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PERSPECTIVES ON COST MANAGEMENT ROLES OF QUANTITY SURVEYORS' IN MECHANICAL AND ELECTRICAL SERVICES PROJECTS

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Abstract

Mechanical and Electrical Services (M&E) is a complex system of buildings and their values constitutes a significant component of construction costs. The procurement is commonly based on lump sum and performance specification and there is lack of reliable cost information regarding elements of M&E services to guide project participants at the inception of building projects leading to inaccurate budget estimate, disputes, time and cost overruns. This study examined the cost management roles and functions performed by Quantity Surveyors (QS) on M&E services projects. The study was carried out using data from questionnaire survey to QS and services engineers in the North-Central geopolitical zone of Nigeria. Data analysis was carried out using t-test of the means to check the significance of the responses to the issues raised in the questionnaire. The results showed that the pre-contract cost management roles performed by QS is limited to the use of single purpose approximate estimating method, statistical method and historical cost information to advice clients' on M&E services project at this stage. At post-contract stage, QS prepare interim valuation, assessment of variations, claims and final account preparation. Quantity Surveyors missed the gap to effectively manage the cost of M&E services project, instead, single price approximate estimating methods based on historical cost information and statistical approach to establish indicative cost of M&E services project. Making it difficult for QS to offer reliable cost advice for comparative design solutions of alternative M&E components and installation. With the increase in the value and complexity of Mechanical & Electrical Services projects, industry clients should engage quantity surveyors to perform the full spectrum of their cost management functions on element of M&E services project. Quantity surveyors should also collaborate effectively with services engineers from the inception of M&E services project to enable them gain full understanding of the technology of M&E services components.

Keywords: Cost management, Mechanical and Electrical Services, Pre-contract, Post contract quantity surveyors.

Introduction

Cost is one of the measures of functions and performance of a building and therefore should be capable of been predicted as well as managed for succesfull project delivery (Bowen & Edwards, 1996). Cost management is considered to be the most important role of Quantity Surveyors (QS) and other building project team members rely strongly on the cost information obtained from the QS to advice clients on their value for money business decisions (Musa, Oyeibisi, & Babalola, 2010). The

traditional cost management roles of QS covers cost planning cost estimation, feasibility studies, cost-benefit analysis, tendering, valuation and final account preparation (Ashworth, Hogg, & Higgs, 2013). The process of cost management by QS can be sub-divided into pre-contract cost planning and post contract cost control of construction projects (Towey, 2013). Ogunsemi (2015) pointed out that when engaged on construction projects, QS are required to ensure that: the client obtains good value for money; and a balancedas well as logical distribution of

the available funds between the various parts of the project and; the total expenditure must be kept within the client's budget.

Mechanical & Electrical Services (M&E) is part of the building project and its cost management is becoming a specialist function for the QS. However, the cost significant attributes in M&E projects may be different from those in building fabrics and finishes but there is a lack of evidence to show that QS are demonstrating leadership role in the cost management of M&E as they demonstrate for building fabrics and finishes (Babalola & Adesanya, 2008; Babalola, 2012). Industry clients' have realized that the traditional approach of managing M&E cost was not satisfactory in determining where the actual costs for engineering services are being expended (Babalola, 2012). The need for rigorous control of this specialist element of building according to Ashworth *et al.*, (2013) is premised on the requirement to reliably consider energy efficiency of systems and alternative sustainable technologies. Meanwhile, studies have shown that total cost management of building project should be the responsibility of QS (Babalola, 2012; Ashworth, *et al.*, 2013).

Studies on cost management of building services with particular reference to the roles and functions of QS in the life cycle of M&E services are scarce and tend to be limited in depth, either concentrating on problems with estimating practices and lack of reliable cost information (Babalola & Adesanya, 2008; Shittu & Izam, 2011; Babalola, 2012). To date, researchers have neglected the need for QS to take charge and fully perform their roles and functions in the life cycle of building services project. It is important to state here that the paper is an extension to the article presented at the second research conference of the Nigerian Institute of Quantity Surveyors (Amuda-Yusuf,

Adebiyi, & Salami, 2015). This article presents further the perception of other industry practitioners (Electrical and Mechanical Engineers) on the assessment of QS cost management roles and functions in the life cycle of a M&E project based on opinion surveys and further analysis of other literature on the core cost management roles of QS. The aim of this study is to examine the extent to which QS perform their traditional cost management roles and functions in the cost management of M&E services in building projects. However, the hypothesis for this research is "QS are not effectively performing their cost management functions in M&E services projects and the survey conducted attempts to validate this hypothesis.

