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Application of data warehouse and Decision Support System in construction management

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Abstract

How to provide construction managers with information about and insight into the existing data, so as to make decision more efficiently without interrupting the daily work of an On-Line Transaction Processing (OLTP) system is a problem during the construction management process. To solve this problem, the integration of a data warehouse and a Decision Support System (DSS) seems to be efficient. 'Data warehouse' technology is a new database discipline, which has not yet been applied to construction management. Hence, it is worthwhile to experiment in this particular field in order to gauge the full scope of its capability. First reviewed in this paper are the concepts of the data warehouse, On-Line Analysis Processing (OLAP) and DSS. The method of creating a data warehouse is then shown, changing the data in the data warehouse into a multidimensional data cube and integrating the data warehouse with a DSS. Finally, an application example is given to illustrate the use of the Construction Management Decision Support System (CMDSS) developed in this study. Integration of a data warehouse and a DSS enable the right data to be tracked down and provide the required information in a direct, rapid and meaningful way. Construction managers can view data from various perspectives with significantly reduced query time, thus making decisions faster and more comprehensive. The applications of a data warehousing integrated with a DSS in construction management practice are seen to have considerable potential.

Keywords: Decision Support System; Project management; Construction; Data warehouse; On-Line Analysis Processing

1. Introduction

1.1. Using Decision Support System (DSS) in construction management

At present, some transaction processing systems, which are updated continually throughout the day, are often employed to run the day-to-day business of a construction company [1]. For instance, if some materials are delivered into the warehouse, the On-Line Transaction Processing (OLTP) will consistently make additions to the inventory. However, it is usually found in such systems that the construction process is a "temporary" and "specific" activity, which means the data of one project can seldom be used for another project. Is that the true situation? Probably not, because although construction products are 'unique', some similarities still exist between them, and con-

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struction processes and management skills are typically common to all projects [2]. How to analyze the successes and failures of finished projects and how to use the existing data to analyze patterns and trends for new projects are the problems we have to face.

During the project control phase, in order to take rectifying actions for any deviations in the performance, project managers often need timely analysis reports to measure and monitor construction performance. They also need timely analysis reports to assist in making long-term decisions [3]. It is found that most of the reporting and analysis, time was spent on collecting data from the various systems before the analysis can be made. Managers want and need more information, but analysts can provide only minimal information at a high cost within the desired time frames [4]. In order to provide information for predicting patterns and trends more convincingly and for analyzing a problem or situation more efficiently, an integrated Decision Support System (DSS) designed for this particular purpose is needed.

An important role of a Decision Support System is to provide information for users to analyze situations and make decisions. Put in another way, a Decision Support System provides information for employees to make decisions and do their jobs more effectively [5]. This decision-making can be of a long-term strategic nature, such as analyzing event patterns over several years to prevent or reduce the rate of occurrence of a particular event. Decision-making can also be short-term and tactical in nature, such as reviewing and changing the time schedule for a particular part of a project. Good systems provide the information needed, so that employees are better equipped to make more informed decisions. Described in this paper is the development of a prototype Decision Support System, employing the new 'data warehouse' technology incorporating large quantity of analysis information needed for both long-term and short-term construction management decision-making.

1.2. Using a data warehouse to support a DSS

Being a new branch of the database community developed in recent years [6], the 'data warehouse' is a read-only analytical database that is used as the foundation of a Decision Support System. The purpose of a data warehouse is to ensure that the appropriate data is available to the appropriate end user at the appropriate time.

A data warehouse is a global repository that stores preprocessed queries on data, which reside in multiple, possibly heterogeneous, operational query base for making effective decisions [5]. The contents of a data warehouse may be a replica of part of some source data or they may be the results of preprocessed queries or both. This method of data storage provides a powerful tool-helping project organizations in making decisions. The architecture of a data warehousing system allows a number of alternative ways to integrate and query (such as previous or projected) information stored in it. Thus, a data warehouse coupled with On-Line Analysis Processing (OLAP) enables project managers to creatively approach, analyze and understand project problems. The data warehouse system is used to provide solutions for construction problems, since it transforms operational data into strategic decision-making information. The data warehouse stores summarized information instead of operational data. This summarized information is time-variant and provides effective answers to queries such as "What are the supply patterns and trends of various construction materials?", "How is the material consumption this year different from its counterpart last year?", "How many accidents happened in the last 10 years and how much did they cost?", "What is the percentage increase in the cost of human resources during the last 5 years?", "Did machine repair have any influence on construction progress? If so, what was the influence coefficient?" and so on. To extract this information from a distributed relational model, we would need to query multiple data sources and integrate the information at a particular point before presenting the answers to the user. In a data warehouse, such queries find their answers in a central place, thus reducing the processing and management costs.

1.3. What is new in our system?

As a matter of fact, Decision Support Systems have been applied in construction management for several years. The early systems such as management information systems, report-oriented systems and so on are often born with flaws [7]. Firstly, they are not separated from transaction systems completely and the