

The Impact of Contractual Governance and Trust on EPC Projects in Construction Supply Chain Performance

Hong Ke¹, Zhipeng Cui¹, Kannan Govindan², Edmundas Kazimieras Zavadskas³

¹Tianjin University of Technology
NO.391, Binshuixi road, Xiqing District, Tianjin
E-mail. czpcoolsomann@vip.qq.com

²University of Southern Denmark
Campusvej 55, DK-5230 Odense M, Denmark
E-mail. gov@sam.sdu.dk

³Institute of Internet and Intelligent Technologies
Vilnius Gediminas Technical University
Sauletekio av. 11, 10223, Vilnius, Lithuania
E-mail. edmundas.zavadskas@vgtu.lt

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This paper theoretically refines and empirically extends the debate on the type of interplay between formal and informal governance in an under-researched area: Engineering, Procurement and Construction (EPC) Projects in construction supply chain. Taking contractual governance as the core element of formal governance, and trust as the core element of informal governance, this paper seeks to address their impact on cooperation and EPC projects in construction supply chain performance by structural equation model. The result shows that contractual governance has a positive effect on EPC projects in construction supply chain performance, but the effect on cooperative behavior is not significant; trust shows some influence both on cooperation and performance; cooperation has a positive significant effect on the performance; different dimension of trust has different effects on cooperation and performance: affect-based trust has a positive significant effect on cooperation and performance; the effect of cognition-based trust on performance is not significant, and it only has a positive effect on cooperation; system-based trust has no effect on cooperation and performance.

Keywords: Contractual Governance, Trust, EPC, Construction Supply Chain.

Introduction

For a long time, the low efficiency and poor performance in construction industry have been perplexing the practitioners and researchers (Vrijhoef & Koskela, 2000; Briscoe & Dainty, 2005; Baccarini *et al.*, 2004; Bankvall *et al.*, 2010). In order to improve internal and external efficiency, reduce waste and add value, the thought of supply chain management (SCM), which has been successfully applied in manufacturing, is introduced into the construction industry, and gradually popularized (Akintoye & Main, 2007; Eriksson, 2010; Meng *et al.*, 2011). It is believed that in the construction industry the competition among individual enterprises has been changed into the competition among supply chains (Pala *et al.*, 2012).

At present, the Engineering, Procurement and Construction (EPC) general contracting mode is one of the mainstream modes in the international project contract. In EPC projects, the owner selects a general contractor or a general contracting joint that takes charge of the whole project engineering, equipment and material procurement, construction and all-round trial operation. In EPC projects general contract, the general contractor needs to take more risks than in the traditional contract, so SCM becomes the optimal choice for the general contractor. However, because the EPC projects have the characteristics of large scale,

complex construction process, and multi-participation, there are a lot of problems in the operation level of the supply chain, such as hostile relationship, quality problem, schedule delay problem, and information distortion problem (Eriksson, 2010). How to improve the supply chain performance through the governance has become the focus of scholars.

Supply chain governance has traditionally been viewed from two theoretical perspectives. The first perspective, in line with transaction cost economics (TCE) (Williamson, 1985), highlights the importance of the contract between trading partners and its formal rules of compliance (Lumineau & Malhotra, 2011) to safeguard against opportunism and conflict. The second perspective focuses on relational governance, which often emphasizes trust in SCM (Cai *et al.*, 2010). This perspective suggests that as buyers and suppliers transact satisfactorily over time, relational norms of flexibility, participation, and solidarity are established (Griffith & Myers, 2005; Tangpong *et al.*, 2010) maintaining the relationship and curtailing behavior promoting the goals of the parties (Zhang *et al.*, 2009).

In this paper, we try to address the impact of the governance mechanisms in EPC projects in construction supply chain in China, by means of an empirical analysis. Because the presence of trust has been described as an important dimension to relational governance, relational governance in this study refers to interorganizational trust

(Zaheer & Venkatraman, 1995). Also in TCE, Williamson (1985) concluded that trust can control opportunism. The relatively stable collaboration, established by general contractor to integrate the superior resources of cooperative enterprise, could reduce the fragmentation of the supply chain. Therefore, compared with traditional model, in EPC Projects the team with general contractor as the core team could better adapt to thought of supply chain management, and form the relatively stable upstream supply chain (see

Figure 1). Specifically, we intend to verify the effects of both contractual governance and trust on the cooperation and EPC projects in construction supply chain performance. Furthermore, we also want to identify the relationship between contractual governances and trust, and the relationship between cooperation and performance. This study could be helpful to guide the SCM and improve SCM performance in EPC projects.

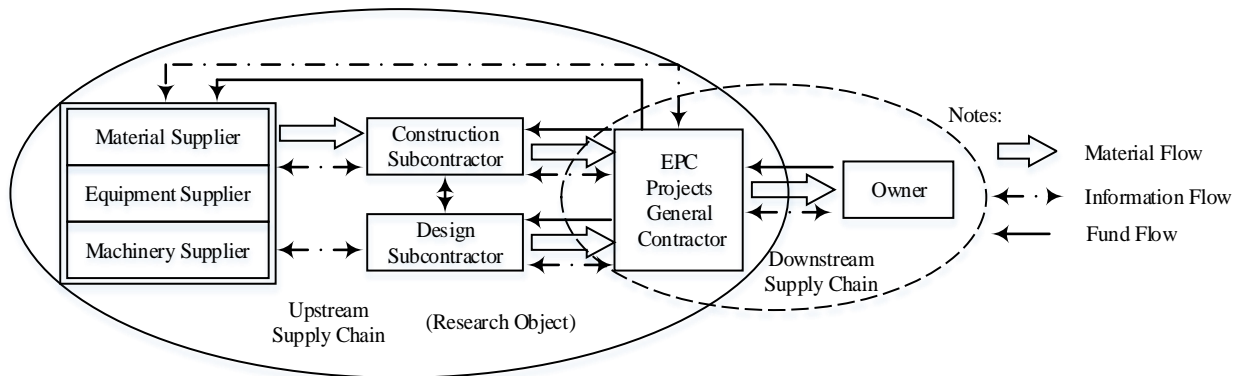


Figure 1. EPC Projects in Construction Supply Chain Structure with General Contractor as The Core

The rest of this paper is organized as follows. The next section provides the theoretical background of contractual governances and trust. We develop the theoretical model and hypotheses in Section 3. In Section 4, we introduce the experiment setting, including the sampling and data collection procedures, the measures and instruments. Section 5, presents the results and analysis on these results. Finally, section 6 discusses the results and research findings, while section 7 concludes.

