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Developing A Smart Construction Schedule Development System

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Abstract

Schedule delays in public construction projects are expected. How to ensure that the planned construction schedule is practicable and executable is one of the problems that must be thoroughly addressed for any contractor. This study attempts to develop a smart construction schedule development system to provide solutions for schedule development. Focused on social housing construction projects, which will continue to be vigorously promoted domestically in the future, this study establishes an assistant system for developing construction schedules, supplemented by an interview with domestic practical experts to ensure the reasonableness and feasibility of the system-generated schedules. Compared to available commercial scheduling software, the developed prototype system is expected to assist schedule planning from the contractor's perspective, with a comprehensive schedule evaluation report.

Keywords: schedule development, social housing, construction projects, schedule evaluation, automation, scheduling tool.

1 Introduction

Globally, schedule delays in public construction projects are expected. Preventing delays or solving delay issues are two major approaches in practice. However, based on the principle that prevention is better than cure, developing a practicable and executable schedule is the best way to manage a project schedule. Although PMI's Practice Standard for Scheduling [1] has provided several well-proven steps, including defining milestones, defining activities, sequencing activities, determining resources, determining duration, and performing critical path calculation, the

schedules in practice could be found problematic. This study focused on developing a schedule that is practicable and executable.

In Taiwan, the Public Construction Commission issued the "Reference Guideline for Managing the Progress of Public Construction Projects" [2] in 2016 to assist governmental agencies in managing construction progress, ensuring effective control and monitoring of construction timelines, and enhancing project execution performance. The primary purpose of this guideline is to help agencies and contractors implement effective schedule planning and control. However, a bad schedule can be found commonly. This implies that the best practices or guidelines can not ensure the quality of schedule networks. Therefore, how to develop a practical and executable project schedule network diagram has become one of the key issues that academia should help the industry address.

2 Literature review on scheduling practice and automation approach

Excluding PMI's Practice Standard for Scheduling, many guidelines issued by governmental institutes are available for reference to improve the quality of the received project schedule. For example, the Government Accountability Office in the United States published the Schedule Assessment Guide [3]: Best Practices for Project Schedules. The guide's preface has a clear message: a well-planned schedule is a fundamental management tool that can help government programs use public funds effectively by specifying when work will be performed in the future and measuring program performance against an approved plan. Clearly, the importance of the practice guide has been proven.

Previous studies have developed and provided useful frameworks and principles to evaluate the quality of generated schedules. For example, Moosavi and Moselhi developed a structured methodology and implemented it in an automated computer application to assist owners in performing such a schedule assessment and evaluation [4]. Similarly, Bragadin and Kähkönen collected 75 schedule requirements classified into five groups (general requirements, construction process, schedule mechanics, cost and resources, and control process) to form a schedule health assessment framework [5]. Therefore, basic schedule requirements can be found in the literature.

Scheduling is a knowledge-intensive and time-consuming process. Several computer systems have been developed to help schedulers generate good schedules effectively. For example, Mikulakova et al. analyzed the schedule planning process and then developed a knowledge-based approach for the automatic generation of schedules and their evaluation [6]. Kim et al. developed an automated as-planned schedule system for efficient scheduling [7]. Recently, a model for BIM-based schedule generation and optimization has been discussed to improve the cohesive schedule management workflow and outcomes [8]. Dzeng et al. also developed a module-based schedule generation and review model. Focused on expressway construction projects, the developed system helps schedulers manage and reuse the modules to build a new schedule, and helps reviewers review schedules [9].

In summary, the idea of effectively providing a tool for schedule generation and evaluation has been proven previously. However, integrating automation processes of schedule generation and evaluation into an available commercial scheduling tool would be challenging. Based on the practice of scheduling for social housing construction projects, this study developed a mart construction schedule development system that helps schedulers develop a practicable and executable schedule evaluated by a module embedded in the system.

3 System Framework and Prototype of Smart Construction Schedule Development System

This study proposed the system framework of a Smart Construction Schedule Development System (SCSD system) for social housing construction projects, shown in Figure 1. All modules are coded in the Visual Basic for Applications (VBA) embedded in Microsoft Project 2023 (MS-Project). All modules are illustrated as follows.

