for the PPP projects to remind the project manager to take refinancing arrangements proactively to prevent potential financial distress that the project might suffer.

From the perspective of passive refinancing, this paper uses the system dynamics method to establish a financial early warning model for PPP projects based on the position of the project company. Moreover, the proposed model is applied to a rail transit PPP project in Chongqing. Through the detection and analysis of the simulation results, this paper verifies that the model can forecast the future cash flow of PPP projects more accurately and provide forward-looking forecast information of financial situation for project managers.

The main contribution of this paper is that the system dynamics method is applied to the PPP project financial early warning research field for the first time. It is shown in a case study that SD model can efficiently warn in advance in operational phase of project. The model reflects the financial condition of the project by predicting cash flow changes, and makes proactive project financial risk management possible.

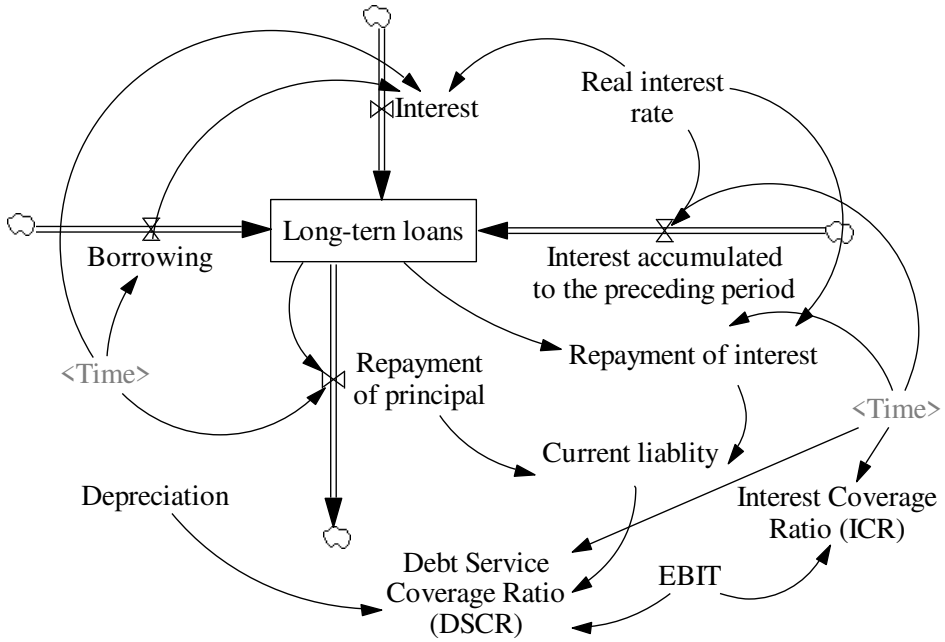

Figure 1. SD model (the part of cash flow of financing and debt service).

MODEL FORMULATION

Financial early warning indicators: The financial risk of PPP projects is caused by the uncertainty of its capital movement that is often accompanied by the cash inflow and cash outflow. Therefore, cash flow is a direct manifestation of the capital movement and there is an inseparable relationship between them. The cash flow condition can comprehensively reflect the financial condition of the project and the balance of cash flow condition is the basis for smooth operation of the project. Therefore, the financial early warning indicators of PPP project, with cash flow as the core, not only reflect the financial condition of the project, but also provide financial warning.

This paper focuses on the solvency and profitability of the PPP project during the operation period. Although the project is faced with the risk of cash flow shortage in the construction phase, the risk is relatively low since construction period is short. Based on the characteristics of the PPP project and the existing literature on the financial early warning of PPP projects, this

paper sets up six cash flow warning indicators that reflect solvency and profitability.

