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Influence of formal and informal stakeholder relationship on megaproject performance: a case of China

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Abstract:	

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Abstract

Purpose (limit 100 words): The purpose of this research is to seek better relational strategies between formal and informal stakeholder relationships to improve ~~the~~ megaproject performance.

Design/methodology/approach (limit 100 words): The conceptual model was developed with twenty hypotheses based on the literature review. Then a questionnaire survey was conducted, and the collected data were analyzed by Partial Least squares Structural Equation Modelling (PLS-SEM)~~,~~ for validating the proposed model. Finally, the findings were discussed by a comparative study to explain the different effects of the formal and informal relationship on megaproject performance, and the managerial implications are presented for the stakeholders to implement the relationship management in the megaprojects.

Findings (limit 100 words): The research finding reveals that formal relationship plays a dominating role in cost, quality, and labor protection; meanwhile, it is still more reliable in improving coordination, safety, and environmental protection. Both formal and informal relationship is equally important towards collaboration and scheduling~~. W~~ while the informal relationship is more effective in communication and project transparency.

Originality/value (limit 100 words): The study extends the knowledge of relationship management in the domain of the megaproject performance. It provides a comprehensive and systematic understanding of the impact of formal and informal stakeholder relationships on ten aspects of the megaproject performance by

the proposed conceptual model and PLS-SEM results. The research findings contribute to the theory of relationship management on how the ~~divergent~~ different influences between formal and informal stakeholder relationships lead to ~~the~~ better megaproject performance from inter-organizational level to project and societal level.

Keyword: Formal relationship; Informal relationship; Megaproject performance; Stakeholder relationship

Introduction

As the critical inter-organizational relationship, the formal and informal relationship has been widely discussed in the research field of organization management(Song et al., 2015, Rank, 2008). A formal relationship is based on the laws, written contracts, and other codified artifacts(Prell et al., 2010). While informal relationship shows the intimate relations and invisible political culture within the organization(Monge and Contractor, 2001, Tichy et al., 1979). The current study reveals that formal relationship is clear to show the official hierarchy in the organization whereas informal relationship is subtle and pervasive sometimes playing the more significant role to realize the organizational objectives(Ackermann and Eden, 2011). Of the framework for stakeholder management in construction projects, formal and informal relationships have been regarded as two crucial relationships in the part of stakeholder relationship(Yang and Shen, 2014), which has been proved to have a critical effect on project performance(Meng, 2012).

The megaproject is widely defined by its ~~vast~~ huge project cost, which is usually over 1 billion USD(Flyvbjerg et al., 2003), involved by various project stakeholders with divergent interests(Mok et al.,

2015). The previous study indicates that the poor performance of megaprojects is highly related to the unsuccessful– stakeholder relationship management (Holland, 2000, Mok et al., 2015). Compared to the traditional construction projects, megaprojects are faced with the complicated contractual relationship, the dynamic project organization structure, and the uncertain project environment(De Meyer et al., 2002, Holland, 2000), which requires stakeholders to have better strategies strengthening their relationships from both formal and informal side. In terms of the formal relationship, the contractual relationship among stakeholders is essential for the improvement of the procurement, delivery, and conflict resolution in megaprojects (Gao et al., 2018, Yang et al., 2018). For the informal relationship, the informal stakeholder networks have been proved to exert substantial influence on the establishment of a robust governance structure in megaprojects (Chi et al., 2011, van Marrewijk and Smits, 2016). However, few studies discuss the divergent effectiveness between formal and informal relationship towards the megaproject performance, since most studies focus on either kind of relationships separately. The bottleneck is calling for the systematic quantitative assessment revealing the various effects of the formal and informal relationship on different aspects of megaproject performance(Yang and Shen, 2014), which is beneficial for project stakeholders to make the priority of the enhancement decision between two kinds of relationships for achieving better project performance.

Therefore, the purpose of this research is to seek better relational strategies between formal and informal stakeholder relationships to improve megaproject performance. The study could be divided into two parts. First, examine the impact of formal and informal relationships on megaproject performance by the proposed conceptual model and the partial least squares structural equation modeling (PLS-SEM)

technique. Second, explore the divergent influence of formal and informal relationships and obtain the managerial implications to improve the megaproject performance by comparing the effects between formal and informal relationships.

Literature Review

Formal relationship

A formal relationship is an official connection among stakeholders in megaprojects. Generally, formal relationships are normative, reflecting the governance structure based on rules, such as laws, contracts, and other codified artifacts(Jensen, 1995, Prell et al., 2010). The position of each stakeholder's formal relationship is clearly defined by a given governance structure (Prell et al., 2010). On the one hand, most stakeholders in megaprojects are linked by complex contractual structures (Holland, 2000). The contract relationship is established and operated by contract endorsement, management, and conflict resolution (Zheng et al., 2008, Zhang et al., 2016b). On the other hand, nearly all official activities in megaprojects are under inspection by supervision structure, which consists of the government, legislative council, and local professional associations(Zhai et al., 2017). Based on these two governance structures, there are two major formal stakeholder relationships in megaprojects: contractual and supervision relationship.

Informal relationship

The informal relationship is an intangible connection among the stakeholders in megaprojects(Zou et al., 2010). Unlikely the contractual and supervision relationships, the informal relationship is not protected by law, but playing a critical role in strengthening the quality of stakeholder performance(Yang and Shen,

2014). Transaction costs can be significantly reduced between project organizations with the assist of an informal relationship (Dyer and Singh, 1998). Since it improves the effectiveness of flexibility, solidarity, and information change between organizations, the informal relationship can work as lubricants to make cooperation among stakeholders running smoothly (Poppo and Zenger, 2002). However, due to the complexity of megaprojects, it is difficult for contracts to cover all the risks during the lifecycle of the project (Kumaraswamy et al., 2005). Hence, informal relationship management can effectively improve cooperation when organizations are facing uncertainties (Zheng et al., 2008). Regarding the content on the informal relationship, it could be divided from perspectives of affection and political authority(Krachardt, 1993, Tichy et al., 1979), which are furtherly composed of four kinds of relationships: influence, common goals and interests, trust, and friendship. In details, considering the division of affects, informal relationship represents the intimate relations among stakeholders, which is referred to friendship and trust by Krachardt (1993). In terms of political authority, there are two sub-divisions. On the one hand, the political coalition among stakeholders is established by common individual and group goals(Tichy et al., 1979). On the other hand, the influence network among stakeholders is highlighted as another invisible authority relationship structure in the previous study(Torenvlied and Velner, 1998, Ackermann and Eden, 2011).

The challenge of megaproject performance

The concept of the megaproject performance is derived from the project performance, which is defined as the extent of achieving the project objectives (PMI, 2013). Since the megaprojects are more complex than the traditional construction projects due to the increasing complexity of the project scope and

environment(Hu et al., 2013), the theory of project performance is no longer limited to the iron triangle of project management: time, cost, and quality, requiring the extension with the broad views(Weaver, 2007). Taking the megaprojects in China as an example, the reliable organizational performance established by informal relational ties between project stakeholders and the state has been highlighted as a determinant to achieve the success of the megaprojects for Beijing Olympic Games (Chi et al., 2011). Besides, as the ~~social protests and tensions are triggered by the development of the megaproject~~development of the megaprojects triggers the social protests and tensions due to the conflicts between local residents and other project stakeholders, the central government has issued the compulsory requirement of the societal performance assessment in the feasibility study of each megaproject in China(Liu et al., 2016). Based on the existing studies, the megaproject performance could be furtherly interpreted by two aspects in addition to the classical project view. From the micro perspectives, the performance of organizations and their interactions impacts the process of the megaprojects(Hu et al., 2016). From the macro perspectives, as megaprojects have a significant influence on the local society(Flyvbjerg, 2014), societal performance has been considered as a critical assessment to examine the project success of the megaprojects(Liu et al., 2016). Thus, it explains the megaproject performance from the three perspectives as follows.

