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A REVIEW OF POTENTIAL AREAS OF CONSTRUCTION COST ESTIMATING AND IDENTIFICATION OF RESEARCH GAPS

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ABSTRACT: *The models structure of construction cost and price forecasting underlie all the techniques being used and yet until quite recently, industry has still not getting familiar with their attributes and characteristics. Without a good comprehension of the various types of cost model, effective cost control and the development of future forecasting techniques are studied. The central theme of this paper is that cost estimating financial and non-financial information includes all the information which quantity surveyors and estimators need to manage effectively to lead their firms to competitive success. However, the specific role of cost estimating in the quantity surveying and contracting firms differ depending on the firm's competitive strategy, organizations, and the management functions to which cost estimating is applied. Meanwhile, changes in the business environment have amended the nature of competition and the types of techniques that quantity surveyors and estimators use to succeed in their businesses including globalization, advances in construction technologies, advances in information technologies, the internet and e-commerce, client centered, new forms of management organization, and changes in the social, political, and cultural environment of business. As a result, some of the relevant potential areas of construction cost estimating have been recognized and being discussed further in this article.*

Keywords: *Cost Modelling; Cost Estimating; Building Construction; Web-Based; Database System*

Introduction

In view of the fact that the profession was being introduced in the country, quantity surveyors are construction professionals and being patronized under the Institution of Surveyors, Malaysia and its Board of Quantity Surveyor Malaysia. They are well trained and able to give advice on both aspects of building and civil engineering construction costs, financial and contractual administration. The experts are capable in cost and management of construction projects and also need to price the bills of quantities,

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negotiating and agreeing schedule of rates (ISM, 2004). In a nutshell, the role of a quantity surveyor is to keep a close eye and presenting detailed information on the various costs of a project, including materials, labour, plant, time taken and workers' salaries to ensure that the initial budget is not exceeded (CIOB, 2007a).

Construction managers are good problem-solvers, forward planners, having great people skills, being good at presenting and debating ideas in meetings. They have an in-depth knowledge of all aspects of the construction business, are well organized and have a good head for figures. Meanwhile, project managers have good organizational and communication skills. They would have lots of experience because they need to know all about the work involved in a building project, the cost, legislation and who's involved (CIOB, 2007b).

Cost estimation is being referred as the procedure of examining a specific scope of work and forecasting the cost of completing the work (Holm et al., 2005). Hence, the precision of the estimate is a task of how well the specific scope of work is distinct and the time obtainable to the estimator and so, cost estimating entails of gathering, investigating and summarizing the data pertaining to a project.

According to Schexnayder and Mayo (2004), estimating is determining how to construct the specified work in the most economical manner and within the time allowed by the contract. A work breakdown structure should be established for this purpose. In construction, specialty items such as plumbing, heating, electrical, roofing and tile work are usually more effectively performed by subcontract. The cost of subcontracted work is the total cost to the prime contractor for the work performed (Schexnayder and Mayo, 2004). If a general contractor intends to use subcontractors in the construction of a facility, it may solicit price quotations for various tasks to be subcontracted to specialty subcontractors. Thus, the general contractor will shift the burden of cost estimating to subcontractors (Hendrickson, 1998).

If all or part of the construction is to be undertaken by the general contractor, a bid estimate may be prepared on the basis of the quantity takeoffs from the plans provided by the owner or on the basis of the construction procedures devised by the contractor for implementing the project. However, the contractor may want to assess the actual cost of construction by considering the actual construction procedures to be used and the associated costs if the project is deemed to be different from typical designs.

Hence, items such as labor, material and equipment needed to perform various tasks are used as parameters for cost estimates (Hendrickson and Au, 1989).

Both the owner and the contractor must adopt some base line for cost control during the construction. For the owner, a budget estimate must be adopted early enough for planning long term financing of the facility. For the contractor, the bid estimate is usually regarded as the budget estimate, which will be used for control purposes as well as for planning construction financing. The budgeted cost should also be updated periodically to reflect the estimated cost to completion as well as to insure adequate cash flows for the completion of the project (Hendrickson, 1998).

Hegazy (2002) stated that the construction process is heavily information dependent. Well-maintained and organized data is crucial to support the timely and cost-effective planning, bidding and control of projects.

Current Practice of Cost Estimating and the Factors Influencing Project Cost Estimation Practice

Cost estimating is the process of analyzing a specific scope of work and predicting the cost of performing the work. Cost estimating involves collecting, analyzing and summarizing all available data related to a building construction project (Holm et al., 2005). According to William (1996), estimating the cost of building and civil engineering works of construction takes into account elements such as labour, material and plant unit cost of the various items of work as itemized in a Bill of Quantities or Specification of Works.