(1) Equity Liability Ratio (ELR). The indicator reflects the capital structure of the PPP project. In general, the lower the ratio, the higher the company's debt repayment risk. The formula is shown as following:

$$\text{ELR} = \text{capital} / \text{liabilities} \tag{1}$$

(2) Interest Coverage Ratio (ICR). This indicator reflects the ability of the project operating income to pay interest. The lower the indicator, the higher the company's debt repayment risk, and should be alerted. The formula is shown as following:

$$\text{ICR} = \text{earning before interest and taxes} / \text{interest payable at the end of the current period} \tag{2}$$

(3) Debt Service Coverage Ratio (DSCR). This indicator reflects the ability of the project operating income to repay the principal and interest in the current period. If the indicator is too low, it indicates that the project may fail to repay the principal and interest on schedule, and an early warning should be given. The formula is shown as following:

$$\text{DSCR} = \text{funds available for repayment of principle and interest} / \text{the amount that should be repaid in the current period} \tag{3}$$

(4) Current Liabilities Cash Flow Ratio (CLCFR). This indicator reflects the ability of the net cash flow from operating activities to repay current liabilities. The formula is shown as following:

$$\text{CLCFR} = \text{net cash flow from operating activities} / \text{current liabilities} \tag{4}$$

(5) Debt-to-Cash Ratio (DCR). This indicator reflects the extent to which the net cash flow from operating activities guarantees the company's long-term debt and short-term debt. In the long run, the lower the indicator, the worse the company's future solvency. The formula is shown as following:

$$\text{DCR} = \text{net cash flow from operating activities} / \text{total liabilities} \tag{5}$$

(6) Cash Return on the Investment (CROI). This indicator reflects the profitability of the project. It is necessary to emphasize here that the CROI is the ratio of the net cash flow of operating activities to the total investment amount of the project, not the ratio of profit to total investment.

Since the PPP project has the characteristics of both engineering and public projects, the government as the public interest representative is more concerned with the project's national economic evaluation indicators, while the private investors are more concerned about the project's profitability. Therefore, when the indicator is less than the ROI required by the private investor, it should be early warning and analyzed whether there is a problem during the operating process. Under the premise that the operation condition cannot be changed, the government can consider other ways to compensate the private investor. The formula is shown as following:

$$\text{CROI} = \text{net cash flow from operating activities} / \text{total investment for construction projects} \tag{6}$$

(7) Net Present Value (NPV). The indicator is to discount the net cash flow obtained by the PPP project in each year in the future to the beginning of the construction period, and to calculate the sum of the present values of each year. If the indicator is less than zero, the NPV of the project is negative and an early warning should be given. The formula is shown as following:

$$\text{NPV} = \sum_{i=1}^{T} (B - C)_t (1+i)^{-t} \tag{7}$$

Where B is the inflow of cash flow; C is the outflow of a cash flow; $(B-C)$ is the net flow of cash flow in the t-year; T is the future calculation period; i is the discount rate.