This study is based on the notion that achieving progress towards effective cost management of building services is critical to the future wellbeing of the quantity surveying profession in Nigeria. Therefore, it is essential to understand QS level of involvement in the cost management of M&E. This will assist in prescribing strategy for enhancing QS roles in cost management of M&E. The literature review is presented in the next section, followed by research methodology, results and conclusions.

Literature Review

QS and Cost Management of Building Engineering Services

Although the cost of M&E services varies widely and depends on the complexity of the facility provided and building type but Rawlison, Nugent, & Dedman, (2010) pointed out that, the cost management of building services requires specialist knowledge founded on an engineering-based approach to identify the best-value design options for M&E services and to appreciate the full implications of design

changes. Marsh (2003) considered that cost expertise must be available within the building services team through either a dedicated resource, such as a cost engineer or quantity surveyor, or through the estimating expertise held by the services contractors. This is because, in the evaluation of alternative design options, selection of building services components based on efficiency is more rational than the selection based purely on lowest capital cost (Boussabaine & Kirkham, 2004).

Quantity surveying according to Watermeyer (2012, pg.293) is "the independent and impartial estimation and control of the cost of constructing, rehabilitating and refurbishing infrastructure with due care, skill and diligence by means of one of the following:

1. Accurate measurement of the works

2. Comprehensive knowledge of various financing methods, construction systems, forms of contract and the costs of alternative design proposals, construction methods and materials
3. The application of expert knowledge of costs and prices of work, labour, materials, plant and equipment required."

Cost management is arguably the most important roles of QS and other project team members relied strongly on the cost information obtained from QS to advice clients on their value for money business decisions (Musa *et al.*, 2010). The QS roles and functions in cost management are subdivided into cost planning and cost control. Similarly, cost planning is further subdivided into three components of cost estimating, cost budgeting and cost check (Ogunsemi, 2015). The relationships between these terms are illustrated in Figure 1.

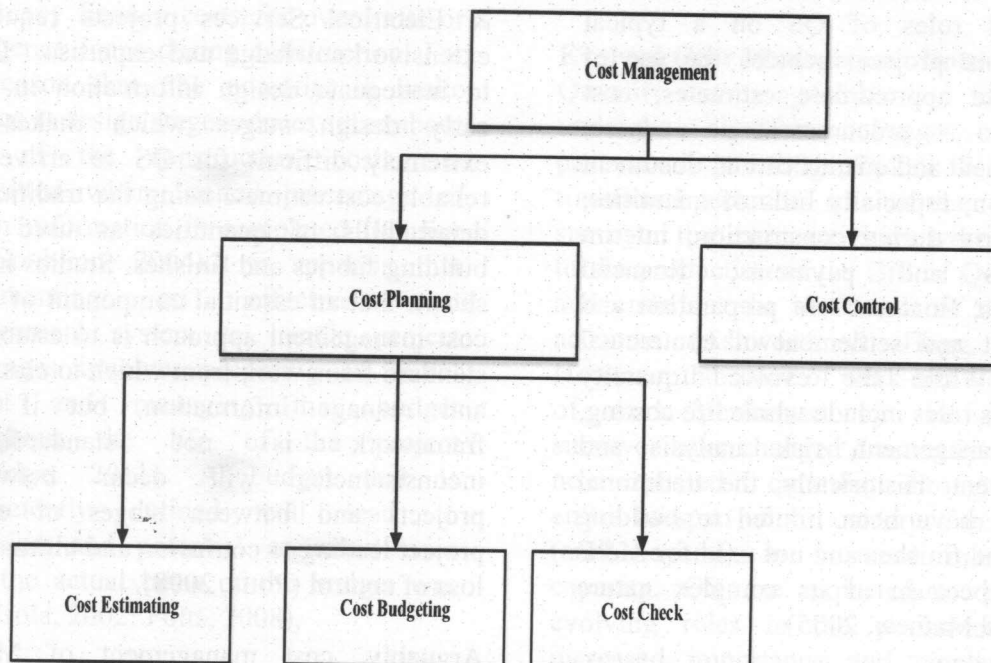


Figure1: Elements of Cost Management

Source: Project Management Institute (PMI), 2012.

