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# Systematic Review of Barriers to Standard Method of Measurement Adoption

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## Abstract

Failure to adopt the standard method of measurement (SMM) affects the uniform preparation of the bill of quantities during construction works. This is based on past and current analyzes of the standard measurement method, with a focus on project construction issues. Nevertheless, various obstacles and difficulties have delayed the implementation of the standard measurement method. The need to study existing knowledge about the barriers to SMM adoption has been given little attention. This paper offers a systematic review of the literature on barriers to SMM adoption, published in academic journals. Following the guideline on Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA), a systematic review was undertaken to evaluate the limitations in the 2000 to 2019 use of a standard measurement method in the Scopus and Google Scholar databases. It was found that the biggest challenge in SMM adoption was resistance or unwillingness to change the current procedure. The lack of information, experience awareness training and skills that influenced the measurement did not help updating the new technologies, construction methods and new materials that occurred. The most widely reported challenges in the literature were no regulatory and legislative body to reflect different uses of the measurement method and different local standard and international standard measurement methods. This study provided the construction practitioners and scholars with a valuable guide to incorporate the SMM in construction projects. Additionally, an established checklist of SMM barriers may be useful for further empirical study in this paper.

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## I. INTRODUCTION

The Eleventh Malaysia Plan (2016 to 2020) states that the construction sector contributes 5.5 per cent to the National Gross Domestic Product, with an annual growth rate of 10.3 per cent in the construction sector. The Construction sector recorded value of gross output RM204.4 billion in 2017 compared to RM177.9 billion in 2015 with an annual growth rate of 7.2 per cent per annum. Malaysia's construction sector recorded the value of construction work done of RM36.1 billion in the third quarter of 2019. The construction sector has also been identified as one of the country's major economic areas in relation to agriculture, mining,



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manufacturing, and services capable of generating economic growth [5].

According to [7], any penny spent throughout the construction industry would also have a penny loss, due to standard and uniform limitations. Therefore, the industry urgently needs to follow standards in building documentation and knowledge to assure the growth of the construction sector within the national economy [4]. Reference [17] explained that a set of measured works or items may be the standard measurement method along with the rules to provide guidance to the tendering contractor to permit against the measured items. [24] describes the standard measurement method as a manual providing the necessary measurement of the building and civil engineering work. This is to make sure that the produced quantity list accurately describes the quantity and quality of the work completed. Due to less ambiguity towards the contractor, it is possible to use this standard to achieve cost-effective projects to meet the same requirements in related work [26]. The purpose of standardization is to avoid waste, overpaid, mismanagement and disputes [27].

The quantity surveyor career plays a role in creating detailed lists to enable the standard to be used. Regular service of a quantity surveyor is to prepare bill of quantities [14]. Quantity surveyors also provide services such as feasibility studies, costs, and planning schedules for early estimates [29]. The bill of quantities is usually closely related to using SMM. The bill of quantities list is a structured document that allows the contractor to provide estimates or to operate correctly on the same basis, thus ensuring a fair and transparent offer [27]. Some issues relating to the quantities in construction compared to standard measurement methods as specified by [25] are the inaccuracies in rates and quantities in which the standard measurement technique is highly sophisticated as in Australia [21], and the rules of this standard measurement method encourage the inaccuracy of quantities in the quantity list. In the case of these quantities being inaccurate, this will result in a conflict and, as a result, contractors are dissatisfied with how the quantity is included in the quantity list [14].

A. Towards a Systematic Review Framework for the Implementation of Standard Method of Measurement Barriers

Although the value of the SMM has recently increased in the preparation of a bill of quantities, its use and adoption still face difficulties. By using the standard document, where all scope of work is clearly and regularly specified, each contractor that enters the project tender will have the same specifics and a common understanding of the work to be done. The requirement also reduces or removes the confusion in the cost of tendering, so more objective and clear selection of qualified contractors is possible. Indirectly, it simplifies contract management and reduces the confusion about project costs.

Given the abundance of research on the standard method of measurement adaptation, efforts to systematically review similar studies are still incomplete. The article attempts to fill the gap in understanding and explains and characterizes the SMM acceptance in the construction sector. Nevertheless, the use of this standard has not been generalized and consultants, contractors and clients in construction projects are fully aware of this.

