4b. Weak ties positively impact megaproject success	H4b: Supported

The SEM analysis produced the following results (see Figure 3). First, strong ties have positive and negative effects on task-related conflict and relationship-related conflict, respectively (strong tie→task-related conflict, 0.172, $p < 0.05$; strong tie→relationship-related conflict, −0.117, $p < 0.05$). Second, weak ties have a positive impact on inter-team conflict (weak tie→task-related conflict, 0.670, $p < 0.05$; weak tie→relationship-related conflict, 0.263, $p < 0.001$). Third, task-related conflict has a positive effect on project success, whereas relationship-related conflict has a negative effect on project success (task-related conflict→project success, 0.125, $p < 0.01$; relationship-related conflict→project success, −0.261, $p < 0.001$). Fourth, both strong and weak ties contribute to project success (strong tie→project success, 0.127, $p < 0.05$; weak tie→project success, 0.159, $p < 0.05$).

5.2. Mediating Effect Test

Mediating effects were deemed significant when the boot 95% confidence interval (CI) did not include 0 [42]. The mediating effect analysis yielded the following results (see Table 5). First, task-related conflict has a positive effect on the relationship between strong ties and project success, whereas relationship-related conflict has a negative effect on the relationship between strong ties and project success (0.113, boot 95% CI = [0.158, 0.214]; −0.137, boot 95% CI = [0.147, 0.236]). Second, task-related conflict has a positive effect on the relationship between weak ties and project success, whereas relationship-related conflict has a negative effect on the relationship between weak ties and project success (0.107, boot 95% CI = [0.101, 0.270]; −0.210, boot 95% CI = [0.182, 0.322]).
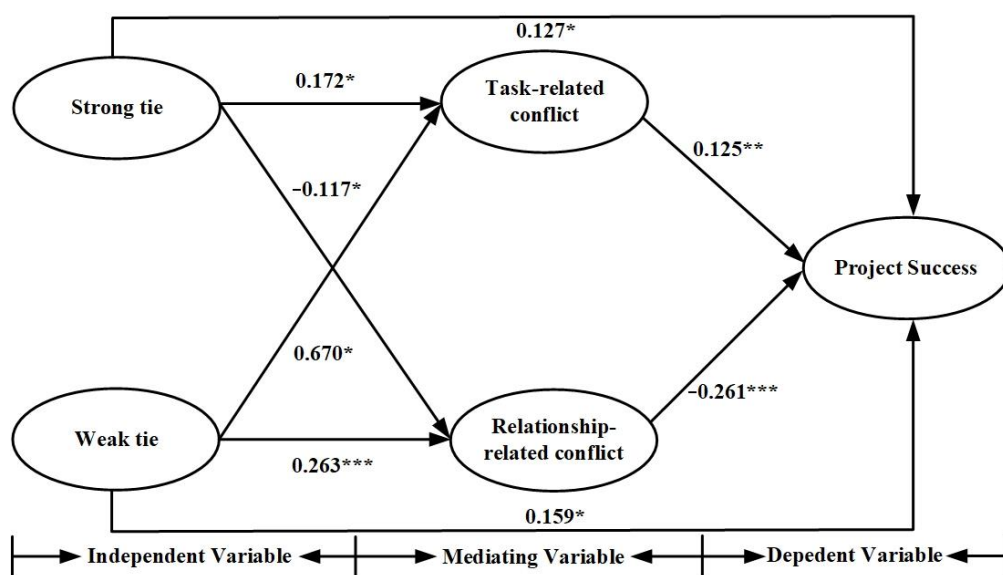
Figure 3. Results of theoretical model analysis. *, $p < 0.05$. **, $p < 0.01$. ***, $p < 0.001$.

Table 5. Mediating effect test.

Category	Coefficient		CI		Existence of a Mediating Effect
	Estimate	S.E.	Lower	Upper	
Variable: TC					
Between ST and PS	0.113	0.027	0.158	0.214	√
Between WT and PS	0.107	0.022	0.101	0.270	√
Variable: RC					
Between ST and PS	−0.137	0.019	0.147	0.236	√
Between WT and PS	−0.210	0.038	0.182	0.322	√

Note: ST, strong tie; WT, weak tie; TC, task-related conflict; RC, relationship-related conflict; PS, project success.