In the inter-organizational level, the 3Cs (communication, coordination, collaboration) reflect the interrelations of multiple stakeholders and have been highlighted to facilitate the project value from relational perspectives (Lin et al., 2018b). The existing studies describe the current situation of 3Cs in megaprojects. First, numerous stakeholders make difficulties in exchanging information and building relationships among institutions, causing the communication problem in megaprojects(Hu et al., 2014).

Besides, more knowledge is required to explore how to improve the coordination within megaprojects, mainly when dealing with conflicts among stakeholders(Söderlund, 2011). As many professional teams jointly work in one project(Suprapto et al., 2015), the efficiency of collaborations among stakeholders plays a critical role in megaproject success.

In the project level, schedule, cost, and quality were regarded as three determinants in the classical theory of project management by Martin Barnes in 1969. Based on the experience of megaprojects around the globe, cost overruns and project delays are much serious in the industry(Flyvbjerg et al., 2003). Meanwhile, aiming to build large and innovative projects, more advanced technologies have been widely used, which increases the difficulties of quality control in megaprojects due to the complexity of techniques and the lack of existing standards(Flyvbjerg, 2014). Besides the traditional triangle model of project management, safety is another critical issue in megaprojects(Lin et al., 2017). As most megaprojects have a high political impact on the local society(Flyvbjerg, 2014), the on-site safety management receives substantial attention from the government to reduce the incident rate and improve the sustainable safety performance(Ma et al., 2019).

At the societal level, as an effective way to create job opportunities, megaprojects attract close attention to labor protection(Wu et al., 2015). Unfortunately, several labor protests and conflicts have occurred in recent years, leading to catastrophic results in relevant projects(Xu et al., 2019). ~~In addition~~Besides, environment protection is one of the top concerns for the community around the megaproject, as reducing environmental damage is an important social responsibility for project stakeholders in megaprojects towards ~~the~~ society(Wang et al., 2017, Lin et al., 2016). Since most megaprojects involve a considerable

investment by government, project transparency is essential for the public to understand whether the money of taxpayers is spent legally and effectively(Locatelli et al., 2017, Lin et al., 2017).

In summary, ~~there are ten aspects~~en aspects are evaluating the megaproject performance from the inter-organizational level to the project and societal level, including communication, coordination, collaboration, schedule, cost, quality, safety, labor protection, environmental protection, and project transparency. The previous studies have shown partial evidence on how ~~megaproject performance is influenced by the formal and informal relationship~~the formal and informal relationship influences megaproject performance. For instance, the trust is considered as a critical informal tie among stakeholders to achieve better megaproject performance(Wang et al., 2019), while the contract is regarded as an essential formal link for stakeholder collaborations to deliver the megaproject (Caldas and Gupta, 2017). However, there is still a lack of systematic assessment on how formal and informal relationships influence the megaproject performance in each specific aspect.

Hypothesis development

Formal relationship and megaproject performance

In the inter-organizational level, Wu et al. (2018) argued that a contractual relationship could strengthen communication quality. Moreover, it signifies the flexibility of the contractual relationship for megaprojects in comparison to the traditional contracts, for enhancing the trust to improve communication among various parties. Besides, the contractual relationship is referred to be useful to coordinate the activities in the megaprojects(Sheng and Lin, 2018). According to the findings of Gao et al. (2018), the contractual relationship is essential for different stakeholders to facilitate the schedule and

working plan when jointly facing complexities in the projects. As numerous stakeholders are involved in the megaprojects, good contractual relationships among stakeholders can reinforce their collaborations, for providing the transparency, expectations, and flexibility of collaborative behaviors (Chakkol et al., 2018). Thus, we propose the hypothesis 1-3 as follows.

H1: Formal relationship is positively related to communication.

H2: Formal relationship is positively related to coordination.

H3: Formal relationship is positively related to collaboration.

At the project level, Choi et al. (2011)believed that efficient schedule performance increases the chances of project completion, ~~.~~ which~~This may~~ could be achieved through the precise schedule aim and incentive policies allocated to each project participant by contract for early termination of the project. As many activities are approved using supervision powers, such as permits issued by the government and specific regulations passed by legislatures (Marshall and Cowell, 2016), a good supervision relationship can operate the megaprojects efficiently and save time. In terms of the cost and quality, a precise aim and control plan of quality and cost included in the contract can drive contracting parties to work together on improving the quality and saving the budget(Adam et al., 2017, El-Hamrawy et al., 2017). For safety, the content of the safety management system is encouraged to be considered in the contract signed by project stakeholders to improve the safety performance of the large EPC projects(Toutounchian et al., 2018). Safety inspections by supervision groups are considered critical for the safety program in the construction projects (Bavafa et al., 2018). Thus, we propose the hypothesis 4-7 as follows.

H4: Formal relationship is positively related to the schedule.

H5: Formal relationship is positively related to cost.

H6: Formal relationship is positively related to quality.

H7: Formal relationship is positively related to safety.

At the societal level, labor and environmental protection are primary responsibilities for the government and the working focus for the representatives of councils(Molle and Floch, 2008, Lin et al., 2015a). The successful interactions with supervision powers are beneficial for project participants to have a good knowledge of various regulations on labor and environmental issues, meanwhile gaining ~~the~~ political support to improve the performance(Lin et al., 2015b). Compulsory items of labor and environmental protection included in the contract are considered an effective way to regulate the stakeholders' behavior to accomplish their social responsibilities(Wu et al., 2015). Furthermore, contractual violation, referring to the non-compliance with the contract provisions, is regarded as a critical factor leading to corruption in the public construction sector(Shan et al., 2017). Hence, the excellent performance of the formal relationship, providing a robust contract-based working environment among stakeholders under supervision by various forces, helps to diminish the opportunity of corruption in the megaprojects. Thus, we propose the hypothesis 8-10 as follows.

H8: Formal relationship is positively related to labor protection.

H9: Formal relationship is positively related to environmental protection.

H10: Formal relationship is positively related to project transparency.

Informal relationship and megaproject performance

In the inter-organizational level, as there are many interpersonal communications in the megaprojects,

stakeholders with good informal relationships are considered to be easier to start the negotiation and more likely to reach agreements in those communications(Butt et al., 2016). For coordination, since each stakeholder has its own interests, informal relationship, such as trust and common goals, builds up a pleasant environment for stakeholders to synchronize their work with ~~less~~ fewer disputes due to their respective interests (Zhang et al., 2016b). ~~In addition~~Besides, the friendship cultivated by previous partnering experience between organizations alongside the personal relationships among organizational leaders furnishes a good foundation for collaborations(Kwan and Ofori, 2001). Thus, we propose the hypothesis 11-13 as follows.

H11: Informal relationship is positively related to communication.

H12: Informal relationship is positively related to coordination.

H13: Informal relationship is positively related to collaboration.

At the project level, schedule in megaprojects is sometimes heavily influenced by informal relationships, particularly with the use of relative influence among stakeholders. For instance, the completion date of several megaprojects in China should be strictly at the time of the national anniversaries. Thus, the government would exert substantial influence on stakeholders to accelerate the project's progress(Chi et al., 2011). For the cost control in megaprojects, the integrated procurement team and collective work agreements are considered as an essential way for stakeholders to work together, sharing the gains and losses of the project profits(Callegari et al., 2018). Hence, the informal relationship would strengthen that kind of teamwork with establishing trust and friendship among stakeholders for achieving the better goal of cost performance. The quality performance can be improved during the life cycle of the project by the

active involvement of project stakeholders in the quality improvement process. Hence, the cooperation among project parties is regarded as a critical factor in the design and construction phase of the project (Arditi and Gunaydin, 1998). The informal relationship would benefit stakeholders for better cooperation on quality issues with building a close working environment. The informal relationship is beneficial for the formation of safety culture, referring to the personal and organizational commitment to safety performance in the megaprojects (Cooper Ph. D, 2000). Stakeholders with common goals and interests are more natural to involve in the teamwork and communication related to the safety policies, practices, and procedures in the construction site(Karakhan et al., 2018). Thus, we propose the hypothesis 14-17 as follows.

