A Study on the Structure of Construction-Agent System Projects based on Governance Intensity

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Abstract: “Construction-Agent System” (CAS) is a significant measure of deepening the reform of governmental investment systems and facilitating the transformation of governmental functions. In this paper, we are devoted to identifying 203 governance activities of a CAS project in multi-case studies to answer the following two key questions within a Chinese context: (1) What are the attributes and features of a CAS project governance activities? and (2) How can the governance structure of a CAS project be classified in consideration of the nature of project governance? This study has proposed a method to categorize governance structures of CAS projects. Our results show that CAS projects can be split into weak, median and strong governance structures, with the structures demonstrating an increase in governance links and subjects from the weak to the strong types. Then, the study defines the meanings and extensions of every governance type, placing emphasis on the key governance links and subjects according to the governance intensity and structure required by the project. In this way, the efficiency of CAS projects will be improved.

Keywords: Construction-Agent System, Project Governance, Governance Structure, Governance Intensity, Project Governance Activities

DOI: 10.7492/IJAEC.2015.016

1 INTRODUCTION

The publication of the “Decision of Reforming the Investment System” has marked the formal implementation of a construction-agent system (CAS) as an investment project in China. The implementation practice of a construction-agent system proves that this management mode can disengage the government from the management of a project’s construction and authorize the work to a professional project management company (or construction agency), which performs the management functions as an agent of the project owner. This is consistent with the contemporary requirement of the comprehensively deepened reform of Chinese politics and economics, as well as for the transformation of governmental functions. In recent years, China has been witnessing a continuously rapid growth in public project investment, which on one hand has built a favorable practical background for a construction-agent system, and on the other hand requires the construction-agent system projects to rely on a more reasonable governance structure to meet public social interests maximally.

As public project governance becomes a worldwide hot issue, the construction-agent system has evolved into a focus on project management. To publicize and improve the construction-agent system, researchers and practitioners have established a solid theoretical foundation and provided abundant practical experience for public reference, while also paying continuous attention to the issues concerning the construction-agent system. Currently, mainstream studies on the construction-agent system abroad mainly revolve around its mode, governance structure design, relations among governance structures (Wang and Chen 2006), incentive and restraint mechanism, risk research, and the relation between structure and performance (Leganza 2003).

Regarding the studies on the construction-agent system in China, there were 1,976 journal articles (January 2003-November 2014) in the retrieval database of CNKI. The research topics were focused on the summary of practical experience (71 articles) and the analysis of construction-agent system modes (66 articles), which accounted for 25.27% and 23.49% of all jour-
nal articles, respectively. Chinese scholars categorize construction-agent modes based on the production and operation modes of the construction agency, the development stages of the construction-agency system, or typical regions. Meanwhile, they compare the operation characteristics of these modes in the hope of providing experience for the construction-agency system projects in other regions. Nevertheless, every mode has been exemplified by successful projects. Thus, the analysis of the mode will result in a lack of practical guidance based on research theory.

In practice, the governmental governance of a construction-agency system project has the requirement of project governance and falls into the category of project governance (Van der Waldt 2010). Project governance is a relational framework structure that is constituted by authoritative bodies to fulfill project targets and recognized by stakeholders (Turner 2010; Bekker and Steyn 2007). Moreover, project governance is also a continuous integration process (Leganza 2003; Crawford 2005) that embodies the institutional arrangement (Yan and Yin 2006) of responsibilities, power and interests among the actors. It also guides, controls and regularizes the activities of the main bodies within the entire lifecycle of the project so that different stakeholders will coordinate with each other (Torfing 2010) and perform a joint action. Though the construction-agency system shows remarkable governance characteristics, only 14 articles revolve around the topic of project governance, taking up 4.98% of all Chinese literature. Most of these articles tend to analyze the performance (Yan and Yin 2006) and key success factors (Yan and Yin 2009) by dint of project governance thought, without going deep into the governance structure of construction-agency system projects. How to categorize the governance structure of construction-agency system projects based on the nature of project governance has evolved into a critical problem faced by theory and practice.

The governance structure of the current construction-agency system, particularly the structure of a complicated project, is still unclear in theory and practice. Various governance structures usually play different roles in practice (Terry Williams 2010), and the blind structure selection will lead to various problems in the process of implementation (Song et al. 2013). This is one of the important reasons to hinder government implementation of the construction-agency system and selection of a construction-agency system mode.

