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Assessment of the Utilization of Standard Method of Measurement Rule in the Quantification of Road Projects in Akwa Ibom State, Nigeria

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ABSTRACT:
The study addressed the dearth of standardization in road works contract documentation and evaluated the use of the Standard Method of Measurement rules in the quantification of road construction projects. The study evaluated the, engineers' level of awareness and compliance with the requirements of the standard methods of measurement. Leveraging mixed data covering extensive literature review, 70 survey questionnaire and archival studies of 22 Bill of quantities or bill of engineering and evaluation documents for road projects in Akwa-Ibom State. Data analyses involve percentages and mean item score to advance the research goal. The study revealed that engineers apparently lack pertinent awareness of the requirements of the standard method of measurement (SMM) imperative for effective contract documentation. Due to low level awareness about the requirements of the SMM, the level of compliance with SMM rules in practice are very low. Based on these results, the study concludes that the use of SMM in road work quantification is low and the overall compliance of BOQ/BEME with the requirements of SMM is negligible and unstandardized. The study recommends that engineers must embrace quantity surveyors into road contract quantification, pricing and documentation as well as embracing requisite training in contract standardization using the SMM.

Keywords- Standard method of Measurement, Bill of engineering measurement, road project

I. INTRODUCTION

Standard Method of Measurement (SMM) provide a uniform basis of measuring building, civil and heavy engineering projects in order to facilitate industry wide consistency and benchmarking to encourage the adoption of best practices and help avoid disputes. The essence of SMM is to provide uniform basis of documentation for tendering purposes, to serve as a basis for fair valuation of variation during the post contract of building and civil engineering projects. It set out the information that should make up the descriptions, the unit of measurement for each item of work and provide rule to what is included within each items. It is in line with this that the Nigerian Institute of Quantity Surveyors (NIQS), directed members and practicing bodies to adopt the use of BESMM4(R) as in producing bill of quantities (BOQ) or Bill of Engineering Measurement and Evaluation (BEME). It is believed that only through a well prepared documentation BOQ following SMM rules that client will achieve value for money spent on road construction projects.

According to Nwannekanma (2019) Bill of engineering measurement and evaluation prepared by engineers are responsible for some of the corrupt practices in the construction industry. This could be as a result of incorrect estimation as quoted by Oyelola in Nwannekanma (2019) which have resulted to project abandonment and delay at different stages of the project execution. Anecdotal evidence has shown that virtual abandonment of road projects could likely be the consequences of not using SMM in preparing BEME or BOQ. Despite increasing sensitization of the significance and importance of SMM as a referenced document to produce a standard bill of quantities, utilization of the SMM is still plagued with issues such as misunderstanding or miscalculating between owners and contractors and inadequate measurement principles for the same parties.

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Several attempts by the Nigeria institute of quantity surveyors (NIQS) to streamline the duties of engineers to design and construction only by sponsoring a bill in the national assembly seeking to replace BEME with BOQ as obtained in other climes. The bill will empower the QS to be incharge of project quantification, estimation, certification and general management of all engineering projects as quoted by Nwannekanmma (2019). According to Nwannekanmma (2019) presenting the word of Akere supporting the chairman of Lagos State NIQS chapter said the quantity surveyors are to evaluate the designs by engineers and cost it as against the BEME prepared by engineers which is very fraudulent because things that should be properly measured are not measured. Nigeria Society of Engineers (NSE) at 1997 Annual General Meeting (AGM) directed its members to charge little or nothing for the preparation of BEME for now. Directing its members to charge little or nothing is unethical and unprofessional. The effects of these problems are; it enhances corruption and its relevant vices; it gives room to waste and inefficiency; it encourages fraud and sharp practices; it encourages unstandardized documents for tenders; it generates skyrocketed contract sums; it results to incorrect estimates; it does not give room for checks and balances.

Following the non-mandatory use of BOQ across Nigeria, the extent of utilization of BOQ is quite uncertain and the proficiency of development of BOQ among construction professionals becomes doubtful and calls for robust evaluation. Based on the earlier highlighted reasons, this study sought to assess the utilization of Standard Method of Measurement rules in the quantification of road construction project in the study area with a view to determining the veracity of the claim that engineers who prepared BEME/BOQ for road projects do not produce it to the required standard.

