

Vol. 5 • No. 1 • Desember 2024

Page (Hal.) : 547 – 560

ISSN (online) : 2746 - 4482

ISSN (print) : 2746 - 2250



Special

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Human Barrier Factors Influencing the Adoption of the Civil Engineering Standard Method of Measurement (CESMM) in Construction Project Management

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Abstract: The Civil Engineering Standard Method of Measurement (CESMM) is a standardized framework used for preparing bills of quantities and managing costs in civil engineering projects. The standard is a pivotal tool in construction project management, promoting standardization, cost control, and transparency. Despite its benefits, the adoption of CESMM varies across construction industries globally and faces numerous challenges, including limited awareness, lack of training, regulatory gaps, and resistance to change. This paper explores the factors influencing the adoption of CESMM in construction project management especially human barrier factors, including unaware of the benefits of the standard method of measurement to their role, resistance to change from traditional values or culture, unfamiliarity of construction professionals with the measurement, inadequate support from construction practitioners for implementation and consultant utilize their own in-house method of measurement. By analyzing these factors, the study aims to examine the factors influencing CESMM adoption, utilizing recent findings and theoretical insights. A model is proposed to enhance adoption rates by addressing barriers and promoting effective integration of CESMM into project management practices to improve the adoption and ensuring better cost control, project efficiency, and standardization in the construction industry.

Keywords: Civil Engineering Standard Method of Measurement, Human Barrier, Construction Project Management

INTRODUCTION

The Eleventh Malaysia Plan (2016–2020) highlighted the construction sector's pivotal role in Malaysia's economy, contributing 5.5% to the GDP with a growth rate of 10.3%. Recent statistics reveal continued positive momentum, with the construction sector recording a value of RM38.9 billion in the Second Quarter, 2024, representing a 5.7% quarter-on-quarter growth. This growth is attributed to significant expansions in civil engineering (39.0%) and non-residential building (27.4%), residential building (22.6%) and special trade activities (11.0%) as displayed in Figure 1.

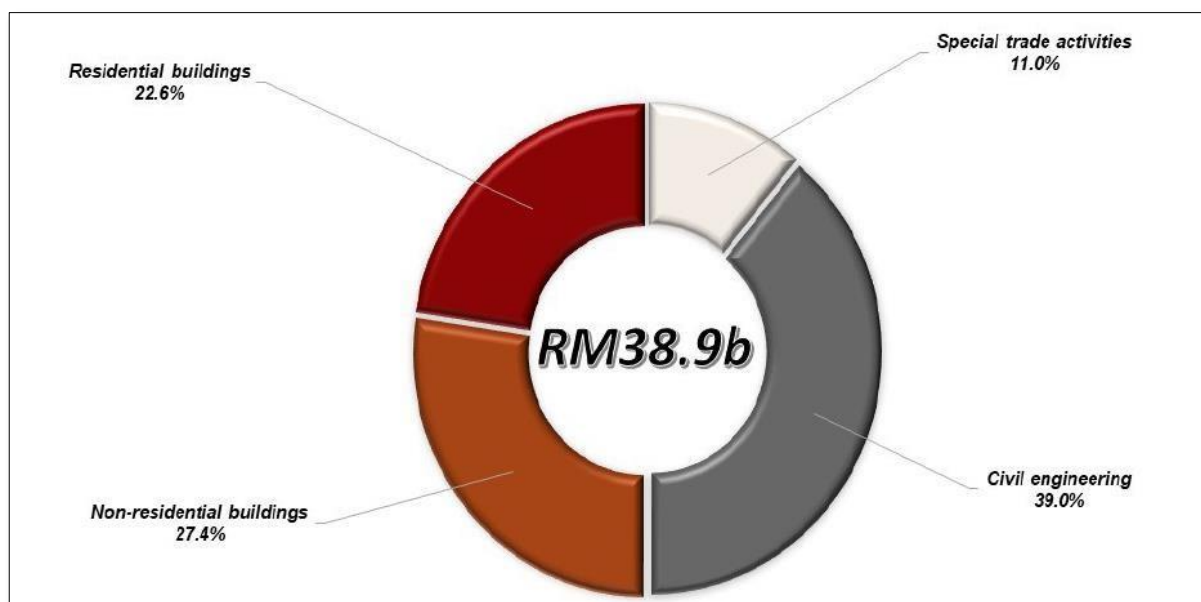


Figure 1. Percentage share value of work done by sub-sector Q2 2024.