With focus placed on the fundamental connotation of project governance, this study explores the key factors in the governance structure of construction-agent system projects from the perspective of governance activities, providing insight for the implementation of governance structure design and laying a foundation for the subsequent structure selection.

2 METHODS AND DATA
This study uses the method of multi-case study. A number of scholars have verified the feasibility of a multi-case study in relevant fields of project governance and construction-agency systems (Mörth 2009; Ruuska et al. 2010). Governance is supposed to touch upon two aspects, including subjects and norms (Müller 2009). Subjects exist in the living examples of construction-agency systems that represent the current situation of practices and the states of every stakeholder; norms exist in relevant institutional laws of construction-agency system projects, with the institution appearing to be an important factor or manifestation mode of governance that embodies the policy orientation and development trend of the construction-agency system (Torfing 2010; Saïdel and Harlan 2010; Komori 2000). In view of this, the instances and laws of construction-agency system projects are selected as research samples. The sample information is collected not only from the internet but also from academic databases, such as the CNKI database, VIP database, Wanfang Database, and Lawyee.net. The samples are selected based on three standards: (1) the projects are selected from the early and large government-invested projects that have significant social influence in the regions with mature project experience; (2) the laws and institutions of the construction-agency system are selected from provincial-level or prefecture-level management measures of the construction-agent system, as well as from the specific laws made for the large public welfare projects in national or key cities; and (3) there is a need to ensure the extensive sources of samples, as well as the even distribution of the numbers, regions, types of projects and law samples.

Finally, 44 construction-agency project instances are chosen (taking up 52.8% of the total sample size and covering four major fields defined in current construction-agent law). Among these projects, public welfare (8), medical treatment (8) and traffic (7) projects constitute the largest proportions, followed by the projects related to residences, education, water conservation, administrative offices, parks, national defense, and stadiums. There are 41 law samples (48.2%), all of which are quoted from relevant construction-agent system articles constituting 23 provinces, 4 municipalities that are directly under the central government and 5 autonomous regions. Every step of this study implemented under the guidance of the standard case study method is replicable.

3 IDENTIFYING GOVERNANCE ACTIVITIES OF CONSTRUCTION-AGENT SYSTEM PROJECTS
Project governance is associated with project activities (Terry Williams 2010). The analysis of governance activities can improve the understanding of relations and
identify the relation interests more easily (Ko and Fink 2010). Therefore, to identify governance activities, attention is paid to the governance links and governance subjects.

3.1 Governance Links

Based on the reference to governance links and the combination with the attributes of construction-agent system projects, the governance links of construction-agent system projects are split into 15 items according to a project’s lifecycle. To provide guarantee for subsequent data analysis, the governance links of construction-agent system projects are coded as Pn, with n=\{1,2,3...15\}, as follows: building of management system (P1) (Lynn Jr. and Heinrich 2010; Aven and Renn 2010; Klakegg and etl 2008), supervision over organizational design (P2) (Ruuska et al. 2010; Ko and Fink 2010), selection of construction agent (P3) (Saidel and Harlan 2010; Crawford and Helm 2009a), sign contracts (P4) (Ruuska et al. 2010; Crawford and Helm 2009a), previous work and approval (P5) (Song and Fu 2010), preliminary design (P6) (Lynn Jr. and Heinrich 2010; Ko and Fink 2010), tendering of construction agent (P7) (Saidel and Harlan 2010; Ko and Fink 2010), fund application and use (P8) (Crawford and Helm 2009b), management over construction organizations (P9) (Bonnet and Wirtz. 2011), quality assurance (P10) (Müller 2009), security assurances (P11) (Ruuska et al. 2010; Crawford and Helm 2009a; Crawford and Helm 2009b), schedule control (P12) (Müller 2009; Klakegg and etl 2008; Crawford and Helm 2009a), investment control (P13) (Müller 2009; Klakegg and etl 2008; Crawford and Helm 2009a), scale control and design changes (P14) (Müller 2009; Crawford and Helm 2009a), and completion and acceptance (P15) (Song and Fu 2010; Müller 2009; Crawford and Helm 2009a).