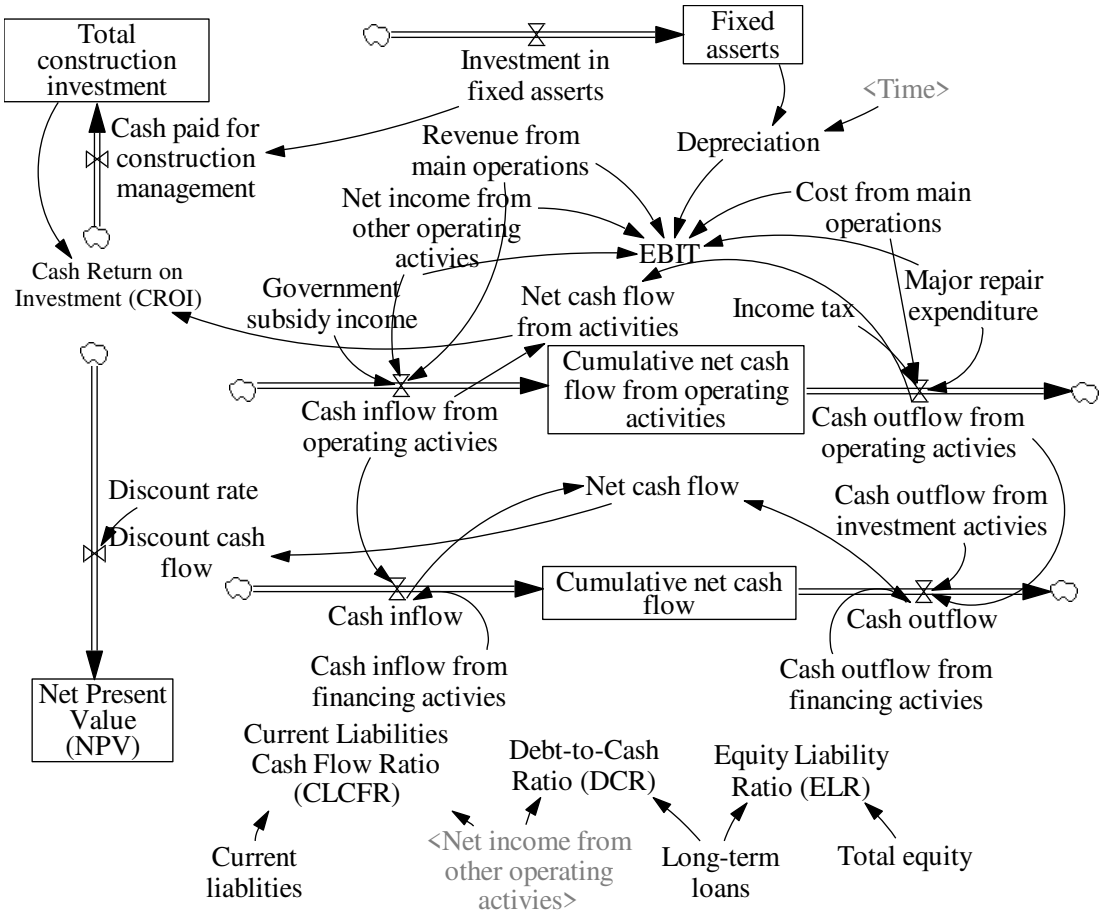

Figure 2. SD model (the parts of cash flow of construction investment estimation and operating activities).

SD model formulation: This paper uses the system dynamics simulation software Vensim-PLE to carry out dynamic simulation, and divides the cash flow of PPP project into three sub-modules: cash flow of financing and debt service, cash flow of construction investment estimation, and cash flow of operating activities.

The main relationship of the variables in the model:

Revenue from main operations=Revenue from main operations of the previous year × (1+ Revenue from main operations growth rate)

Cost from main operations=Cost from main operations of the previous year× (1 + Cost from main operations growth rate)

Cash inflow from operating activities=Income from main operations + Net Income from other operating activities + government subsidy income

Cash outflow from operating activities=Major repair expenditure + Income tax + Operating costs

Cash inflow from financing activities=Borrowing + Cash received from accepting investment

Cash outflow from financing activities=Cash paid for debt + Cash paid for dividend

Cash outflow from investment activities=Cash paid for construction investment

Net cash flow = cash inflow-cash outflow
The model is shown (see Figure 1 and Figure 2).

Table 1. The Value of Part of Main Variables.

Variable	Unit	Estimated Value
Project capital investment	thousand Yuan	20 177 077.90
Construction period loan amount	thousand Yuan	11 267 077.90
Real lending rate		4.90%
Mode of repayment		Equal amount repayment, annual interest payment The repayment period: 18 years The grace period: 3 years
Construction period	Years	4
Proportion of project cost investment		Four years were 0.17、0.22、0.25、0.36 respectively
Total investment in fixed assets	thousand Yuan	19 735 931.30
Ticket revenue (initial value)	thousand Yuan	580 176.80
Ticket revenue growth rate		4% from 2021 to 2029 2.4% from 2030 to 2049
Non-operating net income		10% of ticket revenue
Operating cost (initial value)	thousand Yuan	619 967.20
Operating cost growth rate		1.27% in 2017, and in the subsequent years it grows at a rate of 0.02%