Measuring construction work is critical in cutting costs. A quantity surveyor who works on both building construction and civil engineering projects will typically do his work on the basis of drawings made by architects and engineers through a bill of quantities [4], [5], [27]. To prevent disputes, the preparation of the bill of quantities should be effective and systematic. The measurement method used for uniformity should be standardized in this way too. Malaysian building industry adopts a range of traditional measuring methods, such as the Malaysian Standard Method of Measurement of



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Building Works (SMM2) for building works, and the Malaysian Civil Engineering Standard Measurement Method (MyCESMM) for civil engineering projects [5], [9], [28].

Several of the problems that contributed to the review were the use of a different SMM that can create unevenness. [17] claimed that consultants used standard in-house measurement methods, including measurement description and unit of the same item but in different ways. In the meantime, [9] indicated that the survey by [24] revealed that 46 standard measurement methods exist in all 27 countries around the world. Nonetheless, a literacy study has been recorded that there are several countries which use a number of standard measurement methods but are not listed in the survey. This was also verified by [5] showing that there was no data from the global survey database [24] for the current standard measurement method used in Malaysia because there was no research from RICS member of M

alaysia. Though there was a large gap in the study period (2003 to 2015), Malaysia's main players in the construction industry still referred to various types of measurement methods for construction works and civil engineering works. [5] argued that even though empirical studies had been carried out if there was still no concerted effort to address it, and why the construction industry in Malaysia was still haunted by the issue the problem continued to plague. The current article was guided by the main research question to establish a thorough systematic review – how do construction practitioners adopt the SMM implementation? The main focus of the research was on SMM adoption activities. A particular focus has been given to the barriers of the standard method of measurement implementation in constructions. It will be directly related to the quantity surveyors with consultants, clients and contractors working in the construction industry. The purpose of the study in this paper is to increase the understanding of stakeholders about what prevents the rapid adoption of the SMM through literature review and recommend steps to resolve it. This section explains the aim of performing a systematic review while the second section addresses the methodology and procedure used in the PRISMA Statement (Preferred Reporting Items Systematic Reviews and Meta-Analysis). The third section analyzes and synthesizes the outcome and discussion of barriers to the SMM acceptance in the construction sector. The final section deals with the conclusion and expectations for future research.

## II. METHODOLOGY

The approach used in this section relates to the study of barriers to the standard method of measurement. The Preferred Reporting Items Systematic Reviews and Meta-Analysis (PRISMA) guided the study of which provides techniques (Scopus and Google Scholar) used in the systematic review process. Process steps for analysis which include identification, screening, eligibility, classification and data analysis. PRISMA is often utilized in the field of project management. The PRISMA Statement allows for a thorough search of terms related to barriers to the standard method of measurement and their impact and coded information in future reports on construction management. It is possible to use the technique to track construction professionals' operation to meet the SMM.

Scopus by Elsevier has been used in similar ways and has higher efficiency and precision performance than other search engines [18]. Scopus was also believed to be the best and most efficient search engine for the analysis of a topic [20]. This research was confined to the standard approach to measurement studies which raised concerns about barriers or obstacles or challenges to the standard measurement adoption processes published in scholarly journals (peer-reviewed). The rationale behind this is that peer-reviewed journal articles, given the quality of peer review process, are the most critical sources of information that they pass



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through before publication [1]. Due to limited research articles on the SMM, the Google Scholar search engine has also been used for classifying relevant articles.

Keywords used to search properly include 'barriers', 'challenges', 'obstacles', 'standard method of measurement', 'standard measurement', 'measurement method' and 'construction industry'. An initial search was performed with the article or review paper type, and restricted to articles published between 1999 and 2019 under the ' title / abstract / keyword ' section of the Scopus database. The initial search has resulted in a total number of 255 papers being identified (searched for 18 September 2019). But not all of the articles that were originally reported discussed SMM's conclusions regarding challenges. Some just happened to have in their title or abstract or keywords. Considering that the main purpose of this study was to review the SMM barriers literature, it was important to weed out non-relevant articles. Therefore, a brief review of the abstracts was performed, and in some cases where the abstracts did not provide sufficient information, the substance of the article was originally identified. After filtering, 27 papers were deemed appropriate and eligible for further review. It is important to note that this study focused solely on reviewing and drawing conclusions from the relevant articles collected through the adoption of the specific literature search method but not on reviewing the entire population of articles on the subject. The next section of the paper examined, presented and addressed SMM barriers identified in the 27 pertinent articles.

