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Establishment of Critical Causal Factors for Electrical Cost Estimating Techniques

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ABSTRACT

Cost estimating techniques are approaches towards delivering reliable estimates for any projects or endeavour. However, the usage of the different estimating techniques available depends on prevailing circumstances revolving around such project while the reliability and accuracy of each of the estimating techniques quite differ from each other. This study had through literature review identified six (6) electrical cost estimating methods and through a structured questionnaire assessed the causal factors influencing the usage of the six estimating methods. Data were retrieved from 80 respondents and analysed. The results of the study indicate the most critical causal factors as incomplete details in electrical working drawings, the absence of electrical design drawings and unclear/ambiguous electrical specifications. The study also proffered probable solutions to five of the most critical causal factors. In addition, site-observed productivity constants of electrical technicians at three different residential project sites were obtained which will serve as a valuable cost tool for estimators when carrying out electrical cost estimating jobs. The findings of the research have considerable implications for the education, training and practice of estimators in the construction industry.

***Keywords*:** Estimating methods; electrical installation; productivity constants; estimators; construction industry

1. INTRODUCTION

Electrical services are part of elements of a building (Soutos and Lowe, 2011). An element is defined as a major part of the building, which always performs the same function irrespective of its location or specification (Kirkham, 2007 p. 173). Electrical installation in a general term means any fixed appliances, wires, fittings, apparatus or other electrical equipment used for (or for purposes incidental to) the conveyance, control and use of electricity in a particular place (Electricity Consumer Safety Regulation, 2015, p. 4). Electrical installation is basically subdivided into Electrical Supply/Power/Light systems and Communication/Security/Controls systems of Appendix B of Building Engineering Standard Method of Measurement 3 (Nigerian Institute of Quantity Surveyor [NIQS], 2008, p.214).

In the Nigerian construction industry, the installation cost of an electrical system in a building is significant (Olawumi *et al*, 2016). Simon and Andy (2012) noted that building services installations typically account for 20-30% of the total value of a project; of which electrical installations work contribute between 6% -10% of the total cost of a typical project (Keraminiyage, Amaratunga, Haigh and Perera, 2009).

The need for high accuracy in the costing of electrical installation works in building project cannot be overemphasised because as (Wayne, 2015) noted that inaccurate estimates often lead to problems with customer satisfaction, which often create payment issues; it could also affect the contractors' reputation also, if such endeavours are eventually classified as a failed project or do results in excess cost and time overrun. Meanwhile, various sources of the power generation (electricity) exists although electricity was once a luxury for houses in the past, but it is a necessity for each and every house (or building complex), irrespective of the scale or the category of the household (Keraminiyage *et al*, 2009). Notwithstanding the diverse source of electricity, the fact still exists that there is need for accurate estimation of the electrical components; as the inaccuracy of cost estimates has identified as a common reason for cost overruns in the industry

According to Lawrence (1993), the electricity supply is one of the essential elements of the home that seems to strike fear into the hearts of individual house builders everywhere. This fear and unawareness may lead to undue costs in domestic electrical installations. Hence, it has become apparent that the client should be made knowledgeable about the domestic electrical accessories in order to optimise the domestic electrical installation costs.

It should be noted that the use of an appropriate and suitable cost estimating method is crucial to arriving at accurate and reliable cost estimates for electrical services contracts. With this in mind, this paper would extend to

- Undertake a study of the relevant electrical estimating practices employed in the construction industry;
- Assess critical causal factors influencing the usage of each of the estimating technique;
- Provide solutions to the identified contributing factors, and
- Supply site-observed productivity constants of electrical technicians.

2. COST ESTIMATION: DEFINITIONS

Estimating the effort, time, and resources needed to complete project activities is one of the most challenging tasks that project managers must face; and this is as a result of the inherent uncertainty associated with many activities (PMG, 2015). Cost estimating is the predictive process used to quantify, cost, and price the resources required by the scope of the project, to better manage budgets and deliver projects that do not exceed the identified scope, and that are on time throughout the development process (Washington State Department of Transportation [WSDOT], 2015).

