Xia, Bo & Chan, Albert
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Measuring Complexity for Building Projects—A Delphi Study

Abstract

Purpose-- The aim of this study is to identify complexity measures for building projects in the People's Republic of China (PRC).

Design/Methodology/Approach--A three-round of Delphi questionnaire survey was conducted to identify the key parameters that measure the degree of project complexity. A complexity index (CI) was developed based on the identified measures and their relative importance.

Findings-- Six key measures of project complexity have been identified, which include, namely (1) building structure & function; (2) construction method; (3) the urgency of the project schedule; (4) project size/scale; (5) geological condition; and (6) neighboring environment.

Practical implications--- These complexity measures help stakeholders assess degrees of project complexity and better manage the potential risks that might be induced to different levels of project complexity.

Originality/Value-- The findings provide insightful perspectives to define and understand project complexity. For stakeholders, understanding and addressing the complexity help to improve project planning and implementation.

Key words

Buildings, Complexity, measurement, Delphi method, China

Paper type: Research paper

1. Introduction

Building projects have become progressively more complex since World War II (Baccarini, 1996). Nowadays, many of them have high degrees of electrical and mechanical installations, employ sophisticated structure systems, and serve diversified requirements of different end-users. Although the project complexity has not been clearly defined (Kauffman, 1995; Corning, 1998; Williams, 1999; Bertelsen and Koskela, 2002), it is regarded as one of the critical project characteristics that determine appropriate actions to result in successful project outcomes (Baccarini, 1996). It has been widely recognized that project complexity will influence the project performance and eventually affect the success of a project (Raymond, 1995; Molenaar and Songer, 1998; Austin et al, 2002; Chan et al, 2004).

Although the importance of project complexity to project management has been widely acknowledged, few if not none objective measures are available for assessing project complexity. This is mainly because the complexity is largely connected to the subjectivity of the observer (Dijkum, 1997; Corning, 1998). The measurement of building complexity will differ among clients, designers, project managers and construction managers. Leung (2007) pointed out that an objective tool to provide a quantitative scale to measure the complexity of building projects is urgently required.

The paper is, therefore, aimed at identifying complexity measurement for building projects. It will help define the project complexity and facilitate stakeholders to take appropriate management actions to reduce the potential risks that might be induced to different levels of project complexity. A three-round of Delphi questionnaire survey was carried out with a group of twenty experts in the construction market of China in order to obtain the most important parameters for measuring the complexity of building projects.

2. Literature Review on Complexity Measures

The complexity of a construction project has significant impacts on various aspects of the project outcomes. Many empirical studies in the construction field reflect that project complexity would affect the project duration, cost, and quality (Gidado and Millar, 1992; Raymond, 1995; Walker and Sidwell, 1996; Chan and Kumarawwamy, 1997; Chan, 1998; Dissanayaka and Kumaraswamy, 1999; Tatikonda and Rosenthal, 2000; Nassar and Hegab, 2006). It is has been widely accepted that the project complexity should be objectively measured in order to provide continuous feedback to help control the process of project development (Baccarini, 1996, Little *et al*, 1997; Calinescu *et al*, 2000; Sinha *et al*, 2006; Nassar and Hegab, 2006; Leung, 2007).

However, before establishing a clear definition of the complexity, it is very difficult to obtain complexity measures for building projects. This is because, the concept of complexity, on the one hand, can be derived and used in the theoretical context of complexity theory. The complexity theory is concerned with the behavior over time of certain kinds of complex systems. The systems are dynamic, unstable, and continually changing and evolving in a random fashion. If the complexity of building projects is referred to as the behavior of complex network in the complexity theory (Kaufman, 1995), then the unpredictable and emergent nature of such network would preclude the application of any linear and reductionist approach that are traditionally adopted.