There are some conditions for eligibility and exclusion. Firstly, the kind of literature, only article journals with empirical data are selected. Hence conference proceeding papers, book series, unpublished research articles and internet data source are not included in this review. Secondly, the search efforts omitted the non-English publication and focused solely on articles published in English to avoid any ambiguity and translation difficulties. Thirdly, appropriate literature has been collected over the last 20 years (1999 to 2019) on a small paper published in the respective field, a sufficient period to see the evolution of the research and related publications. The rest of the papers were reviewed and analyzed. Efforts were focused on specific research that answered the questions that were formulated. Then, the data were gathered to define important themes and sub-themes by reading the abstracts, then the full papers (in-depth). Qualitative research was conducted using content analysis to identify trends that are important to SMM adoption.

Fig. 1 summarizes the flow of the research methodology, as explained above. The process involves four stages, starting with papers being identified through the search engine. A screening phase is then taken to eliminate any redundant posts. The papers will be checked for eligibility after review and the documents included for analysis will eventually be analyzed.

## III. BARRIERS TO STANDARD METHOD OF MEASUREMENT ADOPTION

Results from each paper were summarized through a summary of the 27 papers included in this report. Table 1 has been used to allocate the established SMM barriers for ease of presentation. Of the 27 articles, a total of 10 barriers have been identified; however, for further review only barriers found in at least three articles are listed in Table 1. Table 1 shows that several barriers impede the effective adoption of a SMM, but the five most frequently reported barriers are resistance / unwillingness to change current practices, lack of information, experience, awareness, training and skills, failure to update new technologies, construction methods and new materials, no regulation and enforcement and various internal and international SMM standards indicate that these are significant barriers whose representations discourage standard measurement



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methods among construction practitioners. This paper discusses only the top five barriers in the SMM, due to space or word limitation.