6. Discussions

6.1. Strength of Ties and Inter-Team Conflict

The results show that strong ties are positively related to task-related conflict but negatively related to relationship-related conflict. Weak ties are positively related to task-related conflict and relationship-related conflict. This conclusion is inconsistent with the finding of Wu et al. (2021) [30], i.e., the strength of ties has a negative impact on relationship conflicts. The specific reasons are as follows. There are more communication frequencies and interaction times between teams in a strong-connected megaproject network [10]. Because each project's participating team has different knowledge backgrounds and interest demands, it is easy for teams to have different views, ideas, and judgments on project task implementation, resulting in more task-related conflicts [13]. Strong-connected megaproject networks frequently generate shared values and norms [11]. This helps to reduce negative inter-team confrontation during the megaproject's implementation. Meanwhile, a strong-connected megaproject network promotes information sharing among teams and the creation of a harmonious megaproject atmosphere [15]. This contributes to fewer inter-team relationship-related conflicts.

The familiarity between teams in a weak-connected megaproject network is lower than in a strong-connected megaproject network, and the teams frequently do not interact frequently [14]. As a result, teams do not fully understand each other's knowledge, capabilities, and preferences. In this case, different teams' experiences, knowledge, and capabilities frequently result in heterogeneous views, ideas, and judgments about the project's task implementation and project process arrangement, resulting in task-related

conflicts [19]. The loose relationship between teams in a weak-connected megaproject network makes it difficult to generate common values and norms, which easily leads to disharmony and incompatibility between teams [10]. Furthermore, in a weak-connected megaproject network, there is less communication between teams, and it is difficult for teams to interact continuously [15]. As a result, miscommunication, tension, and hostility are more likely to occur between teams, leading to relationship-related conflicts.

6.2. Strength of Ties and Project Success

The results indicate that both strong ties and weak ties have a significant positive impact on project success. This finding supports the conclusion of Hu et al. (2021) [10], i.e., the strength of ties positively impacts project success. The specific reasons are as follows. The teams in megaproject networks obtain the necessary information, knowledge, and resources through network ties [2]. Megaprojects, however, are distinct from traditional construction projects. Megaprojects involve more cutting-edge technology and knowledge, as well as greater complexity and uncertainty [30]. Megaprojects, therefore, demand exceptional innovation skills from the project's teams. Because of the openness of weak-connected megaproject networks, teams can gain access to more diverse knowledge and resources [7]. This aids in the development of new project task implementation plans and solutions. Meanwhile, structural holes with "bridge" functions exist in weak-connected megaproject networks [30]. This is conducive to breaking free from the constraints of the inherent mode and providing solutions for unconventional tasks to meet the breakthrough innovation requirements of megaprojects. This promotes the megaproject's smooth implementation and achievement of the megaproject's success. There are more communication frequencies and interaction times between teams in a strong-connected network, which helps teams fully communicate the difficulties and potential problems of megaprojects, promoting the smooth implementation of the megaproject [11]. Furthermore, a strong-connected network is associated with a high level of trust, which promotes information sharing among teams and the development of a positive project atmosphere. This contributes to the success of megaprojects.

6.3. Inter-Team Conflict's Effects

The research results show that task-related conflict has a significant positive impact on project success, whereas relationship-related conflict has a significant negative impact on project success. This conclusion is consistent with previous research on the relationship between organizational conflict and project performance, i.e., task conflict is a constructive conflict that promotes project performance, while relationship-related conflict is a destructive conflict that reduces project performance [2,13]. Furthermore, the research results indicate that task-related conflict strengthens the relationship between the strength of ties and project success, whereas relationship-related conflict weakens the relationship between the strength of ties and project success. The impact of inter-team conflict is summarized as follows. Task-related conflict encourages the development of new ideas, insights, and judgments about task objectives, contents, and solutions, thereby stimulating the resolution of complex problems [11]. Furthermore, task-related conflict encourages frequent interaction among teams, resulting in the multidisciplinary evaluation and in-depth consideration of project tasks [19]. This contributes to project success by increasing the efficiency of collaboration. Relationship-related conflict diverts the team's attention away from the project task and destroys inter-team mutual understanding [20]. This has a negative impact on the team's cognitive function, inter-team cooperation, project task implementation, and ultimately, the success of megaprojects.