Meanwhile, (Medak, 2015) defines a cost estimate "as an assessment or approximation of the likely costs of an initiative with an indication as to the degree of accuracy, usually +/- percent". It should be noted, however, that one of the first tasks when managing a project is the cost estimation process and that a cost estimate must be accurate, transparent and reliable.

2. 1. Electrical Cost Estimating Techniques

The following electrical cost estimating methods have found its use in the construction industry. However, it must be noted that estimators in various firms may base their estimating method on one or more of the methods mentioned below. Some estimators may use a combination of the estimating methods.

2. 1. 1. Analogous Estimating

Sharma and McDonough (2013) referred to this type of cost estimation as "estimates from a closed project" which "are used to determine the estimates for the new project". For instance, a consultant firm can use historical records of electrical estimates from the previous project which had been collated over time and categorised, say categorised based on building type; such firms could use the same estimates for the design and development of an electrical estimate for another project. However, Sharma and McDonough (2013) noted that "the accuracy of analogous estimates is dependent on the similarities between the two projects" and must be "similar in design and operation to the proposed system" (AcqNotes, 2015b).

This is otherwise known as "Historical bid-based" estimation (WSDOT, 2015). Analogous Estimating is regarded as one of the most common forms of estimating project activities. This technique uses the experience from previous projects and extrapolates that onto the current project (PMG, 2015).

The cost of the proposed system is then estimated by adjusting the historical cost of the current system to account for differences (between the proposed and current systems); such adjustments can be made through the use of factors (sometimes called scaling parameters) that represent differences in size, performance, technology, and/or complexity. Adjustment factors based on quantitative data are usually preferable to adjustment factors based on judgments from subject-matter experts (AcqNotes, 2015b). Analogous/historical costing is one of the most transparent ways of estimating the cost of a project and that historical data were available often gives the most accurate prediction of future costs. However, Billows (2014) and Usmani (2012) argues that analogous estimating doesn't give a perfect solution but it is accurate and based on data not wishes and hopes; it can easily

implement it and also offers the potential for substantially increasing the organization's success rate on projects from 30% to above 60%. The disadvantage of this type of techniques is that the projects for comparison must be similar to each other (PMG, 2015).

2. 1. 2. Parametric Estimating

This type of cost estimation method is quite similar to the analogous estimation technique (Usmani, 2012), and it uses statistical modelling to develop a cost estimate (PMS, 2014) and it also leverages on software that takes historical information as the input, makes assumptions, and then extrapolates the information to compute the overall cost estimates. The accuracy of parametric estimation is dependent on the assumptions made (Sharma and McDonough, 2013).

The cost models which are used for 'what if' simulations are often known as parametric cost models (Keraminiyage *et al*, 2009). Parametric cost models are made up of one or more algorithms or cost estimating relationships (CERs) that translate technical and/or programmatic data (parameters) about a product or asset into cost results (The Association for the Advancement of the Cost Engineering, 2004).

Markgraf (2015) submitted that this method of estimating is "highly accurate and take the least time"; this correlates with Billows (2014) conclusion that parametric estimating is one of the most accurate techniques for determining overall cost and duration of a project as a whole and for individual tasks with tangible output and that it is also very simple to implement. Parametric estimating relies on models/formulas or regression or any other statistical methods scooped from a large database of historical data to develop cost estimating relationships (CERs) (AcqNotes, 2015a). A CER is an equation used to estimate a given cost element using an established relationship with one or more independent variables (AcqNotes, 2015a).

2. 1. 3. Expert Judgment Estimating

Expert judgment method utilizes the experience and knowledge of expert's estimators to estimate the cost of the project; in addition, this technique also takes into account unique factors specific to the project. However, it can also be biased (PMS, 2014). PMG (2015) posited that expert judgment estimating is easy to do - provided there is an expert on the project; this technique looks to the expert to create an estimate based upon their understanding of the project requirements. The advantage of this is that it is quick and if the expert is knowledgeable (PMG, 2015), it is often the most accurate estimate for uncertain electrical activities. The disadvantages are- the unavailability of an expert available and even if the experts are available, the expert may not have a solid rationale for their estimate beyond, "That's what I think it will take to do this" (PMG, 2015).