Cost Planning is an inevitable step in the cost management process as it helps all members of the design team to ensure the project design is realistic and the estimated cost is sufficient to contain any cost incurred by uncertainties (PMI, 2012,). The framework for cost planning in cost management is divided into three stages: pre-contract cost management; post contract cost management and operations and maintenance management (Potts, 2008). According to Olatunde (2006), to perform this functions QS roles can be classified along this two phases of construction contract: Pre-contract roles covers design advice, cost estimates, preparation of tender documents, drafting contacts, assembling frameworks and acquisitions; and Post-contract includes contract administration, interim valuations, valuation of variation, capital allowances calculations, adjudication, arbitration, final accounts and risk management.

Ashworth *et al.*, (2013) considered that the traditional roles of QS on a typical construction project includes the use of single rate approximate estimates; cost planning; procurement advice; measurement and quantification; document preparation, especially bills of quantities; cost control during construction; interim valuations and payments; financial statements; final account preparation and agreement and settlement of contractual claims. While the evolved quantity surveyor's roles include whole life costing, value management, risk analysis and management. Historically, the traditional QS roles have been limited to building fabrics and finishes and not used for M&E services because of its complex nature (Buys and Mathew, 2005)

Pre-contract Cost Management Roles of QS

The approximate estimating techniques commonly used by QS are the unit method and superficial area method which are single price approximate estimating

methods (Ashworth & Hogg (2007). The unit method is based upon the cost per functional unit of the building while the superficial method is based on the cost per square metre of the buildings (Potts, 2008). These methods are mostly employed to provide indicative project cost at early stages of construction projects when the available design information is not adequate for the preparation of details bills of quantities for a proposed project. For example, James (1999) pointed out that single price rate approximate estimating could only be applied to determine the early price of only the structure and it's finishing but not suitable for site works, special foundations and engineering services. According to James (1999), the cost of M&E services is rarely constant between one project and another and is therefore a matter which requires separate attention when preparing budget estimate.

Pre-tender cost estimating of Mechanical & Electrical Services projects requires extensive knowledge and expertise. Due to inadequate design information in the early design stages which makes it extremely difficult for QS to arrive at reliable cost estimate using the traditional detail bills of quantities as used for building fabrics and finishes. Studies have shown that an essential component of any cost management approach is to establish standard framework from which to classify and manage information, but if the framework is not standardised, inconsistencies will occur between projects and between stages of each project leading to confusion and ultimately loss of control (Potts, 2008).

Arguably, cost management of M&E services remains the most difficult to achieve at the design stage of a building project Aibinu, Dassanayake, Chan, & Thangaraj (2015). This may be attributed to the complex nature of the design and installation of M&E services project which

is different from building structure and finishes. It is the Architects that usually design buildings and specifies building finishes, while the structural engineers design the structural aspect of the building. Meanwhile, the client could engage a single consulting engineering firm for the design of M&E or could engage a separate firm (one for mechanical and the other for electrical services) for the procurement of M&E projects.

Inaccurate pre-contract cost estimating has a significant impact on contracting business and could negatively impact clients' business decisions. Over estimated costs may result to difficulty in award decisions, or in some cases unrealistic tender negotiation target which could lead to the tender being unacceptable (Babalola, 2012). Projects may be delayed whilst more funding is arranged or even shelved if additional funds are not available. To proceed with insufficient funds will likely lead to payment problems and heavy finance costs for overdrafts or emergency loans during construction. For the reason that, the potential to make savings at design stage reduces since about 80% of the construction costs are committed when limited percentage of design information is completed (Kinney and Soubiran, 2004). It is apparent that implementing an effective cost management system to handle project challenges involves preparing an initial budget and managing that budget throughout the life of the project (Cartlidge, 2011). A budget that is insufficiently defined will lead to confusion and potential argument over what the actual basis of the budget was (Dell'Isola, 2002; Potts, 2008).

Post-contract Cost Management Roles of QS

As project progresses to construction and installations, costs are required to be monitored and compared with clients' budget as work proceeds in order to be

able to identify and measure variance from pre-contract estimates. Meanwhile to achieve this, Dell'Isola (2002) said that, essential elements and aspects of cost estimating that are critical to cost management must be put in place. Such elements according to Dell'Isola(2002) includes: a standard format; identification of cost drivers; consistent principles of estimate preparation; cost estimating methods; risk management and range estimating; special estimating challenges; life cycle costing and value management. There is a general view in the construction industry that post contract cost control may actually be dependent on the level of reliability ascribed to pre-contract budgeting techniques which is a function of the effort expended and the capability of the person preparing the budget (Fortune & Cox, 2005). Since a large part of QS roles in the construction industry is to provide certainty of cost through estimating process.

