

# Examination of Pre-Tender Budgeting Techniques for Mechanical and Electrical Services in Malaysia

Ganiyu Amuda Yusuf, Sarajul Fikri Mohamed

**Abstract**—The procurement and cost management approach adopted for mechanical and electrical (M&E) services in Malaysian construction industry have been criticized for its inefficiency. The study examined early cost estimating practices adopted for mechanical and electrical services (M&E) in Malaysia so as to understand the level of compliance of the current techniques with best practices. The methodology adopted for the study is a review of bid documents used on both completed and on – going building projects. The analysis revealed that, M&E services cost cannot be reliably estimated at pre-contract stage; the bidding techniques adopted for M&E services failed to provide uniform basis for contractors to submit tender; detailed measurement of items were not made which could complicate post contract cost control and financial management. The paper concluded that, there is need to follow a structured approach in determining the pre-contract cost estimate for M&E services in Malaysian Construction Industry.

**Keywords**—Bidding Techniques; Cost Management; Mechanical & Electrical Services; Procurement

## I. INTRODUCTION

PROCUREMENT and Cost management method adopted for Mechanical and Electrical Services in Malaysia have been criticized for not meeting clients' value criteria and may not stand the test of time in a transforming economy [1]. The major cause of this has been identified as non adoption of Standard Method of Measurement (SMM) in preparing bills of quantities for M&E services making different consultants to adopt different method to prepare BoQ for M&E services [1]; [2].

The Standard Method of Measurement (SMM) currently in use in Malaysia was published in 2001 by Institution of Surveyors Malaysia, the rules of measurement of M&E services are contained in sections Q and R of SMM2 as shown in figures 1 and 2. However, consultants have failed to adopt these rules because there is no regulating and enforcement body; slow learning curve from the side of consultants; reluctance to change; attitude and clients insufficient knowledge of the benefits of adopting SMM for preparing BoQ for M&E services [3].

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Preparation of BoQ for M&E services are mostly carried out by M&E services consultants without making reference to existing SMM, thereby resulting into the use of schedules of prices and lump sum contract. Where bills of quantities are used there are usually inconsistencies in the method of preparation and the rules of measurement are always spelt out in the preamble. The problems are that tender evaluation is made difficult and the cost of tender to contractors increases. At post contract, variation assessment and preparation of interim valuation for payment are complicated which could lead to dispute, time and cost overruns [4];[2].The main focus of this paper is to examine the method adopted in preparing tender documents for M&E services.

## II. AIM OF THE STUDY

The aim of this paper is to investigate the level of consistencies in M&E services bid documents in Malaysia. The study focuses on the analysis of bid documents used for M&E services and is limited to construction projects which adopt traditional procurement strategy.

The methodology adopted for this study is document analysis of bid documents used for completed and on –going M&E services project. A comparison between the rules of SMM in use and the method adopted in preparing the bid documents was drawn.

## III. MECHANICAL AND ELECTRICAL (M&E) SERVICES IN BUILDINGS

M&E services comprises all engineering systems associated with building other than civil and structural engineering works [5];[6]. M&E services in buildings include the followings: disposal systems; piped supply systems; mechanical heating/cooling/refrigeration systems; ventilation/air-conditioning systems; electrical supply/power/lighting systems and communications/security/control systems, Packer, [7];[8].

According to [6], the traditional method of sequential design development delays project completion because contractors' areas of specialization are often not considered at design stage. Meanwhile, services engineers are systems designer and can only specify equipment of required quality but he is not expected to design them (for example, he is not expected to design a boiler or transformer). [6], opined that building services engineer required specialist advice at this stage of design development, but they are not usually involved because of the sequential way of design development following the Royal Institute of British Architects (RIBA) plan of work.

It is observed by [9] that non involvement of specialist contractors always bring about serious problems during construction, especially at the interface between the M&E services design team and M&E contractor. They further stated that this normally occur because of the following reasons:

- 1) Communication gap between designers is often caused by poor coordination of the various design inputs
- 2) lack of management at interfaces and blurred divisions of responsibility
- 3) Procurement of specialist contractors' design – (specialist contractors are not contractually recognized as a member of the team).

M&E services and other related trades according to [10] were generally brought into the process by the main contractor at tender stage. They receive information from the main contractor, process client requirements at their individual organization level without input from the client and even designers [11]. According to [10] M&E services specialist contractors often don't give their best ideas at this stage because of trade secrecy and in anticipation of gaining competitive advantage during tender process.