Source: Construction Statistics, Second Quarter 2024, Department of Statistics Malaysia (DOSM)

For sustained progress, adopting standardized measurement methods is essential. These methods ensure accuracy in project costing and avoid disputes, ultimately promoting efficiency and transparency in construction processes. To overcome barriers like outdated practices and lack of awareness, government-led initiatives, including incentives and regulations, could enhance sector-wide adoption. This will support Malaysia's construction sector in maintaining its critical role in economic growth.

Measurement methods and accurate cost estimation are fundamental aspects of construction project management. The Civil Engineering Standard Method of Measurement (CESMM) offers a comprehensive framework to standardize these processes, providing consistency in tendering, contract management, and project execution. Accurate measurement and cost estimation are critical in construction project management, influencing project outcomes and stakeholder satisfaction. The

Civil Engineering Standard Method of Measurement (CESMM) provides a structured approach for preparing bills of quantities, ensuring uniformity and precision in civil engineering projects.

Developed to streamline measurement and cost estimation in civil engineering projects, CESMM has been widely acknowledged for its ability to reduce disputes, improve transparency, and enhance communication among stakeholders. However, its adoption in construction project management remains inconsistent due to several influencing factors. Despite its global recognition, CESMM adoption remains inconsistent, particularly in developing countries, where institutional and market dynamics vary significantly. Challenges such as insufficient knowledge, regulatory shortcomings, and financial constraints impede its widespread use. This research aims to explore these factors, highlighting strategies to improve CESMM adoption for better project outcomes.

This study investigates these human barrier factors, focusing on challenges related to CESMM adoption, with the goal of fostering its effective integration into the construction sector.

LITERATURE REVIEW AND RESEARCH MODEL

CESMM is a structured guide to preparing bills of quantities, emphasizing clarity, accuracy, and uniformity in civil engineering works. It outlines measurement principles and categorizes work items to ensure consistency across projects. CESMM offers a standardized methodology for measuring and describing civil engineering works. It simplifies the preparation of bills of quantities by categorizing construction activities and setting out measurement principles.

According to statistics from the Construction Industry Development Board (CIDB), the civil engineering sub-sector plays a pivotal role in the economy, contributing RM63.7 billion in gross output, equivalent to 31.2% of the total. This highlights the importance of civil engineering works in driving economic growth. To accelerate the construction industry's development and address future financial demands, industrial transformation is essential.

In this effort, the Construction Industry Transformation Program (CITP) was introduced under the Fourth Strategic Thrust of Internationalization. A key objective of the CITP is the implementation of the Malaysian Civil Engineering Standard Method of Measurement (MyCESMM2). This standard aims to promote best practices by standardizing the measurement of civil engineering works. MyCESMM2 is specifically designed to align with consistent standards, minimizing confusion, enhancing professionalism, and facilitating interaction with various measurement methods. It provides clear descriptions and definitions for work coverage methods associated with each valued item.

The CITP's strategy mandated the adoption of MyCESMM2 for all government projects by 2020. To evaluate the effectiveness of this initiative, a study was conducted to assess the implementation and application of this standardized measurement document. The subsequent section of this research explores the development of documentation for MYCESMM2. Additionally, it examines Malaysian users' behaviours regarding these documents and identifies human factors that impede the broader

adoption of the current MyCESMM2 (CIDB, 2018).

Despite its growing importance in preparing bills of quantities (BQ), the adoption of Standard Measurement Methods (SMM) continues to encounter challenges. SMM ensures that all project scopes are clearly defined and standardized, providing contractors with a shared understanding of required work. This clarity reduces confusion during tendering, enabling objective and transparent contractor selection. Additionally, SMM simplifies contract management and minimizes ambiguities in project costs, leading to smoother implementation and improved cost efficiency. However, broader adoption requires addressing existing barriers to ensure consistent application across the industry.