On the other hand, the term complexity can also be used in its more common sense or dictionary definition rather than in the theoretical context of complexity theory (Thomas and Mengel, 2008). When taking about the complexity of building projects, practitioners are usually referring to the condition of being complex, intricate or hard to understand, rather than the notion of complexity and chaos that has been widely studied in the fields such as astronomy, evolution biology and meteorology (Kauffman, 1995; Lorenz, 1995).

The purpose of this study is to identify an approach to measuring degrees of difficulty when delivering building projects, rather than adding understanding of complexity to highly adaptive and self-organizing systems. Therefore, the complexity of building projects in this paper is defined as a characteristic of building projects that are complicated, multi-faceted, and composed of many interconnected parts.

In the construction field, there have been some attempts to measure the complexity of construction projects. However, given the fact that project complexity is hard to be quantified precisely, many researchers focus on identifying factors/aspects relating to the project complexity. Gidado and Millar (1992) viewed project complexity in terms of (1) technical complexity of task, (2) amount of overlap and interdependencies in construction stages, (3) project organization, (4) site layout, and (5) unpredictability of work on site. Gidado (1996) identified a number of aspects of project complexity, including (1) the employed resources, (2) the environment, (3) the level of scientific and technological knowledge required, (4) the number of different parts in the work flow, and (5) the interaction of different parts in the work flow.

Chan (1998) proposes five casual factors of project complexity: (1) client’s attributes, (2) site condition/site access problems, (3) buildability of project design, (4) quality of design coordination and (5) quality management. Akintoye (2000) finds that the project complexity is made up of following principle components: (1) expected project organization, (2) type of structure, (3) site constraints, (4) method of construction and construction techniques, (5) scale and scope of the project and (6) complexity of design and construction. Cicmil and Marshall (2005) suggest three aspects of complexity in construction projects, which are: (1) complex processes of communicative and power relating among project actors; (2) ambiguity and equivocality related to project performance criteria (success/failure) over time; and (3) the consequence of time flux (change, unpredictability and the paradox of control). Sinhua et al. (2006) proposes the following three complexity justifying factors, namely the workers, material, and tools used in carrying out the project activity.

These research studies provide useful perspectives to understand the complexity of building projects. However, it should be noticed that most of the factors are those broad and vague concepts, and some of them are related to the concept of complexity theory (such as the unpredictability of the work). As a result, it is very difficult to quantify the project complexity based on these findings.

Some other researchers, by contrast, focus on identifying specific variables and rating systems to quantify the project complexity. Santana (1990) classified construction projects into three categories, namely, normal, complex, and singular, according to the scale of complexity. Ten groups of variables are used for the classification, which include (1) owner or investor, (2) cost and financing, (3) terms of study and execution, (4) stages of project, (5) administrative and legal framework, (6) impact on natural and social environment, (7) physical location, (8) technology, (9) resources, and (10) logistics of the construction. Every variable is quantified on a 0-10 point Likert scale, and the average rating is then calculated to obtain the complexity category. However, considering that the construction projects include various categories of projects--which include residential projects, buildings projects, heavy construction projects and industrial projects—it would be not appropriate to use the same variables to measure the project complexity. In addition, the author did not provide weightings of these variables according to their relative importance.

Leung (2007) built up construction complexity index (CCI) as an objective quantitative tool to measure the complexity of construction for building projects. Ten variables defining the project complexity are identified as (1) project duration, (2) working spaces, (3) contract sum, (4) site area, (5) type of structure, (6) height of building, (7) site location, (8) client, (9) usage of building, and (10) total floor area. The CCI is the sum of products for weighting coefficients and complexity rating score. The weighting coefficients are the rotated factor loadings obtained from the factor analysis. The rating scores are derived using cluster analysis technique with reference to the results of the opinion survey. This is a comprehensive model; however, it only focuses on measuring the complexity of construction process. It would not be applicable to assess the complexity of a building project at the early project stage using this CCI model.