Consequently, leading to goal fragmentation and distorted information is produced between the consultant engineer who only do the design, manufacturer who design and manufacture and installer who design and install [12]. In this way, the flow and value generation views will not be considered [13; 14]. Thereby, resulting to a poor process transparency [15] and segmented project control [13]. According to [16], an estimate produced from incomplete project information that does not give all the details is liable to inaccuracy.

It has been observed that, [17], information stored in the BoQ should be arranged and presented in a more meaningful and useable format if the amount of rework is to be reduced. That is the main role of adopting the rules of SMM to prepare detail BoQ at the pre-contract stage of construction projects.

#### IV. STANDARD METHOD OF MEASUREMENT

Standard Method of Measurement (SMM) according to [18] is a document that provides “a uniform basis for measuring building works and the purpose is to ensure that bills of quantities (BOQ) fully describe and accurately represent the quantity and quality of the works to be carried out”. In Malaysia, SMM are set within the legal framework of the construction contract., for example, Clause 12 of PAM (2006), Clause 26(a) of PWD 203A (Rev.10/83) and Clause 26.4 of 203A (2007) requires that SMM be adopted in measuring construction works. According to [4]; SMM set out detailed rules for the measurement of commonly occurring works and provides guidelines as to what a tendering contractor is to allow for against each measured item.

Measurement is central to the financial management of construction projects and it involves the Quantity Surveyor in measuring different types of work as shown on the drawings produced by the architect or engineer [19]. The quantities are prepared in line with the rules of accepted SMM and the tender document prepared is referred to as BoQ. The

completed BoQ is normally forwarded along with other documents for the contractor to price [20].

However, in Malaysia SMM2 is currently in use and the rules of measuring M&E services are contained in sections “Q” and “R”. While section Q (Figure.1) covers rule for measuring plumbing and mechanical engineering installations, section R (Figure.2) provides rules for measuring electrical services installations. The provisions of this important document are rarely used in the preparation of BoQ for M&E services in Malaysia, [1], [3].

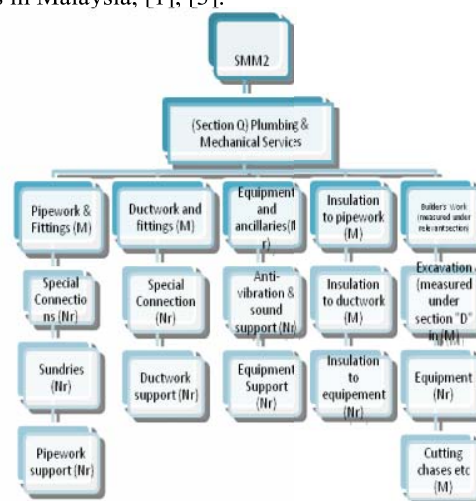


Fig. 1 Section “Q” in SMM2 (Key Plumbing and Mechanical Services & Unit of Measurement)

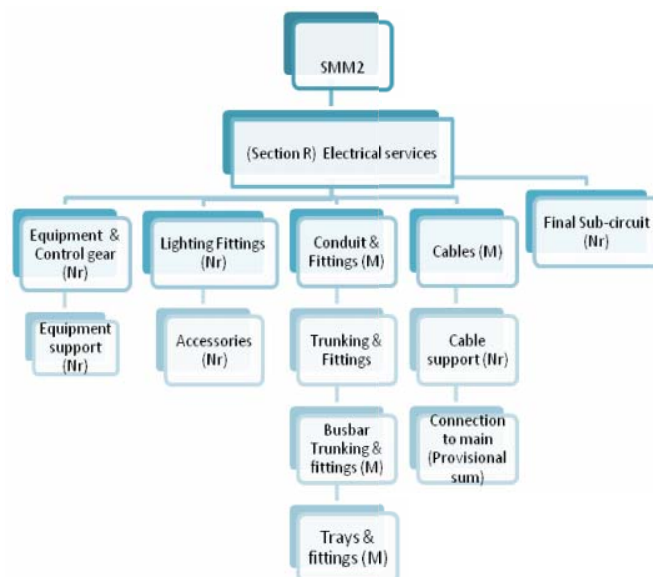


Fig. 2 Section “R” in SMM2 (Key Electrical Services and Unit of Measurement)

The problems with measurement of M&E services according to [8], [21],

- 1) quantity surveyors are not used to measuring M&E services in the past because:
- 2) M&E design are not usually completed at the time of tendering
- 3) Quantity surveyors are not sufficiently skilled in the M&E services

- 4) Traditionally, M&E services are regarded as specialist trade therefore not measured.
- 5) Some M&E engineers are hostile to quantity surveyors.
- 6) Some aspects of design are left to be completed by specialist designer who are not engaged at pre-tender stage.