7. Implications
7.1. Theoretical Implications

This study has the following theoretical implications. First, this research empirically investigates the relationship between the strength of ties, inter-team conflict, and project

success. This adds to the existing network-related literature on megaprojects and broadens the understanding of the strength of ties. Second, this study contributes to the ongoing discussion about network research in construction management [2,7,9]. Previous studies have highlighted the potential role of network governance in the traditional construction industry [12,43]. The hypotheses and findings of this research broaden the discussion on the influence of the strength of ties. Third, by examining the relationship between inter-team conflict and project implementation in the context of megaprojects, this study adds to the existing literature on conflict management and expands the understanding of the impact of conflict on project implementation. The results of this research reveal the constructive and non-constructive effects of inter-team conflict, as well as the mediating role of inter-team conflict between the strength of ties and project success. Specifically, task-related conflict strengthens the positive impact of the strength of ties on project success while relationship-related conflict weakens it. As a result, a megaproject network with high-level task-related conflicts and low-level relationship-related conflicts is conducive to the smooth implementation of megaprojects and the achievement of megaproject success [2,13].

7.2. Practical Implications

Strong and weak ties can provide various types of resources to promote megaproject success. The project's participating teams can achieve efficient communication and high-level trust in the context of strong ties, promoting the completion of project tasks and the smooth delivery of megaprojects. In the context of weak ties, projects' participating teams can obtain more diverse knowledge, information, and experience to develop multiple-task solutions, thereby promoting the smooth implementation of megaprojects and achieving megaproject success. Megaproject managers should identify the megaproject network's strength of ties and encourage the healthy development of those ties [10]. Second, megaproject networks necessitate a high level of maintenance. Establishing effective communication mechanisms (e.g., formal and informal communication) with projects' participating teams can provide project managers with early warning [2]. Effective communication methods encourage task-related conflicts and increase the cohesion of networks. Furthermore, effective communication allows project managers to quickly grasp the implementation of megaprojects, as well as the interests, demands, and difficulties of various teams [8]. This helps to resolve inter-team divergences and reduces relationship-related conflicts.

8. Conclusions

This research investigates the relationship between the strength of ties, inter-team conflict, and project success, as well as how the strength of ties affects project success through inter-team conflict, in the context of megaprojects. The results indicate that: (1) both strong ties and weak ties have a positive impact on task-related conflict; (2) weak ties have a positive impact on relationship-related conflict, while strong ties have a negative impact on relationship-related conflict; (3) both strong ties and weak ties have a positive impact on project success; (4) inter-team conflict is a double-edged sword, which has both constructive and non-constructive effects; and (5) inter-team conflict mediates the impact of the strength of ties on project success. This study adds to the body of knowledge about megaproject networks, inter-team conflict, and project success. The results of this study provide a new perspective on network governance and conflict management for megaproject managers.

9. Limitations and Future Work

This research has the following limitations. First, different types of inter-team conflicts may transform into each other under certain conditions. This study did not explore the transition mechanism of different types of conflicts and their potential impact on project success. Future research should explore the transition mechanism of different types of conflicts and their impact on project success. Second, the implementation of megaprojects is a dynamic process, and the strength of ties may change over time. Future research

should explore the dynamic change of the strength of ties and how it affects project success. Third, the data of this study are limited to megaprojects in specific regions of China. Future research should cover megaprojects in more countries and regions to expand the conclusions of this study.

