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Knowledge-based decision support system for management of variation orders for institutional building projects

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Abstract

This paper describes the development of the knowledge-based decision support system (KBDSS) for management of variation orders for institutional buildings in Singapore. The KBDSS consists of two main components, i.e., a knowledge-base and a decision support shell for selecting appropriate controls. The database is developed by collecting data from the source documents of 79 institutional building projects, questionnaire survey, literature review and in-depth interviews with the professionals who were involved in these projects. The knowledge-base was developed through initial sieving and organization of the data from the database. The decision support shell provided decision support through a structured process consisting of building the hierarchy between the main criteria and the suggested controls, rating the controls, and analyzing the controls for selection through multiple analytical techniques.

The KBDSS is capable of displaying variations and their relevant details, a variety of filtered knowledge, and various analyses of the available knowledge. This would eventually lead the decision maker to the suggested controls for variations and assist in selecting the most appropriate controls. The KBDSS is able to assist project managers by providing accurate and timely information for decision making, and a user-friendly system for analyzing and selecting the controls for variation orders for institutional buildings.

Keywords: Knowledge-base; Variations; Management; Institutional buildings; Singapore

1. Introduction

In a perfect construction world, there would be no variation orders. But there is no perfect construction world [1]. The fact is variation orders are an unwanted, but inevitable, reality of any construction project. The construction process can be influenced by changing variables and unpredictable factors that could result from different sources. These sources include the performance of construction parties, resource availability, environmental conditions, involvement of other parties and contractual relations. As a consequence of these sources, the construction of projects may face problems which could cause delay in the project completion time [2].

Developments in the education sector and the new modes of teaching and learning fostered the need for renovation or extension of existing academic institutions in Singapore. The change of space in academic institutions is required to cater for the new technology used. The construction of an institutional building also poses risks as in the construction of any other large projects. Variations during the design and construction processes are to be expected.

There are three main contemporary rubrics of variation orders, i.e., change orders, variation orders and change directives, usually referred based on the region of the construction industry [3]. Variations are common in all types of construction projects [1,3]. The nature and frequency of variations vary from one project to another depending on various factors. Construction projects are bound to encounter variation orders; the goal of any owner, designer, or construction manager is to control the number of variations [1,4,5].

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In project management, variations in projects can cause substantial adjustment to the contract duration time, total direct and indirect cost, or both [5–7]. Every building project involves a multi-player environment and represents a collaborative effort among specialists from various independent disciplines. Because variations are common in projects, it is critical for project managers to confront, embrace, adapt and use variations to impact positively the situations they face and to recognize variations as such [8]. The variations and variation orders can be minimized when the problem is studied collectively as early as possible, since the problems can be identified and beneficial variations can be made [9]. The variations and variation orders can be deleterious in any project, if not considered collectively by all participants. From the outset, project controls should take advantage of lessons learned from past similar projects [5].

Decision making is a significant characteristic that occur in each phase of a project. In almost every stage, decision making is necessary. Often, these decisions will, or can affect the other tasks that will take place. To achieve an effective decision making process, project managers and the other personnel of one project need to have a general understanding of other related or similar past projects [9]. This underscores the importance of having a good communication and documentation system for better and prompt decision making during various project phases.

If professionals have a knowledge-base established on past similar projects, it would assist the professional team to plan effectively before starting a project, during the design phase as well as during the construction phase to minimize and control variations and their effects. The current technological progress does not allow the complete computerization of all the managerial functions or the creation of a tool capable of carrying out automatically all the required management decisions. To insure the success of this important management function, it is believed that human involvement in this process remains essential. Thus the Decision Support System (DSS) approach for this kind of application seems to be the most natural idea [10].

From the outset, project strategies and philosophies should take advantage of lessons learned from past similar projects [5]. It signifies the importance of an organized knowledge-base of similar past projects. The importance of a knowledge-base for better project control was recommended by many researchers [5,7,10,11].

The knowledge-based system should present a comprehensive scenario of the causes of variations, their relevant effects and potential controls that would be helpful in decision making at the early stage of the variations occurring. The knowledge-based decision support system would assist project management teams in responding to variations effectively in order to minimize their adverse impact to the project. It is therefore important to develop a knowledge-based decision support system for management of variation orders for institutional buildings, given the large number of such projects carried out in this segment of the construction industry in Singapore. The objective of this study is therefore to develop a knowledge-based decision support system for management of variation orders for institutional building projects in Singapore. This is a timely study as the programme of rebuilding and improving existing institutional buildings is currently under way in Singapore; it provides the best opportunity to address the contemporary issues relevant to the management of variation orders. The knowledge-base developed based on the information gathered from the completed institutional projects would help professionals in taking proactive measures for reducing potential variations.

2. Scope of research

The government of Singapore initiated a major program of rebuilding and improving existing institutional buildings to ensure that the new generation of Singaporeans would benefit from the best information technology (IT) available. The new and upgraded facilities in these institutional buildings will include computer laboratories, media resource libraries, IT learning resource rooms, pastoral care rooms and health and fitness rooms. The occupants can also look forward to bigger classrooms and staff-rooms, as well as more interaction areas.

A total of about 290 institutional buildings will be upgraded or rebuilt by a government agency over a period of seven years, at an estimated cost of S$4.46 billion from 1999 to 2005. (Note: at the time of writing, US$1 is about S$1.80.) The projects are of three types, namely, upgrade, rebuild and grass root (new) buildings under the major programme of rebuilding and improving. Developing a knowledge-based decision support system for management of variation orders for institutional building projects will contribute towards the better control of variation orders through prompt and more informed decisions. Hence, this research concentrated on the institutional building projects under this major rebuilding and improvement programme in Singapore. The survey and interviews were restricted to the professionals with a government agency responsible for the rebuilding and improvement programme, the consultants and the contractors who were involved in these institutional projects.

3. Research methodology

To develop the knowledge-base decision support system for management of variation orders for institutional building projects in Singapore, a case study approach and questionnaire survey were carried out. Information for the study was obtained from source documents of the institutional projects completed, and through personal interviews and in-depth discussions with the professionals with a government agency responsible for the rebuilding and improvement