2. 1. 4. Reserve Analysis (Provisional sum)

Reserve analysis is used to determine how much contingency reserve, if any, should be allocated to the project. This funding is used to account for cost uncertainty (PMS, 2014). PMG (2015) noted that is a guess work though it is a fundamental technique for estimating. This technique considers the level of uncertainty and risk in the project and establishes a reserve pool of time, resources, or possibly performance that can be drawn upon to offset the un-estimated issues that arise (PMG, 2015).

2. 1. 5. Cost-based Estimating

Cost-based estimate methods are based on estimating the contractor's cost for materials, equipment, and labour for an item or a set of items. Estimated contractor overhead and profit are added. Cost-based estimates frequently focus on those items that comprise the largest dollar value of the project, typically 20% of items of work that account for 80% of project cost (WSDOT, 2015). The cost of the remainder of estimate line items can be determined using historical bid-based estimate methods. This approach provides for a more efficient use of estimating electrical installation works and reduces the total time and cost of preparing the cost-based estimates. Cost-based estimating is also a good way to check a few large items of work in a historical bid-based estimate to ensure the historical prices are still valid.

2. 1. 6. Engineering Cost Estimating

The Engineering cost estimating method builds the overall cost estimate by summing detailed estimates done at lower levels of the Work Breakdown Structure (WBS). It's a technique where the system being estimated is broken down into lower-level components (such as parts or assemblies), each of which is estimated separately for direct labour, direct material, and other costs. Engineering estimates for direct labour hours may be based on analyses of engineering drawings and contractor or industry-wide standards (AcqNotes, 2015c).

It has the following advantages- The estimator's ability to determine exactly what the estimate includes and whether anything was overlooked; its unique application to the specific program and manufacturer; also, it gives good insight into major cost contributors, and; it is easy to transfer results to other programs.

3. RESEARCH METHODOLOGY

A review of the extant literature was carried out for the purpose of articulating issues regarding the concept of electrical cost estimating methods in the construction industry. The review also aimed at identifying the potential causal factors and probable solutions to the identified problems in the construction industry.

The research employed the survey research design to assess the critical causal factors contributing to the usage of each of the cost estimating techniques earlier listed. Shuttleworth (2008) opined that the "survey research design is a very valuable tool for assessing opinions and trends" and Chan (1998) believed that survey questionnaire is useful in sampling the opinion of individuals in spatially diverse locations.

The type of the survey research design employed is the internet-based survey. McDonald and Adam (2003) and Cobanoglu, Warde, and Moreo (2001) posited that surveys which are based on emails and online mode can significantly reduce time and cost, and makes it easier to manage a large sample size.

The targeted study population included "any party with electrical estimating and installation project experience and has involved with electrical services related tasks". The web-link to the questionnaire was sent to respondents through emails and on various professional platforms (e.g. LinkedIn etc.). The initial respondents were obliged to identify

and forward the web-link to other potential respondents who "met the criteria of the research" (Explorable, 2009). The purpose was to 'snowball' from a few potential respondents to many respondents (Nguyen *et al*, 2009).

For the purpose of measurement, the study used a five-point Likert-type scale to measure variables. Respondents were requested to assess their level of agreement with each of the identified problems according to a Likert scale from 1 to 5, where 1= "strongly disagree" and 5=" strongly agree" with the statements. Krieg (1999) posited that the five-point Likert-type scale provides less bias in mean, variance, covariance, correlation coefficient and the reliability of scores. In order to ensure a quality questionnaire, a number of processes were followed which included the review of the literature, the construct of the questionnaire, questionnaire pilot-test and the review of the questionnaire.

4. RESULTS AND DISCUSSION

The respondents were asked to rate how critical the thirteen (13) causal factors are to the usage of each of the estimating technique for electrical estimating work on a five-point liker-type scale marked with the adjective "strongly disagree – strongly agree". A total of 94 entries were submitted by respondents, out of which 80 entries were complete and valid for data analysis, (85% valid response rate). Moser and Kalton (1971) stated that the result of a survey could be considered significant if the response rate not lower than 30-40% is obtained.