Evolved Cost Management Roles of QS

Quantity surveying skills and roles has undergone significant changes over the past decade (Cartlidge, 2011). Within the traditional technical role of the quantity surveyor the main activities were limited to the production of the Bill of Quantities and ended at the settlement of the final accounts (Ashworth & Hogg, 2007). However, the scope of work and the nature of work performed by the quantity surveyor have changed drastically and are now expected to contribute throughout the entire lifespan of the construction project (and beyond) in a more managerial capacity. QS are expected to perform evolving roles in the profession with increased importance and emphasis on meeting clients' needs. These evolving roles include risk management, value management, and whole life cycle management among others (Ashworth, *et al.*, 2013). However, studies have shown that the traditional approach of allowing

contingency by QS to cover project risks and uncertainties is crude and inadequate (Odeyinka, *et al.*, 2010). For the reason that contingencies are often calculated as an across-the-board percentage addition or lump sum on the base estimate typically derived from intuition, past experience and historical data (Bello & Odusami, 2008). Contingency is typically greatest in the beginning of a project and is gradually reduced as the project is designed, and risks are resolved. Project contingencies provide an allowance to cover a client's risk exposure but make little contribution to its management (Potts, 2008).

Interestingly, the importance of risk management as an evolved role of QS is further emphasised in the recently published NIQS Building and Engineering Standard Method of Measurement (BESMM4). The document now prescribed the primary reference for the classification of identified risks in construction projects. The BESMM4 (NIQS, 2015) classified key project risks into four as design development risks, construction risks, employer change risks and employer other risks. Where projects risks should be identified, analysed and integrated into project cost during pre-contract budget estimating instead of making contingency sum a mere percentage addition. Therefore, it is important for QS to give careful consideration to the provision of a risk management services so as to enhance the reliability of their early cost estimate. This is because, risk management provides opportunity to control the occurrence and impact of risk factors that could lead to variations and provides clients with better

information upon which to make value for money decisions (Ashworth, Hogg, & Higgs, 2013).

Research Methodology

A comprehensive literature review was conducted on the traditional cost management roles of QS on construction projects. This was followed by the development of a structured questionnaires designed to investigate the cost management roles that QS played on M&E project. The survey questionnaire comprises of two sections with both open and closed ended questions. The first section collects background information, while the second section of the questionnaire then attempts to find out the performance of traditional roles and functions of QS on element of M&E services in buildings. Respondents were required to rate according to their level of agreement on how well each of the traditional roles of QS are performed on elements of M&E services on a five point Likert scale with the value of "1" representing strongly disagree and "5" for strongly agree for the close ended questions. The study was conducted through online survey and hand delivery to industry practitioners (Mechanical and Electrical Services Engineers as well as QS) from October 2014 to July 2015. Snowballing sampling approach was used for the study to ensure that respondents have relevant industry experience to give reliable response to the survey. The target group comprises of the practitioners engaged in consulting, clients, contracting organisations in the North central geopolitical zone of Nigeria.

Table 1: Questionnaires Distribution by discipline

Discipline	Sent out	Returned (useable responses)	Percentage
Mechanical Engineer	49	17	35%
Electrical Engineers	52	23	44
QS	88	42	48
Total	189	82	42.33%

Source: Field Survey, 2014

From the 189 questionnaires sent out, 93 responses were received within six months. A total of eleven (11) of the returned questionnaires that were not properly completed were discarded leading to effective response rate of 42.33%. Statistical analysis was conducted using Statistical Package for Social Sciences (SPSS) version 20. T-tests of the means were used to check the significance of the responses to the issues raised in the questionnaires. Out of the 82 responses, 63% are registered professionals, 32% are graduates and 5% diploma. About 7% of the respondents have construction experience of less than ten years. A total of 42% have construction experience of between 11 and 20 years while majority (51%) have construction experience of between 21 and 30 years. The reliability of the survey instrument was tested using Cronbach alpha reliability test. The Cronbach reliability coefficient alpha is 0.897 with f-statistic of 61.5035, $p=0.001$ indicating that the measuring instrument is reliable at 5% significance level.

