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A governance platform for multi-project management in shipyards

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ABSTRACT

Efficient multiple project management is very important to the project-based industries. Current multi-project studies in shipbuilding focus on designing mathematical models and heuristic algorithms to achieve optimal resource usage. However, due to the rigid requirements on complete information, these models are inapt to support decisions in the early stages (such as the project biding stage) that have been acknowledged more and more critical in the ever fierce market. On the other hand, although pieces of information management software have been developed for project management and production, there are works left to be manually executed, such as production prediction of a new project and control of the temporary system access delegated to business partners, hindering further improvements in work efficiency. To bridge these gaps, this paper innovatively proposes a governance platform architecture based on the theory of Governance of Projects. The framework views organization management as important as project management and adopts a new access control method which helps reduce the manual labor. Moreover, a case-based reasoning algorithm that supports planning prediction with limited information is designed. Finally, a prototype system is developed and tested in a shipyard in China. It proves to be both effective and efficient.

1. Introduction

Shipbuilding industry, characterized by the ETO (Engineering-to-Order) production mode, is typically a project-based industry (Zhang et al., 2012). To compete in the ever fierce market, shipbuilding companies are demanded to be competent to conduct several projects at the same time (Ahola & Davies, 2012). Generally, a shipbuilding project is very large and complex (Han et al., 2017). The number of activities can reach up to ten thousand and cross-working is common in shipyards. Since key resources (such as docks, quays and so forth) are finite and have a direct impact on the final project makespan, it is a primary issue to achieve continuous production with minimum project delay in the multi-project context. Meanwhile, considering risks brought by the high budget and the long period of a shipbuilding project, managers always tend to get a more precise prediction and estimation of a new project to bid.

Majority of current multi-project studies in shipbuilding focus on designing mathematical models and heuristic algorithms to solve the Resource Constrained Project Scheduling Problem (RCPSP) (Han, Yang, & Gong, 2010; Li, Hu, Lv, & Sun, 2013a, 2013b). Zhang et al. (2012) extends the RCPSP model with budget constraints and develops an optimization engine on top of Microsoft Project Server. However, rigid requirements on full information make these models inapt to support decisions in the early stages (such as the project biding stage). Boer (1998) develops a decision support system for shipyards to plan and schedule multi-projects. Although RCCP (Rough Cut Capacity Planning) function is provided in the order acceptance phase, the system still subjects to the input acquisition (a large number of process planning data) difficulties. Hans, Herroelen, Leus, and Wullink (2007) proposes a hierarchical project planning framework where flexible usage of planning methods is favored. Nonetheless, the research does not develop any practical tools.

Some researchers indicate that planning is a knowledge-intensive work and introduce case-based reasoning (CBR) method in process planning (Cho, Lee, & Chung, 1996; Qu, Jiang, & Tao, 2013; Seo, Sheen, & Kim, 2007) as well as in work structure decomposition (Li, Mao, & Zhang, 2017) for shipbuilding projects. It is noticeable that a whole plan of a potential project cannot be generated by these studies, let alone a balanced result based on the current production status (Loaggui, Lu, and Xu (1987) develops a network-planning aid system for multi-shipbuilding production. The system can support rapid project duration estimation of a new project on condition that the process

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sequence is known. In other words, decision makers have to acquire the process sequence of a new project by other tools (or manually). To conclude, there is a lack of an automatic tool to predict production for decision makers in the biding stage of a shipbuilding project.

On the other hand, more and more information management systems have been particularly developed for ship manufacturers to well manage their resource, project schedule, production cost and suppliers. Although such systems prove to be effective in their perspective domains, workers complain that sometimes they need to use several systems to complete one business workflow. It can be time-consuming and error-prone. Integration usage that follows the practical business process is on urge demand. Song, Woo, and Shin (2011) defines a standard shipbuilding production management system for shipyards to achieve high agility and flexibility. This system integrates main functional modules (planning & scheduling, material management, quality management and so forth) to work as a whole. However, no light is shed upon the system interfaces for partners to get appropriate information at the right time. This is obviously not good for shipyards to promote the cooperation with outer organizations. Besides, most project management information systems only adopt the role and the department as the access control criteria. It is much less convenient for the dynamic organization structure of a project, especially in the domain of shipbuilding where multi-tier suppliers and subcontractors are involved. The authority control can be very tedious in practice. To the best knowledge of the authors, no practical efforts have been put on dealing with this issue. This is partially because that when designing a project management system, organization management attracts less attention in contrast to scheduling management and other business management.