Accurate measurement of construction work is crucial for cost optimization. Quantity surveyors prepare bills of quantities (BQ) based on architects' and engineers' designs, ensuring systematic documentation to minimize disputes. Standardized measurement methods, such as MyCESMM for civil engineering, are essential for uniformity. However, inconsistent usage, including in-house methods and varying international standards, disrupts uniformity and creates disparities.

Studies reveal global adoption of 46 measurement standards across 27 countries, yet gaps remain, including limited data from Malaysia. Despite ongoing efforts, Malaysia's construction sector still faces challenges due to fragmented measurement practices and insufficient research integration. This research addresses these barriers by analyzing adoption practices, particularly among quantity surveyors, consultants, clients, and contractors. It aims to enhance stakeholder awareness of SMM-related issues and recommends strategies to accelerate adoption while fostering industry-wide standardization.

Despite a significant gap in research spanning 2003 to 2023, Malaysia's construction industry continues to rely on various measurement methods for building and civil engineering works. Studies, such as those by Ahmed, et.al., (2018), highlight that although empirical research has been conducted, the persistent lack of coordinated efforts has allowed this issue to endure. This study seeks to address the research question: how are standard measurement methods (SMM) adopted by construction practitioners? The research focuses on SMM adoption, emphasizing barriers that hinder its implementation. By examining quantity surveyors, consultants, clients, and contractors, this paper aims to enhance stakeholder understanding of the factors delaying SMM adoption and to propose actionable solutions through a comprehensive literature review.

Although there has been a significant research gap from 2003 to 2023, the Malaysian construction industry continues to utilize various measurement methods for building and civil engineering works. Previous studies, including Ahmed, et.al., (2018), indicate that despite empirical investigations, a lack of cohesive action has perpetuated the issue.

This study aims to address this by exploring the adoption of Standard Measurement Methods (SMM) among construction practitioners. It particularly examines barriers to SMM implementation, focusing on its impact on quantity surveyors, consultants, clients, and contractors. Through a systematic literature review, the study seeks to enhance stakeholder awareness of these challenges and propose recommendations to accelerate SMM adoption in the construction industry. By

identifying and addressing these obstacles, the research contributes to a more standardized and efficient measurement practice that supports industry-wide improvements.

1. Summary of Malaysian Civil Engineering Standard Method of Measurement (MyCESMM)

Table 1. Development of Malaysian Civil Engineering Standard Method of Measurement.

Category	Standard method of measurement	Publication year
Civil engineering	CESMM3 from UK	1991
	CESMM	2003
	MyCESMM	2011
	MyCESMM2	2018

(Source: Nizam Akbar et.al.,2021)

Table 1 outlines the evolution of the Standard Method of Measurement (SMM) in Malaysia over the past three decades. The Malaysian construction industry has progressively introduced new SMMs to address its specific requirements for building and civil engineering works. The latest standard, MyCESMM2, was published in 2018, continuing the advancements from CESMM3 (1991), CESMM (2003), and MyCESMM (2011). Despite these efforts, studies (Nizam Akbar et al., 2021) reveal that industry stakeholders still use various measurement standards, highlighting the need to understand quantity surveyors' adoption behaviours regarding MyCESMM in procurement and contract documentation.

2. Human Barrier Factors

Research done by Nizam Akbar et.al., (2021) identifies human behaviour as a significant barrier to SMM adoption. These challenges are grouped into two main categories:

1. **Human Behavior Issues:**
 - Lack of awareness about SMM benefits.
 - Resistance to transitioning from current practices.
 - Insufficient measurement skills.
 - Extended adaptation periods for new SMMs.
2. **Statutory and Regulatory Issues:**
 - Weak enforcement of standards.
 - Limited promotion by governing bodies.
 - Insufficient training opportunities.
 - Lack of incentives to encourage adoption.

According to Muzafar et al. (2023), these barriers significantly impact industry players' willingness to adopt the latest SMMs, underscoring the need for strategic interventions to enhance implementation in Malaysia.

This research examined the barriers to implementing the Standard Method of Measurement (SMM) through an extensive literature review. The most frequently reported challenge was reluctance or unwillingness to change existing practices. Many professionals perceived no need for new standards and struggled with adopting new processes due to the learning curve. Resistance was particularly strong regarding traditional measurement methods. This highlights the critical role of the government in encouraging and regulating the use of standardized methods to overcome this challenge.

