Distribution rules of conflict events and management countermeasures of large-scale construction engineering projects

Yi Wang¹, Yiru Hou², and Xueliang Hou³,*

¹Economy and Management Department, North China Electric Power University, 102206 Beijing, China
²School of Construction Management Technology, Purdue University, 47907 West Lafayette, IN, USA
³School of Economy and Management, North China Electric Power University, 102206 Beijing, China

Abstract. The processes of large-scale construction projects implementation are often affected by various internal and external factors, which result in various conflict events in different stages of the project, and bring different degrees of harm to the construction project. In order to understand and master the distribution rules of various conflict events in different stages in large-scale construction projects, a massive investigation was carried out on 96 large-scale engineering construction units in China, and 325 effective research samples were obtained. Based on this investigation results, the mathematical analysis and summary of the conflict events of large construction engineering projects have been made by multiple statistical analyses, which reveal the distribution law and the primary and secondary relationship of various conflict events in each stage of engineering projects. Combined with the research results, the management countermeasures and suggestions of conflict events are put forward, which provide valuable references for the project managers to effectively manage the conflict events and improve the management level of engineering projects.

1 Introduction

In recent years, in order to promote the stable development of China national economy, and reduce such disadvantages results from covid-19 and the world economic recession, trillions of investments have been used for many large-scale constructions, such as Xiongan district, Guangzhou big bay area, Beijing-Shanghai high-speed railway, UHV engineering, Winter Olympic venues, and other projects. The consequences of these construction projects have proved by the real effects that the projects not only greatly promoted the development of China's related industries, but also played a huge role in ensuring employment and promoting people's livelihood in China, and brought significant economic and social benefits to China's economic development. However, large-scale

* Corresponding author: hou-xl@163.com
construction projects are very complex systematic engineering, and are often influenced or interrupted by various factors from inside and outside the engineering system in the process of construction [1]. Therefore, many kinds of conflicts and contradictions often happened among partners, and such phenomena as low quality, progress delay, cost over-expenditure, safety accidents, contract disputations, and legal conflicts often appeared in the construction [2-3]. Relevant research results have shown that once relevant conflicts occur in the construction project, it may cause certain economic losses to the construction enterprises, lead to the complete failure of the project, and sometimes even bring a certain degree of negative impact to the stability and social development in local areas [4-5]. Just because of this, the question has become one of the important practical problems for construction enterprises and government management departments on how to fully understand and correctly grasp the producing, developing and distribution rules of large-scale construction project conflict events in order to help project managers make the scientific and correct decision.

2 Investigation and statistics of conflict incidents

In order to understand the conflict events in large-scale construction projects, and reveal the objective situation and distribution of conflict events systematically, an extensive investigation has been carried at the support of China national social science fund project and ninety-six large-scale construction enterprises in twenty-seven provinces. After researchers completed the questionnaire edition on the bases of determining survey parameters such as survey object, survey content, survey methods, and survey sample demands, 438 questionnaires were issued in the survey. Finally, 376 questionnaires were recovered. Through the identification, 325 valid questionnaires were obtained, and the questionnaire recovery rate was 85.84%. Based on the actual recovered sample, the response rate of the questionnaire was 86.43%. Therefore, this survey sample size can fully meet the quantity required for large sample studies [6].

2.1 Sample statistics

Captions should be typed in 9-point Times. They should be centred above the tables and flush left beneath the figures. According to the theory of engineering project management knowledge system [7], it is known that the project is divided into four stages of decision-making, preparation, construction and completion based on the actual needs of the project construction and management. In order to find the distribution of conflict events and their main characteristics clearly and accurately in each stage of large-scale construction projects, the four stages that appear all kinds of conflict events in construction projects have been determined in advance before investigation. So, the respondents can be more concise, objective and accurately reflect the conflict problems of each stage of the project. According to the analysis of 325 valid samples, the investigators reported 726 items of conflict events. Through the consolidation analysis of 726 conflict events, it is known that there are 76 representative conflict events in 19 categories in large construction projects, that is, 9 in the decision-making stage, 12 in the preparation stage, 42 in the construction stage, and 13 in the end stage. The category of conflict events in each stage and their cumulative reflection frequency in the survey are shown in Table 1.

<table>
<thead>
<tr>
<th>Stage</th>
<th>Category of conflict</th>
<th>Frequency</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision-making</td>
<td>Project scheme decision-making</td>
<td>15</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>Project feasible study</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Statistic of conflict events in each stage.
2.2 Mathematical distributional characteristics of the conflict events

In the multivariate statistical theory, the mean and median can effectively depict the position characteristics of the study subsample, and the extreme difference, variance and standard deviation can effectively represent the dispersion characteristics of the study subsample[8]. Therefore, to further find and know the distribution characteristics of conflict events in large-scale construction projects, the mathematical distribution characteristics of conflict events have been analyzed through the mathematical analysis of various conflict events in various stages of large-scale construction projects based on the scientific theory of multiple statistics.