Literature Review and Theoretical Background

Contractual Governance

Supply chain governance, whether contractual or relational, attempts to mitigate conflict and promote cooperation between trading partners (Williamson, 1996; Wathne & Heide, 2004). Research on governance has traditionally centered on governance mechanisms under a formal compliance perspective. A large stream of research, including the transaction cost approach, has shown that formal contracts provide the safeguards and adaptation mechanisms that can protect economic exchange from the consequences of bounded rationality and opportunism (Williamson, 1985). Formal contracts may detail roles and responsibilities to be performed, specify procedures for monitoring and penalties for noncompliance, and determine outputs to be delivered (Poppo & Zenger, 2002; Reuer & Arino, 2007).

An EPC project is a complex dynamic system, which involves participants and their interdependencies (Jaafari, 2001). According to the TCE theory, in response to exchange hazards, firms either draw complex contracts or choose to be vertically integrated when contracts are too costly to enforce. The various project processes generally are organized into distinct firms which are related to each other through transactions governed by contractual relation (Winch, 2001), i.e., the contracting is chosen as a governance mechanism.

Trust

Although contractual governance is viewed as the primary means for safeguarding transactions, the implications of relational governance have been discussed by researchers from various fields. To relational governance, Macneil (1980) argue that relational exchange relies heavily on social components—most frequently, trust. Transaction cost have been shown to be lower by effects of trust (Macann, 2013). Sociologists have also demonstrated the embedded role that trust and other forms of social relationships play in economic transactions (Granovetter, 1985). This study defines relational governance as interfirm exchanges which include significant relationship-specific assets, combined with a high level of interorganizational trust (Zaheer & Venkatraman, 1995).

Relational governance mechanisms (such as trust) are regarded as a means to enhance transaction-specific investments associated with less monitoring and bargaining (Barney & Hansen, 1994). (Holm *et al.*, 1996) argued that increased levels of understanding in a relationship will increase the overall commitment level of the relationship. The existence of trust between two partners can help to facilitate joint planning and problem solving (Claro *et al.*, 2003), and can help to create a stable and committed relationship (Talay & Akdeniz, 2014).

Trust is frequently considered to be the positive expectations one party has about another party's intentions. While there are many definitions about trust, most contain two elements: "the confidence of the expected results," and "the willingness to accept vulnerability" (Rousseau, 1998). From the point of formation, trust includes both psychological intervention in micro-level, and system installation in macro-level. At the micro level, Das and Teng (2001) thought that trust includes the acceptance of different forms of vulnerability. This vulnerability bases on the optimistic expectations of goodwill and competence. So trust can be divided into goodwill trust and competence

trust. Goodwill trust means even there are speculative motive and opportunity, the party still adheres to the moral responsibilities and obligations, and put collective interests above personal interests; while competence trust means that one party is expected to have the ability and knowledge to complete a certain behavior in accordance with the requirements of other party. (Hartman, 2002) added intuition trust on this basis, which means the impressions of others on intuition and emotion. There are also some scholars who distinguished the trust from the perspective of different trust levels, such as (Lewick & Bunker, 1998). These trusts include calculative trust, knowledge-based trust, and cognition-based trust. At the macro level, (Hummels & Roosendaal, 2001) considered that trust can be established on the basis of the legal system and the formal procedures, which is system-based trust. And it plays a significant role in normal operation of organization and the relationships among organizations. Integrated predecessors' point of view, (Wong *et al.*, 2008) defined trust as one party has sufficient confidence on the reliability and honesty of other parties. These mainly include system-based trust, cognition-based trust, and affect-based trust, and those effectiveness have been verified.

Given the subject of this paper is downstream supply chain, which takes general contractor as the core, all the enterprise-scale, reputation, competence, and interpersonal relationship could affect the trust relationship among the nodes of the business. Therefore, based on the research of (Wong *et al.*, 2008), this paper divided the trust into system-based trust, cognition-based trust, and affect-based trust. System-based trust depends on the legal system, formal programs without regarding to personal questions. Cognition-based trust relies on the fully understanding on other people or organizations, and the master of reliable evidence. Affect-based trust establishes on the emotional bonds among people, and shows concern to each other.

Cooperation

At early stage, the definition of cooperation in the engineering field is not stable, mostly based on goal-oriented action. Early studies focuses more on the individual's point of view, emphasizing the interaction among individuals. It is thought that the cooperation is the activity among two or more individuals in order to contribute to the achievement of common goals (Dukerich *et al.*, 2002). With the change in management style and organizational form, research object gradually switched on cooperative behavior of organizational level. At the organizational level, the collaboration is the mechanism to coordinate the behavior, which is gradually formed, and keep changing according to the actions of members (Love *et al.*, 2002). For example, (Srinivasan & Brush, 2006) thought cooperation is the group action that made individual action more efficient. (Hoegl & Gemuenden, 2001) defined cooperation as interaction within the team, whereas teamwork is the social, including behaviors, interaction and emotion. (Eriksson & Pesamaa, 2007) defined cooperation as interpersonal relationship building and sharing of goal, information and decision.

Since the subject of this paper is downstream supply chain, which takes general contractor as the core, the author defined cooperation at the organizational level. The

cooperation refers to the behavior beneficial for all parties to promote the realization of project objectives. According to the research of (Eriksson & Pesamaa, 2007), and the common collaboration way such as synchronous decision-making and information sharing, the cooperation in EPC projects in construction supply chain are expressed in building compatible goal system, establishing conflict resolution mechanism, developing information sharing platform, setting cooperative office, and so on (Ha *et al.*, 2011).