The second major barrier was the lack of information, expertise, awareness, training, and skills. Many construction professionals were unaware of the advantages and benefits of adopting SMMs. To address this, the government and stakeholders need to collaborate and provide both financial and non-financial incentives. Effective incentive programs could attract stakeholders and motivate them to adopt standard practices.

The third significant challenge identified in the literature involved technical obstacles and requirements related to new technology, construction methods, and materials. These barriers complicate the integration of SMMs into procurement contracts and construction processes. Recommendations include adapting standards to align with practical advantages for specific types of work, such as building or civil engineering projects.

Another critical barrier was the absence of regulatory and legislative bodies mandating the use of standardized measurement methods. This lack of enforcement demotivates stakeholders, including clients and developers, and contributes to inconsistencies in measurement practices. Such unevenness affects the preparation of bills of quantities and can lead to disputes. To mitigate this issue, it is essential for the government to mandate SMM implementation, particularly for public projects.

The study also highlighted challenges arising from varied measurement standards, including in-house and international methods. Cultural and regional differences were identified as reasons for these variations, necessitating tailored solutions to address local industry needs. By identifying these barriers, the research contributes to a broader understanding of the challenges influencing SMM adoption. The findings emphasize critical areas where policy interventions and strategic approaches could accelerate SMM implementation. Construction practitioners can use this information to address gaps in adoption and focus on areas requiring immediate attention.

Additionally, this research provides valuable recommendations for overcoming barriers to consistent measurement application. By resolving these obstacles, stakeholders are likely to show greater interest in increasing SMM adoption in future construction projects. Finally, the checklist of SMM barriers and references presented in this study can serve as a foundation for further empirical research, exploring barriers across various locations and project types.

According to Nizam Akbar, et. al., (2014), inefficiencies in the construction industry, including a lack of standardization, result in financial losses equivalent to every penny spent. To mitigate this, adherence to standardized building documentation and practices is crucial for fostering sustainable growth within the national economy Nizam Akbar et. al., (2018). CIDB (2018) highlights that standard

measurement methods (SMM) provide structured rules for tendering contractors, ensuring consistency and clarity in measured works. As explained by Molloy (2007), SMMs serve as comprehensive manuals for accurately quantifying building and civil engineering projects, enhancing cost-effectiveness by minimizing ambiguities (Cartlidge, 2011). Their primary goal is to eliminate waste, overpayment, mismanagement, and disputes (Adnan, 2011).

Quantity surveyors play a key role in implementing SMMs by preparing detailed bills of quantities (Davis, 2004). These structured documents enable contractors to provide consistent, transparent estimates and proposals, promoting fair competition (Adnan, 2011). Beyond bills of quantities preparation, quantity surveyors also offer feasibility studies, cost analyses, and planning schedules (Uthpala, 2013).

However, challenges persist in adopting SMMs. Inaccuracies in rates and quantities, as observed in sophisticated systems like those in Australia (Hansen, 2015), may lead to conflicts and contractor dissatisfaction (RICS, 2003). Addressing these issues requires rigorous standardization to improve accuracy and stakeholder trust in the process.

3. Conceptual Model for CESMM Adoption

A conceptual model is essential to evaluate how human barrier factors influence the adoption of the Civil Engineering Standard Method of Measurement (CESMM) in construction projects. This framework describes the relationships between endogenous variables (the outcomes of adoption barriers) and exogenous variables (human barrier factors). The model focuses on five barrier factors categorized as endogenous variables, with human barriers acting as exogenous influencers. Figure 1 illustrates this relationship, positioning the measurement model or outer model as exogenous in connection to the relative endogenous variables (Mukhtar, 2022).

