Analyzing Organization-to-project Interfaces in the Integration Management of Engineering Projects

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Abstract. To carry out the construction project management work effectively, the organization interface management in the workflow is a fundamental challenge. In the ongoing project, multiple project teams need to cooperate multi-party and complete project product delivery in different work interfaces. Organizational interface within workflow will help system planning and management in the engineering field. In this study, we first propose the evaluation indicators of engineering participants and tie strength between different organizations using the design structure matrix (DSM). Then we construct a multi-domain matrix (MDM) based on organization-to-project by correlating multiple participants in the project with the workload completion degree and present a comprehensive strength between the organization and the project to identify the crucial project interface. Finally, we give an engineering case to illustrate the proposed method and discuss its practical value. The proposed methods reinforce several managerial practices for the construction organization and project arrangement.

1. Introduction

In recent years, mega engineering projects have achieved great development and enhance the economic development. In complex construction projects, the participants face many risks such as high cost, long construction period and complex technology et al. To shorten the project construction period, reduce construction costs, and ensure the quality of construction production [1], it is essential to build systematic multi-domain linkage among project participants. Traditional project planning strategies and project management instrument are often inefficient [2]. Organization’s competitive capability has received significant attention in engineering management [3]. To solve these problems of mega projects, we need an interaction interface management system that is capable of identifying and managing the organizations-to-project in phase of the project lifecycle.

A project can be viewed as an assemblage of organizations, work, information, and other attributes that have to be integrated to achieve project objectives [4]. Today, projects have become extremely complex with overlapping activities in the engineering construction project and certain time intervals among the deliverables of different project organizations (i.e. teams). Thus, project managers must deal with interfaces of organizations to projects than ever before. This paper focuses on collaborative relationship of participants and the subprojects with different degrees of interaction.

2. Literature Review

A crucial factor of successful projects is how to establish an appropriate organizational interface among organizational teams [5]. An efficient organizational interface may reduce management complexity during the project process [2]. However, due to the complexity of team’s interdependence,
construction project organization architecture may not be properly established [6]. Delivering of projects on time is significant for construction management [4]. Interface management is used in many large construction projects to enhance coherence among stakeholders and reduce potential conflicts in projects [3]. The researchers propose to combine process management with interface theory, but they do not construct participants interface management from the perspective of organization [7]. The Design Structure Matrix (DSM) method is a powerful network modeling tool to represent the elements involved in the interface and their interactions [5]. The Multi-Domain Matrix (MDM) is an extension of DSM modeling, in which two or more DSM models in different domains are represented simultaneously.

3. Proposed methodology

This paper proposed a methodology to illustrate the interfaces from organization to project. Organizations in the project need to exchange the elements of a task or a construction milestones with the project interface, which includes machinery, materials, facilities and processes. In this paper, DSM methods are used to measure the organizational structure, and MDM is proposed to analyze the dependence intensity between projects from organization to project in engineering projects [4].

As shown in figure 1, the steps of the model are as follows: First, analyse the mutual influence of the project participants from the perspective of investors’ demand. Second, we set up an organizations’ contribution (i.e. Percentage of project completion by each organization) as mapping matrix. Finally, the influence of different participants on the sub-projects in the construction project management is determined.

![Figure 1. A Multi-level Model for DSM and analysis of dependency relationships between organizations and projects](image)

3.1. Organizational interface capability evaluation

The evaluation for the competitive capability of an organization (or teams) in an engineering project is usually completed by the investor. In this paper, we propose “the measurement of organizational reputation level, team performance ability, resource management level, risk control ability, cost control level, green construction technology and project manager ability” as the evaluation criteria. The Organization interaction DSM is established as shown in figure 2.

![Figure 2. Organization measurement matrix and the Organization tie strength DSM](image)

Next, evaluate the dependence of each index in the organization. This paper uses three degrees 1, 5, 9 to determine the organization interaction strength. The bigger the evaluation factor (i, k) is, the
higher affection this parameter made. No number indicates that the evaluation indicator of organization will not affect the interaction among teams. It is noted that the "-" represents negative correlation of the evaluation index. After the weight and relation matrix of each criterion is determined, the relative importance value $\omega_k$ of each criterion can be obtained by Equation (1).

$$\omega_k = \sum_{i=1}^{m} (F_i \times OMM (i, k)) \quad i = 1, 2, ..., m, \quad k = 1, 2, ..., K. \quad (1)$$

In Equation (1), $F_i$ indicates the weight, $OMM (i, k)$ represents the value of row $i$ and $k$ column in OMM, which represents the affection between organization $I$ and the competitive capability by evaluation index, $m$ is the number of teams, and $K$ is the number of evaluation parameters. Based on above description and discussion, the organizational interaction matrix $O_DSM (i, j)$ can be calculated by Equation (2) [7].

$$O_DSM (i, j) = \sum_{k=1}^{K} (\omega_k \times I_{j \rightarrow i} \times OMM (i, k)) \times \left( \sum_{k=1}^{K} (\omega_k \times OMM (i, k)) \right)^{-1} \quad (2)$$

where $K$ is the number of evaluation indicators, $I_{j \rightarrow i}$ indicates the effect of the evaluation criteria on the organization, $I_{j \rightarrow i} = 1$. The denominator represents the overall degree of correlation between the organizations $i$ and all the evaluation indicators, and the numerator indicates the comprehensive influence of the relationship between the evaluation parameters.