H14: Informal relationship is positively related to the schedule.

H15: Informal relationship is positively related to cost.

H16: Informal relationship is positively related to quality.

H17: Informal relationship is positively related to safety.

At the societal level, labor satisfaction could be improved by the development of an excellent personal relationship between workers and managers in the construction projects Li et al. (2018). The high quality of the informal relationship can create a supportive environment for workers to realize their importance in the organization, resulting in the development of a pleasurable emotional state among workers (Li et al., 2018). Regarding environmental protection, the informal relationship would play a critical role in dealing with the relationship between project participants and residential community members in the neighborhood. The good informal relationship helps the project participants better understand the

environmental concerns from the local community, consequently promoting the quality of environmental protection to meet their expectations(Wang et al., 2017). Moreover, the informal relationship improves environmental performance by creating a smooth working culture among stakeholders, which ~~. This can be achieved by~~ encouraginges them to candidly offer suggestions on onsite pollution prevention and asking queries on construction activities likely to harm the environment (Wang et al., 2018). For better project transparency, high quality of informal relationships may reduce the incentives of corruption. Since many corruptions happen for establishing a close relationship like guanxi between two organizations(Zhang et al., 2016a), organizations with trust and friendship have already made such a stable relationship, thus unnecessary for them to build a similar relationship facing with criminal risks. Furtherly, as there is a lack of incentives on corruption among stakeholders with good informal relationships, project participants tend to have fewer worries on the information disclosures to the public. Thus, we propose the hypothesis 18-20 as follows.

H18: Informal relationship is positively related to labor protection.

H19: Informal relationship is positively related to environmental protection.

H20: Informal relationship is positively related to project transparency.

In summary, there are twenty hypotheses established by the literature, which form the ~~theoretical~~ conceptual model shown in Figure 1. The model will be examined by questionnaire survey data and be analyzed by the PLS-SEM technique.

<Fig.1 The conceptual model of the research>

Research method

The structural equation modeling (SEM) is a robust method to verify the conceptual model by assessing a structural correlation among independent constructs (Hair et al., 2013), which has been used in the field of megaprojects (Wang et al., 2019). As one of SEM techniques, the partial least squares structural equation modeling (PLS-SEM) has advantages in analyzing a small number of samples for exploratory research(Hair et al., 2013). Since our research extended the measurements of formal and informal relationships in megaprojects, PLS-SEM was a useful method to test the effects of this exploratory study.

In this study, a questionnaire survey was conducted, and ~~the collected data was analyzed by PLS-SEM~~PLS-SEM analyzed the collected data. In detail, it could be divided into six steps as follows. First, a preliminary questionnaire was designed based on the literature review. Second, a pilot study was taken for testing the format and content of the questionnaire. Third, the questionnaire was refined according to the feedback from the pilot study. Then, the refined questionnaire was used for the final data collection. After that, the partial least squares structural equation modeling (PLS-SEM) was applied to examine the research hypothesis based on collected data. Finally, one follow-up interview with experts was made to validate the result of data analysis.

Samples and data collection

The design of sample selection and data collection considers the proactive strategies to reduce the research bias, including common method bias, informant bias, social desire bias, and non-response bias. As the common method bias could be reduced by the high-level capability and motivation of the respondents(Jakobsen and Jensen, 2015), there are two proposed solutions. First, a pilot study was conducted among eighteen experienced experts who were familiar with the megaprojects to correct the

vague concepts and remove the overlapping content, which may influence the motivation of the respondents. Each expert in the pilot study had at least ten-year working experience related to megaprojects, the profile of which is shown in Table 1. Second, the sampling scope of the questionnaire survey was focused on the stakeholders participating in the megaprojects in China, ensuring their expertise on the content of the questionnaire. There are two criteria for each respondent. One is the budget of the project, which the respondent involves in should exceed 7 billion RMB (equivalent to 1 billion US dollars). Another is each respondent should spend at least half a year with the development of one megaproject. To control the informant bias, multiple respondents among various stakeholders were invited to join the questionnaire survey as recommended by Ernst and Teichert (1998). Hence, the method of the snowball sampling technique was applied, encouraging each respondent to invite more stakeholders who were related to his or her undertaken megaprojects to join the survey, for providing different standpoints to make the data collection unbiasedly. To reduce the social desire bias, the anonymous online questionnaire was selected as the primary approach to collect the data, since this self-administered method was proved to be valid for downgrading the bias due to less social interactions and assured anonymity(Nederhof, 1985). Finally, to minimize the non-response bias, the research team maximized the follow-up during the data collection by remainder emails, as suggested by Smith and Noble (2014).

<Table 1. The profile of participants in the pilot study>

The survey was conducted from May to July 2018. As a result, a total of 397 stakeholders were invited to fill the online questionnaire. The respondent rate was 27.2%. All the responses were effective without missing values or repeated answers. Finally, 108 responses were collected for the research. The demographical characteristics of respondents ~~is~~ are shown in Table 2.

<Table 2. Characteristics of respondents>

In the stage of validation, we invited five key stakeholders who had a rich experience (more than ten years) on megaprojects to attend the individual follow-up interviews. Each interview lasted for more than 1 hour to help us explore the reasons behind the result of data analysis. The interview samples are shown in Table 3, providing comprehensive views of different project stakeholders on the current situation in megaprojects.

<Table 3. Characteristics of interview samples>

Measurements

The measurements were initially developed by a literature study and ultimately revised by a pilot study showing in Table 4. All constructs described in the hypothesis's development were assessed reflectively by five-point Likert scales from 0 (perform very bad) to 5 (perform very well). Besides, three control variables were considered to examine the potential influence of the respondents' characteristics on the research findings, including the job positions, stakeholder groups, and project types, ~~in accordance with~~following the demographical features listed in Table 2.

<Table 4. Measures of constructs>

Data analysis procedures

The survey data were analyzed by partial squares structural equation modeling (PLS-SEM) and calculated by software application SmartPLS 3.0. Two stages were conducted in the process of data analysis. First, the measurement model was built to assess the reliability and validity of its constructs and measurement items (Hair et al., 2013). Second, the structural model was evaluated to examine the research hypothesis(Molenaar et al., 2000).

Research results

Measurement models

According to the previous study on PLS-SEM(Zheng et al., 2017), the measurement models were assessed based on the following four aspects: indicator reliability, internal consistency, convergent validity, and discriminant validity. Regarding indicator reliability, the loading value for each measurement item under the corresponding construct was assessed, which shows all the loading values (Table 5) are higher than 0.7, considering as the satisfactory threshold(Hair et al., 2013). In the aspect of internal consistency, the composite reliability (CR) for each construct was tested, and the results (Table 5) showed that each value was over the requirement of 0.7. Regarding convergent validity, the amount of the average variance extracted (AVE) for each construct was examined to ensure the measurement items under each construct pointed to the same conceptual variable. As a result, all the values of AVE (Table 5) were more than the minimum requirement of 0.5(Hair et al., 2013). There were two ways of assessing the discriminant validity of the measurement model. One was that the value of the square root of AVE for each construct in the diagonal of the Fornell-Larcker Criterion matrix should be higher than any other values of its correlated constructs, as Table 6 showed. Another was that the loading value of each measurement item under the corresponding construct should be higher than any of its cross-loadings with other constructs (Appendix S1). Finally, the measurement models passed those two assessments.

<Table 5. Assessment of Measurement Models>

<Table 6. Correlations of Latent Variable and Evidence of Discriminant Validity>

Structural models

The ~~structural models were assessed by the predictive validity~~predictive validity assessed the structural models based on three parameters: the significance of path coefficients, the coefficient of determination R^2, and the value of predictive relevance Q^2.