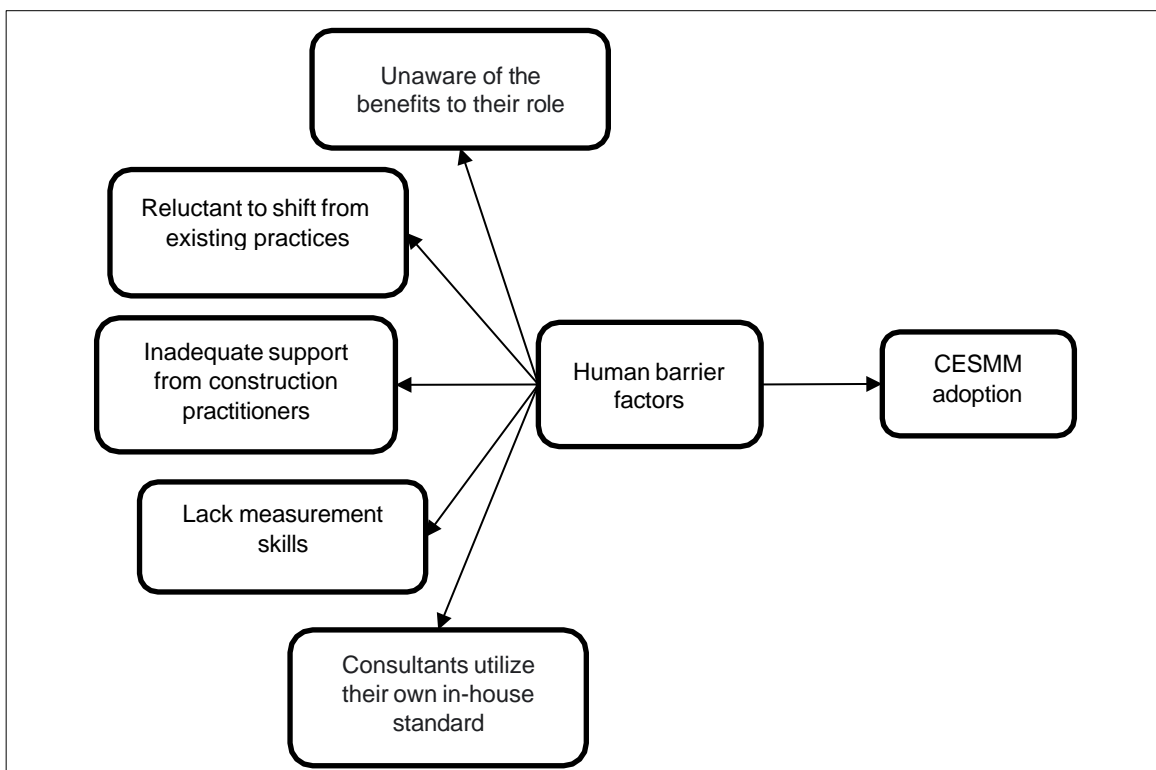


Figure 2. Impact of human barrier factors on a civil engineering standard method of measurement adoption relationship model.

METHODOLOGY

This study employed a quantitative research approach, utilizing an online questionnaire to evaluate the awareness level among construction practitioners, particularly quantity surveyors, regarding barriers to adopting the Civil Engineering Standard Method of Measurement (CESMM) in construction project management. The survey included statements focusing on CESMM adoption challenges.

The data collection was guided by a pre-established conceptual framework. The survey targeted quantity surveyor consultants in Malaysia, specifically those engaged in preparing civil engineering bills of quantities (BQ). Respondents were limited to quantity surveyors working in consultancy firms registered with the Board of Quantity Surveyors Malaysia (BQSM) in the Selangor region. Selangor was chosen due to its significant contribution to the construction industry, accounting for 22.4% of construction activities and RM8.7 billion in project value, surpassing other states like Johor, Sarawak, and Wilayah Persekutuan (Construction Statistics, Q2 2024).

A random sampling method was adopted to focus the scope, and a total of 74 respondents participated, representing private firms and government agencies. The questionnaire comprised three sections aimed at exploring SMM usage in the Malaysian construction industry.

The first section covered demographic information, which included basic respondent details such as gender, age, job title, experience, and category of

organization. The second section is about general perception about civil engineering standard method of measurement implementation in Malaysia and third section focused on the barrier factors on the civil engineering standard method of measurement implementation in construction project management among practitioners.

The survey results were analyzed based on five categories of Likert scale ratings:

(1) Strongly Disagree, (2) Disagree, (3) Neutral, (4) Agree, and (5) Strongly Agree. The mean score obtained from data analysis is based on Score Interpretation Mean Five-Point Likert Scale adapted from Landell (1997) as in Table 1.