3.2 Governance Subject

The different statuses (Pryke and Pearson 2006) and roles (Crawford and Helm 2009a) of stakeholders have led to the complexity of governance levels, which is the characteristic (Tasan-Kok 2010) of the project governance in which multiple independent subjects participate; therefore, the governance subjects of construction-agent system are supposed to be divided into different levels. Governance is intended for the integration of individuals and collectives in a country, society and market (Torfing 2010), including government and non-governmental actors (Komori 2000). For this reason, the governance of construction-agent system projects needs to take into account the public and private actors (Pryke and Pearson 2006). Governance is implemented among multiple subjects or organizations (Ruuska et al. 2010), resulting in the construction-agent system projects becoming trapped in an uncertain complex situation, where the scope of participants

![Figure 1. Governance subject of construction-agent system projects](image-url)
should be more extensive (Crawford and Helm 2009a), and the benefits of stakeholders should be fully considered (Pryke and Pearson 2006).

In combination with the above-mentioned views and attributes of construction-agent system projects, the analysis of sample content finds that the governance activities of construction-agent system projects include 23 subjects and 5 levels, with the coded message shown in Figure 1. From top to bottom, governance authority of the levels is declining. Governance level V is constituted by the most authoritative bodies in project governance, such as a legislative institution and the superior government. Governance level I is at the bottom of governance authority, including the units such as constructor and designer. The subjects at governance levels II, III and IV are both the governor and the governed.

3.3 Identification of the Governance Activities

The activities of the construction-agent system project and law samples are identified according to governance links. The link of investment control is hereby taken as an example to explore the identification process of governance activities, as shown in Table 1.

Finally, 203 governance activities of construction-agent system projects that cover 15 governance links are identified, Max(m)=35, Min(m)=5. The distribution proportion of governance activities can be observed in Figure 2. The conclusion is reached that the “selection of a construction agent” and “the tendering of a construction agent” have drawn high attention, which suggests the selection of a construction agent is highly indispensable for a construction-agent system project. There are large numbers of governance activities in the links, such as “supervision over organizational design”, “fund application and use”, and “management over construction organizations”, which implies that project governance highlights an organization’s supervisory role and avoids “three excesses” in reliance on the use of governance funds and construction management.

4 GOVERNANCE INTENSITY AND STRUCTURE OF CONSTRUCTION-AGENT SYSTEM PROJECTS

The identified governance activities are distributed discretely, and therefore, the governance activities should correlate with governance structure. Any type of project governance structure is associated with project governance activities (Lynn Jr. and Heinrich 2010) as a framework that consists of all governors and all the governed, as well as embodies the essential relationships among all subjects (Song and Fu 2010; Zoogah 2011). Governance activity, subject and structure can be compared with the veins, muscles and skeleton of the human body. Additionally, governance activity, which combines the subjects with each other, is fixed by governance structure to constitute a unified governance mechanism. The manifestation mode of governance activities comes down to the relationships among governance subjects, including control, supervision and

Table 1. Governance activities in the links of investment control

<table>
<thead>
<tr>
<th>Governance links</th>
<th>Activities codes</th>
<th>Governance activities of the construction-agent system project</th>
<th>Governance Subject codes</th>
<th>Data source codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>A13,1</td>
<td></td>
<td>The construction agent improves the budget estimate of total investment in cooperation with users and designers.</td>
<td>Fd, Ad, Ca, Us, Sd</td>
<td>HZ01</td>
</tr>
<tr>
<td>A13,2</td>
<td></td>
<td>The construction agent is rewarded in proportion to the funds saved.</td>
<td>Fd, Ad, Nd, Ca</td>
<td>SH01</td>
</tr>
<tr>
<td>A13,3</td>
<td></td>
<td>The construction agent is fined in proportion to the unapproved fund that exceeds the contractual budget.</td>
<td>Fd, Ad, Nd, Ca</td>
<td>SH01</td>
</tr>
<tr>
<td>A13,4</td>
<td>Investment</td>
<td>The construction agency is rewarded in proportion to the surplus of investment due to the use of new technology and process.</td>
<td>Fd, Ad, Nd, Ca</td>
<td>HNC01</td>
</tr>
<tr>
<td>Control</td>
<td>(P13)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A13,5</td>
<td></td>
<td>The budget estimate is jointly assessed by the construction agent, the user, the designer, the National Development and Reform Commission, the financial department, the auditing department, etc.</td>
<td>Fd, Ca, Us, Sd, Nd, Ad</td>
<td>HZ01,HN01</td>
</tr>
<tr>
<td>A13,6</td>
<td></td>
<td>The financial supervisor is assigned by the financial department to supervise and coordinate the major construction-agent system projects.</td>
<td>Fd, Ca, Us, Su</td>
<td>TJ01,SCH02, SH08</td>
</tr>
</tbody>
</table>
coordination. The structural attribute of governance activities boils down to governance intensity, including governance subject, level and quantity of activities. Therefore, based on the governance activities identified by the case study above, the governance intensity is measured and categorized according to relationships among governance subjects and an analysis of the governance structure.

