Quantity Takeoffs and Detailed Buildings Cost Estimation Using Geographic Information Systems

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ABSTRACT

This paper presents a Geographic Information System (GIS) based cost estimation methodology, which may be helpful in increasing the productivity of quantity estimator by reducing the manual work in quantity takeoffs. Proposed methodology also eliminates missing or duplication of various items of work by visualizing each components corresponding to the items in three dimension (3D). Several scripts developed within ArcView, a desktop GIS based mapping system, have been used to extract the necessary dimensions from the design drawings (prepared in GIS environment) and to perform various calculations of quantity takeoffs. Accurate Bill of Quantities (BOQ) may be generated on the basis of dimensions of various data themes. Methodology has been designed to store construction resource data (materials, workers, and equipments) in tabular form within the GIS environment. Separate tables have been used for each project to generate BOQ, Bill of Materials (BOM), and labor requirements.

Keywords: *Bill of Quantity, Bill of Material, Cost Estimate, Geographic Information System (GIS), Quantity Takeoffs*

INTRODUCTION

With the availability of number of commercial software, the manual approaches for quantity surveying are becoming outdated. Within last three decades automated techniques have changed the way estimates are being produced and will continue to change as new software are being developed. The automation of cost estimation facilitates the decision-making and creative thinking by allowing the designer to quickly recall and review issues relevant to the task at hand (Saleh, 1999). Electronic digitizer, which traces drawings and produces a picture of the item being measured, is used for automated quantity takeoffs process. The CAD systems are also capable of generating quantity takeoffs (Cheng & Yang, 2001; Saleh, 1999). Electronic spreadsheets are used for the preparation of pricing sheets. Spreadsheets

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can quickly perform all mathematical steps for which a quantity estimator spends hours in preparation and checking of calculations. Some of the commercially available estimating software can take the quantities determined either manually, from a CAD file, or with the assistance of digitizers and apply a database of unit prices to calculate the total cost of work.

GIS, a tool that has proliferated within civil engineering in the recent years, is being used to handle various construction project requirements including: cost estimate (Bansal & Pal, 2007; Cheng & Yang, 2001), site layout (Cheng & Connor, 1996), route planning (Cheng & Chang, 2001; Varghese & O'Connor, 1995), integrating information (Bansal & Pal, 2006), construction visualization (Zhong et al., 2004) and scheduling (Bansal & Pal, 2008; Poku & Arditi, 2006).

Cheng and Yang (2001) explored the capabilities of GIS in combination with other software for cost estimation. They developed a GIS based tool called MaterialPlan, to assist planners in quantity takeoffs and assessing materials layout design. MaterialPlan uses GIS in combination with CAD systems to compute quantity takeoff based on the dimensions of the design drawings as well as to generate BOM by using Map/Info and Microsoft Access. The user communicates with the components of the system through a customized interface developed using visual basic application (VBA) and MapBasic. The Open Database Connectivity (ODBC) was also used to write/read the information to/from the associated database.

Bansal and Pal (2007) suggested the use of GIS for cost estimation in a more generalized way by adding new scripts into GIS environment for various cost estimation operations, which allows user to communicate through an interface developed within GIS environment. ArcView, which utilizes the dynamic linkage between the spatial and attribute data, was used for this purpose without ODBC requirement. ArcView has the capability to handle database, thus, study avoid the use of Microsoft Access as suggested in earlier study (Cheng & Yang, 2001).

Cheng and Yang (2001) and Bansal and Pal (2007) used AutoCAD to prepare different data themes, which is a spatial data representation of architectural drawing in GIS. However, the methodology proposed in this study utilizes the ArcGIS to generate the spatial data in place of AutoCAD due to its improved editing capabilities in comparison to ArcView. Therefore, this paper replaces the CAD systems from a GIS based cost estimation methodology. The proposed approach presents a more generalized cost estimation procedure as compare to the earlier study by Bansal and Pal (2007).

The CAD systems are also capable of generating materials requirement and quantity takeoffs (Cheng & Yang, 2001), however, the estimate prepared without detailed engineering data of an organization itself are found to be less accurate (Kerzner, 2003). To increase the accuracy of estimate one needs a well-defined engineering data related to organization itself. Estimate produced from organizational data usually gives better estimate than any published data as it includes group of tasks into consideration such as downtime, cleanup times, lunch, and tea breaks, which varies from industry to industry. Therefore, proposed cost estimation methodology explores the database management capabilities of GIS to store, access and manipulate the information that can later be used for correct building cost estimation. As most of the project related information has been stored in a single database within GIS, any changes in information will instantly update the affected database. Advantages of the proposed methodology over the existing have been discussed in detail in section *Merits and demerits of cost estimation in GIS*.

RESEARCH OBJECTIVE

The main objective of this study was to develop an easy to use GIS based methodology for accurate cost estimation of buildings. The cost estimation involves in determining the quantity takeoffs and cost of various resources required for a construction project. Other sub-objectives which were to be achieved include accurate BOQ, BOM as well as labor and equipment cost based on the construction resource database maintained within GIS.