Table 2. Interpretation of five-point scale mean score

Mean Score	Level
1.00 – 2.33	Low
2.34 – 3.66	Medium
3.67 – 5.00	High

The value of mean and mode are used in exploring the issues that hinder the usage of current Malaysian Civil Engineering Standard Method of Measurement.

RESULTS AND DISCUSSION

Table 3 highlights the demographics of the survey respondents based on completed questionnaire sets. Male respondents constituted 61% of the sample, while females made up 39%. Regarding roles, assistant quantity surveyors dominated with 50%, followed by quantity surveyors at 27%, senior quantity surveyors at 11%, and directors and procurement officers each contributing 5%. Additionally, directors represented 5% of top management respondents, with other roles accounting for 7%. In terms of organizational categories, 73% of respondents were from private consultancy firms, 13.5% from contracting firms, and 9.5% from government agencies.

Table 3. Characteristics of respondents.

Profile	Frequency (N)	Percentage (%)
Gender		
Male	45	61
Female	29	39
Position		
Director	4	5
Senior quantity surveyor	8	11
Quantity surveyor	20	27
Assistant quantity surveyor	37	50
Others	5	7
Category of the organisation		
Private consultant firm	54	73
Contracting firm	10	13.5
Government agency	7	9.5
Others	3	4

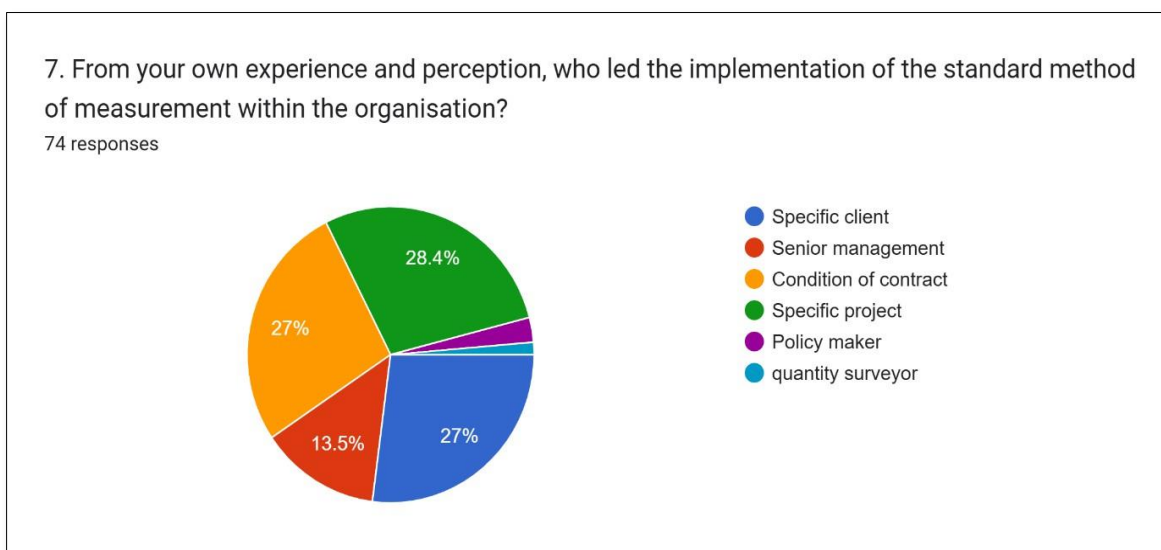


Figure 3. Implementation of the standard method of measurement in organisation.

The survey findings, illustrated in Figure 3, highlight key factors influencing the adoption of the standard method of measurement within organizations. Human barriers emerge as a critical determinant in implementing CESMM. About 28% of respondents identified specific projects, such as civil or building works, as the primary driver. Similarly, 27% attributed adoption to contractual obligations requiring standardized methods, and another 27% pointed to client requirements. Additionally, 13.5% of respondents acknowledged senior management as a significant influence on adoption decisions.

Figure 4 and Table 4 disclosed five (5) human barrier factors identified hinder the adoption of civil engineering standard method of measurement with different in the mean value and rank.