4.1 Definition and Measurement of Governance Intensity

In the same construction-agent system project, the difference in governance structure will lead to the difference in governance subject, relation and activity. Based on the interaction of these factors, the governance intensity required by every governance structure will be different as well. Therefore, categorizing governance structures based on the significant changes in governance intensity is effective.

The factors that influence the governance intensity of construction-agent system projects are analyzed with the following factors: (1) it is obvious that the quantity of governance activities is the significant factor influencing governance intensity; (2) governance activities are performed by governance subjects, and the quantity of stakeholders has an influence on governance intensity; (3) a subject’s control over a project is associated with his status: the higher the level of the governance subject, the stronger the intensity of the governance activities that the subject performs will be. On this basis, inspirations are drawn from the study of Bruno Dente (Dente and Coletti 2011) on governance intensity to construct the measurement indices that can reflect the governance intensity (GI) of construction-agent system projects, including quantity of governance activities, governance subject and governance level.

Bruno Dente insists that $GI = Dense \times Focused \times Complex$, where Dense represents the extent to which the subjects interact with each other in the network (namely, governance amplitude in this study); Focused refers to the ability of the subject to play a central role (namely, governance level); and Complex means the quantity of different views that every subject expresses within the decision-making network (similar to the quantity of different governance activities in this study). Therefore, the measurement indices of the governance intensity of construction-agent system projects can be represented as follows:

(1) Governance amplitude (GA) refers to the extent to which all governance subjects interact with each other in governance activities under a certain governance framework. It is denoted by the array $Ga$ as follows:

$$Ga = \begin{pmatrix}
0 & a_{1,2} & a_{1,3} & \cdots & a_{1,n} \\
0 & 0 & 0 & \cdots & a_{2,n} \\
0 & 0 & 0 & \cdots & \cdots \\
\vdots & \vdots & \vdots & \ddots & \cdots \\
0 & 0 & 0 & \cdots & 0 \\
0 & 0 & 0 & \cdots & 0
\end{pmatrix}_{n \times n}$$

The array $Ga$ is the upper triangular matrix of $n \times n$, with upper triangular elements representing the relationships among the governance subjects. All the relationships among governance subjects in governance activities are analyzed, and the subjects in both rows and columns are sequenced in a descending order ac-
according to the governance level. If there is a governance relationship between two subjects, the value will be denoted as 1; otherwise, it will be denoted as 0 (including the same governance level). The value will be denoted as 1 only if the same governance relationship appears in different governance activities.

(2) Governance level (GL) is expressed by the array \( G_l \). When the subjects in columns are subordinate to the subjects in rows, the values from 5 to 2 should be assigned from level V to level II, and the value 1 will be assigned if the subjects are governors at the same level.

\[
G_l = \begin{pmatrix}
0 & l_{1,2} & l_{1,3} & \cdots & l_{1,n} \\
0 & 0 & l_{2,3} & \cdots & l_{2,n} \\
0 & 0 & 0 & \ddots & \vdots \\
0 & 0 & 0 & \ddots & \vdots \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
0 & 0 & 0 & \cdots & 0 \\
\end{pmatrix}_{n \times n}
\]

(3) Governance complexity (GC): the larger the number of governance activities is, the more factors that need to be coordinated in the project and the higher the governance complexity will be. The number of governance activities performed by the governors (subjects in rows) and the governed (subjects in columns) who are labeled by upper triangular elements in the array \( G_c \) is calculated according to the actual result.

\[
G_c = \begin{pmatrix}
0 & c_{1,2} & c_{1,3} & \cdots & c_{1,n} \\
0 & 0 & c_{2,3} & \cdots & c_{2,n} \\
0 & 0 & 0 & \ddots & \vdots \\
0 & 0 & 0 & \ddots & \vdots \\
\vdots & \vdots & \vdots & \ddots & \vdots \\
0 & 0 & 0 & \cdots & 0 \\
\end{pmatrix}_{n \times n}
\]

The measurement equation is as follows:

\[
G_l = G_a \cdot G_l \cdot G_c
\]

where the operator \( \cdot \) represents the product of the array.