This paper attempts to design a novel governance platform for shipyards to better manage their multiple projects. The aim of the governance platform is threefold. Firstly, the system can integrate with most existing management software in shipyards and serve as a consistent computer-aided tool for business workflows. Secondly, the system can provide a stronger organization management that satisfies the increasing demand on seamless cross-enterprise cooperation. In this aspect, dynamic information access control for multi-organizations should be achieved with less manual work. Moreover, the platform can support decision makers with the planning prediction of a new project in the project biding stage, but merely requests a minimum set of data input. All these features will make this paper unique among peer studies.

The rest of this paper is arranged as follows. Section 2 examines closely to the multi-project management theory with a special attention on temporary organization management for multiple heterogeneous enterprises. Research on case-based reasoning applied in project planning is also analyzed. Section 3 designs organization and resource models necessary to realize the computer-aided Governance of Project (GoP). By this way, a unified representation of the organization, the resource, the process and the project is formed. Based on that, a conceptual framework is introduced, clarifying the structure as well as the operation processes. In Section 4, a planning and scheduling prediction algorithm for a wait-to-bid project is proposed .For implementation, Section 5 develops a prototype system of GoP platform and an application is given to show the benefit of GoP platform. Section 5 concludes this paper with limitations and future work.

2. Literature review

2.1. Multiple project management

In regard to multiple project management, a number of studies have been conducted in mechanism development and instruction innovation. Portfolio management and project governance (PG) are the two most prevalent multi-project management theory (Too & Weaver, 2014). The former is featured by clustering projects in terms of business strategy and market significance, highly depending on experts for its practical use. Even if the clustering process is computer-aided, a large proportion of manual work is still requested. The latter, defined by the Project Management Institute (PMI) as “an oversight function that is aligned with the organization’s governance model and that encompasses the project life cycle by providing a comprehensive consistent method of controlling project” (PMI, 2013), is a significant area of the corporate governance related to project activities. It is the management of project management with clear layers in the organization structure (Too & Weaver, 2014), ranging from the highest board directors to the project manager. To better understand PG and its technical core, some researchers established that there are two distinctive categories: external to any specific project (EXA) and internal to one individual project (INO) (Ahola, Ruuska, Artto, & Kujala, 2014). The idea of applying PG on offshore platform projects origins the research conducted by Ahola and Davies (2012). However, the research does not describe the framework or application manners.

In recent years, the notion of Governance of Project (GoP) has gained attention from both the academic society and the industrial enterprises. To some extent, GoP embraces the aforementioned two kinds of PG and deals with multi-projects in goals of multi-participators. It aims at the global strategic achievements rather than the local ones. Comparison between PG and GoP is presented in Table 1.

A conceptual GoP framework illuminated in Too and Weaver (2014) consists of the strategy system (the parent organization level), the executive system (the portfolio level), and the delivery system (the project level). The latter is again divided into the project management level and the workshop level (also the task level), respectively. All governance layers (the parent organization level, the portfolio level, the project level, and the task level) take responsibilities for the overall Project-based Organization (PBO). The strategy system is charged by the board of directors while the executive system is dominated by senior managers (Müller, Zhai, Wang, & Shao, 2016). The delivery system is proposed for fixed goals to deliver products in a concrete time. Serving as a critical link between the strategy and the executive system, the project sponsor is undertaken by either the project manager from the manufacturer or the project leader from the project owner. Its aim is to balance the benefits between the owner and the manufacturer. Another important role in GoP is Project Management Office (PMO) which connects the organizational governance with the governance of a specific project. The principal responsibility of PMO is to provide the executors (mainly senior managers in executive system) with accurate information about the current state and the near-future trends of all

Table 1
Comparison between PG and GoP (Ahola et al., 2014).

Category	Features	Key approaches	Object	
PG	EXA	(1). Unidirectional relationships (2). Flexibility in the choice of methods and processes	Define polices, institutions and the authority	Individual projects
	INO	(1). Bidirectional relationships (2). Flexibility in the choice of methods and processes	Establish a set of rules, procedures and shared practices	All participates firms in the project
GoP		(1). Heterogeneous types of projects, and inter-organizational relationships (2). Flexibility in organization structures	Execution across the interfaces of project, program, portfolio, as well as boundaries of organizations	Groups of projects and all stakeholders