Integrated Solutions for Infrastructure Development
Edited by Lau, H. H., Tang, F. E., Ng, C. K., and Singh, A.

ISBN: 978-0-9960437-3-1

A DECISION SUPPORT SYSTEM FOR METHODS OF MEASUREMENT IN CONSTRUCTION PROJECTS

ABDELRAHMAN MAGDY and SAMER EZELDIN

Dept of Construction Engineering, The American University in Cairo, Egypt

Cost estimation of any construction project depends on issuing the Bill of Quantities which defines and quantifies the work items of any project to be priced. When preparing these bills, a set of guiding rules can be used to ease the preparation which is known as the Method of Measurement. Some institutions issued standard Method of Measurements such as the CESMM, NRM and POMI. Each Method of Measurement has its own characteristics and uses. The use of these standard Methods of Measurement is studied in this paper for the civil and building projects in the Middle East by preparing a questionnaire to be distributed and returned on quantity surveyors in the Middle East. The Results are analyzed and the findings are used to construct a decision support system that automates the process of selection of the suitable standard method of measurement for civil or building projects based on some project parameters. The model was validated by comparing its results with those in real life projects. A conclusion was reached the standard Methods of Measurement are used with POMI having most uses followed by CESMM unlike NRM that has least use so the model can give suitable choice for the Method of Measurement in civil projects unlike building projects since NRM is issued recently and still not used in Middle Eastern projects.

Keywords: BOQ, Standard Methods of Measurement (MOM), CESMM, NRM, POMI.

1 INTRODUCTION

Cost management is an important factor in the success of any construction project. In every project there is a cost estimation at the beginning of the project and cost control throughout the project. Accurate cost estimation facilitates the cost control process so it is important to prepare an accurate Bill of Quantities (BOQ) for every project. It is worth mentioning that the BOQ discrepancies are usually interpreted against the entity who developed the document. Standard Methods of Measurement (MOMs) facilitate the process of preparing the BOQ by providing guidance rules for the description and quantification of the project work items. Each standard MOM has different characteristics and uses, so it is important to investigate the suitability of these methods for the construction projects according to each project parameters. This is to facilitate the cost control of the project and to help avoid potential conflicts that can arise between the project parties.

This paper aims at investigating three different MOMs, namely; Civil Engineering Standard Method of Measurement (CESMM) for civil engineering projects, New Rules of Measurement (NRM) for building works, and Principles of Measurement International (POMI) for most project

works. These three MOMs are selected since they are international methods that are made to accommodate the needs of the construction projects worldwide.

These MOMs are compared from the perspective of their purpose, characteristics, advantages and disadvantages. An expert system is developed to act as a decision model that helps to choose the most suitable MOM for a project.

2 RESEARCH METHODOLOGY

In order to be able to choose the most suitable MOM for a construction project, the literature is first explored to obtain findings about each of the three methods investigated which are the CESMM, NRM and POMI. The findings are then used to collect data through a questionnaire distributed on a sample of quantity surveyors in the Middle East. The data is analyzed to help construct a decision model that can automate the process of the MOM selection depending on some project parameters. This model is then verified and validated to check its results and finally reach a conclusion.

2.1 Literature Review

The literature is explored to investigate each of the three MOMs as follows:

2.1.1 Civil engineering standard method of measurement (CESMM)

This MOM was issued by the ICE (Institute of Civil Engineers) in 1976 with its last edition as the fourth edition issued in 2012. It is issued for use in heavy civil projects and it is complex so it is used to prepare detailed BOQs in terms of the items' breakdown and description. It divides the project works into 26 work divisions for the works of civil projects in addition to a provision for simple building works (CESMM3 1991). The advantages of CESMM is that it helps in preparing a detailed BOQ for the civil projects whose works are usually hard to anticipate before the execution of the project. Also these detailed BOQs can help in the evaluation of variations. CESMM also has some additional cost information such as the method related charges and it also continues to update its versions to accommodate for the new construction technologies. However, CESMM has some drawbacks since the method related charges can cause problems in case of variations and also companies need to train their employees on how to use CESMM (Eadie *et al.* 2013).