EPC Projects in Construction Supply Chain Performance

An EPC project can be a complex one-of-a-kind product development, made up of a large number of interconnected subsystems and components, requiring considerable human efforts and financial commitment (Yeo & Ning, 2002). In Engineering (E) phase, the owner or developer defined their needs into clear requirements, both in quantity and quality, which will be communicated to the builders or contractors. In procurement (P) phase, a contractor begins to procure project equipment and construction materials upon receipts of engineering drawings, specifications and other relevant documents. A contractor begins to construct specified facilities in construction (C) phase according to work packages prepared during the engineering phase, and use equipment and materials obtained in the procurement phase (Yeo & Ning, 2002).

EPC projects in construction supply chain refers to a supply and demand network model, taking EPC projects contractor as the core, integrating design subcontractors, construction subcontractors, material suppliers, equipment suppliers, machinery suppliers and owners through command of information flow, logistics, and capital flow (Figure 1) (Pryke, 2009). Relatively stable cooperative relations that established by general contractor to join together subcontractors, suppliers and other cooperative enterprises could overcome one-off and temporary of the project (Cheng *et al.*, 2000), and form a more stable supply chain. Therefore this paper mainly studied the upstream supply chain, which takes general contractor as the core component. The evaluation indicators of engineering supply chain performance are not uniform, but most were selected from three aspects: project objectives, supply chain operations, member relationship, as specified in Table 1.

When established the index system, the indicators were selected according to manufacturing supply chain without taking into account the characteristics of the construction supply chain. Relative to manufacturing supply chain that every part receives different products, construction supply chain is committed to one product—construction project (Meng, 2010). It is because that construction project only has project output instead of node output. Also, due to the lack of distribution in contribution supply chain, the common indicator: “inventory cost” in manufacturing supply chain is inapplicable in contribution supply chain (Vidalakis *et al.*, 2011).

Table 1

Common Evaluation Indicators of Engineering Supply Chain Performance

Aspect	Indicator	Field	Index System	Reference
Project Objective	Schedule, Quality, Cost	Engineering Project	Project Management Performance Evaluation System	(Xue <i>et al.</i> , 2007)
Supply Chain Operations	Reliability, Quick Response, Flexibility, Cost, Asset Utilization Ratio	Manufacturing Supply Chain	Supply Chain Operations Reference-model	(Pan <i>et al.</i> , 2010; Cheng <i>et al.</i> , 2010)
Member Relationship	Satisfaction of Owner, Satisfaction of Core Enterprise, Affinity of Partner	Universal Relevance	Relationship Transition Model	(Meng <i>et al.</i> , 2011)

Therefore, considering the characteristics of EPC projects in construction supply chain, the author selected indicators of upstream supply chain from two aspects: basic thought and common evaluation methods of supply chain performance.

(1) From the basic thought of supply chain performance evaluation.

The basis thought of supply chain performance evaluation, which is proposed by (Meindl & Chopra, 2006), is properly evaluate the supply chain operation condition and the relationship among upper and lower node businesses. a) First, the overall operation condition of supply chain. Owing to the feature of long-period and large-scale, EPC projects in construction supply chain only has one product—construction project. The result of overall operation is reflected in performance, which concludes schedule, quality, and cost. Because of the characteristics of EPC projects in construction supply chain, there are a lot of uncertainties in the operations process, and supply chain members need to cope with various changes, which manifests as the members’ responsiveness towards change—flexibility. Therefore, the overall operation condition of supply chain can be evaluated from the points of schedule, quality, cost, and flexibility. b) Second, the relationship among upper and lower node businesses. EPC projects contractor, as a core enterprise, its satisfaction degree towards supply chain impact the choice of subcontractors and suppliers, and the stability degree of supply chain, directly. In the specific implementation process of the project, subcontractors and suppliers, as the actual

operators, their closeness level is also directly affects the normal operation of the supply chain (Akintoye *et al.*, 2000). It means that the relationship among upper and lower node businesses mainly manifests as satisfaction of core enterprise and closeness of cooperative partner. Therefore, perspective from the basic idea of supply chain performance evaluation, EPC projects in construction supply chain performance can be evaluated by six indicators: schedule, quality, cost, flexibility, core enterprise satisfaction, partner closeness.

(2) From common methods of supply chain performance evaluation—ROF method.

The ROF method was proposed by Beamon (1999), this method selects indicators to evaluate reflect the strategic goals of the supply chain from three aspects: resource, output, and flexibility. From the point of EPC projects in construction supply chain, resources mainly include engaged time and money, which can be evaluated from schedule and cost; outputs include product response and quality. The product response is mainly reflected in core enterprise satisfaction owing to the research object of upstream supply chain; flexibility is the ability of rapid response in changing environment, including the collaborative ability and coping capacity—cooperation partner closeness degree and organizational flexibility. Therefore, perspective from the common methods—ROF method, EPC projects in construction supply chain performance still can be evaluated by these six indicators, shown in Figure 2.