4. 1. Method of Data Analysis

The relative importance index method (RII) was used to determine the respondent's perception of the significant causal factors contributing to the usage of the identified estimating method in the construction industry. This calculation puts the factors in rank order and indicates how much the top ranked is more important than the next (Abubakar *et al*, 2014) and so on.

The RII was computed as:

$$\textit{Relative importance index (RII)} = \Sigma w / (A \times N) \text{ - - - , } (0 \leq \textit{index} \leq 1)$$

Where: w = weighting given to each factor by the respondents and ranges from 1 to 5 where 1 is not significant and 5 is extremely significant, A = highest weight (i.e. 5 in this case), and N = a total number of respondents (i.e. in this case 80). Meanwhile, the respondents' years of experience and the number of projects undertaken were also analysed in percentage.

4. 2. Presentation of Analysis Results

Respondents' demographics

Data from table 1 revealed that a larger percentage of quantity surveyors/estimators/cost engineers have less than 5 years' experience in electrical installation project with a greater percentage of respondents being involved in 0-1 projects so far; this is not far-fetched as noted by Olawumi *et al* (2016) who noted that "most architectural drawings for residential buildings such as those of bungalows and duplexes in

Nigeria are not usually accompanied by its corresponding detailed electrical drawings" and this has resulted in estimators not to concerned themselves with the electrical services aspect of building works and this work instead has been taken up by semi-skilled artisans (e.g. electricians etc.).

However, a combined percentage of respondents (58%) have been involved in 2-10 electrical installation projects; though none of the respondents have been involved in more than 10 projects and none of the respondents have more than 20 years of experience in electrical installation projects. Meanwhile, Lowe (1998) stressed the importance of experience to the early stage design cost estimator; He reiterated that experience is acquired over time and has been associated with the development of knowledge, familiarity, feedback, professional judgement and estimating expertise.

Table 1. Respondents demographics in electrical installation related projects.

	Demographic	**Percentage**
A	**Years of Experience**	
	Less than 5 years	41.3
	6-10 years	25.0
	11-15 years	32.4
	16-20 years	1.3
	Over 20 years	0
B	**Projects Involved**	
	0-1 projects	41.2
	2-5 projects	31.3
	6-10 projects	27.5
	11-15 projects	0
	More than 15 projects	0

Source: Field Survey 2015

Table 2. Critical causal factors of Electrical estimating methods.

S/N	**CAUSAL FACTORS**	**Analogous**		**Parametric**		**Expert**		**Reserve**		**Cost**		**Engineering**	
		RII	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**	**RII**	**Rank**
1	Estimator's inadequate proficiency in electrical services estimating.	0.678	5	0.776	3	0.790	3	0.656	11	0.706	7	0.490	11

2	Absence of electrical design drawings.	0.798	2	0.786	2	0.816	1	0.822	5	0.662	10	0.510	10
3	Incomplete details in electrical working drawings.	0.710	3	0.682	5	0.800	2	0.908	1	0.826	2	0.596	6
4	Unclear or ambiguous electrical specifications.	0.818	1	0.582	10	0.776	4	0.896	3	0.810	3	0.666	4
5	Organizational policy on electrical service costing.	0.700	4	0.790	1	0.520	10	0.742	9	0.828	1	0.812	1
6	Volatile market conditions.	0.496	12	0.456	13	0.510	12	0.758	8	0.516	12	0.622	5
7	Estimator unfamiliarity with M & E systems and equipment.	0.630	9	0.748	4	0.518	11	0.800	7	0.620	11	0.478	13
8	Ever-changing client's need during the course of the project.	0.488	13	0.570	11	0.510	12	0.610	13	0.796	6	0.520	9
9	Unavailability of historical record or data on electrical estimates jobs.	0.652	6	0.642	6	0.588	8	0.698	10	0.670	9	0.580	7
10	The need for precision in estimating.	0.612	10	0.548	12	0.578	9	0.616	12	0.798	4	0.790	3
11	The need to reduce the time spent on estimating.	0.636	7	0.602	9	0.630	7	0.802	6	0.682	8	0.488	12
12	Undefined project scope.	0.632	8	0.606	8	0.658	6	0.898	2	0.512	13	0.528	8
13	The type/size or complexity of such electrical installation project.	0.542	11	0.642	6	0.712	5	0.890	4	0.798	4	0.798	2