2.1.2 New rules of measurement (NRM)

This MOM was issued by the RICS (Royal Institute of Chartered Surveyors) with NRM2 as the volume used in BOQ preparation issued in 2012. It is issued for building works and it is used to produce very detailed BOQs since it is broken down into 41 work divisions (NRM2 2012). The advantages of NRM are that it gives accurate project pricing as well as being flexible in variations. However, NRM can be a waste of time in small projects. Also, NRM can increase the tender price of a project if there is double counting when pricing an item. In addition, contractors may reject pricing the detailed items and include their prices on major items. Also, the use of NRM needs a lot of training (Towey 2013).

2.1.3 Principles of measurement international (POMI)

It is a simple MOM issued by RICS Business Services Limited (a wholly owned subsidiary of the RICS) in 1979 and it is suitable for most project types. It produces abstract BOQs since it

is divided into 15 work items (POMI 1979). The advantages of the POMI are represented in the idea that it is simple so most quantity surveyors are familiar with using it especially in the Middle East. However, POMI can be considered to ignore some project details which may give false idea about the project scope as well as inaccurate pricing. Also POMI is considered outdated (BCIS Report 2012).

3 DATA COLLECTION

The data collection process is conducted by preparing a questionnaire that was distributed to 140 quantity surveying professionals in the Middle East. The population was categorized into three (3) main categories; clients, consultants and contractors. The target of the questionnaire was to: a) check the recognition of each of the three methods of measurement by Middle Eastern professionals, b) gather information about the characteristics of detailed and brief BOQs, c) understand how each project parameter can affect the choice of the suitable standard MOM for each project, d) rank the project parameters according to their percentage impact on the decision making process, e) investigate which MOM would be preferred for a certain type of project if it is to be constructed in the Middle East.

4 DATA ANALYSIS

The replies received were 45, 15 from clients, 15 from consultants and 15 from contractors forming a percentage response of 32.14%. The findings of the questionnaire came addressing its 5 objectives as follows: a) among the three MOMs investigated, the majority of respondents showed experience with POMI followed by CESMM and then NRM with the least percentage recognition. b) The types of BOQs produced by the three MOMs were divided into two types; Detailed and Brief BOQs. The characteristics of each BOQ type were investigated and it was obvious that detailed BOQs can enhance project pricing since they clarify the exact items that need to be priced. However, detailed BOQs are useless and a waste of time in case of small projects since the work items are few and don't need that detailed breakdown for the project works. Also, detailed BOQs give clear description of the project works, so they are easily understood by contractors decreasing the probability of pricing errors. In addition, they can enhance the quantification of variations since the items affected directly by the variations can easily be identified. However, they can increase the tender price as it increases the possibility of double counting since contractors may double price an item. For Brief BOQs, their characteristics were investigated and it was obvious that since they are abstract, they help in quick issuance of tender documents when time is of essence. Also, brief BOQs neglect necessary details leading to pricing mistakes; however, an opposing opinion disagrees with that point and 70% of the disagreeing responses came from the side of the contractors who claim they are experienced with dealing with the brief BOQs. This may suggest that contractors prefer brief BOQs to help compensate for their losses in a project by using BOQ misinterpretations to claim extra money. In addition, brief BOQs are believed to obstacle the quantification of variations since they use the inclusive approach making it hard to define exactly what items are affected by variations. In addition brief BOQs are believed to cause pricing inaccuracies. c) The project parameters assumed were the nationality of the client and the contractor, project type, contract value and contract type. If the client was international; meaning he belongs to a foreign country other than the country where the project is being executed, then the client may be willing to choose a detailed BOQ to avoid project risks unlike local clients who may be willing to save time as they are more likely to be experienced with the conditions within their country so they may go for brief BOQs and the same trend is applicable for contractors. For projects with high contract