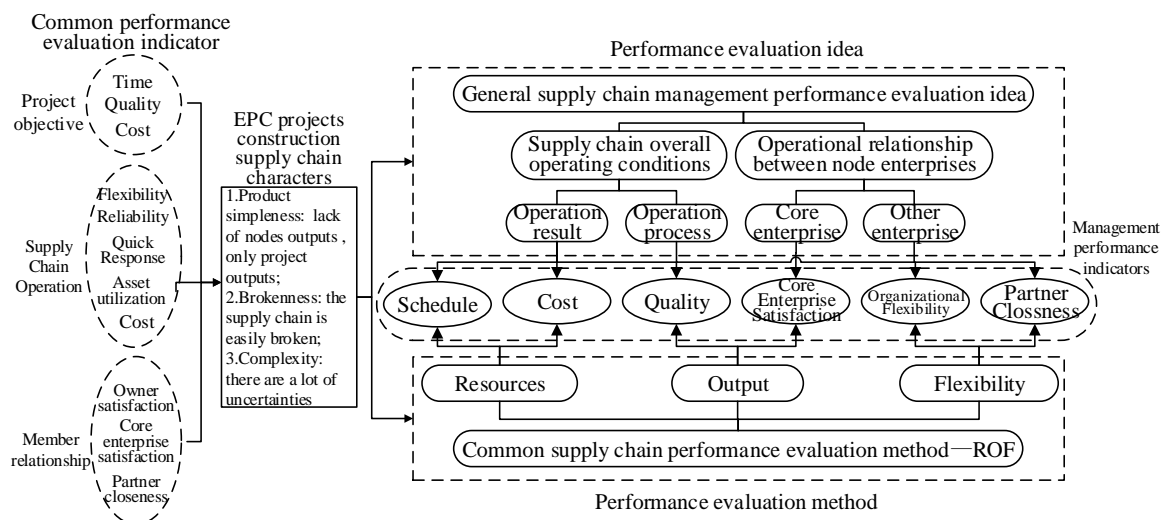


Figure 2. The Evaluation Index Selection of EPC Projects in Construction Supply Chain Performance

According to the above analysis and the characteristics of EPC projects in construction supply chain, this paper selected schedule, quality, cost, organizational flexibility, core enterprise satisfaction, and partner closeness as evaluation index of EPC projects in supply chain performance.

Hypotheses

The Influence of Contractual Governance on the EPC Projects in Construction Supply Chain Performance

The contractual governance mechanism can reduce living space of opportunism and restrain moral hazard. A construction project contract determines the outcomes or outputs to be delivered within the given time and budget. It gives a thorough description of the roles and responsibilities of each party, and specifies the monitoring procedures and default penalties. A typical project contract usually includes three parts. The first part is the fundamental elements, which specify the key principles and agreements among the parties, e.g. delivery deadline, quality standards and budget of the project. The second part is the contractual terms associated with provisions specifying principles, tactics, organization structures and processes for settling unforeseeable events. The third part is the contractual terms associated with governance elements specifying the ways to maintain the relationships through a clear statement of the measurements, penalties and incentives (Ouchi, 1992), to claim and give the termination of an agreement, and to resolve disputes among parties. If construction contracts do not set special safeguard clauses (such as contractors' performance guarantee) to protect the temporary specificity of the owners and the safeguard clauses (such as the clause of progress payments) to protect the investment of contractors, the two of them are worried about opponents' holding up in the re-negotiation and then reducing the investment in project construction, which will damage the project performance (Luo *et al.*, 2013). (Roehrich & Lewis, 2010) concluded that contracts can reduce uncertainties by providing a clear specification of what is allowed and what is not, and can minimize the risk of opportunism by enforcing legal rules and standards.

(Judge & Dooley, 2006) recognized that the contract can enhance the performance of the exchange due to restraining opportunistic behaviors. (Luo, 2002) also gave the result that contracts are associated with the performance and contract completeness driving firms' performance, and the data are collected from China. This leads to our first hypothesis.

H1. Contractual governance positively affects EPC projects in construction supply chain performance.

The Influence of Trust on the EPC Projects in Construction Supply Chain Performance

The general contractor is the leader in construction supply chain, and also one of the most promising to improve the cost performance through effective supply chain management and strategic alliance of downstream enterprises. Trustful relationships across the construction supply chain is likely to yield higher project performance

outcomes (Nicola *et al.*, 2005). (Yeo, 2002) pointed out that trust can improve the performance of EPC projects in construction supply chain management. He put forward that strengthening the trust relationship among supply chain members, establishing extended value system, making full use of the resources and advantages of external partners, and ultimately realizing EPC projects in construction supply chain performance improvement. Many scholars had confirmed that trust is one of the key factors affecting the performance of construction supply chain management in general contracting model, such as (Manu *et al.*, 2012; Eriksson, 2010). Compared with the traditional model, EPC model has the characteristic that design, procurement, and construction are conducted and coordinated by the same contractor (general contractor), in order to achieve joint design and construction. And ultimately shorten the construction period, improved project quality. The coordination of design, procurement, and construction orderly requires the general contractor, supplier, and subcontractor integrated management based on trust, and thus enhancing the performance of supply chain management. Related studies have shown that trust is the premise for general contractor selecting suppliers and subcontractors. (Liu *et al.*, 2009) addressed that trust is important in curtailing opportunism and improving supply chain performance from China's evidence. Integrating framework based on trust can effectively improve supply chain performance. The lack of trust among members of the supply chain will lead to slow material and information flow, and will cause quality, cost, duration and other issues, thus will reduce supply chain performance (Meng *et al.*, 2011). Thus, our second hypothesis encapsulates this potential effect.

H2. Trust positively affects EPC projects in construction supply chain performance.

There are also scholars from different dimensions of trust and key indicators of supply chain performance trust to study positive role of trust in construction supply chain. System-based trust is built on the commitment to the contract. Member companies believe that the contract is binding on opportunistic behavior, and strengthen the bilateral adaptability of traders for problem solving, thereby saving monitoring and implementation costs, reducing transaction risk cost, and improving the efficiency and quality of projects (Meng, 2010). Therefore, this leads to our third hypothesis.

H2a. System-based trust has a positive effect on EPC projects in construction supply chain performance.

Cognition-based trust is built on the confidence in partners' competence (cognition-based trust). Good expectations for the common goal save monitoring and implementation costs, so that the project objectives can be better achieved (Lui & Ngo, 2004). In addition, (Leung *et al.*, 2005) found that competence allows partners to show psychological commitment and establishes *guanxi* with their collaborator, thus performance can be improved. Therefore, some scholars have clearly pointed out and confirmed the direct influence of trust on the project schedule, quality, cost, such as (Manu *et al.*, 2012; Khalfan, 2007). Therefore, we propose our fourth hypothesis as follows.

H2b. Cognition-based trust has a positive effect on EPC projects in construction supply chain performance.