APPLICATION OF FINANCIAL EARLY WARNING MODEL FOR PPP PROJECTS

The proposed model is applied to a rail transit PPP project in Chongqing, which is to verify the validity of the financial early warning model. The project is a newly-built project, which is planned to adopt the “BOT+EPC” model. The government and private investors set up the project company that is responsible for financing, engineering design, construction, procurement

and operation management. After the franchise period expires, the project will be handed over to the government. There are two assumptions in this paper for the purpose of model simplification. First, the construction fund is invested once at the beginning of the year; Second, the increase in equity and short-term financing during the simulation period or the impact of asset impairment losses and deferred income tax are not considered. The franchise period of the PPP project is from 2016 to 2039 (a total of 34 years), so the simulation period of the model is 34 years and the simulation step is 1 year.

Estimation of model variables initial value: Based on the data from feasibility study of Chongqing rail transit project, this model divides the variables into three parts: project financing, investment and operation. The value of part of main variables are shown (see Table 1).

Reliability test of simulation. Because multiple indicators are zero during the construction period, the real value and the simulated value of early warning indicators in the second year of the operation period (2021) are selected for inspection. The test results are shown (see Table 2).

Table 2. Inspection of Early Warning Indicators in 2021.

Early warning indicators	Estimated value for 2021	Real value for 2021	Absolute error
Equity Liability Ratio	1.064709	1.064710	-0.000001
Interest Coverage Ratio	0.049734	0.049734	0.000000
Debt Service Coverage Ratio	0.658993	0.658988	0.000005
Current Liabilities Cash Flow Ratio	1.064709	1.064710	-0.000001
Debt-to-Cash Ratio	-0.541879	-0.541875	-0.000004
Cash Return on the Investment	52709.906991	52709.900000	0.006991
Net Present Value	0.030495	0.030495	-0.000000

It can be seen that the other indicators test error is within 0.00001 in addition to discounted cash flow. For a project with an investment of 20 billion Yuan, the error of about 0.007 million Yuan is negligible.

In summary, the early warning model can be considered to simulate the project well.

Simulation results: This paper selects the CLCFR and the CROI as the representative to analyze the solvency and profitability of the PPP project (see Figure 3 and Figure 4).

As shown in Figure 3, in the stage of repaying interest, the company's CLCFR is greater than 1 and increase, which indicates that the cash flow generated by the company's operating activities can pay the amount of the current repayable principal and interest, and further manifests that the short-term solvency of project is strong. The changes of CROI can be divided into two stages. At the beginning of the operation period (7th to 24th years in the figure), the project has a higher CROI due to the government paying the project company lots of subsidies

each year. In the latter part of the operation period (25th to 34th year in the figure), since the government no longer pays subsidies at this stage, the cash inflow of project company only relies on the operation of the project itself that leads CROI at a low level. But increases of CROI indicates the project's profitability is gradually increasing.

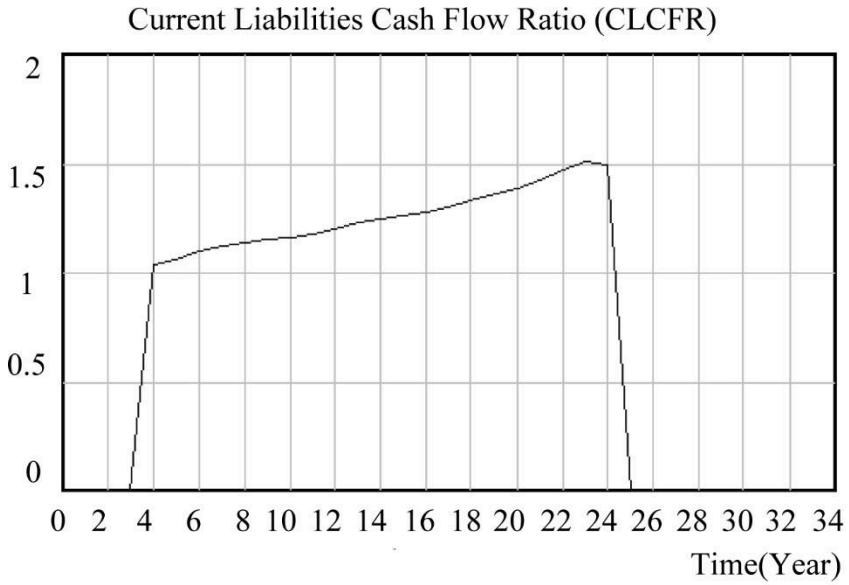

Figure 3. Simulation results of CLCFR.