II. LITERATURE REVIEW

A. The Concept of Measurement

Measurement is the transformation of drawn information into description and quantities, undertaken to value, cost and price construction works, as well as enabling effective management. It is not just about the quantity surveyor producing a bill of quantities for contractor to price during tendering. It is used in both pre- and post-contract work, helping to assess the likely cost of the works, and determining what contractors and subcontractors should be paid for work that has been completed.

Levels of Detail for Measured Information

The degree of detail to which construction works can be measured varies according to its use and the stage in the projects. In the very early design stages, there is not much detail available, so estimates are based on general parameters, such as:

- Functional unit: for example, cost per school pupil, cost per theatre seat, cost per hospital bed, and so on.
- Floor area: cost per square meter gross floor area. As design progresses and more information is known, estimates can become more detailed; such as elemental estimates (for walls, floors, roof, frame, etc). During the later stages of the design, the work required to construct the building may be measured by:
- Itemized specification: a detailed cost plan which is broken down into a series of elements. Initially, the elemental cost plan will simply be the total construction cost for the projects divided into elements on a percentage basis.
- Approximate quantities: a first attempt to measure defined quantities from the drawings (or to take them off from a Building Information Model (BIM). This should be accompanied by a schedule of assumption made.
- Bills of quantities: the work is measured in details, usually in accordance with a Standard Method of Measurement.

From the above analogy, the concept of measurement is very central in determining how bills of quantities are generated from the approved Standard of Method of Measurement current at a time. Hence, determination of the description of works itemized in the bills of quantities should be generated based on the rules of measurement and its respective coding. More so, the quantities derived from these drawings are gotten in line with their relevant unit of measurement gotten from the Standard Method of Measurement. Hence, the use of Standard Method of Measurement is a cost management tool applying the principles and concept of measurement as a guide. The SMM has given a clear definition of the rules of measurement taking cognizance of the respective divisions explained in the SMM and the supplementary rules. Measurements of road works are to be based on the Standard Method of Measurement.

B. The Concept of Standard Method of Measurement

It is important that there is a uniform basis for measuring building, civil and heavy engineering works in order to facilitate industry wide consistency and benchmarking to encourage the adoption of best practice and help avoid disputes. A standard method of measurement provides a structure for the information that should make up the descriptions. It

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also defines the units of measurement for each item – m^2, m^3, number, tonnes, and so on.

- It provides rules as to what is included within each item
- Defines the term used to avoid disputes.
- Allows familiarity to develop, so measurement becomes easier and quicker.
- Provides a clear system for structuring other project information and cross-referencing specification with bill of quantities information.

The most commonly used standard methods of measurement for building works is the New Rules of Measurement (NRM2), which replaced Standard Method of Measurement 7 (SMM7) in 2012. The current one now in Nigeria from the Nigerian Institute of Quantity Surveyors (NIQS) is Building and Engineering Standard Method of Measurement 4th edition (Revised) (BESMM4 (R)) which was produced in 2017 by NIQS.

The New Rules of Measurement 2 (NRM2) are published by the Royal Institute of Chartered Surveyors (RICS) and prepared by the quantity surveying and construction professional group. NRM2 provides a set of detailed measurement rules for the preparation of bills of quantities or Schedules of rates for the purpose of obtaining a tender price. It also deals with the quantification of non- measurable work items, contractor designed works and risks. Guidance is also provided on the content, structure and format of bills of quantities, as well as the benefits and uses of bills of quantities. The current Standard Methods of Measurements now in Nigeria are:

a) Building and Engineering Standard Method of Measurement fourth edition (Revised) BESMM4(R)
b) Civil engineering standard method of measurement (CESMM4)

These documents are almost the same with various divisions that are very different fromNRM2. They enhance description of works, unit of measurement and the appropriate code to be used for element of works.