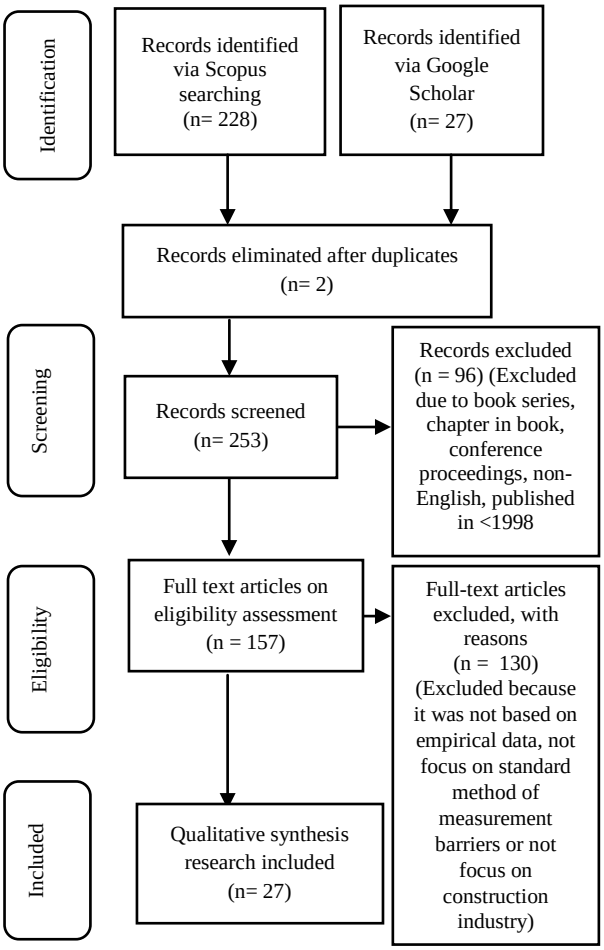


**Fig. 1. PRISMA flowchart for the systematic review of the barriers linked to SMM adoption**

**Table-I: Barriers to SMM identified from previous research**

| No. | Barriers | Authors |
|---|---|---|
| 1. | Resistance/unwillingness to change the current practices | [2], [5], [8], [9], [10], [11], [13], [14], [15], [19], [23], [26], [27], [29] |
| 2. | Lack of information, experience, awareness, training and skills | [2], [8], [9], [10], [11], [13], [15], [19], [27], [29] |
| 3. | Measurement does not update emerging new technologies, construction methods and new materials | [2], [4], [5], [9], [13], [14], [23], [26] |
| 4. | No regulation and enforcement body reflect various usage of the method of measurement management | [3], [5], [10], [13], [19], [23], [26], [27], [29] |
| 5. | The different set of standard measurement methods by in house and international standard | [3], [5], [9], [10], [11], [13], [19], [27], [29] |
| 6. | Difficulty in developing a simple, precise, compact and detailed SMM | [3], [5], [9], [13], [14], [19], [27] |
| 7. | Drawings, not detailed items when preparing bills of quantities | [3], [5], [9], [10], [11], [23] |
| 8. | Standard measurement fails to meet local industry needs | [3], [5], [23], [26], [27] |
| 9. | Lack of level of clarification for non-specialized measurer | [9], [10], [13], [23], [26] |
| 10. | Contractors more familiar with lump sum compared with detailed amounts | [3], [5], [23], [26] |

Previous studies demonstrated a reluctance to change current practice, which is hard to switch from traditional ad-hoc practices to new standards. [15] argued that it was difficult to change the way of thinking among the disadvantages of new standard use. The fact that the quantity surveyor profession was generally ineffective with a theoretical background has also been addressed, making it difficult for them to change discipline from traditional to new practice [23]. The previous one was reported to be easier to use, and no ambiguities were created [19]. According to the study [3], [5] most senior respondents were consistent with the old standard measuring process due to their slow learning curve. An obsolete standard was used during their training as quantity surveyors, as were mostly Malaysian quantity surveying firms founded in the 1970s and 80s. [12] also emerged that Ghana was also faced with the same phenomena as its company was founded during the same time and that SMM5 was used in comparison to SMM7 due to the low standardization of building materials and the inadequate definition of bills of quantities preparation. It has been stated that there was no generally accepted standard measuring method, particularly for building services such as mechanical and electrical services in Malaysia [9], [13] because of the reputation as a specialist field, quantity surveyors were prevented from taking any serious consideration Therefore, difficulty in recognizing the normal measurement by design consultants has contributed to resistance [10], [11]. It was noted that this barrier also reflected Indonesian players in the



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construction without the need for standard and the difficulty of learning a new one [27]. 2] considered that a lack of standards of measurement applicable to the construction industry would lead to confusion and to an international standard due to a different culture.

The second most noted barrier in literature to SMM adoption was lack of information, experience, awareness, training and skills. 16 per cent of respondents reported that they did not understand the traditional method of measuring civil engineering works and did not even know the existing standard [19]. Consultants still lack professional quantity surveyors who are knowledgeable enough to follow the standard [23]. In some cases, a study carried out by a specialist technical area [9] which discouraged many quantity surveyors from considering the measurement due to inadequate ability. In fact, the designs were often not ready during the tender stage owing to the consultants' involvement in the design stage either late or no participation at all [10]. While some consultant services engineers were ignorant of any specific measurement method and unsurprisingly, most did not know how to use the standard, and the opinion was only prepared by the quantity surveyor [11]. The lack of understanding of the basic implications of implementing an SMM in Indonesia [27] was therefore one of the reasons it did not apply. In Sudan, the efficiency of their construction projects was impacted by the lack of standard [29]. Construction practitioners were required to apply the measurement, especially in terms of cost and time efficiency, to avoid problems and obstacles. The standard workshop or training should be better suited to inspiring construction practitioners to adopt the standard.

The study found that the technical challenges and requirements related to the implementation of a SMM in construction were the third barriers most identified. The SMM between developed and developing countries was influenced by technology, according to [12]. Indirectly, it would also influence the measuring system used for the construction industry, such as labor-intensive and in situ construction, as opposed to automated construction. The mainstream implementation was not up-to-date with the latest technologies, including Industrialized Building System (IBS), Building Information Modeling (BIM), and Green Technology which different methods of measuring for each type of technology. Furthermore, the format was not consistent with quantity surveying systems such as BIM making this obstacle under technical difficulties and requirements. Nowadays, with many new software developments coming in, a quantity surveyor needs to learn and research with a new construction technique and new materials to adapt to the construction industry.