Research Findings

Opinion of professionals

Basically, the t-test result in Table 2 shows that respondents are of the opinion that 11 out of the 23 cost management roles of QS are statistically significant ($p<0.05$). The results shows that QS are involved in only 7 out of the 11 functions that are statistically significant judging from the magnitude of the mean scores. These 7 factors are spread across the pre and post contract cost management roles of QS as shown in Table 2 and these includes 3 pre-contract roles namely: cost estimates are usually based on historical cost data (Mean=4.7317); the use of single purpose approximate estimating methods for different components on a single project (Mean=4.6707); statistical method are used to forecast future cost of M&E projects (Mean=4.6951). A total of 4 post contract roles: Preparation of M&E interim valuation (Mean 3.4969); Assessment of M&E claims (Mean 3.8231); Provision of early warning systems (Mean=3.5488); and preparation of final account (Mean=3.6821).

Table 2: Mean Ratings and t-test Results

Ref	Cost Management Roles of QS	Mean	T	P
Pre-Contract Roles				
CM1	Constructability issues are always properly considered in relation to cost at design stage	2.1707	1.380	.171
CM2	M&E bills of Quantities are always prepared by QS	2.8537	-1.488	.141
CM3	QS always collaborate with all parties involved on M&E projects	2.6707	-1.109	.160
CM4	Tender are usually thoroughly analysed prior to award of contract	2.9878	-1.000	.320
CM5	Structured approach is adopted for preparing pre-contract cost estimate	2.1833	-1.003	.326
CM6	Cost estimates are usually based on historical data	4.7317	35.176	.000*

Ref	Cost Management Roles of QS	Mean	T	P
CM7	There is always a balanced distribution of expenditure among various building services components	3.0000	.000	1.000
CM8	Different approximate estimating methods are used for various components on a single project	4.6707	27.749	.000*
CM9	Statistical method is used to forecast the future cost of building services project	4.6951	29.879	.000*
CM10	Cost information are properly captured prior to tender	2.7805	-2.759	.007
CM11	Clients always consider engaging QS	1.3293	-24.814	.010
CM12	There is a cost planning framework used at the beginning of a project	2.7683	-4.161	.000*
Post Contract Roles				
CM13	A generally agreed method is used for post contract cost control	2.3049	-12.253	.000*
CM14	Interim valuation for M&E work is usually prepared by QS	3.4969	4.047	.000*
CM15	Assessment of M&E claim is to a large extent prepared by QS	3.8231	9.913	.000*
CM16	Effective cost monitoring are easily achieved	2.7847	-1.223	.226
CM17	Early warning sign are always provided by QS in anticipation of cost overrun	3.5488	6.306	.000*
CM18	There is a means of remedial action for cost overruns	2.1087	-1.123	.226
CM19	Final account preparation and agreement of M&E work is usually prepared by QS	3.6821	7.144	.000*
Evolved Roles				
CM20	M&E pricing risk are usually identified by QS	1.7561	-1.192	.210
CM21	Projects risks are adequately expressed in monetary terms	2.7439	-5.281	.000*
CM22	Risk assessment process are integrated in the design and construction stages	2.3049	3.689	.301
CM23	Value engineering methodology is always adopted for component selection	1.7561	-4.134	.100

*Significant at $p < 0.05$

Source: Field Survey, 2014

Furthermore, a Kruskal-Wallis test showed that there was no statistically significant difference in the opinion of the 3 responding groups (Mechanical Engineers, Electrical Engineers and the QS) on the level of performance of QS cost management roles on elements of M&E projects. These respondents group are

variously engaged in clients, consulting and contracting forms of organisations. As illustrated in Table 4, the chi-squared statistics is 2.222, the statistical significance $p=0.329$ ($P>0.05$) with mean rank of 33.57 as shown in Table 3 for Mechanical Engineers, 37.91 for Electrical Engineers and 22.32 for QS.

Table 3: Mean Ranks by Professional Background

Performance of QS Cost Management Roles on M&E services projects	Prof Background	N	Mean Rank
	Mechanical Engineers	17	33.57
	Electrical Engineers	23	37.91
	QS	42	22.32
	Total	82	

Table 4: Test Statistics^{a,b}

	PQSCMM&E
Chi-Square	2.222
df	2
Asymp. Sig.	.329
a. Kruskal Wallis Test	
b. Grouping Variable: Prof. Background	

A further examination of the mean rank indicates that QS with over 20 years practicing experience and about 80% of those in contracting organisations perceived themselves to be performing the full spectrum of QS cost management functions on elements of building engineering services. Generally, the mechanical and electrical services engineers believed that QS are not performing their traditional cost management roles and functions on element of building services. The following sub-sections will discuss the findings of the survey.