C. Standardization of Methods of Measurement in the built Environment

The goal of standardization is to ensure uniformity to certain practices with the industry. Standardization focuses on the product creation, process, operations or businesses, technology in use, and how specific compulsory processes are instituted or carried out. One example of standardization in construction industry and this research work is the Standard Method of Measurement (SMM). The UK Institute of Civil Engineers have the Civil Engineering standard method of measurement, fourth edition (CESMM4) and the Nigerian Institute of Quantity Surveyor (NIQS) in a circular dated 17th March, 2019, explained the need for standardization of bills of quantities based on BESMM4(R) thus: "with effect from 1st March, 2021, all bills of quantities for building and engineering works prepared and produced by all members and quantity surveying firms in the country must be based on Building and Engineering Standard Method of Measurement, fourth Edition as revised (BESMM4(R)) published by the Institute".

The circular further enjoined chapter Chairmen to conduct workshops and trainings to enhance the capacity and proficiency of members in the usage and application of BESMM4(R).

The standardized documents in Construction Industry in Nigeria are:

1) The CESMM3;
2) The CESMM4;
3) The BESMM4;
4) The BESMM4(R);

In order to ensure the industry's growth, by having a good long term, rational and cost effective project or building, there is an urgent need within the industry to adopt standardization in construction information and documentation (Bandi and Abdullah, 2012a, Perumal and Abu Baker, 2011). Standardization will help in achieving consistency in management and operation thus indirectly reducing conflict among the key players, Smit and Cronje (2002) as cited by (Perumal and Abubakar,2011) stresses out on the main purpose of adopting standardization is to develop a specific level of conformity.

Building Works SMM

The earliest SMM was issued by the RICS for the UK (Royal institute of Chartered Surveyors of the United Kingdom) in 1922 for use in the United Kingdom and territories in the British Commonwealth. The manual has since undergone numerous revisions and is now in the 7th (Seventh) edition, otherwise known as SMM7. The most recent now in Nigerian construction world is the Building and Engineering Standard Methods of Measurement revised(R). Construction is generally science oriented as a subject, but the technological process by which construction goods are produced, involved the science and art of management, legal systems and cultural practices which vary in different regions of the globe. Consequently, different SMMs are in existence in different parts of the commonwealth and the rest of the world, duly adapted to suit the peculiar needs of each region or country.

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Civil Engineering Works SMM

Although the quality of materials and a number of processes of building works are the same with those of Civil Engineering Works, the circumstances under which some types of civil engineering works are executed are usually radically different and in this regard a standard method of measurement for major civil works also exists. The SMM of Civil Engineering quantities was first issued by the ICE (Institution of Civil Engineers of the UK) in 1935. The revision published in 1976, also changed the title of the manual to CESMM (Civil Engineering Standard Method of Measurement). The previous edition was CESMM3, published in 1991. The latest now is CESMM4.

SMMIEC (Standard Method of Measurement of Industrial Engineering Construction)

This method of measurement is authorized by a joint Agreement between the Association of cost Engineers and the RICS and issued by the (JDB) Joint Documentation Board and the RICS (Royal Institute of Chartered Surveyor). The first edition was published in 1984. The manual is essentially for measurement of Industrial Engineering Works in the UK, but may be applied in other parts of the world where the construction industry, shares the same basic features with those of the UK

Civil Engineering Projects

Civil Engineering is one of the oldest jobs in the world. Civil engineering deals with constructing, designing, and maintaining a physical environment. This includes structures such as airports, roads, bridges, dams, sewerage, railways, and many more. A civil engineer has an impact on the things we use every day and our surroundings.

D. Rules of Measurement for civil Engineering works

There are basically two standard methods of measurement documents adopted for the measurement of civil engineering works. These documents are the Civil engineering standard methods of measurement (CESMM4) and the building and engineering standard methods of measurement (BESMM4R) revised 4th edition.

Rules measurement based on CESMM4

The rules for the measurement of civil engineering works set out in the Civil Engineering Standard Methods of Measurement (CESMM4) fourth edition. The earlier measurement rules for civil engineering works followed the general wordy format of their contemporary building works SMM, but in 1976, the format was radically changed into a tabular one resulting in the first edition, that is CESMM1. There has since been a second edition, CESMM2 in 1985 and the third edition CESMM3 and the present CESMM4.