The sum of all column volumes is the governance intensity under the governance structure, and the measurement equation is as follows:

\[
GI = \sum(G_i)
\]

4.2 The Correlation between Governance Intensity and Governance Structure

After governance intensity is figured out, energy should be devoted to exploring the correlation between intensity, link and subject to improve the features and internal relevancy of governance structures in the face of different intensities.

Relevancy 1: the distribution of governance activities in governance links. According to the statistical results regarding the distribution of governance activities, the governance links can be split into three types, as shown in Table 2.

The frequency of the governance activities in the first four links, such as the “selection of construction agent”, exceeds 10%; the cumulative frequency arrives at 53.2%. As observed, half of the governance activities are carried out in these four governance links, which have constituted the most significant process in the governance of construction-agent system projects. This process highlights the governance of the activities in all governance structures, aside from weak governance activities. Thus, the four links above can be termed as the “core governance links”.

The frequency of the governance activities in the next four links, such as the “management over construction organization”, ranges from 4.9% to 9%. The frequency of the core governance links added to the frequency in these four links is equal to 77.83%, and the frequency

<table>
<thead>
<tr>
<th>Governance Links</th>
<th>Frequency</th>
<th>Percentage</th>
<th>Cumulative Percentage</th>
<th>Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>P3</td>
<td>35</td>
<td>17.24%</td>
<td>17.24%</td>
<td>Core</td>
</tr>
<tr>
<td>P2</td>
<td>28</td>
<td>13.79%</td>
<td>31.03%</td>
<td>Governance</td>
</tr>
<tr>
<td>P7</td>
<td>23</td>
<td>11.33%</td>
<td>42.36%</td>
<td>Links</td>
</tr>
<tr>
<td>P8</td>
<td>22</td>
<td>10.84%</td>
<td>53.20%</td>
<td></td>
</tr>
<tr>
<td>P9</td>
<td>18</td>
<td>8.87%</td>
<td>62.07%</td>
<td>Extended</td>
</tr>
<tr>
<td>P11</td>
<td>11</td>
<td>5.42%</td>
<td>67.49%</td>
<td>Governance</td>
</tr>
<tr>
<td>P14</td>
<td>11</td>
<td>5.42%</td>
<td>72.91%</td>
<td>Links</td>
</tr>
<tr>
<td>P10</td>
<td>10</td>
<td>4.93%</td>
<td>77.83%</td>
<td></td>
</tr>
<tr>
<td>P1</td>
<td>9</td>
<td>4.43%</td>
<td>82.27%</td>
<td>Peripheral</td>
</tr>
<tr>
<td>P6</td>
<td>7</td>
<td>3.45%</td>
<td>85.71%</td>
<td>Governance</td>
</tr>
<tr>
<td>P11</td>
<td>7</td>
<td>3.45%</td>
<td>89.16%</td>
<td>Links</td>
</tr>
<tr>
<td>P12</td>
<td>6</td>
<td>2.96%</td>
<td>92.12%</td>
<td></td>
</tr>
<tr>
<td>P13</td>
<td>6</td>
<td>2.96%</td>
<td>95.07%</td>
<td></td>
</tr>
<tr>
<td>P5</td>
<td>5</td>
<td>2.46%</td>
<td>97.54%</td>
<td></td>
</tr>
<tr>
<td>P15</td>
<td>5</td>
<td>2.46%</td>
<td>100.00%</td>
<td></td>
</tr>
</tbody>
</table>
of these four links rises by 24.63%. This suggests that the four links above carry out fewer governance activities and face a slower growth, and not all governance structures are required to lay emphasis on these links. As a result, these four links can be called “extended governance links”.

The frequency of the governance activities carried out in the next seven links, such as “the building of management system”, is smaller than 4.5%, which implies that these seven links perform the fewest governance activities and only when the governance structure is strong enough will the 15 links need to be planned comprehensively. Thus, these seven links can be named “peripheral governance links”.