Source: Field Survey 2015

4. 3. Discussion of Analysis Results

4. 3. 1. Causal factors critical to the usage of the identified cost estimating techniques

1. ***Analogous estimating:*** The respondents identified unclear/ambiguous electrical specifications (RII=0.818 R=1), the absence of electrical design drawings (RII= 0.798 R=2) and incomplete details in electrical working drawings (RII=0.710 R=3) has been critical to the usage of analogous estimating as revealed in Table 2.

2. ***Parametric Estimating:*** Table 2 shown that organizational policy on electrical service costing (RII=0.790 R=1), the absence of electrical design drawings (RII=0.786 R=2) and the estimator's inadequate proficiency in electrical services estimating (RII=0.776 R=3) in descending order were ranked by respondents has been quite critical of the usage of parametric estimating technique.
3. ***Expert Judgement Estimating:*** The critical causal factors to the usage of expert judgement estimating techniques includes: absence of electrical design drawings (RII=0.816 R=1), incomplete details in electrical working drawings (RII=0 R=2) and the estimator's inadequate proficiency in electrical services estimating (RII=0.790 R=3) as shown in both Table 2.
4. ***Reserve Analysis:*** Respondents elicited as shown in Table 2 that incomplete details in electrical working drawings (RII=0.908 R=1), undefined project scope (RII=0.898 R=2) and unclear or ambiguous electrical specifications (RII=0.896 R=3) are the three most critical causal factors to the usage of reserve analysis (provisional sum).
5. ***Cost-based Estimating:*** The following three critical causal factors were identified by respondents (as shown in Table 2) has been responsible for the usage of cost-based estimating technique as the preferred option by some estimators for electrical estimating jobs; this includes: the organizational policy on electrical service costing (RII=0.828 R=1), incomplete details in electrical working drawings (RII=0.826 R=2) and unclear or ambiguous electrical specifications (RII=0.810 R=3).
6. ***Engineering Cost Estimating:*** Organizational policy on electrical service costing (RII=0.812 R=1), the type/size or complexity of such electrical installation project (RII=0.798 R=2) and the need for precision in estimating (RII=0.790 R=3) in that order were identified by respondents (as revealed in Table 2) has been critical to the usage of engineering cost estimating as the preferred option by quantity surveyors or estimators.

4. 4. Probable Solutions to the Identified Causal Factors

Based on the RII wherewith the critical causal factors were identified for each of the six (6) cost estimating techniques; the following five (5) causal factors were identified as critical causal factors by respondents in more than one of the cost estimating techniques. These include incomplete details in electrical working drawings (4 times); absence of electrical design drawings, unclear/ambiguous electrical specifications and organizational policy on electrical service costing (3 times) and estimator’s inadequate proficiency in electrical services estimating (2 times). The proffered solutions include among others:

1. Provision of electrical working drawings with complete details
2. Clear and unambiguous electrical specifications
3. Good organizational policy on electrical service costing
4. Training and re-training of estimators (through professional training, seminars and workshops).
5. Adoption of best practice for electrical installation jobs

5. PRODUCTIVITY CONSTANT OF ELECTRICAL TECHNICIANS

This section provides the observed productivity constant of electrical technicians; which is a vital input when calculating the labour output/cost for any given electrical job. Chancellor (2015) noted that the factors that influence the productivity of personnel are at both macroeconomic and microeconomic levels. This research delimits itself to the actual labour output as observed on three (3) project sites.

Table 3 illustrates the site observed productivity constants of electrical technicians at three different residential project sites where electrical installation works were on-going; this will greatly assist estimators in their estimating and price analysis tasks.

Table 3. Productivity constant of electrical technicians.