It can be concluded that there is no consensus on the identification of complexity measures for building projects. Researchers assess the project complexity from different perspectives. The identified measures include not only specific characteristics of construction projects but also conceptual aspects relating to the theory of complex system. Furthermore, considering that the complexity in this paper is defined as the degrees of difficulty when delivering building projects, the complexity measures would vary in different geographical locations due to their unique market conditions. Therefore, this study focus on identifying key parameters that can be used by industrial practitioners to measure the complexity of building projects in the construction market of China.

3. Research Methods—the Delphi survey

As mentioned in the section of literature review, there is no consensus on the identification of complexity measures. Researchers measure the project complexity from different perspectives and using diversified variables. The Delphi method is designed to obtain the most reliable consensus from a panel of experts by a series of intensive questionnaires interspersed with controlled opinion feedback, and with results of each round being fed into the next round (Chan *et al.*, 2001). Even if these collective judgments of experts are made up of subjective opinions, it is more reliable than individual statements, thus, more objective in its outcomes (Masini 1993). Therefore, the Delphi method is considered as one of the best known consensus-reaching methodologies (Jones, 1980).

The Delphi method typically involves the selection of suitable experts, development of appropriate questions to be put to them and analysis of their answers (Cahanis, 2002, Outhred, 2001). The original Delphi procedures have three features: (1) anonymous response; (2) iteration and controlled feedback; and (3) statistical group responses (Adnan and Morledge, 2003). The features are designed to minimize biasing affects of dominant individuals, irrelevant communications, and group pressure toward conformity. The number of rounds varies between two and seven (Rowe and Wright, 1999; Adnan and Morledge, 2003). Too many rounds would waste respondents' time, and stopping the study too soon could yield meaningless results (Schmidt, 1997). In order to reach an acceptable and stable degree of consensus, the majority of the studies have used three rounds. The majority of Delphi studies involve 15-20 respondents (Ludwig, 2001). Moreover, with a homogeneous group of experts, good results can be obtained even with a panel as small as 10-15 individuals (Ziglio, 1996).

The Delphi method used in this research was composed of three rounds with 20 experts. In first round of the Delphi survey, respondents were asked to list at least five variables for measuring the complexity of building projects in the construction market of China. In round 2 of the Delphi questionnaire survey, the respondents were provided with the consolidated results from round 1 and were asked to provide ratings to the top seven measures (the top seven measures have been selected for further study based on a criterion that all of them were selected by at least 50% of experts), based on a five-point Likert scale. In round 3 of the Delphi questionnaire survey, respondents were asked to reconsider the ratings of each measure in the light of the consolidated results from round 2. The questionnaires in each round are as follows:

Questionnaire1: Please list at least five most important complexity measures for building projects in the construction market of China

Questionnaire2: Please give ratings to the complexity measures according to their importance.

Questionnaire3: Please re-rate the complexity measures in the light of the results from round 2.

4. Three Rounds of Delphi Questionnaire Survey: Results and Analysis

4.1 Selection of expert panel

One of the most important considerations when carrying out Delphi study is the identification and selection of potential members to constitute the panel of experts (Ludwing1997, Stone and Busby1996). The selection of members or panelists is important because the validity of the study is directly related to this selection process. In this Delphi survey, the researchers attempted to identify panelists who meet all the following selection criteria:

(1) Having sufficient working experience or knowledge in the building field,

(2) Working in relevant organizations in the building industry,

Finally, 20 experts who meet all the selection requirements agreed to participate in the Delphi survey. A list of the panel members and their affiliations are shown in Table 1.

Table 1 List of the panel experts for the Delphi study

Type of firm / department	Number
Real estate developer	1
Government department	3
Design consultant company	3
Project management company	3
University	4
Construction company	6
Total	20

The selected experts represent a wide spectrum of construction professionals in China and provide a balanced view for the Delphi study. All the experts have sufficient experience and expertise in building projects. Table 2 depicts the frequency of the respondent's number of years working in the building industry.