References

1. Ma, L.; Fu, H. A governance framework for the sustainable delivery of megaprojects: The interaction of megaproject citizenship behavior and contracts. *J. Constr. Eng. Manag.* **2022**, *148*, 04022004. [CrossRef]
2. Liu, C.; Cao, J.; Wu, G.; Zhao, X.; Zuo, J. How does network position influence project performance in Chinese megaprojects? An inter-organizational conflict-based perspective. *Int. J. Confl. Manag.* **2022**, *33*, 448–474. [CrossRef]
3. Lu, Y.; Liu, B.; Li, Y. Collaboration Networks and Bidding Competitiveness in Megaprojects. *J. Manag. Eng.* **2021**, *37*, 04021064. [CrossRef]
4. Wang, T.; Chan, A.P.; He, Q.; Xu, J. Identifying the gaps in construction megaproject management research: A bibliographic analysis. *Int. J. Constr. Manag.* **2020**, *22*, 1585–1596. [CrossRef]
5. Anderson, L.L., Jr.; Polkinghorn, B. Managing conflict in construction megaprojects: Leadership and third-party principles. *Confl. Resolut. Q.* **2008**, *26*, 167–198. [CrossRef]
6. Denicol, J.; Davies, A.; Krystallis, I. What are the causes and cures of poor megaproject performance? A systematic literature review and research agenda. *Proj. Manag. J.* **2020**, *51*, 328–345. [CrossRef]
7. Liu, C.; Cao, J.; Wu, G.; Zhao, X.; Zuo, J. Interenterprise collaboration network in international construction projects: Evidence from Chinese construction enterprises. *J. Manag. Eng.* **2022**, *38*, 05021018. [CrossRef]
8. Wang, G.; Zhou, K.; Wang, D.; Wu, G.; Xie, J. Tensions in governing megaprojects: How different types of ties shape project relationship quality? *Int. J. Proj. Manag.* **2021**, *39*, 799–814. [CrossRef]
9. Cao, D.; Li, H.; Wang, G.; Luo, X.; Tan, D. Relationship network structure and organizational competitiveness: Evidence from BIM implementation practices in the construction industry. *J. Manag. Eng.* **2018**, *34*, 04018005. [CrossRef]
10. Hu, Z.; Wu, G.; Zhao, X.; Zuo, J.; Wen, S. How does the strength of ties influence relationship quality in Chinese megaprojects? The mediating role of contractual flexibility. *Balt. J. Manag.* **2021**, *16*, 366–385. [CrossRef]
11. Wu, G.; Li, H.; Wu, C.; Hu, Z. How different strengths of ties impact project performance in megaprojects: The mediating role of trust. *Int. J. Manag. Proj. Bus.* **2020**, *13*, 889–912. [CrossRef]
12. Xue, J.; Shen, G.Q.; Yang, R.J.; Zafar, I.; Ekanayake, E.M.A.C. Dynamic network analysis of stakeholder conflicts in megaprojects: Sixteen-year case of Hong Kong-Zhuhai-Macao bridge. *J. Constr. Eng. Manag.* **2020**, *146*, 04020103. [CrossRef]
13. Wu, G.; Liu, C.; Zhao, X.; Zuo, J. Investigating the relationship between communication-conflict interaction and project success among construction project teams. *Int. J. Proj. Manag.* **2017**, *35*, 1466–1482. [CrossRef]
14. Granovetter, M.S. The strength of weak ties. *Am. J. Sociol.* **1973**, *78*, 1360–1380. [CrossRef]
15. Badir, Y.F.; O'Connor, G.C. The formation of tie strength in a strategic alliance's first new product development project: The influence of project and partners' characteristics. *J. Prod. Innov. Manag.* **2015**, *32*, 154–169. [CrossRef]
16. Liu, C.; Cao, J.; Duan, K.; Wu, G. Effect of network position on inter-team conflict and project success in megaprojects. *Eng. Constr. Archit. Manag.* 2022; *ahead-of-print*. [CrossRef]
17. Evald, M.R.; Klyver, K.I.M.; Svendsen, S.G. The changing importance of the strength of ties throughout the entrepreneurial process. *J. Enterprising Cult.* **2006**, *14*, 1–26. [CrossRef]
18. Um, K.H.; Oh, J.Y. The mediating effects of cognitive conflict and affective conflict on the relationship between new product development task uncertainty and performance. *Int. J. Proj. Manag.* **2021**, *39*, 85–95. [CrossRef]
19. Lu, L.; Zhou, F.; Leung, K. Effects of task and relationship conflicts on individual work behaviors. *Int. J. Confl. Manag.* **2011**, *22*, 131–150. [CrossRef]
20. Bell, M.A. The effects of substantive and affective conflict in problem-solving groups. *Commun. Monogr.* **1974**, *41*, 19–23. [CrossRef]