Descriptions	Gang Size	Unit rate	Time rate	Number per day (8-hrs day)	Labour Cost [in dollar $]
Draw and fix a roll of Cable (1.5mm2)	2	0.08	5	100m	20.0
Fixing of Wall brackets	1	0.60	36	14	12.5
Fixing of Fluorescent fitting	2	0.53	32	15	17.5
Fixing of Luminaries (ceiling pendant)	1	0.64	38	13	12.5
Fixing of Luminaries (others)	1	0.44	27	19	12.5
Fixing 10A 1,2,3 gang Switches	1	0.63	38	13	12.5
Fixing of 10A 2-way, 1 gang Switches	2	0.53	32	15	17.5
Fixing of 13A/15A Sockets	1	0.58	35	14	15.0
Cutting and fixing Conduits	2	0.61	37	14	20.0

Source: Field Survey, 2015

6. CONCLUSIONS

This study has through literature review identified six (6) cost estimating techniques employ by estimators/cost engineers/quantity surveyors for electrical estimating contracts. The choice of the preferred option is usually based on the prevailing circumstances as of the time of carrying out the estimating work. Also, critical causal factors which may necessitate the usage of any of the estimating technique were also identified and this will serve as a guide to estimators and clients' organizational due to the fact that some cost

estimating techniques reduces the precision of estimating and in order to avoid such, estimators and clients' organizational should guide against encouraging or exhibiting some of the contributing factors such as absence of electrical design drawings and the estimator's inadequate proficiency in electrical services estimating.

Meanwhile, the solutions proffered in this study should be applied appropriately were necessary by stakeholders in the construction and engineering services industry, has it will greatly help and assist them in solving inherent problems in the industry and imbibe relevant industry best practices.

Furthermore, the productivity constants of electrical technicians and a market survey carried out as part of this study are deem valuable and quite reliable tools for quantity surveyors in carrying out cost estimating work in any electrical installation projects.

References

[1] Abubakar M., Ibrahim Y.M., Kado D., Bala K., (2014). Contractors Perception of the Factors Affecting Building Information Modelling (BIM) Adoption in the Nigerian Construction Industry; *Computing in Civil and Building Engineering* (ASCE Journal)

[2] AcqNotes (2015a). Cost Estimating: Parametric Cost Estimating. <22 September 2015> <http://acqnotes.com/acqNote/parametric-cost-estimating>

[3] AcqNotes (2015b). Financial Management: Cost Estimating Methods. <22 September 2015> <http://acqnotes.com/acqnote/careerfields/cost-estimating-methods>

[4] AcqNotes (2015c). Cost Estimating: Engineering Cost Estimating. <22 September 2015> <http://acqnotes.com/acqnote/tasks/engineering-cost-estimating>

[5] Chan, D.W.M (1998). Modelling construction durations for public housing projects in Hong Kong. *HKU Scholars Hub*. http://hdl.handle.net/10722/34830

[6] Chancellor, W., (2015). Drivers of productivity: a case study of the Australian construction industry, *Construction Economics and Building*, 15(3), 85-97. DOI: http://dx.doi.org/10.5130/AJCEB.v15i3.4551

[7] Cobanoglu, C., Warde, B., and Moreo, P.J. (2001). A comparison of mail, fax, and web-based survey methods, *International Journal of Market Research*, 43(4), 441-455.

[8] Dick Billows (2014). Parametric Estimating. <22 September 2015> <http://4pm.com/parametric-estimating/>

[9] Electricity Consumer Safety Regulation (2015), 'Public consultation draft', pp. 4 <September 16, 2015> <http://goo.gl/qFdf1n>

[10] Explorable.com (2009). Non-Probability Sampling. <August 19, 2015> <https://goo.gl/a9Mljm>

[11] Fahad Usmani(2012) Three Tools to Estimate Activity Duration. <22 September 2015> <http://pmstudycircle.com/2012/06/three-tools-estimate-activity-duration/>

[12] Keraminiyage, K, Amaratunga D, Haigh R. and Perera, R.S. (2009), Selection of Electrical Accessories: A "Cost Modelling" Approach. *Research Institute for the Built and Human Environment,* The University of Salford, UK. http://goo.gl/x5nPBl