He added that the total construction costs should also include of site charges or what is known as preliminaries overheads and establishment charges, provisional sums, day works and prime cost amounts. Meanwhile, Pratt (2004) stated that, in pricing a construction estimate, there are five price categories that need to be considered including labour, equipment, materials, subcontractors and job overheads.

Effectively, parametric estimating (either preliminary or elemental) is made without working drawings or detailed specifications (Hegazy, 2002). The data may consist of a rough concept of the gross area or volume of a project, or it may be a set of

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detailed plans and specifications. Using whatever data is available; the estimator first divides the project into components or elements of work and then estimates the cost for each of these. The estimate may be based on individual labour, material, equipment or subcontractor estimated costs for each. The estimated cost for the project is determined by adding the estimated costs for all of the components of work (Holm et al., 2005). From the explained general procedures and elements of work in preparing the construction cost estimates by various authors above (Holm et al., 2005; William, 1996; Pratt, 2004), the author understood that these principles can then be actually applied to all the component or work packages in a building construction cost estimates including the demolitions and alterations, piling, groundwork, concrete work, masonry, woodwork, structural steelwork, roofing, surface finishes, glazing, plumbing, roadwork, drainage, landscaping and other external works.

This is of course by customizing the productivity rates by referring to the company historical data and to be suited with the construction or building technologies which are involved for erecting a particular building element for the project. Usually, the detailed cost estimating for a building construction project would be initiated with the receipt of a request for proposals or invitation to bid. As when the contractor has decided to submit a proposal, the company estimator or quantity surveyor is assigned to prepare the detailed cost estimate (Holm et al., 2005).

According to Holm et al. (2005) again, the process starts with the development of the WBS for the project. On the other hand, Hegazy (2002) commented that, the main difference between parametric and detailed estimating is that detailed estimating can be performed only when work items are identified and a take off of their quantities is possible. A detailed estimate requires analysis of the method of construction to be used, the quantities of work, the production rates of resources, and the factors that affect each sub-item. The key to the quantity take off is a structured work breakdown structure (WBS) with a proper code of accounts for all work items (Holm et al., 2005; FAST, 2007).

Bottom-up estimates are often prepared by contractors to support their proposal bid process. This involves using a detailed WBS and pricing out each work package making up the project. However, the method may be laborious and time consuming, but it can result in a fairly accurate estimate if the work content is well understood (Chapman, 1997). In truth, very little of the research contains major information fitting to the factors involved in costing construction projects (Akintoye, 2000).

According to Law (1994), contractors have formulated their own cost estimating methods and bidding although there is a process for contractor cost estimating. However, very often that these techniques are inaccurate and unstructured and are solely based on contractors' own experiences and general purpose procedures stated by the software systems they use (Hegazy and Moselhi, 1995). Carr (1989) has found a serious lack of commonly accepted estimating guidelines, despite the literature on the process and principles involved in costing. Estimating is part art and part science but for the practice, it is still possible for the estimators to follow certain guidelines in developing the construction cost estimates (Kerzner, 2001; Halpin and Woodhead, 1998; U. S. Department of Energy, 1997).

Elemental Cost Analysis and Building Cost Drivers and Indicators

The cost modeling could be explained as the symbolic representation of a system, by articulating the contents of that system especially on the factors which influences its cost (Ferry, 1999; Jaggar et al., 2002; Skitmore and Marston, 1999). In this case, it serves the purpose to give confidence and economic assurance pertaining to the predicted project cost to the client. At the same time, the technical model should be developed in a fast, accurate manner and updateable in the light of changes in external market and environmental conditions, without taking much time in representing of the building construction where the building costs could be examined and analysed in the later stage (Ferry, 1999).

With the development of cost models, a system must be established for advising the designers on the cost that is compatible with the process of realizing the designs, hence, the prototype can be used as early as when the designers make the first decision which is quantifiable and should be also capable of refinement, to deal with the following more detailed decisions (Jaggar et al., 2002). In a broader sense, this would form a link between the design cost controls which involves the cost of resources at the preliminary stage and those responsible for managing the construction processes (Skitmore and Marston, 1999).

According to Berahim (2006), majority of the Quantity Surveying consultants from advanced countries have started developing their own Database Management System (DBMS) for cost estimation purposes since 30 years ago. Development and installation

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of the software required high expenses. The scenario encourages the development of estimating software in the market for the expectation of higher profit return. Currently, there are many estimating software in the market, nonetheless, these systems are difficult to be adopted, incomprehensive and not user-friendly as they are not really tailor-made to fit into the local practices of Quantity Surveying.