These problems makes it difficult for quantity surveyor to measure and prepare a reliable early cost estimate for M&E services, thereby, they allow prime cost sums in the BoQ for the important aspect of building [22].

[23] Argued that, allowing prime cost sums based on historical cost data was applicable in the past because the systems have previously consisted of familiar plant, equipment and components arranged in tried and tested configurations to fit within the building fabric. [23] opined that the approach will fail considering the current trend whereby M&E services are integrated with ICT and essentially linked to building energy efficiency, the reduction of carbon emissions, workplace productivity, health and well being, planning and sustainability. [24] Considered that the increase in M&E services components in building has pushed the cost up from the traditional 20 – 30 percent of total project cost to between 20 – 70 percent of the total cost of buildings. [21] opined that, a gap exists in the management of the cost of this 20 – 70 percent of the building cost and unless this is address, the client will be exposed to significant financial risk.

#### V. RESEARCH METHODOLOGY

The methodology adopted to get information about the current method of preparing tender documents was document review which covers documents used for both on – going and completed M&E projects. The documents reviewed are those used on projects procured based on traditional procurement methods. The exercise was carried out in a client organization handling a total of 26 building projects which amounts to over RM1 billion under 9th Malaysian Plan (RMKE – 9 projects). Although the client’s organization is located in Southern Peninsular Malaysia, the professionals engaged on the projects have their offices located in different parts of Malaysia and they are registered members of their respective professional bodies. The client organization was approached and after explaining the aim of the research, they requested for a standard letter briefly explaining the documents required before allowing access to the documents. The same letter was sent to all the project participants through email by the client organization requesting for interactive session with the project participants which has not been fully granted. A total of thirty seven (31) tender documents were reviewed on projects awarded between 2008 – 2010 on M&E services as shown in table I.

TABLE I  
SUMMARY OF M&E SERVICES DOCUMENT REVIEWED

Systems types	Subsystem m Doc. No.	Total
Mechanical systems		
HVAC & Building Automation	6	
Liquid Petroleum gas Systems	1	
Lift Installations	5	

Fire Fighting Systems	4	
Fluidized Bed	1	
Mechanical Systems Total		17
Electrical systems		
IT systems	3	
installati s/infrastructure		
Electrical High Voltage	2	
Structured Cabling and Networking	1	
Electrical Systems & Telephone	6	
Extra Low Voltage System	2	
Electrical Systems Total		14
Total Documents reviewed		31

#### VI. RESEARCH FINDINGS

The research findings were reported under key and cost significant items contained in the rules of measurement. For the purpose of clarity and justification of deviation from existing standard, reference were made to SMM2 which is the SMM in use in Malaysian construction industry. The findings are presented as follows:

##### A. Classification of Works

M&E services were not appropriately classified as required by sections Q.2 and R2 of SMM2. This will make it difficult for tenderers to identify the appropriate heading where the work will be executed. In order to reduce the amount of rework at post contract stage, information stored in BoQ should be arranged and presented in a more meaningful and useable format [25] [26].

##### B. Locations of Work.

Only 10% of the documents reviewed described the location where work will be carried out contrary to the rules of sections Q.3 and R.3 of SMM2 which required location where work will be carried out to be clearly identify as external, internal or roof top. Among the importance of stating the location where work will be carried out is to enable tenderer anticipate the kind of protection to price for and the method of hoisting in place [19].

##### C. Pipework and Fittings.

Pipe works and fittings, pipe work support, special connection as well as sundries are deemed included in the measurement without detailed description and receiving background. Meanwhile, SMM2 (Section Q.7 – Q.12) required that pipe work be measured in meter, pipe work support, special connections and sundries to be enumerated. Receiving back ground is also required to be stated. This will make it easy for tenderers to identify and appropriately priced for all items required for proper execution of the project; in addition, during tender evaluation, it will assist quantity surveyors to determine the appropriateness of what each tenderer actually allowed for each item; this will also ease quantity surveyors’ work during assessment of variations as well as interim valuation [25]; [4].