Part 1: The explanatory sections 1-7, which gives rules and guidelines regarding application, terms and applicable conditions.

Part 2: The work classifications rules which are sub-divided into 26 classes each detailing measurement rules for different types of civil engineering works.

Each work classification further consists of two parts.

(a) The measurement rules in a tabular form and
(b) The further rules, which classifies or expansiates on the measurement rules made also in a tabular form.

These rules are under four headings as discussed above.

(i) Measurement rules explain how the quantities of each item is to be derived
(ii) Definition rules clarify terms used or to be used in the CESMM or BOQ
(iii) Coverage rules define or clarify the pricing limits for the affected bill items
(iv) Additional description rules indicate the extent of additional information or description required for specified items, that is information that has impacted on pricing or rate build up assumption.

Rules of Measurement Based on BESMM4(R)

Building and Engineering Standard Method of Measurement fourth edition as reviewed (BESMM4) part one provides rules for the measurement for building works including simple building incidental to civil engineering works.

BESMM4 (R) part two is intended to be used only for civil engineering works. The object of BESMM4 (R) part two is to set forth the procedure according to which the Bill of quantities for civil works shall be prepared and priced and the quantities of work expressed measured.

By the use of work classification, BESMM4 (R) seeks to principally defined

(a) How work is to be divided into separate items in the bills of quantities.
(b) The information to be given in item description.
(c) The units in which the quantities against each items are to be expressed.
(d) How the work is to be measured for the purpose of calculating quantities

E. BESMM4 ® work classification

The work classification divides work commonly encountered in civil engineering contract into 26 main classes. Exactly as is in CESMM4. Each class comprises up to three divisions which classify work at successive levels of details. Each division comprises of a list of up to eight description features

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of work. Each item description in the bill of quantities shall identify the components of work covered with respect to one feature from each division of the relevant class, for example class 2H (Precast concrete) contains three divisions of classification. The first classifies different types of precast concrete units, the second classified different units by their mass. Each item description for present concrete units shall therefore identify the component of work in terms of the type of unit, its dimension and mass.

Under mode of description, the rule is that item description for permanent works shall generally identify the component of the works and not the tasks to be carried out by the contractor, for example, or item should be described as "plain round mild steel bar reinforcement to nominal size 20mm". Where the work identified by an item is specially limited, the limitation shall be stated in the item description, for example "plain round mild steel bar reinforcement to nominal size 20mm excluding supply and delivery to the site". Item descriptions for work which is divided between two classes require such limitation to be stated, for example, item descriptions for miscellaneous metal work inserts which are to be cast in-situ concrete require appropriate additional description if items are given in both 2G for casting in the insert and 2P for supplying the inserts.

Under separate items, the work is to be divided into items in the bill of quantities so that the component of work which is included in each item does not exhibited more than one feature from each division of any one class of the bar work classification, for example, one item for precast concrete work shall not include more than one of the types of concrete unit listed in the first division of class 2H neither shall it included different units whose dimensions are not within one of the classification listed in the second division of class 2H, nor shall it include different units whose mass does not lie within one of the ranges listed in the third division of class 2H. The unit of measurement for each item shall be that stated for the item in the work division. The unit of measurement against a description feature in the work division shall apply to all items to which that descriptive feature applies.

III RESEARCH METHODOLOGY

The research adopted a descriptive survey design and was conducted in the Akwa-Ibom State of Nigeria. The choice of the state was due to the handful of road construction work going on in the urban and rural areas of the state. The population for this study was drawn from registered construction professionals practicing and working in various government organizations.

The study used 90 professionals as its sample size and purposive sampling methods. An exhaustive examination of the academic literature was conducted in order to fulfill the purpose of this paper, and a survey questionnaire and interview were used to gather data. The tools used to obtain data from a variety of respondents included structured questionnaires and interviews. Validity and reliability tests were performed on the data gathering instruments. Participants within the study area self-administered the instruments both directly and through online posting. The data were analyzed using Mean, frequency, percentage, bar and pie charts.The statistical package for the social sciences (SPSS) software was used to make the data analysis easier.