Discussion of findings

Perspectives on Cost Management Roles of QS in M&E Services Projects

From the perspectives of the respondents, the pre-contract cost management roles performed by QS as shown in Table 2 include the use of historical cost data to estimate pre-contract price of M&E, the

use of single purpose approximate estimating methods for different components of M&E and adoption of statistical method to forecast the future cost of M&E projects. These methods relies principally on subjective and experienced judgement of QS using historic cost information as basis for predicting probable cost of M&E services projects. The level of reliability is low and risky to use as basis for establishing the contract price of building services project. Quantity Surveyors are not often engaged by client for cost advice on M&E services project as shown in Table 2. Consequently they are not able to: (i) prepared detail bills of quantities for M&E services projects; (ii) evaluate M&E services tender submitted by contractors prior to contract award; (iii) collaborate with M&E services consultants for cost comparison of alternative design solutions; (iv) keep reliable cost information on M&E services project for historic cost records; and (v)

consider constructability issues before tender documentation. These findings corroborate earlier assertions that M&E services drawings are often not detailed enough to allow QS to prepare detailed cost breakdown for M&E services project (Nanayakkahara and Fitzsimmons, 1999; Swaffield and Pasquire, 2000; Babalola & Adesanya, 2008; Babalola, 2012).

There are a number of limitations associated with the current practices because the more uncertain the project information is at the pre-construction stage when the BOQ is prepared and priced by the QS, the more risky it is for cost and time performance to be guaranteed to the client at project completion. While at post-contract stage making changes to design and installation will result into additional costs which are difficult to quantify. In addition, it is not possible to have reliable cost and price information which could provide a basis for identifying areas and targets for cost reductions without affecting quality of installations on future projects

Furthermore, respondents considered that the post-contract duties performed by QS on M&E services projects includes interim valuation for payment purpose, assessment of M&E services claim, providing early warning in anticipation of cost overrun, and preparation of final account. Though from the perspectives of the respondents, the post-contract roles identified are performed by QS. These post-contract roles of QS may have no significant positive impact on BS cost because the pre-contract tender documents are not prepared in line with QS traditional BOQ. They only inherit documentation and measurement related problems that require pure professional judgement to solve. Therefore reconciling quantities and amount due to contractors during valuation of work could lead to dispute and pricing variation for inclusion in the interim valuation or final account will be difficult. This gives the contractor good opportunity

to make claims and thereby increasing costs and time for project delivery because the reasons for cost increases are normally also reasons for time extensions (Towey, 2013).

The effectiveness of post contract cost control is dependent on the reliability of the method used at the pre-contract stage. Similarly, on the evolved roles, as can be seen on Table 2, QS are not performing any of the evolved roles identified on M&E services project. The variables under this role include risk assessment and application of value engineering methodology in M&E services project. Adoption of risk and value management on M&E services project could enhance both its cost and time performance. However, these methodologies have not been widely implemented in the Nigerian construction industry.

Conclusion

This study has investigated the extent to which QS are performing their traditional cost management roles and functions on M&E services project from the perspectives of M&E services engineers and QS using data from questionnaire survey. The study concludes within the limitations of data set confined to North-Central geopolitical zone of Nigeria that QS mainly adopt single purpose approximate estimate, statistical method and historical cost information to provide cost advice to clients' on M&E projects at pre-contract stage of building projects. Quantity Surveyors are usually not engaged by clients' for building services projects, hence, there is no opportunity to prepare bills of quantities, tender evaluation and reporting, collaborate with services engineers to provide cost advice on alternative design solution, and no room to consider constructability issues on M&E services project. They are not able to carry out cost comparison of alternative design solution during M&E design development and are not able to employ

the key principles of quantification, estimating and tendering process throughout a Mechanical & Electrical Services project.

The study further concludes that, the post contract roles and functions performed by QS include preparation of interim valuation, assessment of M&E services claims and preparation of final account. It is believed that, budget estimate which serves as basis for tender have direct effect on the final account of M&E services projects. Paradoxically, QS missed the opportunity to set reliable budget for M&E through a balanced distribution of expenditure among various M&E components. With the increase in the value and complexity of Mechanical & Electrical Services projects, industry clients should engage quantity surveyors to perform the full spectrum of their cost management functions on element of M&E services project.

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