First, the significance of path coefficients was tested by bootstrapping with the total sample of 108, 5000 subsamples, and no significant changes for options in Smart PLS3.0. According to the result of the significance test on path coefficients, most hypotheses ~~was~~ were supported except for H15, H16, and H18. Therefore, the formal relationship was considered to have a positive effect on all three levels of megaproject performance, while the informal relationship has a positive impact on most aspects of megaproject performance but having no significant ~~effect~~ effect on the performance of cost, quality, and labor protections.

Second, the value of R^2 was used to assess the central criterion for the structural models, which explained the variation in the endogenous constructs. As Figure 2 showed, the range of R^2 was 35%-62%, which substantiated the model's predictive validity(Hair et al., 2013).

Third, Stone-Geisser's Q^2 values were obtained by the method of the blindfolding procedure. As the results showed in Figure 2, each dependent variable was over zero, which means the structural models had predictive relevance.

<Fig.2. Results of PLS-SEM analysis for structural model>

The effects of formal and informal relationship

As Table 7 presented, there were three hypotheses rejected, including H15, H16, and H18, which indicates only formal relationship exerts a significant impact on the issues of cost, quality, and labor protections. ~~All the remaining hypotheses were supported by PLS-SEM~~PLS-SEM supported all the

remaining hypotheses. Based on the path coefficient values, the different effects between formal and informal relationships on megaproject performance were revealed. Formal relationship shows more significant influence on the issues of coordination (0.482>0.371), safety (0.441>0.310), and environmental protection (0.501>0.233). While the informal relationship has more effectiveness on the issues of communication (0.508>0.340) and project transparency (0.394>0.255). ~~In addition~~Besides, formal and informal relationship show ~~the~~ a close impact on the issues of collaboration (0.352, 0.387) and schedule (0.330, 0.347).

The effects of control variables

As Figure 2 showed, all the control variables were insignificant towards the dependent variables, which indicated the results of the PLS-SEM were not varied by various features of respondents, including the job positions, stakeholder groups, and involved project types. Therefore, the research findings were proved to be valid and could be applied to interpret the influence of the formal and informal stakeholder relationship on the megaproject performance. The results of the control variables were in Appendix S2.

<Table 7. Results of Hypothesis Testing>

Validation of the Research Findings

The research findings were validated by five experts who had joined neither the pilot study nor the questionnaire survey, thus reducing the bias on the validation results. The involved project types of experts were varied to test whether the findings would be applicable among various kinds of megaprojects. The validation process was composed of two parts. First, the appropriateness of indicators in the measurement constructs ~~were~~ was reviewed by experts. All the experts believed the selected

indicators comprehensively represented the stakeholder relationship and megaproject performance. Second, the objectiveness of the research findings was validated considering the various megaproject types. Generally, all the experts agreed with the results of the PLS-SEM model, which indicated the informal relationship plays an insignificant role in the aspect of cost, quality, and labor protections. ~~In addition~~Besides, some experts emphasized the significance of the stakeholder relationship based on the features of their undertaken projects. One senior government officer (SO) highlighted the affection of formal relationship towards the safety performance in the mega transport projects. Form his perspectives, safety incidents are frequently occurred in the transport projects due to the geographical complexity, which calls for the strict safety regulations in the contract system among project stakeholders. One project manager from the client (PM-1) emphasized that environmental protection is significantly influenced by formal relationships, particularly in the mega energy project. In his views, the relationship management with the supervision groups (i.e., government, council members, professional associations) is beneficial to improve the urgent protection measures when some unpredictable environmental incidents happen. Besides, the comparison between formal and informal relationships on each aspect of the megaproject performance was made by experts, and the views will be presented in the discussion part.

Discussion: Comparative study

In the inter-organizational level, informal relationship (0.508) has a stronger impact on the performance of communication among stakeholders than the formal relationship (0.340). Although formal relationship provides the duties and regulations in the communication, most communications require flexibilities when facing with the uncertainties in the megaprojects. One project manager (PM-2) from the contractor

verifies the situation that sometimes it is still challenging to have efficient communication between organizations with contractual or supervision relationship, but without an excellent informal relationship. The project manager (PM-2) also points out that compared with the formal relationship, the informal relationship is more efficient to make ~~the~~ instant communication to answer the emergencies in the megaprojects~~.~~. On the contrary, formal relationship (0.482) plays a more critical role in the performance of coordination than the informal relationship (0.371). Unlikely with the communication focusing on the information exchange, coordination is for the optimal allocation of organizational tasks among stakeholders to maximize the overall outcomes(Lin et al., 2018b). Therefore, the formal relationship has the advantages of the distribution of responsibilities and duties based on the contract provisions or supervision regulations. The finding also reveals that formal (0.352) and informal relationships (0.387) are equally important in the performance of collaboration. Formal relationship regulates the responsibilities of each stakeholder in the joint working. While informal relationships stimulate the incentives and willingness of collaboration among stakeholders, which is echoed by Dewulf and Kadefors (2012).

In the project level, formal relationship (H5, H6) significantly impacts the performance of quality and cost in megaprojects, while informal relationship (H15, H16) shows insignificant impacts. The results indicate that the quality and the cost performance should be improved by the formal relationship rather than the informal one. For cost performance, as megaprojects are long term projects, the inflation of materials, the complexed technical problems, and the interruption caused by political forces and natural disasters lead to the severe cost-overrun problems (Siemiatycki, 2016). Unfortunately, the informal relationship rarely makes a significant impact when facing those challenges. One project manager (PM-1)

from the client explains that, as cost issues are highly related to the interests and benefits of stakeholders, it is difficult for them to make compromises and reach agreements in their teamwork without the basis of contract provisions or the mediation from the supervision forces, even though they have good informal relationship. In contrast, a transparent cost risk allocation in the contract provides a foundation to face the uncertainties and complexities in the megaprojects (Molenaar, 2005). One senior officer (SO) from the government mentioned that when some unforeseen risks happen, an instant and effective interaction with supervision groups can gain policy supports, which is prone to alleviate the cost overrun and receive the extra budget for project recovery. In terms of quality control, project quality should be strictly controlled by rules and specifications stated in the contract and supervised by the independent forces (Yung and Yip, 2010), while the informal relationship may interfere with the strictness of quality control by unofficial connections between organizations, which brings the variations on quality performance. For instance, one project manager (PM-2) from the contractor reveals that trust among stakeholders may cause the potential risks of less strictness in the quality inspections and the punishment of irregulated behaviors may not be firmly conducted due to the friendship between the organizations. In addition, one senior officer (SO) from the government points out that as some quality problems can be hidden for a long time, the coalition among stakeholders may be formed to cooperate with several misconducts on quality for achieving the common goals and interests, which could bring them instant profits. To improve safety performance, formal relationship (0.441) has a relatively higher impact than the informal relationship (0.310). As rules and regulations are considered as a significant role in the safety management, frequent inspections and no compliance with violations of safety standards can lead to better safety

implementation (Swuste et al., 2012). Hence, the formal relationship plays a critical role in safety control by establishing functional interactions between stakeholders and supervision groups. Meanwhile, informal relationships supplement the reinforcement of safety performance. As the present study shows that more protection and a safer environment are not always adequate without the improvement of safety culture (Feng, 2013), the informal relationship is useful to cultivate the culture by supporting the smooth communication between project participants and workers (Mohammadi et al., 2018). For schedule performance, formal (0.330) and informal (0.347) relationship show the close positive impact, indicating that the two kinds of relationships complementary with each other on the schedule issues. On the one hand, formal relationship strengthens the contract management among stakeholders, which is regarded as a critical factor to mitigate the time delay by providing a clear objective and obligation in the contract system (Oyegoke and Al Kiyumi, 2017). On the other hand, informal relationship helps stakeholders to obtain timely responses in different kinds of activities with efficient communications, saving the time for the megaprojects, explained by one project manager (PM-4) from the consultancy.