3.1 Schedule development module

This module is developed to help schedulers develop their schedules. Figures 2 and 3 are the interfaces captured from the system. The user should provide the system with basic project information through several interactive steps. After inputting the information, the SCSD system will automatically generate a schedule. Excluding the project's start and finish dates, when the activity information is missing, the SCSD system will use the default values collected from the best practice and examined by domain experts.

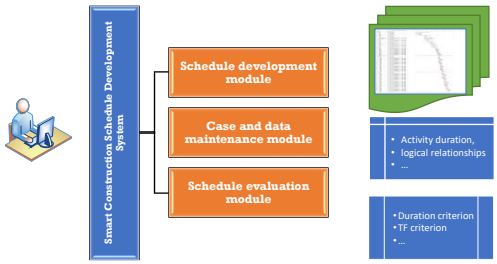

Figure 1: System framework of SCSD system.

Figure 2: Interface for providing basic project information.

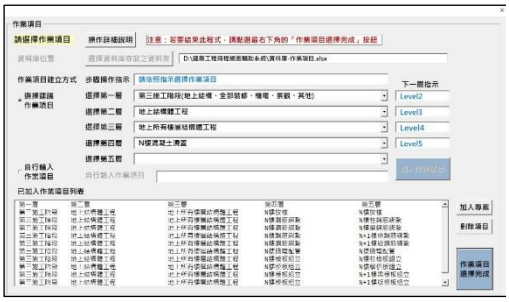

Figure 3: Interface for selecting activity information.

3.2 Schedule evaluation module

This module performs a comprehensive schedule evaluation after the user opens an MS-Project schedule or finishes the work in the schedule development module. This module will generate an evaluation report in MS Excel, as shown in Figure 4. For example, the SCSD system checks the values of activity duration (the number of high duration, i.e., >= 30 days)and total float (the number of high TF, i.e., >= 30 days). All evaluation criteria and threshold values can be found in the reference [10].

Figure 4: Schedule evaluation report.

3.3 Case and data maintenance module

The SCSD system saves all schedules collected from the practice. Those cases are valuable for generating new projects. Therefore, the case and data maintenance module provides a channel to update the case schedules and default values for schedule evaluation. Figure 5 shows the interface for the user to perform necessary modifications.

Figure 5: Interface for editing case information.

4 System Validation

The research team has evaluated the prototype of the SCSD system to confirm its correctness and operability. To improve its practicality and applicability, this study invites domain experts with intensive experience in social housing construction projects and scheduling practices.

The validation was performed through an interview, which included an introduction to the system and case validation. The experts acknowledge the performance of the SCSD system, although some minor suggestions are provided to improve the clarity of illustrations for the user.

Based on an expert's viewpoint for evaluating the quality of the construction schedule, the outcomes of schedule evaluation by the SCSD system provide worthwhile values. The domain experts also suggested providing complete illustrations with examples of evaluation criteria because most practitioners might not have the required knowledge to understand those criteria. In summary, the SCSD system can improve the schedule quality of social housing construction projects.

5 Conclusions

A high-quality project schedule provides a solid basis for managing construction projects and decreases the possibility of schedule disputes. This study develops a commercial scheduling tool-based system for the scheduler to generate a construction schedule efficiently and improve its quality by providing a schedule evaluation report. The outcomes of this study have been validated by domain experts, revealing its value in enhancing schedule development and evaluation practice. This study used the term "smart construction schedule development system" because the system can be extended when incorporating more cases into the case base. Moreover, the schedule might be different for different project constraints. The developed system can provide a schedule evaluation report for the user to adjust schedule components to obtain an anticipated and healthy schedule outcome.

Due to space limitations of this article, the detailed information about the SCSD system can be found elsewhere [10]. Although this study used the social housing construction projects as an empirical case, the framework and system codes can be adopted into various project types easily and quickly. Furthermore, the SCSD system could be a support system, not an automatic schedule generation system. Experience schedules still play an irreplaceable role in the schedule management domain.

Acknowledgements

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