IV. FINDINGS AND DISCUSSIONS

Table 1: Questionnaire administration and response rate

Questionnaire	Frequency	Percentage (%)
Number received	70	77.8
Number not received	20	22.2
Total	**90**	**100**

Survey data from the research field (2021

According to Table 1, a total of 90 copies of the questionnaire were given out to the target respondents using a purposive sampling methodology. The response rate was 77.8% with 70 of the 90 copies of the survey given being completed and returned. Due to the researcher's professional colleagues' assistance in disseminating and collecting the questionnaire, the response rate was high. Some studies carried out in the field of construction cost management and Supply Chain Management had

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relatively average and high response rates. For instance, Oludara, Okunola, and Oluseye (2018); Obi and Arif (2017); Chigara, Moyo, and Mudzengere (2013); and Abeselom (2008) had response rates of 54%, 57.83%, 73%, and 73.91% respectively. All these cited works affirm the response rate adequacy for this study

Table:2 Respondent's characteristics

	Characteristics of respondents	%
1	**Nature of organizations**	
	Contracting	36.00
	Consultancy	27.00
	Public service	37.00
2	**Roles in the organizations**	
	Consultant Supervising Engineer	36.00
	Contractor's Supervising Engineers	27.00
	Ministry Supervising Engineers	37.00
3	**Academic qualification**	
	HND	21.00
	BSc/B. Tech./B.Eng.	56.00
	MSc/M. Tech./M. Eng.	23.00
4	**Professional registration**	
	MNSE/COREN	85.00
	FNSE/ COREN	15.00
5	**Years of experience**	
	0-5years	26.00
	6-10years	40.00
	11-15years	26.00
	16-20years	6.00
	20years and above	2.00

Source: Author's Field Survey 2021

The distribution of the respondents across organization is heterogeneous. However, the public service has the highest number of respondents. This distribution is adequate and confirms that the public sector is the largest client of road works construction globally. This pattern of distribution also applies to the roles of the respondents in their respective organizations. The study shows that more engineers participated from the public service than the consultancy and contracting. Over 77% of the respondents are holders of first degree and its equivalent (HND). However, 23% of the respondents are holders of master's degree in civil engineering. The average years of experience varies between twelve years. However, the median lies between eight years. Overall, the level of education of respondents, professional qualification and experience are cognate to affirm that the practices reported in this study are valid position in the industry.

Table 3: Level of awareness of SMM rules for quantifying road construction works

S/N	**Questionnaire Themes**	Total	No of Respondents	%
1	Meaning of BEME (Bills of Engineering Measurement and Evaluation)	70	70	100%
2	Not aware of the use of SMM	35	35	50%
3	Aware of the use of SMM	35	35	50%
4	Having Knowledge of the latest edition of SMM	0	0	0%

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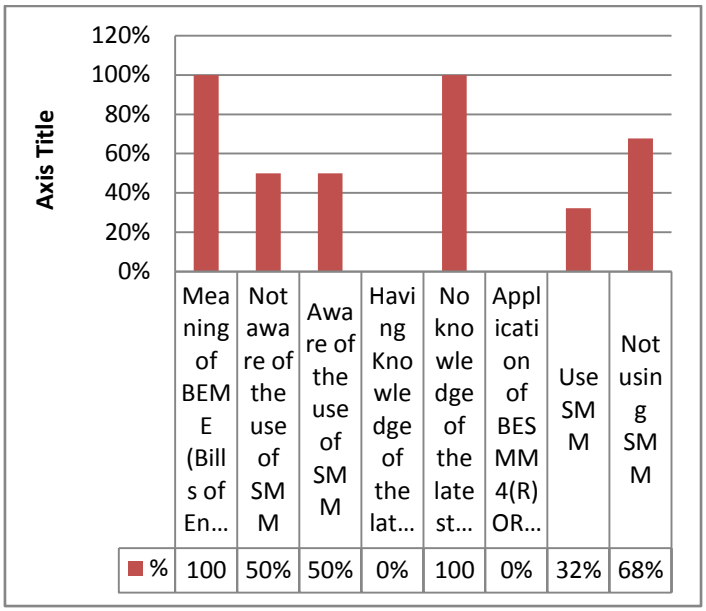
5	No knowledge of the latest edition of SMM	70	70	100%
6	Application of BESMM4(R) OR CESMM4	0	0	0%
7	Use SMM	23	23	33%
8	Not using SMM	48	48	68%