At the societal level, the formal relationship has a positive impact on the performance of labor protection, while the effects of informal relationships are insignificant. The results implicate that contract and supervision are two dominant ways to protect labors' rights, consistent with the study by Lan et al. (2015) and Montgomery and Maggio (2009). Though establishing an informal relationship between workers and other stakeholders enhances the labors' job satisfaction (Li et al., 2018), it makes limited effects on protecting their human rights. One project manager (PM-3) from the subcontractor mentioned that currently, the primary function of the informal relationship between workers and other stakeholders is for

increasing labors' productivity. However, the higher productivity with the sacrifice of their rest and health probably makes labors' working situation even worse. In the aspect of environmental protection, formal relationship (0.501) shows a more significant impact on the informal relationship (0.233). As the unforeseen environmental risks may frequently occur due to the complexities of megaprojects, one senior officer (SO) from the government pointed out that long-term cooperation between project participants and supervision groups is beneficial to detect the potential risks and make the instant action if problems arise. At the same time, the positive effect of maintaining an excellent informal relationship between the project team and local communities cannot be ignored as the residents in the neighborhood are major stakeholders heavily involved in environmental issues(Wang et al., 2017, Lin et al., 2018a). One project manager (PM-2) from the contractor explains that the friendship and trust between project participants and community leaders is an effective way to relieve the worries of environmental issues and make the community cooperated with project teams to protect the environment. For the improvement of project transparency, the Informal relationship (0.394) has a more significant impact than the formal relationship (0.255). Although formal relationship provides a shield to improve the project transparency with rules and regulations, there are still incidents of corruptions happened from time to time (Shan et al., 2015). The results indicate that the performance of informal relationships plays a more critical role in improving project transparency. One project manager (PM-1) from the client explains that good informal relationship is useful for stakeholders to deal with unclear issues in the contract. Otherwise, corruption would often take place to solve those problems. ~~In addition~~Besides, as most corruptions are for establishing a close relationship between organizations (Zhang et al., 2016a), stakeholders with good

informal relationships have fewer incentives to build similar relationships with the price of committing the crime.

Managerial Implications

<Fig.3. The managerial map on improving the megaproject performance by Formal & Informal relationship>

According to the comparative study of the results in PLS-SEM assessments, a managerial map on the relationship management was drawn in Fig.3 for the improvement of the megaproject performance. In detail, as Table 7 shows, the informal relationship plays an insignificant role in the aspect of cost, quality, and labor protections. Thus formal relationship is depicted as the dominating approach at the left polar of the map. Then, by the comparison of the significant path coefficient values in Table 7, the relative importance of formal and informal relationships on each aspect of the megaproject performance is presented on the map.

Based on the proposed managerial map, the corresponding strategies for project stakeholders to improve the relevant aspect of the megaproject performance are as follows. First, the formal relationship is considered as a dominating approach to tackle the issues on the cost, quality, and labor protection rather than informal ties. Second, a formal relationship is more reliable than the informal one to deal with coordination, safety, and environmental protection. Third, both formal and informal relationship is equally essential when facing tasks related to collaboration and scheduling. Lastly, the informal relationship has the potential to be more effective ~~on~~ in better communication and project transparency than a formal relationship in megaprojects.

Research and Practice Implications

Both theoretical and practical implications have been made in this study. Theoretically, the study extends

the knowledge of relationship management in the domain of the megaproject performance. It provides a comprehensive and systematic understanding of the impact of formal and informal stakeholder relationships on ten aspects of the megaproject performance by the proposed conceptual model and PLS-SEM results. The research findings contribute to the theory of relationship management on how the different influences between formal and informal stakeholder relationships lead to better megaproject performance from inter-organizational level to project and societal level. Practically, through the comparative study, the managerial map is firstly established for promoting each aspect of megaproject performance according to the different effects between the formal and informal relationships. The managerial map divides the strategies into four groups: formal relationship dominated, formal relationship reliable, equality between formal and informal relationship, and informal relationship reliable, which benefits the stakeholders to improve the specific aspect of project performance in practice.

Conclusion

As relationship management is recognized to promote the performance of the construction projects, the results of this study show the effects of the formal and informal relationship on megaproject performance from inter-organizational level to project and societal level. The research findings indicate that formal relationship plays a dominating role ~~on~~ in cost, quality, and labor protection; meanwhile, it is still more reliable on improving coordination, safety, and environmental protection. Both formal and informal relationship is equally important towards collaboration and scheduling. While the informal relationship is more effective ~~on~~ in communication and project transparency.

There are still some limitations to the research. First, the bottleneck comes from the sample scope. Since

all the samples are from China, the generalization of the research findings is waiting for ~~the~~ the further cross-regional study to verify. Besides, the number of the respondents from external stakeholders (i.e., community member, supervision group) only accounts for 22 percent of the total samples, thus calling for more samples from external stakeholder groups to supplement the dataset. Second, as the body of knowledge and its impact of formal and informal relationships will change over time with the development of the construction industry, similar future studies are suggested to be done. For instance, the content of the informal relationship is from the perspectives of affection and political authority. As the informal relationship would be interpreted from broader views in the future, the indicators to assess the informal relationship should be updated periodically. Third, the management priority explored in the study shows the consensus on the effectiveness of formal and informal relationships among stakeholders, whereas the preference for each kind of project stakeholder is calling for further empirical studies. However, the method of the research could be implemented in different regions to assist with the local project stakeholders to improve the megaproject performance by enhancing their relationship management.

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Appendix

<S1. Cross loadings>

<S2. Results of Hypothesis Testing among Control Variables>

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The information of each Figure