Due to the one-time feature resulted in the friability of

supply chain, affect-based trust encourages the willingness of supply chain members to consider others instead of exploiting others vulnerabilities. Affect-based trust, together with cognition-based trust, integrated the entire organization to avoid or minimize conflicts, litigation and claims. (Hempel *et al.*, 2009) found that managing conflict can strengthen trust and consequently facilitates performance. Good trust could improve the ability of supply chain members to cope with uncertainty, which is flexibility. Therefore, the issue that trust can enhance the relationship of nodes enterprises has also been discussed by many scholars, such as (Chen *et al.*, 2007; Meng *et al.*, 2011; Gannon, 2012) and so on. Therefore, it is hypothesized as follows:

H2c. Affect-based trust has a positive effect on EPC projects in construction supply chain performance.

The Influence of Contractual Governance on the Cooperation

For large-scale public projects, such as EPC projects, contracts play an important role in cooperation. The economists who study the transaction cost take contracts as devices for structuring ex-post adjustments and for constraining wasteful (rent-dissipating) efforts to influence the distribution of gains from trade (Masten & Saussier, 2000). As pointed out by (Williamson, 1985) and highlighted in empirical studies (Saussier, 2000), contracting partners might want to shape a complete contract ex-ante in order to avoid ex-post adaptation because such adaptation might be costly without any cooperation.

From one side, contracts could encourage each supply chain members perform their proper function by securing the parties. From this perspective, the contract may be analyzed as a tool to generate trust, with contracting parties investing ex-ante at the cost of less ex-post cooperation (Saussier, 2000). On the other side, contracts could reduce opportunism. An explicit contract specifies acceptable behaviors and unacceptable behaviors (Lui & Ngo, 2004), and can mitigate opportunistic behavior (Poppo & Zenger, 2002). (Lui & Ngo, 2004) argued that contracts can curb opportunism through two mechanisms. First, contracts can change the payment structure by increasing the cost of opportunistic behavior. Second, contracts can reduce the monitoring cost by increasing the transparency of relationships (Reuer & Arino, 2007). (Luo *et al.*, 2011) proposed and verified that cooperative behaviors, such as commitment, information sharing, compliance to power execution and dependence continuity, are subject to the influence by contractual governance. Therefore, it is hypothesized that:

H3. Contractual governance has a positive effect on cooperation among supply chain member.

The Influence of Trust on the Cooperation

Most scholars believe that, due to the uncertainty and opportunistic behavior in the project, trust is essential in formation and maintenance of inter-enterprise cooperation (Lui & Ngo, 2004; Rashed *et al.*, 2013). Trust can create good cooperation environment, mitigate the hostile atmosphere, and make it possible to produce cooperation (Lui *et al.*, 2006; Hausman & Jhonston, 2010). Under the premise of a friendly atmosphere, the existence of trust helps

bilateral members reach the agreement, which contributes to the formation of cooperation (Ndubisi *et al.*, 2011). The cooperation among supply chain members is usually a long-term cooperation based on mutual trust, due to the greater emphasis on integration, synchronization and coordination. In China, trust, increased by the level of guanxi, leads to communication and cooperation (Pressey & Xuan, 2007). (Cai *et al.*, 2010) addressed that trust affects two elements of information integration, namely, information sharing and collaborative planning. By building trust, confidence, and spontaneous common goal instead of paying attention to risks brought by uncertainties and complexities, effective integration among the organizations can be realized, and ultimately achieve long-term and stable cooperation (Kadefors, 2004). (Black *et al.*, 2000; Laan *et al.*, 2011) have confirmed the positive impact of trust on cooperation in construction supply chain (Bachmann & Inkpen, 2011). Therefore, it is hypothesized that:

H4. Trust has positive impact on cooperation.

Some scholars studied the effect on cooperation from different dimensions of trust. System-based trust is the good expectation for partners' future action in the objective environment, emphasizing the role of constraints (Bachmann & Inkpen, 2011). Owing to the trust for contract, law, and regulation, supply chain members believe that honor an agreement can obtain reward and compensation, while others who breach of the contract will be punished. Therefore, system-based trust raises the possibility of cooperation by restriction mechanism. Therefore, it is hypothesized that:

H4a. System-based trust has a positive effect on cooperation.

Compared with system-based trust, cognition-based trust and affect-based trust put more emphasis on interpersonal cooperation. EPC projects are complex and require multi-stakeholder involvement. Establishing trust on the basis of competence understanding and recognition enables the initiative cooperation (Mumbi & McGill, 2008). Based on the analysis of questionnaire collected from 129 owners and contractors in China, (Yin & Xu, 2012) found that trust derived from competence has positive impact on cooperation. Studies have shown that cognition-based trust has direct relation with decision synchronization, benefit distribution, and risk sharing, which are the concrete manifestation of supply chain members' cooperation. Therefore, it is hypothesized that:

H4b. Cognition-based trust has positive impact on cooperation.

Establishing affect-based trust on the basis of character recognition makes each other believe the other will not deceive ourselves by self-interest, thereby enhancing the likelihood of the commitment and ensuring the permanence and stability of cooperation (Bakker *et al.*, 2006). (Lu & Hao, 2012) addressed that affect-based trust has a significantly positive influence on cooperation. And their results are interpreted in light of Chinese culture. Therefore, it is hypothesized that:

H4c. Affect-based trust has a positive effect on cooperation.