3.2. Project DSM based on organization-to-project MDM

3.2.1. The interface of engineering project. The investor of the project will sign multiple engineering contracts with a number of project participants whom complying with an agreement in accordance with the responsibilities. Figure 3 shows that milestone delivery of building products occurs at different stages in different tasks. All the participants in the current task have formed the engineering project interface. $D (i)$ represents upstream activity $i$, $D (j)$ represents downstream activity $j$, and the teams between the upstream and downstream exists in the different activities between $i$ and $j$. Fig.3 (a) indicates that the participant will do the downstream activity after the preliminary activity is completed. Fig.3 (b) shows that the participant will do the upstream activity after the preliminary activity is completed.

![Figure 3. Construction milestones delivery](image)

The coordination between the organizations is not only for a single task, but also for the progress of multiple tasks. Multiple organizations complete part of the subproject. Therefore, the intensity of interaction in organizational management highly depends on the coordination between the organizational units performing tasks.

We use the organization's contribution (e.g. percentage of project completion by each organization) to build the organization-to-project DSM. As shown in the figure 4 below:
The letters in Fig. 5. (a) are calculated by the Equation (2), Fig. 5. (b) is a typically non-square matrix mapping the domain of organizational interaction DSM to the domain of project DSM, which represents organization’s contribution in different engineering projects. It is important to note that the sum of the parameters α, β, γ is 1.

3.2.2. Organization-to-project MDM. The Multi-Domain Matrix (MDM) model can be utilized to reveal the relationship between different domains. MDM is an extension of DSM modeling in which two or more DSM models in different domains are represented simultaneously [1]. As shown in Fig. 7 (a) and (b), the MDM includes organization DSM (as shown in 3.1), project DSM and DMM (as shown in 3.2.1).

The dependency strength $P_{DSM}(I,J)$ among projects (see Fig. 6.(a)) which results from organizational relationships can be calculated with Equation (3)[7].

$$P_{DSM}(I,J) = \sum_{i} (DMM(I,i) \times \sum_{j} (O_{DSM}(i,j) \times DMM^T(j,J)))$$

where $O_{DSM}(I,J)$ is the value of dependency strength between teams $i$ and $j$ in the org DSM, each row and column is an organization. $DMM(i,j)$ is the mapping value between organization and project where its value indicates the organization’s contribution in different engineering projects. $P_{DSM}(I,J)$ represents the comprehensive intensity which are influenced by the capability of interface from the organizational interface.

4. An illustrative example

In this paper, we applied the proposed concepts and models to an example, a Steam turbine installation of Power plant project. According to the industry specification and contract division, the steam turbine installation project is mainly divided into the following five steps: A = The foundation of the turbine hall above the floor zero meter; B = The delivery of the turbonator’s foundation; C = The sealing and the roof’s end construction of the turbine hall’s; D = steam turbine’s platen in position; E = ST box up.

Through the reputation level of organization, organizational performance ability, resource management level, risk control ability, cost control level, green construction technology and project...
manager ability as the evaluation criteria. As shown in figure 6, the organizational evaluation matrix and the Organization interaction DSM are established.

![Figure 6.Organizational evaluation and organization interaction DSM](image)

Further, the organization interaction DSM is mapped into the "organization-project" matrix, as shown in Fig.7. It can be seen that the influence degree of project A to other projects is 0.78+0.7+0.73+0.9=3.11, and the influence degree by other projects is 0.7+0.74+0.68+0.92=3.04. Therefore, the leading role of project A in the entire project interface is 3.11/3.04=1.3; similarly, the leading roles of project B, C, D, and E in the entire project interface are: 0.67, 0.85, 0.71, and 0.8. Project B is mostly affected by other projects. Therefore, it is necessary to combine the interactions among organizational interfaces with the actual situation of projects to manage multiple construction projects.

![Figure 7.Organizational evaluation and organization-to-project DSM](image)

### 5. Conclusion

A systematic methodology in construction integration management has been presented in this paper. The proposed method can evaluate the interaction capability of organizational interface and dependencies influence of project interface. Another significant contribution of this paper is the organization's contribution (percentage of project completion by each organization) to build the organization-to-project DSM. It is significant to combine the interactions among organizational interfaces with the projects interfaces to manage multiple construction projects. The investor of the project can establish an effective connection between multiple projects and multiple organizations by using this method. Several aspects of the model presented in this paper merit further examination. First, the organizational interface capability evaluation criteria need to be explained in detail and quantitative. Second, the information iterations in multiple projects will also feedback organizational interactions, which should be further investigated.

### 6. References

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