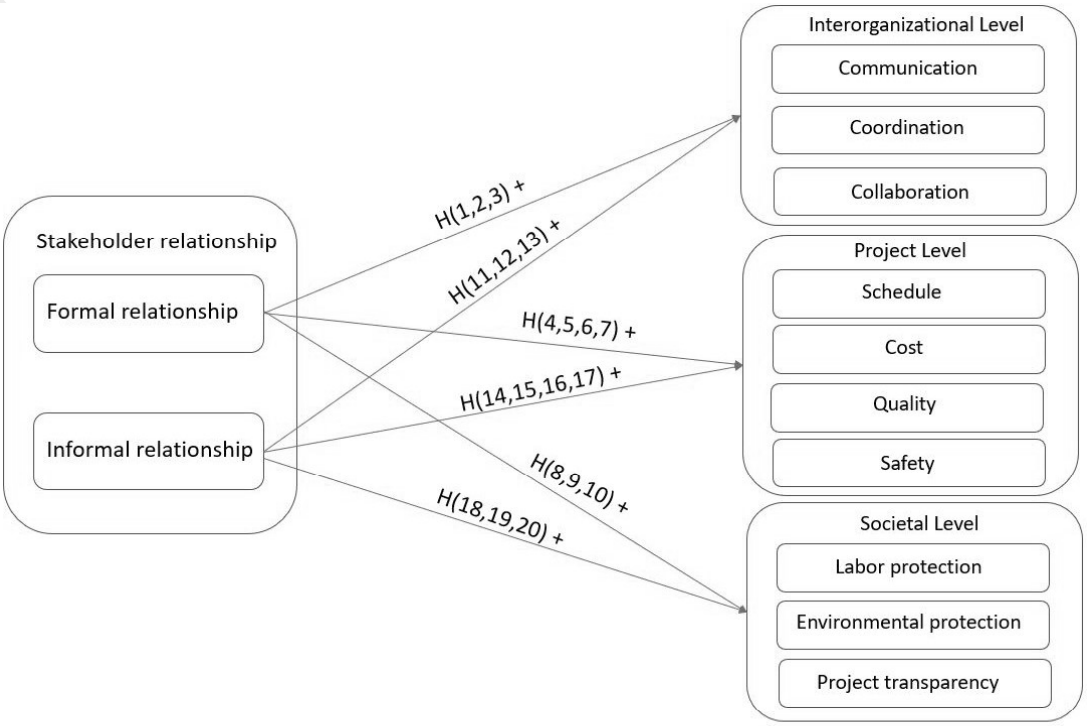


Fig.1The theoretical conceptual model of the research

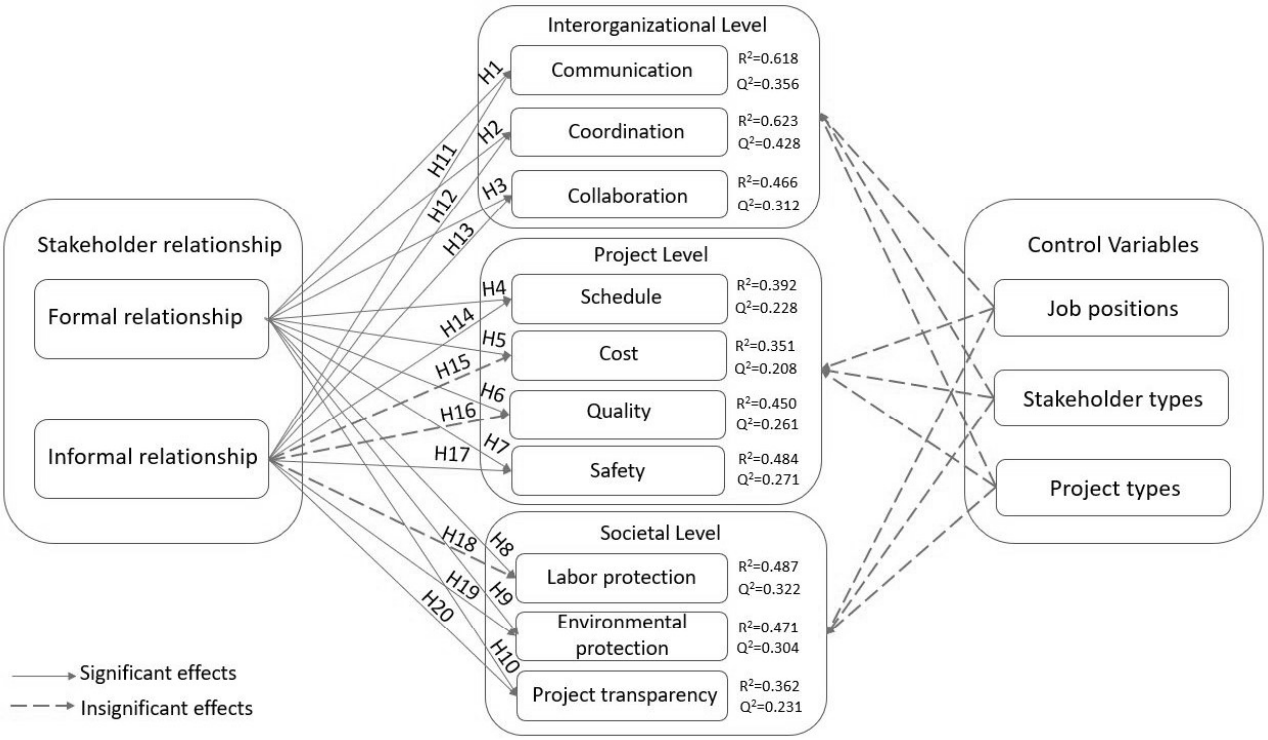
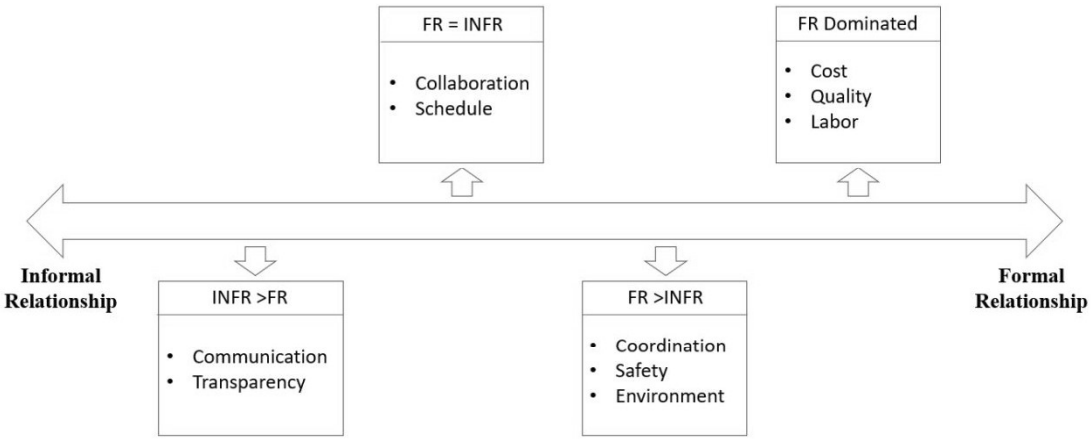


Fig.2. Results of PLS-SEM analysis for structural model



Notes:
- FR Dominated: Only formal relationship is effective on enhancing the performance of the listed indicators.
- FR >INFR: Formal relationship is more effective than the informal relationship.
- FR = INFR: Both formal and informal relationship are equally important.
- INFR>FR: Informal relationship is more effective than the formal relationship.

Fig.3. Managerial map on improving the megaproject performance by Formal &Informal relationship

The information of each Table

Table 1. Profiles of participants in the pilot study

Participant Type	Quantity	Experience (years)
Government officer	2	10, 15
Owner	2	11, 15
Contractor	3	10, 10, 12
Consultant	3	10, 11, 10
Researcher	8	10, 10, 11, 15, 11, 12, 10, 10

Table 2. Characteristics of respondents

Feature	Distribution				
Job positions	junior	medium	senior		
	33%	57%	10%		
Stakeholder types	supervision group	contractor	consultant	client	
	15%	25%	19%	16%	
	end user	supplier	subcontractor	community member	
	6%	6%	6%	7%	
Project types	public building	bridge	tunnel	railway	highway
	23%	14%	11%	10%	12%
	airport	harbor	dam	energy facilities	
	7%	6%	7%	10%	

Table 3. Characteristics of interview samples

Code	Experience (years)	Stakeholder Type	Project Type
SO	10	Government	Transport
PM-1	12	Client	Energy
PM-2	11	Contractor	Airport
PM-3	15	Subcontractor	Harbor
PM-4	11	Consultancy	Public Building

Table 4. Measures of constructs

Constructs	Description of measurement items	Key sources
Formal relationship (FR): 6 items	FR1: Project activities endorsed by contract FR2: Contract management FR3: Conflicts solved based on contract FR4: Interactions with the government in the process of supervision FR5: Interactions with the legislative in the process of supervision FR6: Interactions with local associations in the process of supervision	(Zhai, Ahola, Le and Xie, 2017, Zheng, Roehrich and Lewis, 2008, Gao, Chen, Wang and Wang, 2018)
Informal relationship (INFR): 4 items	INFR1: Influence INFR2: Common goals and interests INFR3: Trust INFR4: Friendship	(Yang and Shen, 2014, Lincoln and Miller, 1979, Wong and Boon-itt, 2008)
Communication (COM): 4 items	COM1: Routine communication COM2: Direct communication COM3: Information sharing COM4: Communication in conflicts	(Dietrich, Eskerod, Dalcher and Sandhawalia, 2010, Salas, Sims and Burke, 2005)
Coordination (COO): 3 items	COO1: Problems resolving among organizations COO2: Work synchronization COO3: Cooperation and assistance across organizations	(LePine, Piccolo, Jackson, Mathieu and Saul, 2008, Hoegl and Gemuenden, 2001)
Collaboration (COL): 2 items	COL1: Joint working COL2: Team integration	(Suprapto, Bakker, Mooi and Moree, 2015)
Schedule (SCH): 3 items	SCH1: Start on time SCH2: Achieve each milestone on time SCH3: Completion on time	(Chang, Hatcher and Kim, 2013, Plotch, 2015)
Cost: 3 items	COST1: Completion within budget COST2: No delay on project payment COST3: Quick action for extra funding on an emergency	(Callegari, Szklo and Schaeffer, 2018, Olaniran, Love, Edwards, Olatunji and Matthews, 2016, Mahamid, Bruland and Dmaidi, 2011)