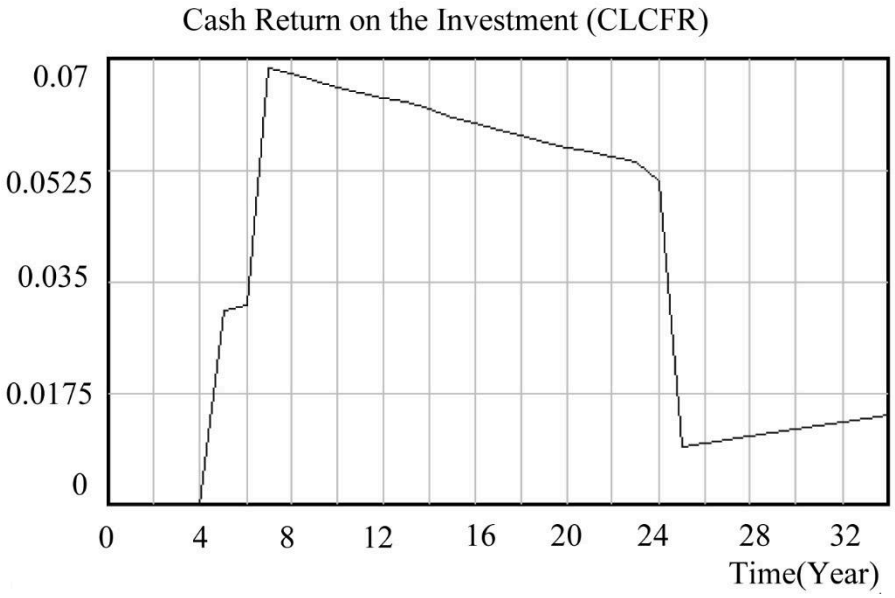

Figure 4. Simulation results of CROI.

Generally speaking, the project company has strong short-term solvency and poor profitability. The profitability reflects the ability of the project to generate cash flow, and the funds for the project's debt service mainly comes from the net cash flow of operating activities. Therefore, the manager should be warned that the overall financial condition of the project company is relatively poor and the project company has a high cash flow risk. However, due to the strong public service nature of rail transit projects, the government has multiple restrictions

on pricing charges. Thus project companies should improve ROI by increasing the income of other operating activities (such as advertising revenue and station commercial leasing income).

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CONCLUSION

From the perspective of refinancing, this paper constructs the financial early warning model of PPP project by using system dynamics method. The proposed model is used to predict the future cash flow changes of PPP projects. Applied to a real rail transit case, the model proves to be reliable in financial early warning. The model can alert the managers to the cash flow risks that the PPP projects will suffer in future operating period and help the managers make refinancing decision.

However, the early warning scope is not complete enough-financial risks warning during the construction period of PPP projects is not included. The research work done in this paper is a new attempt to apply the system dynamics method to the PPP project financial early warning field. In the future, researchers can conduct more in-depth exploration according to specific problems.