The Influence of Cooperation on the EPC Projects in Construction Supply Chain Performance

The academic works for cooperation positive impact on construction supply chain mainly include two aspects: the ideas of supply chain management, and features of construction project. a) From the point of view of supply chain management thought, the substance of supply chain management is to emphasize cooperation and coordination mechanisms among supply chain members. (Liu *et al.*, 2013) obtained data from a survey administered to 246 firms in China, and find that operational coordination is positively associated with operational performance in supply chain. To make the information, material and fund flow smoothly transfer among supply chain enterprises, and to reduce costs, short the construction period, improve the owners satisfaction, improve the performance, we must conduct an effective coordination among supply chain members, which are demonstrated by the synchronization decisions, information sharing, benefits distribution, and other cooperative behaviors. b) Considering from the characteristics of long construction period, technical complexity, there are many uncertainties in the process of EPC projects. These produce a lot of variation orders and site instructions, which require general contractors,

construction subcontractors, and design subcontractors establish close relations of cooperation, strengthen communication, and finally achieve cost reduction and finished ahead of schedule (Shi *et al.*, 2010). Meanwhile, EPC Projects have too many purchasing links and a large amount of purchase quantity, materials and equipment's situation directly affect the implementation of the project. So the general contractor, construction subcontractors, and suppliers require close cooperation to concern the long-term interests and common goals, and finally achieve the efficient operation of the supply chain (Eriksson, 2010). Therefore, whether departure from the idea of supply chain management or from the characteristics of EPC projects, the cooperation has an important positive impact.

Based on the above analysis, the positive role of cooperation on EPC projects in construction supply chain performance has been generally recognized. The hypotheses were proposed as follows:

H5. Cooperation has a positive effect on EPC projects in construction supply chain performance.

The Model

The complete model is presented in Figure 3.

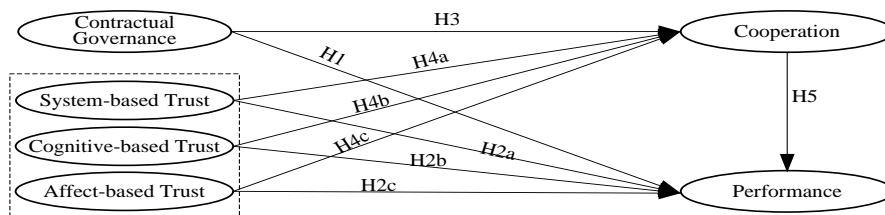


Figure 3. Research Hypothesis Model

Research Methods

Structural Equation Modeling

Structural equation modeling (SEM) is widely used to characterize relationships among observed and unobserved variables by way of path diagrams (Hair *et al.*, 1998). Researchers use statistical methods to deal with complex theoretical model, depending on the relationship consistency of model and data, and make appropriate evaluation about theoretical model so that they can prove or disprove the prior assumption of theoretical model. From the process, the features of SEM can be as follows:

- Theoretical priority;
- Dealing with measure and analysis problems at the same time;
- With the use of covariance as the core;
- Emphasis on the application multiple statistical indicators.

In this study, SEM describes the structure of variables that shows the impacts of contractual governance towards cooperation, contractual governance towards performance, trust towards cooperation, trust towards performance, and cooperation towards performance.

Scale Development

In this study, variables measurements adopted Likert-type scale. Respondents were asked to measure the degree of

agreement between questionnaires and enterprise's actual situation according to "1–5" points. 1 means "completely out of line." 5 represents "exact match". Specific questions of the relevant variables are shown in Table 2.

Independent variable: 6 items to measure contractual governance according to the study of (Goo *et al.*, 2009; Lu, 2014), and Setting 9 items to measure trust according to the study of (Wong *et al.*, 2008).

Intervening variable: Setting 5 items to measure cooperation according to the study of (Eriksson & Pesamaa, 2007).

Dependent variable: Setting 6 items to measure EPC projects in construction supply chain performance according to the study of (Pan *et al.*, 2010).

Data Source and Structure

This study used questionnaire to collect data covering three aspects: trust, cooperation and EPC projects in construction supply chain performance. In order to ensure the rationality and effectiveness of questionnaire, the author gave out initial questionnaire to 15 professionals for review; then revised and improved questionnaire according to their feedback; and finally formed the formal questionnaire.

General contractor of EPC projects is responsible for coordination and communication in EPC projects, and they can directly observe the situation of contract and relationship in EPC projects in supply chain operation. So

this study chooses the general contractor company, directly participating in EPC projects, as the survey object. Given the different political, economic, technology condition in different regions, which would impact the EPC projects in construction supply chain performance, this survey was limited to Beijing and Tianjin, such as Beijing Urban Construction Design & Research Institute Co., Ltd. and Tianjin Urban Construction Group Co., Ltd. Since the concept of EPC projects in construction supply chain is relatively new in practice, the survey is direct to the EPC projects manager participating in the project that has been completed in the last three years. In the questionnaire, the author elaborated on the concept of EPC projects in construction supply chain, ensuring the questions can be understood accurately and answered effectively. The main form used is electronic questionnaire. Firstly, we use E-mail and chatting software such as QQ to distribute and recover questionnaires. In particular, to improve recovery rate, we contact the respondents who is in charge of the survey once a week. Secondly, after collecting the e-questionnaire, we visit the respondents' sites with a few paper questionnaires which are different from the electronic ones. In this study, the process of data collection lasted for three months, from September 2014 to December 2014, and a total of 250 questionnaires were distributed; 230 questionnaires were recovered. After removing null questionnaires, we have 176 valid questionnaires. The efficiency reached 70 %. Among

the respondents, senior managers accounted for 35,8 %; middle managers accounted for 52,3 %; and general managers accounted for 11,9 %. The average working life of the respondents was 5,5 years. Among the 176 respondents, 115 persons get bachelor degree, 50 persons get master degree and 11 persons are PhD. The respondents who had adopted supply chain management accounted for 20,5 %; who had not explicitly adopt supply chain management, but adopt similar SCM management mode in practice accounted for 72,7 %. Therefore, this investigation is deemed to be reliable.

The Reliability and Validity Testing

In this paper, SPSS and AMOS were used to test the reliability and validity. Cronbach's α value was used to estimate the reliability, which should be greater than 0.7. In this study, the Cronbach's α value of each multi-item variable is greater than 0.7, which implies high internal consistency. Composite Reliability (CR) and Average Variance Extracted (AVE) were used to estimate the convergent validity. It is necessary that CR value is greater than 0,7 and AVE value is greater than 0,5 (Nunnally, 1978; Fornell & Larcker, 1981). It can be seen from Table 2 that for each variable, the CR values range from 0,84 to 0,94, and the AVE values range from 0,64 to 0,82. All of them are higher than the required level. These show good convergent validity and construct validity of the scale.