Quality (QUA): 5 items	QUA1: Pass the quality supervision QUA2: Win the quality award QUA3: Few quality incidents QUA4: Well-organized mechanism for quality control QUA5: Quality management based on specification and regulation	(Yung and Yip, 2010, He and Wu, 2016)
Safety (SAFE): 5 items	SAFE1: Few safety accidents and near miss SAFE2: Safety supervision and management SAFE3: Safety awareness SAFE4: Safety education and training SAFE5: Adequate protective gears	(Bavafa, Mahdiyar and Marsono, 2018, Mohammadi, Tavakolan and Khosravi, 2018)
Labor protection (LABOR): 4 items	LABOR1: No delay on labor payment LABOR2: Labor health LABOR3: Improvement of labor skills LABOR4: Labor workload	(Wang and Jing, 2018, Fayek, Yorke and Cherlet, 2006, Cheng, Smyth and Guo, 2015)
Environmental protection (ENV): 4 items	ENV1: Environmental evaluation in planning ENV2: Protection consideration in design ENV3: Protection measures in construction ENV4: Communication with local community on environmental issues	(Wang, He, Xia, Meng and Wu, 2018, Valdes-Vasquez and Klotz, 2012)
Project transparency (TRAN): 3 items	TRAN1: Control of corruption incidents TRAN2: Information disclosure for public TRAN3: Transparency in tendering	(Chan and Owusu, 2017, Zhang, Le, Xia and Skitmore, 2016)
Control variable 1	CV1: Job Positions	Demographic characteristics of the respondents
Control variable 2	CV2: Stakeholder Types	Demographic characteristics of the respondents
Control variable 3	CV3: Project Types	Demographic characteristics of the respondents

Table 5. Assessment of Measurement Models

Construct/item	Loading	T value	AVE	CR	Construct/item	Loading	T value	AVE	CR
FR	—	—	**0.716**	**0.938**	QUA	—	—	**0.706**	**0.923**
FR1	**0.773**	11.236	—	—	QUA1	**0.818**	18.241	—	—
FR2	**0.866**	23.295	—	—	QUA2	**0.877**	35.300	—	—
FR3	**0.862**	25.666	—	—	QUA3	**0.827**	20.061	—	—
FR4	**0.896**	32.833	—	—	QUA4	**0.867**	28.833	—	—
FR5	**0.865**	23.014	—	—	QUA5	**0.810**	19.500	—	—
FR6	**0.807**	14.268	—	—	SAFE	—	—	**0.680**	**0.914**
INFR	—	—	**0.717**	**0.910**	SAFE1	**0.718**	11.982	—	—
INFR1	**0.794**	13.800	—	—	SAFE2	**0.854**	27.002	—	—
INFR2	**0.858**	23.284	—	—	SAFE3	**0.866**	19.209	—	—
INFR3	**0.879**	23.354	—	—	SAFE4	**0.862**	25.234	—	—
INFR4	**0.854**	27.643	—	—	SAFE5	**0.815**	19.928	—	—
COM	—	—	**0.696**	**0.902**	LABOR	—	—	**0.795**	**0.939**
COM1	**0.818**	20.521	—	—	LABOR1	**0.879**	24.895	—	—
COM2	**0.801**	15.293	—	—	LABOR2	**0.911**	47.640	—	—
COM3	**0.853**	19.602	—	—	LABOR3	**0.897**	34.405	—	—
COM4	**0.863**	22.064	—	—	LABOR4	**0.878**	34.186	—	—
COO	—	—	**0.806**	**0.926**	ENV	—	—	**0.772**	**0.931**
COO1	**0.898**	40.043	—	—	ENV1	**0.911**	42.039	—	—
COO2	**0.886**	34.574	—	—	ENV2	**0.897**	37.131	—	—
COO3	**0.908**	32.581	—	—	ENV3	**0.869**	29.777	—	—
COL	—	—	**0.822**	**0.902**	ENV4	**0.836**	21.770	—	—
COL1	**0.927**	70.025	—	—	TRAN	—	—	**0.797**	**0.922**
COL2	**0.886**	23.011	—	—	TRANS1	**0.903**	33.549	—	—
SCH	—	—	**0.762**	**0.906**	TRANS2	**0.884**	23.682	—	—
SCH1	**0.828**	17.273	—	—	TRANS3	**0.891**	29.538	—	—
SCH2	**0.908**	33.514	—	—					
SCH3	**0.880**	27.323	—	—					
COST	—	—	**0.749**	**0.899**					
COST1	**0.858**	23.115	—	—					
COST2	**0.906**	45.112	—	—					
COST3	**0.830**	18.426	—	—					

Table 6. Correlations of Latent Variable and Evidence of Discriminant Validity

Construct	COL	COM	COO	COST	ENV	INFR	LABOR	TRANS	QUA	SAFE	SCH	FR
COL	**0.907**	—	—	—	—	—	—	—	—	—	—	—
COM	0.722	**0.834**	—	—	—	—	—	—	—	—	—	—
COO	0.821	0.795	**0.898**	—	—	—	—	—	—	—	—	—
COST	0.685	0.586	0.689	**0.865**	—	—	—	—	—	—	—	—
ENV	0.711	0.717	0.724	0.636	**0.879**	—	—	—	—	—	—	—
INFR	0.636	0.748	0.712	0.481	0.588	**0.847**	—	—	—	—	—	—
LABOR	0.714	0.739	0.761	0.620	0.830	0.575	**0.891**	—	—	—	—	—
TRANS	0.701	0.665	0.616	0.581	0.760	0.574	0.795	**0.892**	—	—	—	—
QUA	0.740	0.668	0.740	0.739	0.769	0.566	0.763	0.701	**0.840**	—	—	—
SAFE	0.686	0.692	0.750	0.660	0.867	0.622	0.809	0.721	0.810	**0.825**	—	—
SCH	0.748	0.643	0.720	0.697	0.664	0.581	0.704	0.670	0.706	0.676	**0.873**	—
FR	0.626	0.700	0.745	0.585	0.667	0.709	0.687	0.534	0.655	0.661	0.576	**0.846**

Table 7. Results of Hypothesis Testing

From	FR		INFR		
To	Path coefficient	T value	Path coefficient	T value	Results
COM	0.340 [c]	3.609	0.508 [c]	5.557	H1: Supported H11: Supported
COO	0.482 [c]	4.672	0.371 [c]	3.648	H2: Supported H12: Supported
COL	0.352 [b]	3.049	0.387 [c]	3.362	H3: Supported H13: Supported
SCH	0.330 [b]	2.979	0.347 [b]	3.085	H4: Supported H14: Supported
COST	0.490 [c]	3.845	0.134	1.097	H5: Supported H15: Not supported
QUA	0.509 [c]	5.291	0.205	1.939	H6: Supported H16: Not supported
SAFE	0.441 [c]	4.709	0.310 [b]	3.014	H7: Supported H17: Supported
LABOR	0.561 [c]	5.530	0.177	1.621	H8: Supported H18: Not supported
ENV	0.501 [c]	5.352	0.233 [a]	2.190	H9: Supported H19: Supported
TRANS	0.255 [a]	2.147	0.394 [c]	3.656	H10: Supported H20: Supported