From the results in Table 3 all the respondents are conversant with meaning of the acronym BEME (Bill of Engineering Measurement and Evaluation). However, 50% of the samples are not aware of the existence and practice of road contract documentation using standard method of measurement, while the remainders (50%) are aware of the existence of standard method of measurement. However, the less average awareness among sample does not translate into use of the SMM. The result of the use of SMM shows that 32% of the sample actually engaged with practice of the document in the contract documentation in road works while 68% of the samples are not using the Standard Method of Measurement. Apparently, a number of engineers are not aware of the most recent version of the CESMM4.

In Table 4 the level of awareness on specific measurement guideline is presented. The items descriptions in Table 4.6 are adapted from BEME and apparent conformity in terms of description was not evaluated, except the unit of measurement. The results show that the respondents' awareness related to the unit of measurement of pre-cast concrete cover slab in drain, precast culvert, quarry dust on sharp sand, bituminous spray and excavation are consistent with the requirements of Standard Methods of Measurement especially the building and engineering standard method of measurement fourth edition as revised (BESMM4 (R))

Table 4: Awareness in Specific guideline of the BESMM4 (R)

Item	**Item descriptions**	**Unit in BEME**	**%**	**No of Respondents**	**Unit in BESMM4 (R)**
A	Provide and place R.C cover slab on the entrance measuring 900mmx450mmx150	No	100	62	Nr

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	mm				
B	Provide and lay 600mm ring precast reinforced concrete ring culvert rate to include excavation, haunching, formwork, reinforcement, surrounding concrete works etc. in accordance to Engineers' specifications	M	100	62	Lin.m
C	Provide, spread and compact quarry dust on sharp sand to receive interlocking; 50mm average thickness	M^2	100	62	Sq.m
D	Provide and lay prime coat bituminous surfacing to base using MCO or MCL, cut-back bitumen at rate not exceeding 1.1 liters/m^2 and blind with clean sharp sand	M^2	100	62	Sq.m
E	Excavate unsuitable materials, soft spots and weak layers as directed by the Engineer's representatives and cart away material to spoil	M^3	100	62	Cu.m

Level of compliance with SMM rules in Road Work Quantification

In this objective, the study presents data related to stakeholder's awareness of specific requirements of CESMM4 or BESMM4(R) using archival studies. The data in this section unlike the previous section was mined from practical BEME for completed projects. Archives of 22 completed and on-going projects were examined to appraise conformance to SMM rules using an SMM based template for road construction projects. The parameters for considerations were the prescribed units of measurement and compliance with standard description based on the 119 items on the road template. It was observed that 0% was for items on standard description while 7.28% was items that complied with prescribed unit of measurement. The cumulative total number for the 22 projects was 2618. Out of this 189 which is 79% was in compliance with the prescribed unit of measurement. This means that 93% of the items of unit on measurement are based on the engineer's experience, conceptions and perceptions. In items of the description based on the BESMM4 (R) of the 2,618 items, it was observed that 0% complied with standard description while 100% of the descriptions in the 22 selected BEME were not in compliance with the template description from BESMM4 (R), as shown in figure 2 This practice is not tenable from one place to the other and lack of standardization.