(1) Mean and median values

In the multivariate statistical theory, the mathematical model for obtaining the average of the study sample is \( \mu = \frac{1}{n} \sum_{i=1}^{n} \mu_i \), where, \( n \) is the calculated number of samples, \( \mu_i \) is the \( i \)th sample number value. Because the number of samples is even, the corresponding value of the median is 401. Based to the data in Table 1:

\[
\mu = \frac{1}{n} \sum_{i=1}^{n} \mu_i = \frac{1}{4} (71 + 155 + 401 + 99) = 181.5
\]

(2) Extremum, variance and standard deviation

Similarly, according to the multivariate statistical theory, the maximum value \( \text{Max}(\mu_i) \) is 401, the minimum value \( \text{Min}(\mu_i) \) is 71 in the four studied subsample values, so, the extremum, variance and standard deviation can be known as follows.

\[
R = \text{Max}(\mu_i) - \text{Min}(\mu_i) = 330
\]

\[
\sigma^2 = \frac{1}{n} \sum_{i=1}^{n} (\mu_i - \mu)^2 = \frac{1}{4} \left[ (71-181.5)^2 + (155-181.5)^2 + (401-181.5)^2 + (99-181.5)^2 \right] = 67899
\]

\[
\sqrt{\sigma^2} = 260.57
\]

Based on the above analysis of data, it can be found that the conflict events in large-scale construction projects generally possess partial normal distribution characteristics. From the project decision stage to the preparatory stage, the amount will increase significantly, and the number of conflict events will reach a peak at the project construction stage. According to the rule, project managers just could realize that all kinds of preparations should be done in advance when the project gradually enters the preparation stage from the decision-making stage. So that, in the process of engineering management,
they can have sufficient project resources and working time to effectively deal with various conflict events that appeared in the preparation stage and construction stage, avoid burying potential troubles, and provide more advantageous conditions for the smooth implementation of the construction project.

3 The primary and secondary relationship of conflict events

It can be seen from Table 1 that there are different numbers of conflict categories in different stages, which have also different frequencies. Obviously, those conflict events that occur more frequently and have a great impact on the project will undoubtedly consume more resources of the project and need managers to invest more energy in processing and controlling. Therefore, from the perspective of engineering project management, a comprehensive and systematic analysis of the impact on the frequency and consequences of conflict events has a higher scientific significance and value.

For this problem, it can be known based on the multi-factor integration theory of system science that the frequency $f_i$ and consequences $q_i$ of conflict events have a high positive correlation with the degree $r_i$ that project managers need to pay attention to the conflict events \[9\]. If let $f_i$ as the level value of the conflict event, let $q_i$ as the weight value of the conflict event, the level weight summary value $r_i$ reflecting the importance of the conflict event is product value of the two parameters.

Just based on such consideration in the research, the investigators were required that not only described the conflict events in each stage, but also gave the corresponding qualitative analysis results of every conflict event according to five degrees of the consequences caused by conflict events, that is, very serious, serious, general, small and negligible. In this way, the consequences qualitative degree of conflict events can be quantified through the conversion of membership grade in fuzzy mathematics. Here, let 0.9, 0.7, 0.5, 0.3, and 0.1 respectively delegate very serious, serious, general, small, and negligible. Thus, the weight value of each conflict consequences severity can be learned, and the level weight summary value reflecting the importance of every conflict event in each stage can also be obtained furtherly. According to this analysis method, the comprehensive values of various conflict events in large construction projects can be shown in table 2 together with the data of Table 1 and the survey result.

Table 2. The comprehensive values of various conflict events.