[a] $p < 0.05$ ($t > 1.96$)

[b] $p < 0.01$ ($t > 2.58$)

[c] $p < 0.001$ ($t > 3.29$)

Appendix

S1. Cross loadings

	COL	COM	COO	COST	ENV	INFR	LABOR	TRANS	QUA	SAFE	SCH	FR
COL_1	**0.927**	0.744	0.833	0.629	0.689	0.629	0.682	0.637	0.672	0.642	0.643	0.626
COL_2	**0.886**	0.548	0.637	0.615	0.594	0.516	0.607	0.638	0.673	0.600	0.725	0.498
COM_1	0.529	**0.818**	0.640	0.459	0.612	0.653	0.568	0.484	0.540	0.578	0.438	0.612
COM_2	0.555	**0.801**	0.590	0.460	0.493	0.558	0.544	0.534	0.427	0.487	0.557	0.499
COM_3	0.756	**0.853**	0.696	0.525	0.632	0.696	0.670	0.678	0.651	0.613	0.596	0.587
COM_4	0.558	**0.863**	0.719	0.507	0.644	0.578	0.678	0.516	0.592	0.619	0.558	0.627
COO_1	0.726	0.678	**0.898**	0.629	0.665	0.658	0.640	0.545	0.659	0.698	0.556	0.704
COO_2	0.746	0.700	**0.886**	0.567	0.628	0.659	0.728	0.591	0.663	0.655	0.740	0.643
COO_3	0.738	0.765	**0.908**	0.660	0.657	0.600	0.684	0.521	0.670	0.666	0.647	0.656
COST_1	0.579	0.483	0.615	**0.858**	0.584	0.387	0.539	0.508	0.629	0.600	0.649	0.536
COST_2	0.609	0.530	0.632	**0.906**	0.565	0.431	0.590	0.542	0.640	0.596	0.607	0.549
COST_3	0.594	0.510	0.534	**0.830**	0.495	0.436	0.474	0.452	0.654	0.510	0.548	0.421
ENV_1	0.619	0.633	0.643	0.521	**0.911**	0.570	0.740	0.636	0.652	0.755	0.582	0.603
ENV_2	0.645	0.695	0.700	0.629	**0.897**	0.566	0.771	0.642	0.702	0.795	0.568	0.599
ENV_3	0.639	0.590	0.632	0.568	**0.869**	0.436	0.694	0.654	0.673	0.779	0.559	0.575
ENV_4	0.597	0.598	0.567	0.517	**0.836**	0.488	0.708	0.746	0.679	0.721	0.627	0.567
FR_1	0.388	0.472	0.550	0.368	0.467	0.520	0.464	0.347	0.396	0.492	0.368	**0.773**
FR_2	0.518	0.530	0.619	0.477	0.528	0.582	0.554	0.423	0.529	0.546	0.501	**0.866**
FR_3	0.582	0.633	0.663	0.537	0.586	0.577	0.563	0.397	0.635	0.530	0.498	**0.862**
FR_4	0.627	0.628	0.720	0.524	0.604	0.682	0.636	0.497	0.605	0.614	0.511	**0.896**
FR_5	0.542	0.619	0.640	0.521	0.611	0.620	0.626	0.544	0.598	0.607	0.588	**0.865**
FR_6	0.486	0.646	0.574	0.519	0.569	0.601	0.621	0.479	0.525	0.552	0.433	**0.807**
INFR_1	0.491	0.606	0.561	0.417	0.482	**0.794**	0.417	0.416	0.457	0.482	0.367	0.592
INFR_2	0.515	0.614	0.555	0.392	0.508	**0.858**	0.476	0.490	0.464	0.516	0.467	0.576
INFR_3	0.607	0.658	0.615	0.418	0.522	**0.879**	0.508	0.524	0.479	0.575	0.595	0.627
INFR_4	0.536	0.655	0.677	0.405	0.482	**0.854**	0.538	0.509	0.516	0.530	0.523	0.606
LABOR_1	0.643	0.601	0.670	0.570	0.755	0.495	**0.879**	0.681	0.702	0.715	0.564	0.607
LABOR_2	0.649	0.697	0.665	0.539	0.741	0.540	**0.911**	0.680	0.712	0.723	0.666	0.659
LABOR_3	0.631	0.675	0.666	0.573	0.746	0.427	**0.897**	0.721	0.695	0.681	0.620	0.550
LABOR_4	0.620	0.661	0.712	0.534	0.718	0.573	**0.878**	0.754	0.614	0.761	0.655	0.621
QUA_1	0.533	0.600	0.641	0.583	0.688	0.517	0.671	0.580	**0.818**	0.695	0.609	0.538
QUA_2	0.701	0.538	0.620	0.659	0.661	0.514	0.662	0.640	**0.877**	0.684	0.672	0.574
QUA_3	0.579	0.561	0.624	0.589	0.542	0.428	0.604	0.583	**0.827**	0.619	0.510	0.533
QUA_4	0.600	0.566	0.564	0.665	0.669	0.422	0.593	0.528	**0.867**	0.665	0.558	0.551

QUA_5	0.687	0.543	0.655	0.603	0.664	0.489	0.669	0.606	**0.810**	0.733	0.606	0.552
SAFE_1	0.497	0.508	0.552	0.399	0.589	0.441	0.516	0.484	0.576	**0.718**	0.506	0.515
SAFE_2	0.644	0.582	0.682	0.557	0.751	0.585	0.625	0.627	0.699	**0.854**	0.530	0.548
SAFE_3	0.580	0.610	0.617	0.590	0.736	0.532	0.690	0.634	0.663	**0.866**	0.670	0.523
SAFE_4	0.581	0.574	0.641	0.578	0.740	0.559	0.715	0.636	0.692	**0.862**	0.552	0.565
SAFE_5	0.516	0.576	0.594	0.586	0.751	0.437	0.785	0.580	0.702	**0.815**	0.530	0.572
SCH_1	0.569	0.520	0.540	0.490	0.524	0.436	0.564	0.568	0.546	0.574	**0.828**	0.395
SCH_2	0.683	0.624	0.705	0.698	0.649	0.529	0.693	0.647	0.678	0.618	**0.908**	0.620
SCH_3	0.695	0.530	0.622	0.612	0.554	0.547	0.574	0.536	0.611	0.579	**0.880**	0.466
TRANS_1	0.609	0.557	0.560	0.519	0.655	0.537	0.701	**0.903**	0.635	0.627	0.586	0.511
TRANS_2	0.588	0.557	0.527	0.447	0.625	0.488	0.667	**0.884**	0.550	0.635	0.641	0.372
TRANS_3	0.676	0.662	0.558	0.580	0.748	0.509	0.754	**0.891**	0.681	0.669	0.574	0.531

S2. Results of Hypothesis Testing among Control Variables

From	CV1		CV2		CV3	
To	Path coefficient	T value	Path coefficient	T value	Path coefficient	T value
COM	0.025	0.355	-0.109	1.480	-0.049	0.709
COO	-0.059	0.837	-0.075	0.950	0.043	0.594
COL	-0.110	1.453	0.001	0.007	0.099	1.233
SCH	-0.094	1.273	-0.133	1.484	-0.045	0.438
COST	-0.063	0.791	-0.237	1.022	0.054	0.554
QUA	-0.157	1.224	-0.124	1.553	0.136	1.759
SAFE	0.029	0.358	-0.074	0.943	0.136	1.901
LABOR	-0.053	0.714	-0.060	0.734	0.120	1.570
ENV	0.034	0.427	-0.039	0.459	0.085	1.099
TRANS	-0.063	0.813	-0.139	1.528	0.004	0.049

[a]$p < 0.05$ ($t > 1.96$)

[b]$p < 0.01$ ($t > 2.58$)

[c]$p < 0.001$ ($t > 3.29$)