Table 2

The Measurement Statements of Metric, Reliability and Validity

Elements	Measurement statements	Factor Loading
Contractual governance	<i>Cronbach's $\alpha=0,92$; CR=0,94; AVE=0,72</i>	
	1. The contract has detailed the obligations and rights of every party.	0,83
	2. We have a clear expression of the default definitions and formula.	0,85
	3. The contract has specified the procedures and methods for disputes.	0,81
	4. The contract has described the safety management requirements, quality standards, contract price and its payment to manage the agreements among parties.	0,80
	5. The contract has specified major principles or guidelines for handling unanticipated contingencies as they arise.	0,80
System-based Trust	6. The contract has allowed us to respond quickly to match evolving client requirements.	0,81
	<i>Cronbach's $\alpha=0,88$; CR=0,88; AVE=0,71</i>	
	1. You believe that the long-term partners have clearly defined the job tasks required of each parity, in order to reinforce goal achievement	0,84
Cognition-based Trust	2. You believe that there is effective communication platform in the supply chain to avoid ambiguous situations and discrepancies	0,89
	3. You believe that there is clearly defined contract document in the supply chain so as to minimize future arguments	0,80
	<i>Cronbach's $\alpha=0,88$; CR=0,88; AVE=0,71</i>	
Affect-based Trust	1. You believe that there are good interaction and communication in the supply chain so as to facilitate better understanding among individuals	0,85
	2. According to the track record of partners, you believe you cooperation partners are capable for the project.	0,86
	3. You believe that all the long-term partners recognize integrity is the foundation of cooperation	0,81
Cooperation	<i>Cronbach's $\alpha=0,84$; CR=0,84; AVE=0,64</i>	
	1. You believe that your long-term partners will show care and concern to their workmates at appropriate time	0,79
	2. You believe that the long-term partners will consider from your perspective	0,83
	3. You believe that there is good personal relationship in the supply chain, which guaranteeing good working relationship	0,78
	<i>Cronbach's $\alpha=0,90$; CR=0,84; AVE=0,64</i>	
EPC projects in Construction Supply chain performance	1. There is explicit joint objectives between you and your long-term partners	0,78
	2. There is policy for conflict solution in supply chain	0,79
	3. There is shared IT-database for shared information in the supply chain	0,81
	4. There is shared coordination office (or similar institution) in the supply chain	0,79
	5. Your long-term partners committed to team building activities	0,85
	<i>Cronbach's $\alpha=0,93$; CR=0,93; AVE=0,68</i>	
EPC projects in Construction Supply chain performance	1. The EPC project you selected is expected to be completed in accordance with project schedule	0,81
	2. The EPC project you selected has no situation of cost overruns	0,80
	3. The EPC project you selected is in good quality	0,82
	4. The partner of EPC project respond effectively to a variety of changes that appear in the project	0,81
	5. The project leader or manager is satisfied with the overall condition of the selected EPC projects	0,81
	6. There is a good relationship and harmonious atmosphere among the partners of EPC project your selected	0,90

Results

We test our hypotheses using the structural equation model in AMOS. The initial confirmatory model test results

in a good model fit: $\chi^2/df = 1,29$, NFI = 0,93; CFI = 0,99, IFI = 0,99, and RMSEA = 0,03.

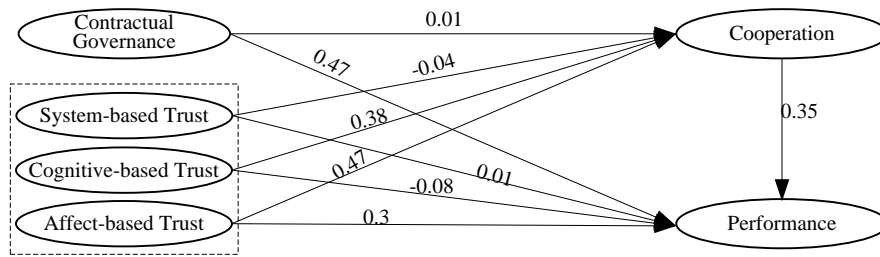


Figure 4. The Structural Model with Path Coefficient

According to the Figure 4, it is found that contractual governance has positively significant impact on EPC projects in construction supply chain performance ($b=0,47$, $p<0,001$), while the impact of contractual governance on cooperation is not significant ($b=0,01$, $p=0,787$). Trust has partially impacted on cooperation and EPC projects in construction supply chain performance. Compared with trust, contractual governance has more significant impact on EPC projects in construction supply chain performance. In addition, we can also conclude that cooperation has positively significant impact on EPC project in construction supply chain performance ($b=0,35$, $p<0,001$). Different dimensions of trust have different impact on cooperation and EPC projects in construction supply chain performance. Specifically, Cognition-based trust and affect-based trust has positively significant impact on cooperation ($b=0,38$, $p<0,001$; $b=0,47$, $p<0,001$). System-based trust has negative impact on cooperation, but not significant ($b=-0,04$, $p=0,513$). Only affect-based trust has positively significant effect on EPC projects in construction supply chain performance ($b=0,3$, $p<0,001$).

Discussion

Theoretical Implications

This paper studied the impact of governance on contract action and EPC projects in construction supply chain performance. The results show that: 1) contractual governance has positive impact on EPC projects in construction supply chain performance, but the impact on cooperative behavior is not significant; 2) trust shows influence both on cooperation and performance; 3) cooperation has a significant positive influence on the performance; 4) different dimensions of trust have different impact on cooperation and performance: system-based trust has a significant positive influence on cooperation and performance; the impact of cognition-based trust on performance is not significant, and it only has positive influence on cooperation; affect-based trust has no influence on collaboration and performance.