21. De Dreu, C.K.; Van Vianen, A.E. Managing relationship conflict and the effectiveness of organizational teams. *J. Organ. Behav.* **2001**, *22*, 309–328. [CrossRef]
22. Alasfour, F.S.; Mirzal, A. Impact of project management on project success at engineering firms in Kuwait. *Int. J. Proj. Manag. Product. Assess.* **2021**, *9*, 68–89. [CrossRef]
23. Prabhakar, G.P. What is project success: A literature review. *Int. J. Bus. Manag.* **2008**, *3*, 3–10. [CrossRef]
24. Imam, H. Roles of shared leadership, autonomy, and knowledge sharing in construction project success. *J. Constr. Eng. Manag.* **2021**, *147*, 04021067. [CrossRef]
25. Angus, G.Y.; Flett, P.D.; Bowers, J.A. Developing a value-centred proposal for assessing project success. *Int. J. Proj. Manag.* **2005**, *23*, 428–436.
26. He, Q.; Wang, T.; Chan, A.P.; Li, H.; Chen, Y. Identifying the gaps in project success research: A mixed bibliographic and bibliometric analysis. *Eng. Constr. Archit. Manag.* **2019**, *26*, 1553–1573. [CrossRef]
27. Serrador, P.; Turner, R. The relationship between project success and project efficiency. *Proj. Manag. J.* **2015**, *46*, 30–39. [CrossRef]
28. Bryde, D.J. Methods for managing different perspectives of project success. *Br. J. Manag.* **2005**, *16*, 119–131. [CrossRef]
29. Ilgen, D.R.; Hollenbeck, J.R.; Johnson, M.; Jundt, D. Teams in organizations: From input-process-output models to IMOI models. *Annu. Revis. Psychol.* **2005**, *56*, 517–543. [CrossRef]
30. Wu, G.; Zheng, J.; Zhao, X.; Zuo, J. How different strengths of ties influence project performance in Chinese megaproject? A conflict-based perspective. *Int. J. Confl. Manag.* **2020**, *31*, 753–780. [CrossRef]
31. de Wit, F.R.; Jehn, K.A.; Scheepers, D. Task conflict, information processing, and decision-making: The damaging effect of relationship conflict. *Organ. Behav. Hum. Decis. Process.* **2013**, *122*, 177–189. [CrossRef]
32. Lau, R.S.; Cobb, A.T. Understanding the connections between relationship conflict and performance: The intervening roles of trust and exchange. *J. Organ. Behav.* **2010**, *31*, 898–917. [CrossRef]
33. Tidd, S.T.; McIntyre, H.H.; Friedman, R.A. The importance of role ambiguity and trust in conflict perception: Unpacking the task conflict to relationship conflict linkage. *Int. J. Confl. Manag.* **2004**, *15*, 364–380. [CrossRef]
34. Simons, T.L.; Peterson, R.S. Task conflict and relationship conflict in top management teams: The pivotal role of intragroup trust. *J. Appl. Psychol.* **2000**, *85*, 102–111. [CrossRef] [PubMed]
35. Puck, J.; Pregernig, U. The effect of task conflict and cooperation on performance of teams: Are the results similar for different task types? *Eur. Manag. J.* **2014**, *32*, 870–878. [CrossRef]
36. Choi, K.; Cho, B. Competing hypotheses analyses of the associations between group task conflict and group relationship conflict. *J. Organ. Behav.* **2011**, *32*, 1106–1126. [CrossRef]
37. Peter, J.P. Reliability: A review of psychometric basics and recent marketing practices. *J. Mark. Res.* **1979**, *16*, 6–17. [CrossRef]
38. Havitz, M.E.; Dimanche, F. Leisure involvement revisited: Conceptual conundrums and measurement advances. *J. Leis. Res.* **1997**, *29*, 245–278. [CrossRef]
39. Kaiser, H.F. An index of factorial simplicity. *Psychometrika* **1974**, *39*, 31–36. [CrossRef]
40. Flynn, B.B.; Huo, B.; Zhao, X. The impact of supply chain integration on performance: A contingency and configuration approach. *J. Oper. Manag.* **2010**, *28*, 58–71. [CrossRef]
41. Pesämaa, O.; Larsson, J.; Eriksson, P.E. Role of performance feedback on process performance in construction projects: Client and contractor perspectives. *J. Manag. Eng.* **2018**, *34*, 04018023. [CrossRef]
42. Preacher, K.J.; Hayes, A.F. SPSS and SAS procedures for estimating indirect effects in simple mediation models. *Behav. Res. Methods Instrum. Comput.* **2004**, *36*, 717–731. [CrossRef] [PubMed]
43. Park, H.; Han, S.H.; Rojas, E.M.; Son, J.; Jung, W. Social network analysis of collaborative ventures for overseas construction projects. *J. Constr. Eng. Manag.* **2011**, *137*, 344–355. [CrossRef]