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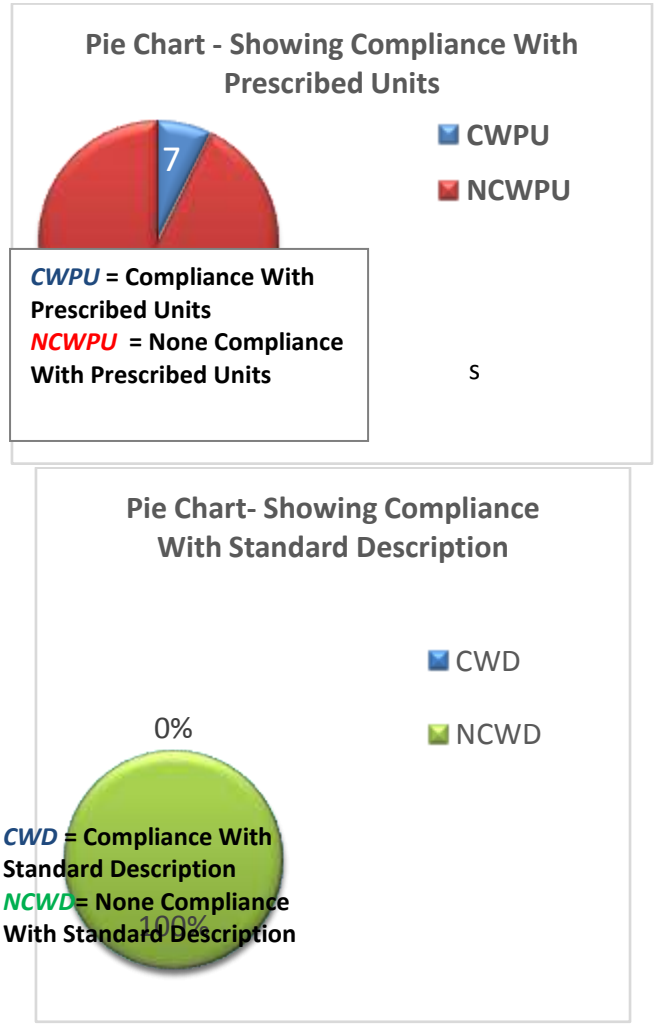

Figure 2: Compliance with Standard Description and Prescribed Units

From the table above, we have 119 distinct items in the template for preparing Bills of Quantities for road works. The description in the 22 No BEME of road projects from the State Ministry of Works were cross-examined to assess the level of their compliance with description (CWD) and compliance with prescribed unit of measurement (CWPU) using BESMM4(R). Out of these assessments, it was noted that none of the description in the BEME complied with the 119 No distinct items in the template representing 2,618 total no of items of description which stood for 0% of the entire work as showed in the pie chart above.

It was also noted that only 189 items compiled with the standard units of measurements representing 7.7% while 2,429 items of the entire BEME did not comply with the standard units' measurement representing 93% as shown in the pie chart above.

V. CONCLUSION AND RECOMMENDATIONS

The study addressed the dearth of standardization in road works contract documentation and evaluated the use of the Standard Method of Measurement rules in the quantification of road construction projects towards determining the veracity of the claim that engineers who prepared BEME/BOQ for road projects do not produce it to the required standard. The study also revealed that the engineers apparently lack pertinent awareness of the requirements of the Standard Method of Measurement imperative for effective contract documentations. The lack of awareness synergizes non-standardization, use of rule thumbs, intuition and the dearth of scientific approach in road work quantification and documentation. This understanding shows that the "bills of quantities" for road entails what the project engineers directs and conceive in terms of quantities and specifications. Also, even though the survey of selected items in the study showed some level of

conformity with standard unit of measurement for pre-cast concrete slab and culvert, quarry dust sprayed on bitumen binder and excavations, the descriptions of these items and coding lacks innovation and standardization.

Due to low awareness about the requirements of the Standard Methods of Measurement, the level of compliance with standard methods of measurement rules in practice are also very low. Only 7.22% items out of 2,618 documented work operations in 22 BEME evaluated conformed to the requirements of the standard method of measurement in terms of unit of measurement based on the template for building roadwork. Again, flowing from the low compliance, prevalent of heuristics and intuition, over 24.73% of the billed items were priced and qualified as provisional sums. More so, 74.82% stood for measured items and 0.45% stood for items that should be measured but covered with provisional sums. This understanding suggests that most engineers lack knowledge and skills about the scope of the work or dedicate less time to their design functions thereby contributing to the inability to offer adequate details imperative to produce detailed bills of quantities.

The research recommends training through workshops, seminars and structured learning would improve engineers' awareness and the ability to comply with the requirements of the standard methods of measurement in quantifying road construction projects in Akwa-Ibom State of Nigeria.

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