Table 2 Respondent classifications by years working in the building industry

Years	The percentage
0-5	5%
6-10	30%
11-20	30%
20+	35%
Average (Years)	15

Furthermore, most of the experts hold senior positions in their organizations. The respondents' job positions/titles are provided in Table 3.

Table 3 the job positions of the panel experts

Job position	Number
Chief engineer	1
Deputy chief engineer	2
Deputy general manager	2
Project manager	3
General director	1
Project management director	1
Academic	2
Engineer	2
Project management consultant	2
Director of research institute	2
Deputy division chief in government	2
Total	20

The sufficient working experience, senior job positions and relevant organizations of the selected experts ensure the validity of this Delphi research.

4.2 Round 1: Listing the complexity measures for building projects

The first round of the Delphi questionnaire survey was conducted as the exploration process and was of crucial importance. Every expert was required to list at least five complexity measures for building projects. The findings in the literature review were also provided for their reference. All the twenty experts returned their responses. After the completion of first round survey, measures suggested by the 20 experts were carefully analyzed and a list of complexity measures was formed. Finally, 18 measures were consolidated, which is shown in table 4.

Table 4 Complexity measures provided by respondents in Round one Delphi survey

Complexity measures for building projects	Experts frequency
1. Building structures and functions	95%
2. Construction methods (including the construction techniques and process)	95%
3. The urgency of the project schedule (time management requirements)	80%
4. The size/scale of building projects	70%
5. Neighboring environment (including the site access/location)	70%
6. Geological condition	65%
7. Repetition of similar type of projects	55%
8. Project organization	45%
9. The level of coordination	30%
10. The amount of overlap and interactions	30%
11. Cost restraints (cost and financing)	25%
12. Changes of construction works	25%
13. Logistics of construction works	15%
14. Buildability of the design work	15%
15. Quality requirements	10%
16. Ambiguity of performance criteria	5%
17. Legal framework.	5%
18. Delivery system	5%

Similar to Chan et al. (2001), only the measures that have been selected/proposed by 50% of experts or above will be selected for further consideration. Seven complexity measures met this criterion in the first round of the study, which include: (1) building structure & function; (2) construction methods; (3) urgency of the project schedule; (4) project size or

/scale; (5) neighboring environment; (6) geological condition; and (7) repetition of similar type of projects.

4.3 Round 2 Delphi questionnaire survey: Ratings obtained from the experts

The purpose of the second round Delphi survey was to begin the process of building the consensus among the panelists regarding the importance of each complexity measure. A list of seven complexity measures with their explanations and experts-frequency was provided to experts for their reference. Finally 17 experts returned their responses. At this stage, a 5-point Likert rating scale was used, which ranges from 1=not important, 2=somewhat important, 3=important, 4=very important, and 5=extremely important or essential. In this research, the mean score of 3.0 was adopted as a cut-off point. Only the measure regarded as IMPORTANT remains for the re-evaluation in round 3. Table 5 shows the results of round 2 of the Delphi questionnaire survey.

Table 5 Result of round 2 questionnaire survey--the complexity measures for building projects

Complexity measures for building projects	Mean	Rank	Importance weightings
Building structure and function	4.38	1	0.189
Construction method	4.11	2	0.177
The urgency of the project schedule	4.06	3	0.175
Project size/scale	3.68	4	0.159
Geological conditions	3.64	5	0.157
Neighboring environment	3.32	6	0.143
The repetition of similar projects	2.79	7	

Notes：

Number (n) =17.

Kendall's Coefficient of Concordance (W) =0.529. Level of significance=0.000

Except *the repletion of similar projects*, all the other measures pass the cut-off point. A preliminary series of weighted complexity measures (CM) was developed based on the mean ratings advocated by the 17 experts. The weighting for each of the top six CMs was computed by using the following equation:

$$W_{CMi} = \frac{M_{CMi}}{\sum_{i=1}^{6} M_{CMi}} \qquad (1)$$

Where:

W_{CMi} represents the importance weighting of a particular top six complexity measure.