Firstly, in this paper, the result of the impact the governance on the performance has similarity with other scholars, however in Chinese context it also has dissimilarity with previous research. As (Tennant & Fernie,

2012) addressed, governance providing an institutional framework to define the rights obligations and responsibilities in the future. The performance will be improved, as the contact is complete. However, this paper has different result with (Luo, 2002) on the conclusion that governance has insignificant influence on cooperation. (Luo, 2002) believes that contract provides an institutional framework guiding the course of cooperation, while cooperation overcomes the adaptive limits of contracts. It means that governance can enhance cooperation, and thus improve the performance. In contrast, this paper argues that trust enhance cooperative behavior more apparently. As (Chen & Partington, 2004) addressed, many differences between Chinese and Western construction project management caused by different culture. In Chinese context, both contractor and client are inclined to cooperate with people who have *guanxi* (means relationship) with them. Meanwhile, recent research on the promotion of cooperation among parties mainly focuses on relational governance, e.g., relational norms (Tangpong *et al.*, 2010; Cao & Lumineau, 2015). This is because the characteristics of contract (incompleteness) made it difficult to conduct cooperation reach every aspect of a matter. And China's national conditions determine the cooperative in engineering field rely more on personnel relationship.

Secondly, the positive impact of trust on EPC projects in construction supply chain is accordance with most research. In this paper, both the cognition-based trust and affect-based trust have positive influence on cooperation, and the influence of affect-based trust is more significant. Cognition-based trust primarily relies on supply chain members' expertise and reputation. Owing to the large-scale, clear division, and technical complexity of EPC projects in construction, the recognition of professional ability among supply chain member can reduce costs, and better allocate the resources. Reputation could reduce moral hazard in the transaction process through constraint mechanism, so the partners prefer long-term cooperation. (Lu & Hao, 2012) also find that affect-based trust has a significantly greater positive influence on cooperation than cognition-based trust. Affect-based trust has a positive impact not only on cooperation but also on performance. (Wong *et al.*, 2008) addressed that system-based trust has higher path coefficient than affect-based trust, but in this

study affect-based trust is more apparently. This is due to Wong's survey area in Hong Kong where culture is more like western culture. Trust, in Chinese context, is more based on one's credit of ability of return favors than relied on one's integrity and competency, as in the western context (Wang, 2007). Trust often plays a more salient role than legal contracts in Chinese Business (Yau *et al.*, 2000), and China individuals are often likely to rely on the trust developed with a partner rather than relying on legal interpretations (Pressey & Xuan, 2007). Chua *et al.*, (2009) believe that, in the Chinese context, the personal network of Chinese culture is the direct cause of trust. Our cooperation values personal network, especially the relationship between senior management among enterprises. And this emotion relationship has interactivity. It ultimately expresses as cooperation, and affects the performance directly.

Significant impact of cooperative behavior on the performance is consistent with most researches. The results show that cooperation has positive impact on EPC projects in construction supply chain performance. And cooperation is intermediary of trust and management performance. Therefore, cooperation plays an important role in the performance improvement. This conclusion is consistent with the findings of (Anvuur, 2008; Lui & Ngo, 2004; Rowlinson *et al.*, 2010), which explains that under different management scenarios, cooperation will contribute to the formation of a good working relationship, thus achieving performance improvement (Anvuur, 2008; Lui & Ngo, 2004).

Management Inspirations

Selecting a reasonable means of governance is the basis for improving the EPC projects in construction supply chain performance. Industrial practices show that it is not satisfactory to rely only on contract and rigid constraints to reduce opportunistic behavior among members to maintain a high level of cooperation. Therefore, it is suggested that the general contractor pay attention not only to governance, but also to relationship building among member companies. In the situation of weak governance, trust has become the primary means of maintaining cooperative behavior, particularly cognition-based trust and affect-based trust. Meanwhile, the malfunction of cooperative behavior by contract does not affect the improvement of supply chain performance by governance. The constraint of rights, responsibilities and benefits by contract affect performance through incentive mechanism. Therefore, the general contractor is concerned should pay attention not only to governance, but also to relationship building between member companies. Developed rigorous, appropriate model of contract and committed to close cooperation between the teams at the same time. As for owners, when selecting alliance of EPC projects in construction supply chain, they should not only examine professional competence, but also pay attention to the relationship between supply chain members and team building, and select the appropriate type of contract to ensure the project success. In China, although contractual governance has positive effect on EPC projects in construction supply chain on performance, its effect on cooperation, which is more significant in China, is not well

addressed and studied. In addition, it is found that trust is a crucial factor for both performance improvement and cooperation. Compared to contractual governance, trust is more flexible and more suitable for characteristics of guanxi culture in China.

Limitations and Future Research

Several limitations in our research provide potential directions for further investigations. First, this study acquiesces relationship between collaborators are equal and mutual recognition. And conduct the research only on general contractor. However, there are still unilateral relations in reality (such as unilateral trust). Investigate from different perspectives, such as general contractor, suppliers, and subcontractors would be more comprehensive. Second, most scholars believe that there is a correlation between the relationship management and contractual governance. Is it possible for trust to influence the performance by improving governance; and is it possible for governance to influence cooperation by improving trust? These should be studied in the future. Third, we used data collected from China to empirically verify our hypotheses. The considered hypotheses are more relevant in the context of construction supply chain in Chinese environment and may be not considered as revealing, we will exert our best to propose better hypotheses in future study.

Conclusion

This paper attempts to identify the effectiveness of contractual governance and trust in EPC projects in construction supply chain management. Using EPC projects in China as the empirical setting, we have four major findings. 1) Contractual governance shows direct positive impact on EPC projects in construction supply chain performance, but the impact on cooperative behavior is not significant. 2) Trust shows indirect influence on performance through cooperation, and some influence is direct. 3) Compared with trust, contractual governance has more significant positive influence on performance. 4) Different dimension of trust has different influence: affect-based trust have significant direct influence on performance, and indirect influence on performance through cooperation; cognition-based trust has no direct influence, but indirect influence on performance through cooperation; system-based trust has non-significant influence on performance.

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