<table>
<thead>
<tr>
<th>stage</th>
<th>Category of conflict</th>
<th>$f_i$</th>
<th>$q_i$</th>
<th>$r_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision-making</td>
<td>Project scheme decision-making</td>
<td>15</td>
<td>0.81</td>
<td>12.1</td>
</tr>
<tr>
<td></td>
<td>Project feasible study</td>
<td>24</td>
<td>0.76</td>
<td>18.2</td>
</tr>
<tr>
<td></td>
<td>Project investment estimation</td>
<td>19</td>
<td>0.75</td>
<td>14.3</td>
</tr>
<tr>
<td></td>
<td>Report submission and approval</td>
<td>13</td>
<td>0.81</td>
<td>10.5</td>
</tr>
<tr>
<td>Preparation</td>
<td>Engineering survey and design</td>
<td>59</td>
<td>0.75</td>
<td>44.5</td>
</tr>
<tr>
<td></td>
<td>Project bidding</td>
<td>39</td>
<td>0.73</td>
<td>28.3</td>
</tr>
<tr>
<td></td>
<td>Land expropriation and resident migration</td>
<td>26</td>
<td>0.77</td>
<td>20.0</td>
</tr>
<tr>
<td></td>
<td>Construction procedures transaction</td>
<td>31</td>
<td>0.76</td>
<td>23.7</td>
</tr>
<tr>
<td>Construction</td>
<td>Safety management</td>
<td>64</td>
<td>0.77</td>
<td>49.2</td>
</tr>
<tr>
<td></td>
<td>Contract disputes</td>
<td>28</td>
<td>0.76</td>
<td>21.4</td>
</tr>
<tr>
<td></td>
<td>Engineering quality</td>
<td>46</td>
<td>0.74</td>
<td>34.0</td>
</tr>
<tr>
<td></td>
<td>Environmental problem</td>
<td>48</td>
<td>0.72</td>
<td>34.4</td>
</tr>
<tr>
<td></td>
<td>Construction schedule</td>
<td>53</td>
<td>0.72</td>
<td>38.3</td>
</tr>
<tr>
<td></td>
<td>Personnel coordination</td>
<td>45</td>
<td>0.72</td>
<td>32.5</td>
</tr>
<tr>
<td></td>
<td>Resource allocation</td>
<td>67</td>
<td>0.75</td>
<td>50.1</td>
</tr>
</tbody>
</table>
According to the analysis results in Table 2, the conflict events in each stage of large construction projects have the following characteristics.

1. In the decision-making stage, the main conflict events focus on the disputes of project feasibility study among participators, and the lowest one is such problem as the report submission and approval.

2. In the preparation stage, the problems of the conflict events are mainly concentrated in the conflicts and contradictions among participators in the drawing review and technical explanation due to the poor engineering survey and design, the secondary problems are mainly such conflict events as project bidding, construction procedures transaction and land expropriation and resident migration.

3. In the construction stage, the main occurring conflicts from the top to low are respectively the resource allocation, safety, construction schedule, technology, environment, quality, personnel management and contract disputes. It can be seen that the prominent conflict event in the project construction stage is the project resources and interest allocation closely related to all participants.

4. In the completion stage, the conflict events mainly turn to the residual problem handling and the cost settlement, which has a high degree of consistency with the actual problems appearing in the construction project.

### 4 Related countermeasures and suggestions

It can be seen based on the above empirical data and theoretical analysis results that a variety of conflict events closely related to various works in their stages appear at different stages in large-scale construction projects. These conflict events may not only occur in their stage but also continue to the next stage if the conflict problem has not been solved in the previous stage. For example, if some problems exist in engineering design in the preparation stage and the problem is not solved thoroughly, then, the problem will appear again in the construction stage. Meanwhile, the problem would make relative participators debate each other, and bring a series of adverse effects to engineering quality, schedule, cost, safety, and so on. Therefore, combined with the main characteristics and distribution rules of various conflicts in each stage of the large-scale construction project, the following relevant countermeasures and suggestions are given as follows to improve the construction project management level.

1. At the decision-making stage of the construction project, project managers and decision-makers should carry out the platitudeous survey and feasibility study of the proposed project; determine the effective construction plan and scheme through deep discussion and analysis with relative participators. Thus, some advantageous conditions could be formed for avoiding and reducing the occurrence of conflict events in the later stages.

2. In the preparation stage of the project, the project managers and decision-makers should actively organize the project participating parties, and let them carefully read and understand the project's detailed construction plan. On the base of this, clarify the functions and responsibilities of all parties. These actions can avoid more conflicts and contradictions among the relevant parties in the late construction stage.

3. In the construction stage, whether the various project resources can be provided in time is not only related to whether the parties can complete their respective tasks in time but also
their enterprise’s economic benefits, so, resource conflict becomes the main problem in the construction project. Therefore, the project managers and decision-makers should establish the information management system of project resources in advance, and understand and grasp the requirements of resource allocation in the process of construction comprehensively and accurately, ensuring all participators enable to get the necessary resources support and guarantee.

(4) In the completion stage of the construction project, all parties expect to quickly complete the project handover and cost settlement, and obtain their profit. To this, the project managers should make the overall arrangement, and treat different conflict events together with their different situations in face of project confirmation and handover, residual problem handling and expense settlement. Thus, the end work of the project can be completed smoothly, and the conflicts among all participators can be minimum.

The research has been supported by the national social science foundation, No. 21BGL123, and ninety-six large-scale construction enterprises, the authors especially thank them for this work.

References