The authors then found that a system which has been developed that integrates the application of DBMS system and Elemental Cost Analysis (ECA) method has increased the efficiency and the speed of estimating. However, the elemental cost analysis must be capable in comparing against with other known schemes in order to justify whether the amount of money allocated to each of the building elements is reasonable in it and is also a reasonable proportion of the whole (Ferry et al., 1999).

Therefore, the authors suggested that the elemental cost analysis which may be is a type of product-based cost model should be referred together with other relevant documentations including the project priced BQ, drawings showing plans and elevations and a list of elements whenever a cost estimating exercise is being carried out. Meanwhile, the elemental cost analyses should be accompanied by outline plans and elevations prior to the availability of a rapid appraisal of the nature of the project described in the cost analysis (Jaggar et al., 2002). Yet, the reliability of the cost data is still a question where it is very often with a corresponding loss in accuracy and certainly with some loss of context. According to Ferry et al. (1999) again, in order to adapt the floor area rate from one project to another when shape is not known requires consideration of seven factors such as market conditions; size and number of storeys; specification levels; inclusions and exclusions; services; site and foundation conditions; and other relevant factors as well.

As we can see here, although the historical cost data could be recorded in a systematical and structured format, there are still needs for answering the questions such as how are these cost data could be manipulated so as to increase the accuracy in cost estimating.

Attempts and the endeavour to describe cost as simple functions of different measurements of the finished building and elements or components have neglected the fact that construction is a process comprising of different but dependent physical activities occurring over a period of time, cost and duration (Bowen et al., 1987).

According to Blocher et al. (2008), an activity consumption cost driver measures how much of an activity a cost object uses. The authors also explained that, activity-based costing (ABC) is a costing approach which assigns resource costs to a cost object based on activities performed for the cost object. However, a resourced-based estimate is very useful especially for the purposes of production-cost control and monitoring. This type of estimate would deal quite separately with the different resource cost components of labour, plant, material and subcontractors (Toh et al., 2007; Ferry et al., 1999).

In this case, the resourced-based estimator should be very expert in envisaging and pricing the site organization and project duration, including the management of all subcontractors' programmes and the integration of their work with building structure and with each others' effort (Ferry et al., 1999). Hence, a project work breakdown structure is significant for the planning and scheduling purposes where the productivity rates are reflecting from that particular project.

Construction Estimating Software and Database Management System

Rapid examination of cost data is very crucial and it is unworkable to achieve by manual taking off, measurement and estimating nowadays especially in the construction industry where decisions are taken in a very rushed and short periods of time. In this case, the computer based time or cost models are necessitated to enable prompt responds through evaluating of alternative solutions and ease the analysis of data (Zakieh, 1991).

Laptali et al. (1997) stated that whenever the construction projects are meant to be profit making, the best estimate figure is therefore very essential for the contractor to be awarded the construction contract, and hence, the quantity surveyors or estimators should be able to determine the whole project cost even though it is a total subcontracted works. These prices are including especially for activities of groundwork, brickwork, joints, carpentry, concrete; formwork and reinforcement. As a consequence, computer software can be utilized to increase the speed of estimating the repetitive calculations for similar or common items in the projects. Integrated computer models are significant for a quick and accurate investigation of the quantitative data with the intention to produce a less time consuming tendering decision making.

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This would directly lead to a reduction in the cost of tendering which by referring to the practitioners being interviewed is the highest overhead cost in a construction project (Laptali et al., 1997). In this digital age, there is a fast growing pattern among business organizations to expand their e-business operations using web-based systems which only needs a web browsing software (such as Mozilla Firefox, Internet Explorer or Netscape) to function. Web-based system does not require additional software installation and information could be accessed as long as a computer is connected to a central server or the World Wide Web (WWW) where this software is usually come together with the whole computer or downloadable from the internet without costing any.

In this case, employees could carry out on-line transactions, data analysis or information sharing, and even communicating their information using almost any computers. Indeed, it has become ubiquitous in 2000 as more and more computers have been linked to the WWW or to a central server (Turban et al., 2004). A database system is basically just a computerized record-keeping system. The database itself can be regarded as a kind of electronic filing cabinet; that is a repository or container for a collection of computerized data files. A database is a collection of persistent data that is used by the application systems of some given enterprise (Date, 2004). According to Rolland (1998), a database system is any computer-based information system where the data that supports that system may be shared. Besides, a database is also a collection of related data. By data, we mean known facts that can be recorded and that have implicit meaning. On the other hand, a database management system (DBMS) is a collection of programs that enables users to create and maintain a database.