Relevancy II: the match between governance subjects and activity links. The level of governance subjects and the frequency of governance activities are summarized in Table 3 without including the lowest frequency or the subject that is only governed. To determine which subjects are able to meet the basic operating requirements in the core, extended and peripheral governance links, a pair-wise correlation analysis is performed on the governance links and subjects. The result shows that every link is governed by the subjects at different levels, and the governance subjects in governance links should be selected based on the principles as follows: (1) the subjects participating in governance activities more frequently should be selected; (2) on equal conditions, the subjects at adjacent levels should be selected; (3) the subjects should be selected based on the comprehensive consideration of other links. According to the analysis of the correlation between links and subjects, as well as the subject selection principle, three subjects (National Development and Reform Commission, construction agent, and user) are required to perform the governance functions in four core links; the correlation analysis is shown in Table 4. In this study, the structure with low governance intensity is named “weak governance structure”. Meanwhile, the above analysis is also made on the major subjects in the core and extended governance links, as well as on the subjects in every link in a similar way. The results have manifested the median governance structure, strong governance structure, the governance intensity of every structure, and the relations between links and subjects, as shown in Figure 3.

### 4.3 Classification of Governance Structure

Upon determining the governance intensity structure of construction-agent system projects, attention should be paid to work out the value range of every structure to heighten the feasibility of the conclusion. To carry out the horizontal comparison among different projects, the intensity is normalized and the value is restricted to [0,1]. The equation is as follows:

\[
SGI_i = \frac{GI_i}{\text{Max}(GI)}
\]

*SGI* represents the normalized value of the governance intensity of a certain construction-agent system project on the condition of *i*; *GI* means the value of governance intensity on the condition of *i*; Max(GI) refers to the maximum value of governance intensity. Due to the different attributes and sizes of the construction-

### Table 3. The level of governance subjects and the frequency of governance activities

<table>
<thead>
<tr>
<th>Governance Subjects</th>
<th>Level</th>
<th>Activities</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior government</td>
<td>v</td>
<td>2</td>
<td>0.20%</td>
</tr>
<tr>
<td>Head executive</td>
<td>iv</td>
<td>2</td>
<td>0.20%</td>
</tr>
<tr>
<td>Legislative institution</td>
<td>v</td>
<td>6</td>
<td>0.70%</td>
</tr>
<tr>
<td>Media and community residents</td>
<td>ii</td>
<td>6</td>
<td>0.70%</td>
</tr>
<tr>
<td>Commission for discipline inspection and ministry of supervision</td>
<td>v</td>
<td>11</td>
<td>1.30%</td>
</tr>
<tr>
<td>Supervisor</td>
<td>ii</td>
<td>29</td>
<td>3.50%</td>
</tr>
<tr>
<td>Auditing department</td>
<td>v</td>
<td>30</td>
<td>3.70%</td>
</tr>
<tr>
<td>Competent construction department</td>
<td>iv</td>
<td>35</td>
<td>4.30%</td>
</tr>
<tr>
<td>Industry management departments</td>
<td>iv</td>
<td>38</td>
<td>4.60%</td>
</tr>
<tr>
<td>Regulatory agency of agent construction project</td>
<td>iii</td>
<td>47</td>
<td>5.70%</td>
</tr>
<tr>
<td>Financial department</td>
<td>iv</td>
<td>54</td>
<td>6.60%</td>
</tr>
<tr>
<td>User</td>
<td>iii</td>
<td>107</td>
<td>13.00%</td>
</tr>
<tr>
<td>National development and reform commission</td>
<td>iv</td>
<td>142</td>
<td>17.30%</td>
</tr>
<tr>
<td>Construction agent</td>
<td>ii</td>
<td>175</td>
<td>21.30%</td>
</tr>
</tbody>
</table>