M_{CMi} represents the mean rating of a particular top six complexity measure.

$\sum M_{CMi}$ represents the summation of mean ratings of the top six complexity measures

In order to compile a composite indicator to evaluate the complexity of building projects, a Complexity Index (CI) is developed which can be represented by the following formula:

$$\begin{aligned} CI = {} & 0.189\times\text{building structure and function} + 0.177\times\text{construction method} \\ & + 0.175\times\text{schedule urgency} + 0.159\times\text{project size/scale} \\ & + 0.157\times\text{geological condition} + 0.143\times\text{neighboring environment} \qquad (1) \end{aligned}$$

The Index is derived based on the assumption that this is a linear and additive model. It is logical and valid to derive this linear and additive model because the Pearson correlation matrix as shown in Table 6 reveals that the top six weighted complexity measures are not highly correlated with each other at 5% significance level. Though it seems more sophisticated to use a non-linear model to fit the data obtained, over-fitting is a common problem with non-linear models especially when the sample size is not sufficiently large (Neter et al., 2005; Weisberg, 2005).

Table 6 Correlations matrix among the seven complexity measures

	Structure & function	Construction methods	Schedule urgency	Project size	Geological conditions	Neighboring condition	Project similarity
Structure & function	1	.458	-.035	.167	.153	.111	.309
Construction methods		1	-.171	-.074	.149	.303	-.038
Schedule urgency			1	.256	.506*	.283	.406
Project size/scale				1	.079	-.034	.585*
Geological condition					1	.540*	.307
Neighboring condition						1	.527*
Project similarity							1

Notes: * Correlation is significant at the 0.05 level (2-tailed).

Meanwhile, in order to obtain a measure of consistency, the Kendall's Coefficient of Concordance (W) was calculated with the aid of the SPSS software. The Kendall's coefficient of concordance indicates the current degree of agreement among the panel members on the ordered list by taking into account the variations between the rankings (Doke and Swanson, 1995). According to the level of significance (showed in Table 5), which is less than 0.05, the null hypothesis that the respondent's ratings within the group are unrelated to each other would have to be rejected. It can be concluded that a significant amount of agreement among the respondents has been reached.

4.4 Round 3 Delphi questionnaire: Re-assessing the Ratings

In the round 3 Delphi survey, the experts were asked to re-assess their ratings in the light of the consolidated results obtained in round 2. Finally, 17 experts retuned the questionnaire. Most experts had reconsidered their ratings and had made adjustments to their ratings. However, Table 7 shows that the rankings of all the variables remain unchanged when compared with the consolidated results in Round 2. The Kendall's Coefficient of Concordance (W) for the rankings of these variables is also provided in Table 7. The increased value of Kendall's Coefficient of Concordance (from 0.529 to 0.543) means that the agreement level among the panel experts has improved.

Table 7 Result of round 3 questionnaire survey—the complexity measures

Complexity measures for building projects	Mean	Rank	Importance weightings
Building structure and function	4.35	1	0.189
Construction method	4.11	2	0.179
The urgency of the project schedule	4.06	3	0.177
Project size/scale	3.62	4	0.157
Geological conditions	3.52	5	0.153
Neighboring environment	3.32	6	0.145

Notes：

Number (n) = 17.

Kendall's Coefficient of Concordance (W) = 0.543 Level of significance=0.000

The Pearson correlation matrix as indicated in Table 8 manifests that the top six measures are not highly correlated with each other at 5% significance level. It indicates that these measures are independent with each other, and they are not likely to have any multiplier effect between them. Finally, the complexity index (CI) is composed of the top six complexity measures identified in round 3 of the Delphi questionnaire survey. The coefficients are their individual importance weightings, which are calculated by their individual mean ratings divided by the total mean ratings.

$$CI = 0.189\times\text{building structure and function} + 0.179\times\text{construction method}$$
$$+ 0.177\times\text{schedule urgency} + 0.157\times\text{project size/scale}$$
$$+ 0.153\times\text{geological condition} + 0.145\times\text{neighboring environment} \quad (2)$$