#### *D. Ductwork and Fittings/ Insulation*

Sections Q.14 –Q16 required ductwork to be measured in meter , ductwork support enumerated and Q25 – Q28 of SMM2 required insulation to pipe work, ductwork and to equipment to be measured in meter. In all the documents reviewed this rules were not adopted, instead, ductwork and all associated works were lumped together and given in per without adequate description. This practice will complicate tender evaluation, assessment of variation and interim valuation process as previously enunciated because it will be difficult to know which item the contractor actually allowed for [4].

#### *E. Equipment and Ancillaries/ Equipment and Control gears*

To enable the tendering contractors to price on the same basis, sections Q.19 – Q.23 and R.4 – R.5 required that quality (brand) rated capacity, size of equipment and receiving background be clearly stated. Although, all the documents reviewed stated the rated capacity of equipment and followed SMM unit of measurement (enumerated), but they all required contractor to state the brand and source of the equipment. This practice defeat one of the primary functions of BoQ, which is meant to provide uniform basis for the tenderers [25], [4], [26]. In this situation, it will be difficult to state that tenderers submitted bid on the same basis.

#### *F. Conduit, Trunking, Cable and Cable tray*

These items were covered under SMM2 sections R.9 – R.16 and they are required to be measured separately. Surprisingly, all the documents reviewed under electrical services lumped these items together and measured in linear meter. Descriptions were also not sufficient enough to provide uniform basis for tenderer to submit bid for fair evaluation. This will have negative impact on post contract cost control and can result to delay and disputes [25]; [4];[26].

#### *G. Lighting Fittings and Accessories*

All the documents reviewed complied with the rules of SMM 2 which requires that, lighting fittings and accessories measured per – point and conduit and cables are deemed included.

#### *H. Sundries*

All the documents provided for as built drawings, testing and commissioning of M&E services, in compliance with sections Q.30 and R.22 of SMM2.

#### *I. Builders Works*

None of the documents reviewed measured builders work in accordance with the rules of SMM2. For instance, where cable are to be laid underground and protected with cable cover. SMM2 required that excavation be measured in line with section D.12 – Linear metre, cable cover to be measured in metre and cutting of chases to be linear meter. All the documents reviewed on electrical services only measured cable and described excavation and cable cover deemed included. The descriptions are not adequate to provide uniform basis for tenderer.

#### *J. Completeness of the Drawings*

About 97 percent of the documents reviewed stated that “drawings are to be considered as diagrammatic and approximate only and cannot be used for setting out purposes”; cable routes shown in the drawings are for tender purposes only. This implies that design information is not complete. However, the more uncertain the project information is at the pre-contract stage when BoQ is prepared and priced, the more risky it is for cost and time certainty to be guaranteed to the client at project completion [27].

#### *K. Work Not Measured*

To protect the clients and consultants from claims that could possibly arise from incomplete drawings. Works not measured are usually covered with provisions such as- “the contractor shall provide all materials or fittings or perform any work which is obviously necessary for the works ..... even though such materials or work may not be explicitly mentioned in the specification.....” This provision is unfair to contractor, as it makes the contractor to bear the risk of under measurement resulting from incomplete design information. This type of method is normally used on works that were extremely uncertain in extent and this represents an unfair and unsatisfactory contractual arrangement. [25; 4; 26; 28].

#### *L. Provisional Nature of the BoQ*

BoQ used for tender purposes are provisional in nature for example, length of cable indicated in the drawings and/or BoQ is for tendering purpose only. The implication of this is that, final price can only be determined after the work must have been executed. This is contrary to [4] opinion that the pre-contract budget estimate determined at the pre – contract stage should form the basis of the contract sum and the construction project is expected to be completed within the initial estimate. The practice can put unnecessary financial pressure on clients’ organization, particularly the public sector organizations which are in conflict with the public interest [29].

#### *M. Attendance*

Some of the documents reviewed required nominated subcontractor to erect and remove temporary office and reimburse main contractor for repair of road regardless of contract provisions.

#### *N. Method of Measurement*

Detailed measurements of BoQ items were not made. Single descriptions are most often used to cover 3 – 4 items and contractors are required to insert price for execution. This will make assessment of variation and interim valuation difficult to achieve [30; 31; 4; 26]

### VII. RECOMMENDATION

It is essential to formulate strategies that will assist construction industry stakeholders to appreciate the importance of adopting a standardized method in forecasting cost of M&E services at the early stage of building projects.

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