### Table 4. The participation level of governance subjects

<table>
<thead>
<tr>
<th>Governance Links</th>
<th>Frequency</th>
<th>Percentage</th>
<th>Hazard Performance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ca</td>
<td>Us</td>
<td>Nd</td>
</tr>
<tr>
<td>P8</td>
<td>22</td>
<td>10.8%</td>
<td>12.6%</td>
</tr>
<tr>
<td>P7</td>
<td>23</td>
<td>11.3%</td>
<td>12.0%</td>
</tr>
<tr>
<td>P2</td>
<td>28</td>
<td>13.8%</td>
<td>12.0%</td>
</tr>
<tr>
<td>P3</td>
<td>35</td>
<td>17.2%</td>
<td>17.1%</td>
</tr>
</tbody>
</table>
agent system projects in reality, it is inevitable that the structural types will be evenly distributed and their theoretical values will also accord with random distribution; that is, the random variable is \( SGI_i \sim U[0, 1] \). Then, the normalized intensity value can be discrecited based on equal width, while the continuous value range of the governance intensities \([0, 1]\) can be divided into 3 intervals of equal width: \( 0 \leq SGI_i \leq 0.33 \) represents weak governance intensity; \( 0.33 < SGI_i \leq 0.66 \) means median governance intensity; \( 0.66 < SGI_i \leq 1 \) stands for strong governance intensity. Considering that the equal-width algorithm is an unsupervised discrete algorithm that gives little consideration to sample information, the governance links, subjects and activity factors are used for supervision and inspection. The links of weak, median and strong governance structures include 108, 158 and 203 governance activities, respectively, with 68, 128 (including 68 activities in weak governance structure) and 203 performed by the subjects of corresponding structures, respectively. Therefore, the activity interval \([0, 203]\) in the governance structure is split into three subintervals, namely, \([0, 68]\), \((68, 128]\), \((128, 203]\). After normalization, it is found that \( 0 \leq SGI_i^* \leq 0.30 \) stands for weak governance; \( 0.30 < SGI_i^* \leq 0.63 \) stands for median governance; \( 0.63 < SGI_i^* \leq 1 \) stands for strong governance. Due to the small differences, the equal-width discrete algorithm can be deemed to have high empirical validity.

5 CONCLUSIONS AND INSPIRATIONS

In this paper, energy is devoted to analyzing the project governance structures from the perspective of the governance activities of the construction-agent system projects in an innovative way, which has ascertained the identifiability of the governance activities within current policy boundaries. Meanwhile, the governance activity sets of construction-agent system projects are improved through the evaluation of a multi-case study. In light of the statistical analysis of the cases about the relationships between governance subjects, governance level and quantity of governance activities, the equation for measuring the governance intensity of the construction-agent system project is built. Based on the governance activities, an analysis of the relations of governance intensity, link and subject is conducted to work out the weak, median and strong governance structures of the construction-agent system projects, as well as their corresponding calculation methods. The major governance subjects of weak governance structure include the National Development and Reform Commission, the user and the construction agent, with the governance focused on four links, including supervision over the organization of construction, selection of the construction agent, tendering of the construction agent, and the fund application and use. Based on a weak governance structure, the major governance structure brings in subjects, such as the financial department, and the governance links, such as the management over construction organization, to perform governance activities from the perspective of 8 subjects and 8 links. Based on the median governance structure, a strong governance structure is oriented to 14 subjects and 15 governance links.

This study not only supplemented relevant theories of construction-agent systems but also showed high practical value:

- It is suggested that while implementing construction-agent system projects, a government should select the optimal governance structure according to different situations and project...
features rather than the modes according to stages and regions.

- Emphasis should be placed on the governance links and subjects in light of the different governance intensities and structures required by a construction-agent system projects to avoid unnecessary resource expenditure, such as saving cost and improving efficiency.

- The National Development and Reform Commission, the construction agent, and the user are the core subjects of all construction-agent system projects, and meanwhile, the supervision over the organizational design, selection of the construction agent, tendering of the construction agent, and the fund application and use are the core governance links of all construction-agent system projects. Therefore, every project is expected to support the relationships among governance subjects and ensure the quantity and quality of the activities in the core governance links.

- Because the selection of agency constitutes the key link in governance of construction-agent system projects, the governance activities of construction-agent projects are required to embody the nature of entrustment. The governance of construction-agent system projects highlights the organization’s supervisory role, avoiding three excesses in reliance on the use of governance funds and management over a construction organization.

The construction-agent system project is characterized by the complex design of governance structure. Thus, the subsequent study may result in an in-depth exploration of the process, such as the selection of governance structure of construction-agent system project, the attributes of different governance structures, and the influence of governance structure on performance.

ACKNOWLEDGMENT

This study is financially supported by the National Natural Science Foundation of China (“Study on the Governance Structure Design and Application of the Construction-agent System for Government-funded Projects”, 71272091). We would also like to appreciate ICSDM for setting up such a communication platform.

REFERENCES