Table 8 Pearson correlations matrix among the six complexity measures

	Structure & function	Construction methods	Schedule urgency	Project size/scale	Geological conditions	Neighboring condition
Structure & function	1	.364	-.057	.020	.181	.029
Construction methods		1	-.236	-.236	.409	.347
Schedule urgency			1	.280	.186	.311
Project size/scale				1	-.239	-.204
Geological condition					1	.558*
Neighboring condition						1

Notes: * Correlation is significant at the 0.05 level (2-tailed).

5. Discussion of the Identified Complexity Measures

The final outcome of this paper was the identification of six complexity measures for building projects in the construction market of the People's Republic of China. Based on the identified measures and their importance weightings, a complexity index (CI) has also been derived. It should be added that the Delphi method by its inherent nature serves as a self-validating mechanism because individual experts are given chances to re-assess their scores with reference to the consolidated mean scores as assessed by other experts. By using the Delphi method, the maximum amount of unbiased and objective information can be obtained from the panel of experts.

Building functions & structure

Building function & structure is regarded as the most important parameter affecting project complexity. Every building project serves a variety of functions, some of which would constitute great difficulty to the contractor. This is because firstly, the contractor may be unfamiliar with certain specialized functions such as those required in hospital projects. Secondly, the contractor may lack the capability or resources to achieve some functions such as those required in complex high-rise buildings. Building structures are employed to accomplish building functions. It is necessary to realize that structural design decision will not only influence the general architecture design but also the development of systems for power, lighting, thermal control, ventilation, water supply, vertical transportation, and so on (Ambrose, 1993). In addition, different structures will present different complexity with reference to the buildablity (Leung, 2007). For example, buildings using shear-wall structures (usually the high-rise buildings) are generally regarded as more complex than skeleton-structure buildings. Therefore, the ideal structural system should accommodate the other sub-systems of the building, facilitate popular architectural forms and details, and provide better buildability for the contractors.

Construction method

Construction method is the second most important parameter affecting project complexity. Modern methods of construction are about better products and processes. They involve construction techniques and processes to seek improvement in the delivery and performance of construction (NAO, 2005). Many sophisticated construction methods, such as the prefabrication techniques, are required in complex modern buildings. These methods demand a number of specialized staff and equipments. In particular, considering the extent of sub-letting of work today, it requires the main contractors to have adequately qualified technical staff to see that sub-contactors perform to the standard required (Illingworth, 2000). Therefore, most of the researchers consider the construction method/technique as one the main sources of the project complexity (Akintoye, 2000; Gidado and Millar, 1992; Gidado, 1996; Palaneeswaran and Kumaraswamy 2000; Santana 1990). Given the importance of construction method, it is usually taken as one of the most important selection criteria in the bid evaluation.

Urgency of project schedule

The complexity of the construction project increases when there is an unrealistic schedule for completion. Project scheduling is intended to match the resources of equipment, materials and labor with project work tasks over time (Hendrickson, 1998). When the project is under urgent or compressed schedule, it demands sufficient material supply, adequate staffing and sophisticated coordination, which subsequently add difficulty to project management. Palaneeswaran and Kumaraswamy (2000) implies that the requirement of early completion will increase the project complexity. In order to shorten the project duration, it usually forces an increase in the overlaps and interactions of design and construction, which may lead to frequent design changes. These changes will, in turn, cause construction changes and increase the complexity of project management.

Project size/scale

The size of a project usually affects project complexity. Larger size of a project does not necessarily lead to higher degree of complexity, but it usually calls for multiple contracts, various sub-contractors and suppliers, and complex coordination systems. Corbett et al. (2002) states that an organizational system should be over a minimum critical size to be considered as a complex system. In building projects, availability of facilities, materials and staffing are all potential sources of risk associated with large projects. As the size of a project increases, difficulties in coordination work among all participants increase, affecting the project complexity in terms of management. In addition, the complex coordination between sub-projects in large projects is also a potential risk (Pheng and Chuan, 2005). A delay in one sub-project often creates risks for others and requires complex rescheduling and arrangement of contractor's restraint resources.