The fourth barrier identified was the particular use of the common measurement method due to the lack of a regulatory or legislative body required to follow and the connection to a single reference for measuring and preparing the bill of quantities [19]. The barrier supported the survey carried out by [3], [5] pointing to the conventional method of measurement not adopted by authority and regulation. In enforcing the use of the SMM, the regulatory board was ineffective [5], [10], [21], [22]. A quantity surveyor cannot be forced to use a particular measurement method because he / she cannot predict any construction situation and may not be appropriate measurement rules for specific situations [23]. The scenario is occurring and therefore it is a necessary action to promote a new thing to satisfy a mandatory need for a government-ruled law or authority.

In the construction industry the current practice is that different standard techniques are used significantly from one another. Such standards are developed by the department of quantity surveying in contractors or developers and qualified quantity surveyors. The consultant also using his / her own measurement method [17]. According to [5],



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Malaysia's case suggested standard use by project type such as private or government. The international standard will be used when it comes to mega or global ventures. In fact, we will use a different standard for massive and complex civil projects. This barrier, after all, continues to hinder SMM adoption because there is no regulatory body and compliance body ordered to use a single standard system for measuring work to prepare bills of quantity [5], [21], [22]. 29] argued that this would result in project failure due to the use of the different measurement methods and would hinder the development of the construction industry in Sudan. Using the different standard would cause the unevenness of the measurement system and eventually lead to the non-uniformity preparation of bills of quantities.

## IV. CONCLUSION

This research conducted literature on barriers to implementation of the SMM. The Scopus and Google Scholar search engine were used to gather relevant articles from a validated academic journal in this analysis. Many barriers were found to influence the SMM adoption with the purpose of evaluating the literature on the SMM barriers. Literature's most widely reported barriers were reluctance or unwillingness to change current practice, lack of information, expertise, awareness, training and skills that did not upgrade emerging new technology, construction techniques, and new material. There were no regulatory and legislative bodies representing different uses of the standard and different standard in-house measurement methods, as well as international standards among other barriers mentioned in the report.

The most widely reported difficulties in the literature were the unwillingness to change the current procedure in the direction of the traditional measurement. Most of them noticed there was no need for new standards and challenges in learning a new process because of their learning curve. Therefore the government must play its role in encouraging and regulating the use of this standard.

The lack of information, experience, awareness, training and skills was the second barrier that affected the widespread measurement method. The players were not aware of the advantages and benefits of using a standard measurement method. The government and stakeholders should be providing incentives to resolve the challenge. They should join shoulder to shoulder in making that effort effective. To attract stakeholders, the government should provide appropriate financial and non-financial incentive programmes.

The findings also showed that the technical obstacles and requirements for new technology, construction methods and new materials on the market were the third biggest barrier in the literature. The main advice was to conform to any sort of procurement contracts and construction. The level will be classified according to the practicality advantages of either building works or civil engineering works.

The result showed that no regulatory and legislative body representing different use of the measurement method was a significant barrier to demotivating stakeholders, especially clients and developers, to apply standard measurement. The unevenness of the measures used will also affect the preparation of bills of quantity which will ultimately constitute a possibility and disputes. Therefore the government should take a step to make this requirement mandatory to be implemented, especially in public projects. The unwillingness to change the current standard came up against major challenges as no regulation enforces the standard's use.

The analysis also showed that one of the big dominant trend was the different standard measurement by in-house and international standard. It can be understood that because the culture and lifestyle of each country were not the same, and it



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was necessary to address the needs of the local industry.

By defining the most identified barriers in the literature, this research had contributed to the awareness of challenges influencing the SMM adoption. The findings were important because they provided information on significant barriers to SMM implementation, resulting in a better understanding of what inhibits the rapid adoption from a global SMM perspective. Construction practitioners can identify gaps in SMM implementation, and thus explore critical areas where a policy or strategic approach can help speed up SMM adoption. The contribution to the global community of construction was to provide a list of recommendations that would address barriers to consistent measurement application. It is expected that when the obstacles are resolved, stakeholders will be more interested in increasing the implementation of an SMM than in common features in future construction projects. However, the SMM barriers and references checklist provided in this paper may be applicable to scholars for further empirical studies on SMM barriers at various locations and project types.

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