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Developing a city-level multi-project management information system for Chinese urbanization

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Abstract

The unprecedented Chinese urbanization leads to massive government-funded construction projects. In most cities, a special project management mode called "Agent Construction Model (ACM)" has been adopted to manage and govern these projects under the same umbrella of administrative standards. The ACM integrates all available government resources to complete the urbanization projects but meanwhile it faces great challenges from overwhelming complex information and information processing. This study presents the development of a city-level multi-project management information system to decompose the information processing complexity in the context of ACM management mode. The complex adaptive system and two specific development techniques—adaptive project framework and modularized functional design method—are introduced for the system development. The system was validated at a typical urbanization city in Changchun, China. This research complements the existing project information system by adopting complexity design principles and it also provides practical value for managing large-scale urbanization projects.

Keywords: Urbanization; Multi-project; Complexity; Case study; Project management information system

1. Introduction

1.1. Background of Chinese urbanization and project management models

China is experiencing the largest expansion of urbanization ever in its history, where the urbanization ratio increased from 36.22% to 52.57% in 2000 to 2013, with an estimation of 60% in 2020 (Pan and Wei, 2013). Nationwide urbanization brings massive infrastructure and construction projects in all geographical areas. Since 1992, China, on average, invested 8.5% of its Gross Domestic Product into infrastructure and construction industry, far exceeding any other countries in the world. In terms of monetary value, annual spending of Chinese infrastructure and construction now surpasses the United States and the European Union (Chen et al., 2013). Between 1997 and 2007, over 80% of the project funds came from government supported or related subsidies (Wang et al., 2011) where majority of infrastructure projects are funded by state-owned investment entities and corporations. Under the leadership and generous support of the government, enormous achievements have been achieved in the infrastructure and construction industry, making China as one of the top countries with the longest railways, highways, and high-speed rails.

Due to particular economic regime and market attributes in China, those large-scale infrastructure projects used to have three procurement system for construction: self-build model, government construction commanding unit model, and state-owned construction enterprises model. Such methods can successfully run particular types of project based on investment entity, project

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location, level of authority, and other administrative reasons. However, a series of problems have also been reported (Lu et al., 2011), such as budget overrun from project scope creep by administrative decision makers, poor quality due to limited professional construction management service, and misconduct and corruptions owning to rent-seeking of administrative relationships.

In 2004, State Council of China issued the "Regulation on Reforming the Government Investment System" to encourage a new project management mode, Agent Construction Model (ACM) or in Chinese "Dai Jian Zhi", for all not-for-profit projects in an effort to improve the effectiveness and efficiency of infrastructure construction management. The ACM is a management model of delivering construction projects by means of consigning the project to specialized engineering management organization that is called agent owner, who is familiar to laws, regulations, and construction procurements (Hou, 2003). The appointed ACM firm is expected to manage the project's construction process effectively and deliver the completed project to end-users within project's cost, time, and specification (The State Council of China, 2004).

In practice, two ACM systems have been emerged: market-based ACM and government-based ACM (Bing et al., 2005; Shen et al., 2006). Market-based ACM appoints the construction project management services to a private firm via market bidding and tendering process. Such process takes advantage of competing market to select the most qualified agent to manage the project. Compared to the market-based ACM, the government-based ACM is more administrative oriented. In such model, the government establishes a specialized management unit called *ACM center*, as an official unit belonging to the department of urban and rural construction of each municipality. The ACM center manages the construction process of all public-invested projects across different departments, such as public school facilities, courts, and fire stations. With the support of the government, the ACM center can apply the administrative power and authorities to assembly the resources needed by the projects and to run those "thorny" projects.

Due to the direct financial and administrative support by the government, the ACM center has advantages of centralized planning, coordination, and resource allocation, thus considerably improve the project management efficiency and reduce the management cost (Yin et al., 2010). The ACM center remains organizationally stable for a longer duration and is more reliable in applying project management principles for most public construction projects (Bing et al., 2005; Shen et al., 2006; Wu et al., 2012; Yan and Zhou, 2009). As a result, the ACM center became a popular project management method for Chinese government-invested project. This study will focus on the ACM center as the context of Chinese project management mode for all city-level infrastructure renewal projects.

One should note that the ACM center is originally developed from the Construction Manager (CM) (Yin et al., 2010) but show differences from CM in following three perspectives. First, the ACM center is a more integrated entity by managing multiple projects for various project owners at the same time rather than CM. For instance, the ACM center of a typical Chinese city manages hundreds of public projects simultaneously, such as educational facilities, roads, and bridges; while the CM is mainly focused on managing one single project at a time. Second, the ACM center is a government agency and also only manages government invested projects (Gao and Zhu, 2006). This brings special considerations since those projects are not only bounded with economic targets but also involved with social issues and various stakeholders. Especially in the urbanization process when most of projects are built on existing facilities, management of those projects need extensively coordination and support from local communities. But CM is primarily used for "for-profit" clients and contractors with less social considerations. Third, the responsibilities of the ACM center are different from CM. The ACM does not charge for the maximum grantee price (as in the CM "at risk") but in most cases is required to complete the projects within a strict time and budget set by its client, typically the government. These differences highlight the ACM center as a special project management model for Chinese urbanization.

2. Research needs and significance

Although above numerous special advantages of the ACM center, the overwhelming expansion of urbanization has caused great challenges and problems for the government centralized management system. For example, the ACM center needs plan and construct various types of complex projects, from bridges, transportation hubs, to hospitals, under tight schedule and intertwined management scopes. It is also difficult to coordinate and manage hundreds of projects and thousands of participants simultaneously from diversified industries with different requirements and fragmented information pieces. As projects become more complex, the amount and the level of information details related to the ACM center increase that makes the process of storing, retrieving and analyzing the control information more complicated (Ruwanpura et al., 2012). In addition, the variability and uncertainty of external environment commonly lead to delayed decisions. All of the above issues call for advanced information management solutions and decision-making support systems.

Existing practices show that multi-project information management system can integrate the fragmented information in the decentralized environment, promote the effectiveness of communication and coordination, process complex project information, and enhance managerial performance at project, program, and portfolio (Bekkers, 2007; Froese, 2010; Halfawy, 2010; Han et al., 2009; Park and Ryoo, 2008; Zeng et al., 2012). Current project management information system software, such as Oracle Primavera P6, can provide solutions to detect latent issues before they occur, meet schedule deadlines, and easily collaborate. However, most of them are not capable of managing multi-project (Raymond and Bergeron, 2008), and also show less suitable for the ACM center which require cross-organizational coordination, integrated process management for investment, contract and budget, and ad-hoc customized functions. These limited options do not be address