value, it is preferred to go for detailed BOQs since the project would be important and it is preferable to avoid project risks that may arise from using brief BOQs. This is unlike the case of projects with small values where brief BOQs might satisfy their purpose. For the contract type, in re-measured or unit price contracts the BOQ has high priority among the contract documents and so going for detailed BOQs might be suitable unlike lump sum contracts where the BOQs are only used in the case of variations and so brief BOQs might be suitable. For the percentage preference according to the project type, it is addressed in the following point e) in the data analysis section. d) For the effectiveness of the project parameters on the decision making process, table 1 shows the ranking of the respondents to the parameters affecting the choice of the MOM for any project to be used in the model.

Table 1. Effectiveness of each project parameter on the choice of the MOM.

Project Parameter	Average Percentage Weight
Project Type	23%
Client's Nationality	26%
Contractor's Nationality	12%
Contract Value	21%
Contract Type	18%

For the choice of the most suitable MOM according to the project types, the projects were classified into two categories; building projects and civil projects. Each category of the two had a list of projects with different types such as residential buildings and office buildings for the building category and as the tunnels and bridges for the category of civil projects. The responses came preferring POMI for building projects over NRM and preferring CESMM over POMI for civil projects.

5 MODEL DEVELOPMENT

The approach followed in constructing the model is the weighted average approach through getting the sum of multiplying the percentage weight by the percentage preference of each BOQ type for the corresponding project parameter. A sample of how the model works is shown in table 2 below:

Table 2. Mechanism of how the model works.

Project Parameter	Percentage Preference		Weight
	Brief	Detailed	
Office Building	68%	32%	23%
Local client	49%	51%	26%
Local contractor	64%	36%	12%
Low contract value	71%	29%	21%
Lump sum contract	75%	25%	18%
Result	65%	35%	

In this example shown in table 2, the preferred BOQ type for this combination of parameters is the Brief BOQ type, so an equation is used to define the basis of selecting the suitable MOM is used and it is explained in the following figure 1 below:

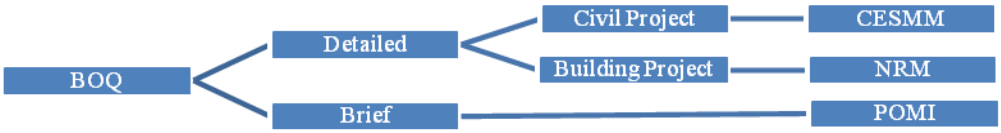

Figure 1. Mechanism of choice for suitable MOM based on the BOQ type chosen by the model.

A user interface for the model was prepared using Visual Basic for Applications as shown in the following figure 2 below:

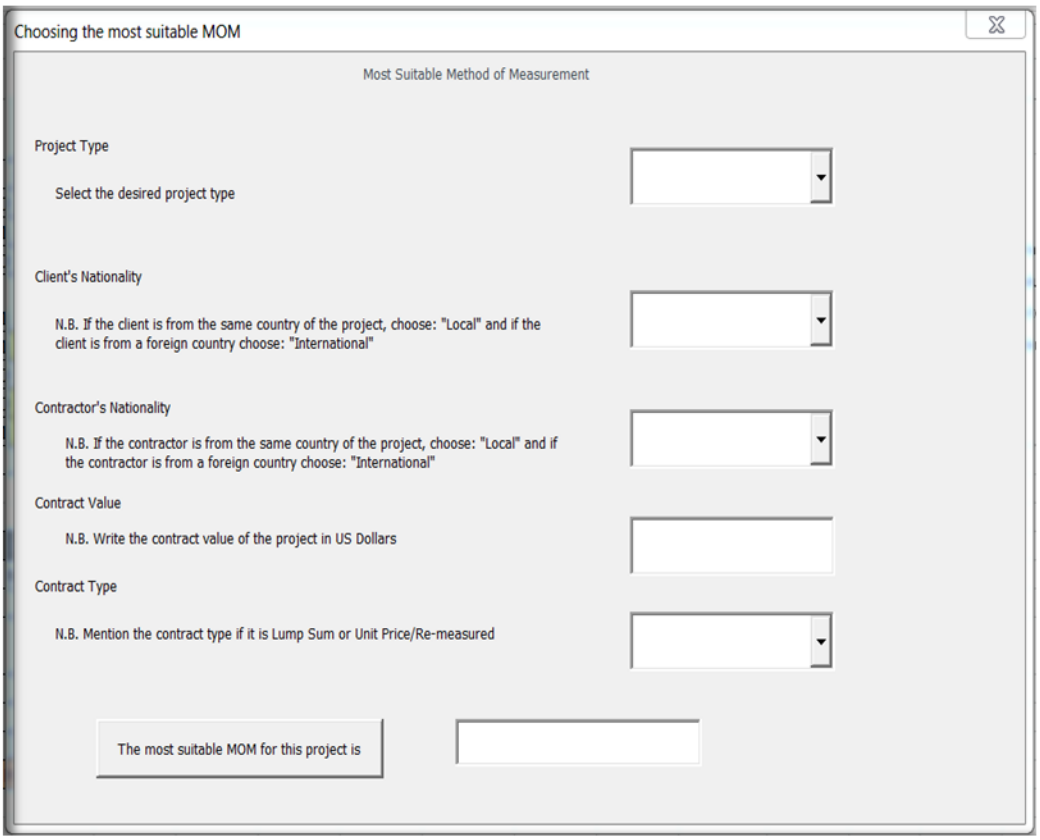

Figure 2. User Interface for the model.

As shown in figure 2, each project parameter to be chosen has some guiding tips that explain on what basis the choice should be made.

6 MODEL VERIFICATION

In order to check that the model implements the assumptions correctly, two verification steps were conducted. The first simple check is to input the extremes of the project parameters that will result in a previously known answer for the standard MOM to be chosen and the model gave the expected results. The second step in the verification was to let a sample of quantity

surveyors to use the model and give their feedback. Their feedback was that the model is simple to use and the guiding tips help avoid confusion.

7 MODEL VALIDATION

The model validation is performed to check the convergence of the model's results to the real life projects cases. The model's results are compared with the MOMs chosen actually for the project. Three (3) civil projects were studied and the model gave an output of CESMM as the most suitable MOM which was the same choice in real life. However, (2) two building projects were used to test the model and the model produced NRM as the most suitable choice. This was unlike that chosen in real life since POMI was actually chosen. A justification was that the NRM has been recently issued and still not used in Middle Eastern building projects.

8 CONCLUSIONS

It can be stated that the standard Methods of Measurement investigated are recognized in the Middle East with POMI having the most recognition followed by CESMM while NRM is still not well recognized. Also, the sector of the clients and consultants are more biased towards preparing a detailed BOQ to avoid project risks that can arise from brief BOQs unlike the sector of contractors who consider brief BOQs as a chance to compensate for their losses in a project by using its discrepancies to claim extra money. Moreover, choosing the most suitable standard Method of Measurement depends on the project parameters. Finally, the proposed model produces better results for the civil projects when compared to building projects.

References

CESMM3: Civil Engineering Standard Method of Measurement, Institute of Civil Engineers, London, 1991.

Eadie, R., Millar, P., and Harte, N., A comparison between CESMM3 and MCHW as methods of measurement for Civil Engineering Work, *International Journal of Procurement Management*, Elsevier, 6(5), 523-543, August, 2013.

NRM2: Detailed Measurement for Building Works, Royal Institute of Chartered Surveyors, Reading, 2012.

POMI: Principles of Measurement International, RICS Business Services Limited, London, 1979.

RICS 2011 Principles of Measurement International Survey Report, BCIS Building Cost Information Service, RICS, London, 2011.

Towey, D., *Cost Management of Construction Projects*, John Wiley & Sons, Somerset, 2013.