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Linking Top Management Team's Internal Social Capital and Project Performance in a Mega Construction Project: The Mediating Role of Behavioral Integration

Jingyuan Wan[1]; Yun Le[2]; Jin Li[3]; and Ge Wang[4]

[1]Ph.D. Candidate, School of Economics and Management, Tongji Univ., Shanghai, China 20092. E-mail: wjy1656@163.com
[2]Professor, School of Economics and Management, Tongji Univ., Shanghai, China 20092. E-mail: leyun@kzcpm.com
[3]Ph.D. Candidate, School of Economics and Management, Tongji Univ., Shanghai, China 20092. E-mail: 15882873719@163.com
[4]Lecturer, College of Public Administration, Huazhong Agricultural Univ., Wuhan, China 430070. E-mail: ge_wang@yeah.net

ABSTRACT

This paper extends the previous literature of mega construction projects (referred to as megaprojects) by empirically exploring the relationships between the internal social capital of the top management team (TMT) and the project performance by considering the mediating effect of the behavioral integration. Questionnaires were used to collect data from 133 top managers of megaprojects in China. The results obtained from partial least squares analysis showed that structural and cognitive social capital have positive impacts on project performance, but relational social capital has no effect on project performance. In addition, the results further indicate that top managers' behavioral integration has a critical, but varied mediating role in the relationships between internal social capital and project performance. This paper reinforces that the realization of the values of internal social capital needs to be mediated by the exchange and integration of resources. The findings presented in this paper also provide new insights into the use of the TMT's social capital to facilitate the improvement of project performance in megaprojects.

INTRODUCTION

In recent years, the acceleration of the urbanization process has led to the rapid growth many megaprojects, especially in China (World Bank 2010). Megaprojects are large public projects that have a significant influence on countries' political, economic, social, scientific and technological development, as well as environmental protection, public health, and national security (Flyvbjerg et al. 2003). Considering the large investment, the long construction period, the extent to which high technology is involved, and the multiple participants of megaprojects, the government usually sets up a special team for each specific project, such as the Construction Committee of the South-to-North Water Diversion project, the China Three Gorges Corporation, the construction headquarters of the Shanghai World Expo, and the Hong Kong-Zhuhai-Macao Bridge Authority. Managers with certain administrative levels in such organizations form the top management teams (TMTs) of the megaprojects. They are responsible for making strategic decisions and managing important affairs on a daily basis, and, to some extent, these activities determine the success of megaprojects (Bai et al. 2016). Many studies have found that achieving the goals of a project depends largely on the quality of the relationship network among the members of the TMT. In other words, the social capital of the TMT has an important influence on the process of functioning as a team and on project performance.

The social capital theory first was proposed by Bourdieu (1986), and it is now used extensively in sociology, economics, management, and other disciplines. Coleman (1988) posited that social capital, rather than being the same as social networks, was the result of embedding networks, i.e., the ability of individuals to access and use scarce resources in networks and broader social structures. In addition to the network, other characteristics of social organizations, such as trust, norms, and values, also are included in the category of social capital (Quigley 1996). Based on this concept, Shipilov (2006) proposed the concept of TMT social capital in combination with the theory of social capital and the theory of the upper echelon, and they divided it into internal and external research levels. Internal social capital refers to the ability of team members to exchange and share decision information and resources acquired through the external network. It is a kind of social capital at the collective level. TMT members of megaprojects come from various administrative departments of the government or state-owned enterprises, and all of them have certain administrative levels. They have unique advantages in mobilizing social resources, which ensures the smooth progress of megaprojects. However, the building of the TMT is random, and there is no basis for cooperation among the members of the TMT. The psychology of self-protection will lead to the isolation of members or the rapid formation of multiple small groups. How to make full use of the power of TMT to transform the self-and private interests among TMT members into win-win and team interests, and further enhance the behavioral integration willingness of TMT members to avoid the occurrence of "1+1 < 2"? TMT social capital theory shows strong explanatory power in this aspect.

The concept of TMT is rooted in the upper echelon theory that was proposed by Hambrick and Mason (1984). This concept has undergone a research and evolution process from demographic characteristics to team operation. In this process, scholars have proposed various process variables, such as communication, conflict, integration, and cohesion, to identify the theoretical black box between the TMT characteristics and organizational performance (Lawrence 1997). On this basis, Hambrick (2007) proposed the concept of behavioral integration. Behavioral integration combines decentralized communication, cooperation, decision-making and other factors, and, as a whole, it represents a more comprehensive consideration of the operation of the TMT and has attracted extensive attention by many scholars. However, in the current research related to the TMT and project performance, the impact of internal social capital and operation process of a team has not been explored extensively.