Geological condition

The geological condition of a project is characterized by uncertainty and unpredictability, which increases the degree of project complexity (Gidado and Millar, 1992). The unforeseen soil condition and underground obstructions require sophisticated site investigation, proper design of ground-works and foundations, and necessary precaution approaches. In particular, the unexpected geographical condition would become a source of project risks after the construction work commences on site. This is because the construction process is irreversible, and it will require extra efforts to compensate for the potential loss. As a result, the uncertainty in geotechnical engineering is particularly acute so that the assignment of risks in this area should be a major concern (Hendrickson, 1998).

Neighboring environment

Neighboring environment affects project complexity in various ways. In general, projects located in an urban environment with convenient access to good roads, services and adequate supply of equipment, materials, components and communication system, are far easier to operate than those located in remote areas with limited access. In addition, many specific conditions of the neighboring environment will cause extra workloads and risk to the contractor. For example, the foundation excavation may cause damage to the surrounding buildings thus demand extra precautions; night work may not be allowed in some urban areas thus require re-scheduling of the work plan. Even the weather condition adds up complexity to the construction of building projects and should be carefully addressed throughout the project duration. Therefore, the site location and site constraints/access are addressed by many researchers as sources of project complexity (Akintoye, 2000; Chan 1988; Leung, 2007; Palaneeswaran and Kumaraswamy 2000; Santana, 1990).

6. Limitations and future works

As with any other opinion-based study, this study suffers from some limitations. As discussed in the ‘selection of panel experts’ section, efforts were made to ensure that all the respondents are the fully experienced experts in the building industry. This has indeed helped increase the quality of responses, but the effects of subjectivity, bias, and imprecise definitions cannot be completely ruled out. However, the effects of these limitations could be further reduced by taking a still larger panel size and increase the interaction between the researchers and respondents.

Future research should be conducted to set up the complexity rating system for building projects. In the Complexity Index (CI), the degree of complexity for a project is defined by two components: the weighting coefficient and the complexity rating score. The weighting coefficients describe the contributors of the measures for the index, which have been obtained in the study. The complexity rating scores can be obtained based on values of the measures for each project. A complexity rating system should be developed in the future to help determine the complexity score of each measure for the building project. In addition, since the complexity measures were identified in the construction market of the People’s Republic of China, further research should be also conducted in other geographical locations to find out their similarities and differences for international comparisons.

7. Conclusions

A three-round of Delphi survey has been conducted to identify the complexity measures for building projects in China. The descending order of the top six weighted measures were found to be: (1) building function and structure, with the weighting of 0.189; (2) construction method, with the weighting of 0.179; (3) the urgency of the project schedule, with the weighting of 0.177; (4) project size/scale, with the weighting of 0.157; (5) geological condition, with the weighting of 0.153; and (6) neighboring environment, with the weighting of 0.145. The findings help develop a composite complexity index (CI) for measuring the complexity of building projects in China. In identifying the parameters in assessing project complexity, the Delphi method serves as a self-validating mechanism and provides a valuable framework for tapping expert knowledge on this field. Although Delphi technique cannot fully eliminate the subjectivity of evaluation, the careful selection of the panel experts ensures the reliability of the research finding.

The research findings of this study provide some practical implications. Stakeholders can use this Index to measure and compare the complexity degrees of their partnering projects. Based on this information, stakeholders can take appropriate management actions to reduce the potential risk that relate to the project complexity. For contractors, the complexity information can facilitate them to enhance managerial decisions in tendering, project goal setting, risk assessment and staffing. For clients, understanding and addressing the complexity help to improve project planning and implementation. The findings of this study will deepen the current body of knowledge in the construction industry of China.

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