The DBMS is hence a general-purpose software system that facilitates the process of defining, constructing, manipulating and sharing databases among various users and applications (Elmasri and Navathe, 2004). Building a modern business application needs a database management system. A modern database system is one of the most powerful tools to be used for building business applications (Post, 2005).

Databases today are essential to every business. They are used to maintain internal records, to present data to customers and clients on the World-Wide-Web, and to support many other commercial processes. A database management system is a powerful tool for creating and managing large amounts of data efficiently and allowing it to persist over long periods of time safely (Ullman and Widom, 2002). Databases are

easy to set-up, easy to be manipulated and easy to use. A database allows maintaining an order in what could be in a very chaotic environment. Database makes sense, flexible and they force the user to think in a very logical and linear path. If truth be told, managing information is crucial and a database is truly an invaluable tool for any organization (Reach Canada, 2007).

The applications of DBMS for construction project management have been explored by quite a number of researchers. Chou and O'Connor (2007) have developed system architecture for a preliminary cost estimation system that toggles project input information, predictive item-level quantity, and segregates unit price of highway projects. Li et al. (2006) focused primarily on the system database, which provides a high degree of flexibility through its data structure to support three-level project control. Abudayyeh et al. (2001) explained that the Internet is used as a way for communicating project control information. Thus, the DBMS applications should be enhanced more into the basic building construction cost estimating instead.

Conclusion

In short, construction cost estimating practices diverse depending on the nature and types of organization either quantity surveying or contracting firms and hence the factors influencing the project cost estimation are also varied accordingly. By referring to the various literature syntheses being carried out so far, the authors found that cost estimating is a very subjective subject which does not possess standard methods of calculation but rather an adoption of certain basis as steps and procedure to estimate construction costs. Among the Malaysian practice especially in the quantity surveying firms, elemental cost analysis has been heavily relied in order to determine the project budget during the early stage in the whole project life cycle.

All at once, the criteria's data and information being studied in the elemental cost analysis are the factors that are influencing the project costs and in other words, they are the cost drivers and indicators of the particular project. Nonetheless, the current prorated, mean and average methods adopted could not accurately reflect the real per square foot floor area for instance. Therefore, the examination of elemental cost analysis could still be improved. Together with the theories as backbones, database system is an application which enables the manipulation of cost data in a user-friendly

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manner. In addition, the existence of database system is essential as it can speed up the estimating process systematically, maintaining internal records and disseminating the cost data and information simultaneously.

References

- Abudayyeh O., Temel B., Al-Tabtabai H. and Hurley B.** (2001). "An Intranet-Based Cost Control System." *Advances in Engineering Software* 32, 87-94.
- Akintoye A.** (2000). "Analysis of Factors Influencing Project Cost Estimating Practice." *Construction Management and Economics*. 18(1), 77-89.
- Berahir @ Ibrahim, Siti Khairizan** (2006). "Development of Database Management System (DBMS) Based on Elemental Cost Analysis (ECA) Methodology." Masters thesis, Universiti Teknologi Malaysia.
- Blocher E. J., Stout D. E., Cokins G. and Chen K. H.** (2008). "Cost Management: A Strategic Emphasis." Fourth Edition. New York, America: McGraw-Hill Irwin.
- Bowen P. A., Wolvaardt J. S. and Taylor R. G.** (1987). "Building Cost Modelling and Computers." E & FN Spon. 15-24, 387-395.
- Carr R. I.** (1989). "Cost Estimating Principles." *Journal of Construction Engineering and Management*. 115(4), 545-551.
- Chapman J. R.** (1997). "Cost Estimating." Available: http://www.hyperhot.com/pm_cost.htm. Last accessed: 12th August 2007.
- Chartered Institute of Building** (2007a). "Quantity Surveyor." Available: <http://www.ciob.org.uk/careers/view/quantitiesurveyor>. Accessed: 9th July 2007.
- Chartered Institute of Building** (2007b). "Project Manager." Available: <http://www.ciob.org.uk/careers/view/projectmanager>. Accessed: 9th July 2007.
- Chou J. S. and O'Connor J. T.** (2007). "Internet-Based Preliminary Highway Construction Cost Estimating Database." *Automation in Construction* 17. 65-74.
- Date C. J.** (2004). "An Introduction to Database Systems." Eight Edition. USA: Pearson Education, Inc; Addison Wesley.
- Elmasri R. and Navathe S. B.** (2004). "Fundamentals of Database Systems." Fourth Edition. USA: Pearson Education Inc; Addison Wesley.