The highly complex and comprehensive management of megaprojects has shifted from relying on a single leadership model to relying on a multi-disciplinary model of TMTs. The operation process of the TMT is a complex and delicate process in which different stakeholders interact with each other. How to achieve synergy by improving the quality of internal social capital, improve the integration of team behavior, and ensure high-quality engineering outputs also are urgent problems in the engineering community. Therefore, based on China's megaproject management situation, we used empirical methods to study the influence of social capital on project performance, the mediating role of behavioral integration in the process, and to provide a reference for improving the management capacity and output levels of megaprojects.

RESEARCH HYPOTHESES AND THEORETICAL MODEL

As an aggregate construct, behavioral integration includes three dimensions, i.e., cooperative behavior, information exchange, and joint decision-making. First, cooperative behavior, as a

sociological dimension in behavioral integration, emphasizes the voluntary mutual support among the TMT members (Hambrick 2007). Good cooperative behavior effectively can supplement both resources and skills, build cohesive teams, create a good team atmosphere, and avoid interpersonal conflicts caused by a lack of connections (Yao and Sun 2010). Second, communication and sharing based on information exchange is a prerequisite for efficient operation of the team. The waste of resources due to inadequate exchange of information may result in ineffective use of the expertise of the TMT members. In other words, the diverse skills of the TMT members can not be used effectively in the process of completing organizational tasks. Third, as the task dimension of behavioral integration, joint decision is considered as the embodiment of team cohesion. Sarin and McDermott (2010) found that, the more the members of the TMT participated in making decisions, the more they were able to inspire each other, generate additional ideas, and enhance the TMT's ability to cope with changes and solve problems. The following hypothesis is suggested based on the analysis presented above:

H1: There is a positive relationship between TMT behavioral integration and project performance.

Internal social capital contains three dimensions, i.e., the structure dimension, the relationship dimension, and the cognition dimension (Nahapiet and Ghoshal 1998). The structure dimension emphasizes the conditions of exchanging resources among TMT members, which is generally considered from both horizontal and vertical perspectives. The horizontal perspective refers to the frequency of communication between team members through informal activities. The vertical perspective refers to the degree of general contact between members. Princus (2010) showed that adequate communication reduces communication barriers between team members and increases their willingness to cooperate with each other. Wang et al. (2017) proposed that TMT members exchange views and extend communication to more private areas in informal ways, such as spontaneous conversations, unstructured meetings, and networking activities, which are conducive to reflecting their true thoughts, attitudes, and motivations for making decisions and facilitating the combination and exchange of information and resources within the team. With the enhancement of the density of the network, the connection among the TMT members in megaprojects has changed from being centralized and work-oriented to being more flexible and expressive connections, which ameliorates the difficulties in daily communication and the lack of willingness to cooperate among members. Based on this, we propose the following theoretical hypotheses:

H2a: Structural social capital is related positively to behavioral integration.

H2b: Structural social capital is related positively to project performance.

The relationship dimension emphasizes the willingness of the TMT members to exchange resources, while trust generally is considered to be the core element of relational social capital. Trust is an important resource in the team relationship network, and it is the basis for cooperation among members. Yeung et al. (2009) addressed the mechanism of the function of trust on internal integration and indicated that trust had a positive effect on internal integration. Parayitam (2010) found that mutual trust between the members of the TMT could improve the quality and commitment of the team's decision-making. However, distrust or low trust among the members of the TMT can lead to suspicion, even hostility, among the members. Lack of motivation for sharing information among the TMT members leads to the unproductive consumption of time and energy, which eventually can lead to project delays (Chen and Ye 2006). Studies have indicated that the efficiency of making and implementing decisions depends on the willingness of the decision makers to cooperate with each other. The level of trust among