[13] Kirkham, R. (2007) Ferry and Brandon's Cost Planning of Buildings, 8th edition, Wiley Blackwell, Oxford

[14] Krieg, E. F. (1999). Biases induced by coarse measurement scales. *Educational and Psychological Measurement*, 59(5), 749-766. DOI: 10.1177/00131649921970125

[15] Lawrence, M. (1993) The which? Book of Wiring &Lighting, Consumer's Association, London

[16] Lowe, D.J. (1998). The development of expertise in early stage cost estimating through experiential learning. In Proceedings of the RICS Construction and Building Research Conference, Oxford Brookes University, 2P3 September, Edited by M Keeping and D Shiers, ISBN 1P873P640P23P4

[17] Markgraf B. (2014a). Project management cost estimating techniques. <22 September 2015> <http://smallbusiness.chron.com/project-management-cost-estimating-techniques-40508.html>

[18] Markgraf B. (2014b). What Are Reasons for Cost Overruns in Project Management? <22 September 2015> <http://smallbusiness.chron.com/reasons-cost-overruns-project-management-63225.html>

[19] McDonald, H. and Adam, S. (2003). A comparison of online and postal data collection methods in marketing research, *Marketing Intelligence and Planning*, 21(2), 85-95. DOI: 10.1108/02634500310465399

[20] Medak K. (2014). A Project manager's guide to cost estimating and cost planning. <22 September 2015> <http://www.framegroup.com.au/cost-estimating-and-planning/>

[21] Moser, C.A. and Kalton, G. (1971): Survey Methods in Social Investigation. *Heinemann Educational, London.*

[22] Nguyen, Nhat H., and Skitmore, Martin and Wong, Johnny K.W., (2009). Stakeholder impact analysis of infrastructure project management in developing countries: a study of the perception of project managers in state-owned engineering firms in Vietnam. *Construction Management and Economics*, 27(11). pp. 1129-1140. DOI: 10.1080/01446190903280468

[23] NIQS (2008) Building and Engineering Standard Method of Measurement (BESMM 3), the 3rd ed., *The Nigerian Institute of Quantity Surveyors;* ISBN: 998-36754-7-8.

[24] Olawumi T.O., Ogunsemi D.R., and Ogunsina S. (2016) Modelling the Costs of Final Sub-Circuits in Residential Electrical Installations (under review). *Journal of Construction Engineering and Management*

[25] PMG (2015) Project Management Estimating Tools & Techniques. <22 September 2015> <http://www.projectmanagementguru.com/estimating.html>

[26] PMS (2014). Project Cost Estimating Tools & Techniques. <22 September 2015> <http://www.project-management-skills.com/project-cost-estimating.html>

[27] Sharma R. and McDonough M.(2013). Tools Used to Estimate Costs in Project Management. <22 September 2015> <http://www.brighthubpm.com/project-planning/54986-tools-used-to-estimate-costs-in-project-management/>

[28] Shuttleworth, M. (2008). Survey Research Design. https://explorable.com/survey-research-design

[29] Simon, R. and Andy, D, (2010). "Specialist Costs: M & E Services". <Dec. 16th, 2012> <http://goo.gl/oRLTL0>

[30] Soutos, M. and Lowe, D.J. (2011). Elemental cost planning: current UK practice and procedure. *Journal of Financial Management of Property and Construction*, 16(2), DOI:10.1108/13664381111153123

[31] The Association for the Advancement of the Cost Engineering (2004) Parametric Cost Estimating Model for Buildings (online) <http://www.aacei.org/technical/costmodels/BuildingModel.shtml>

[32] Washington State Department of Transportation [WSDOT], (2015). Cost Estimating Manual for Projects [pdf]. <22 September 2015> <http://www.wsdot.wa.gov/publications/manuals/fulltext/M3034/EstimatingGuidelines.pdf>

[33] Wayne J.D. (2015). Electrical Estimating Methods, (4th ed.). *John Wiley and Sons Inc.* ISBN: 978-1-118-76698-9

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