- Federal Aviation Administration Acquisition System Toolset** (2007). "Documentation Guidance for FAA Cost Estimates: Cost Basis of Estimate." Available: <http://fast.faa.gov/investment/cboe.htm#3.1%20Cost%20Estimation>. Last accessed: 12th August 2007.
- Ferry D. J., Brandon P. S. and Ferry J. D.** (1999). "Cost Planning of Buildings." Seventh Edition. Great Britain: Blackwell Publishing.
- Halpin D. W. and Woodhead R. W.** (1998). "Construction Management." Second Edition. USA: John Wiley & Sons, Inc. pp 210-217.
- Hegazy T.** (2002). "Computer-Based Construction Project Management." Upper Saddle River, New Jersey: Pearson Education, Inc; Prentice Hall.
- Hegazy T. and Moselhi O.** (1995). "Elements of Cost Estimation: A Survey in Canada and the United States." *Cost Engineering*. 37(5), 27-31.
- Hendrickson C.** (1998). "Project Management for Construction: Fundamental Concepts for Owners, Engineers, Architects and Builders." Department of Civil and Environmental Engineering, Carnegie Mellon University, Pittsburgh, PA 15213 Copyright C. Hendrickson 1998. Available: <http://www.ce.cmu.edu/pmbook/>. Last accessed: 28th June 2007.
- Hendrickson C. and Au T.** (1989). "Project Management for Construction: Fundamental Concepts for Owners, Engineers, Architects and Builders." First Edition, USA: Prentice-Hall.
- Holm L., Schaufelberger J. E., Griffin D. and Cole T.** (2005). "Construction Cost Estimating: Process and Practices." Upper Saddle River, N. J.: Prentice Hall.
- Institution of Surveyors Malaysia** (2004). "Quantity Surveying." Available: http://www.ism.org.my/1_public/p_quantitysurvey.asp. Accessed: 3rd July 2007.
- Jaggar D., Ross A., Smith J. and Love P.** (2002). "Building Design Cost Management." Osney Mead, Oxford, UK: Blackwell Science Ltd.
- Kerzner H.** (2001). "Project Management: A Systems Approach to Planning, Scheduling, and Controlling." Seventh Edition. USA: John Wiley & Sons, Inc.
- Laptali E., Bouchlaghem N. and Wild S.** (1997). "Planning and Estimating in Practice and the Use of Integrated Computer Models." *Automation in Construction* 7. 71-76.
- Law C.** (1994). "Building Contractor Estimating: British Style." *Cost Engineering*. 36(6), 23-28.

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- Li J., Moselhi O. and Alkass S.** (2006). "Internet-Based Database Management System for Project Control." *J. of Engineering, Construction and Architectural Management*. 13(3), 242–253.
- Post G. V.** (2005). "Database Management System: Designing and Building Business Applications." Third Edition. New York: McGraw-Hill, Irwin.
- Pratt D. J.** (2004). "Fundamentals of Construction Estimating." Second Edition. USA: Thomson, Delmar Learning.
- Reach Canada™** (2007). "A Personal Guide for Building a Reach-type Organization: The Importance of a Database." Available: <http://www.reach.ca/building/database.htm>. Last accessed: 25th July 2007.
- Rolland F. D.** (1998). "The Essence of Databases." Great Britain: Pearson Education Limited.
- Schexnayder C. J. and Mayo R. E.** (2004). "Construction Management Fundamentals." First Edition. USA, New York: McGraw Hill.
- Skitmore R. M. and Marston V. K.** (1999). "Cost Modelling." London, Great Britain: E & FN Spon, Taylor and Francis Group.
- Toh T. C., Lim C. C., Ali K. N. and Goh K. C.** (2007). "Differences between Quantity Surveying and Project Management in Building Construction Cost Estimating." Proceedings of the International Conference on Built Environment in Developing Countries, 3-4 December 2007. Penang, Malaysia: Universiti Sains Malaysia.
- Turban E., Mclean E., and Wetherbe J. C.** (2004). "Information Technology for Management: Transforming Organizations in the Digital Economy." John Wiley & Sons, Inc.
- Ullman J. D. and Widom J.** (2002). "A First Course in Database Systems." Second Edition. USA: Pearson Education; Prentice-Hall, Inc.
- U. S. Department of Energy** (1997). "Chapter 15: Estimating Methods." Available: <http://www.directives.doe.gov/pdfs/doe/doetext/neword/430/g4301-1chp15.pdf>. Last accessed: 5th October 2007.
- William J.** (1996). "Estimating for Building and Civil Engineering Works." Ninth Edition. Great Britain: Butterworth Heinemann.
- Zakieh R.** (1991). "Quantity-Significance and Its Application to Construction Project Modeling." PhD Thesis, University of Dundee, Scotland.