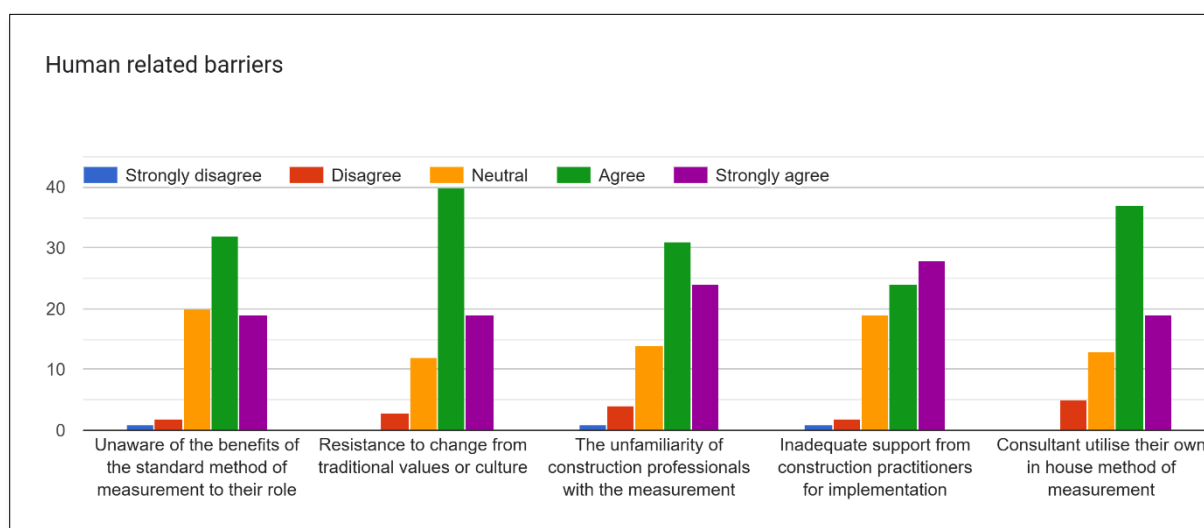


Figure 4. Human barrier factors

Table 4. Human barrier factors mean value and rank.

No.	Human barrier factors	Mean	Mode	Rank
1	Resistance to change from traditional value or culture	4.04	5.00	1
2	Inadequate support from construction practitioners for adoption	4.03	5.00	2
3	Consultants utilize their own in-house standard method of measurement	3.96	5.00	3
4	Unfamiliarity of construction professionals with the measurement	3.91	5.00	4
5	Unaware of the benefits of the standard method of measurement to their role	3.89	5.00	5

According to Table 4, resistance to change from traditional values or culture ranks as the most significant factor, with a mean value of 4.04. This finding aligns with research by Nizam Akbar et al. (2021), where experts emphasized that, in the absence of regulatory enforcement and clear organizational benefits, traditional practices are likely to persist if project stakeholders maintain effective communication. As a result, inconsistency in adopting standard measurement techniques remains a challenge.

The second-ranked factor is inadequate support for construction practitioners in adopting standards, with a mean value of 4.03. Experts highlighted that a major barrier to full adoption of the current CESMM is the lack of incentives. They suggested that contractors are more likely to adopt standard measurement methods if financial or other incentives are provided. This approach aligns with Maslow’s principle, as seen in Malaysia’s Industrialized Building System (IBS) projects, which receive government incentives. A similar strategy has been applied to promoting Building Information Modelling (BIM) in the era of Industrial Revolution 4.0 (Nizam Akbar et al., 2021).

The third-ranked factor is consultants using their own in-house CESMM, with a mean value of 3.96. Experts argue that the construction industry will recognize the benefits of newly developed SMMs only when these standards are gazetted or mandated by the government. However, this factor is considered less critical than the lack of regulatory enforcement. Without such enforcement, traditional practices are likely to continue if stakeholders effectively communicate and perceive no added value from adopting standards.

Unfamiliarity among construction professionals with measurement standards ranks fourth, with a mean value of 3.91. Research by Nizam Akbar et al. (2021) supports this finding, noting that practitioners often lack the necessary measurement skills. While respondents ranked this as the second issue, experts placed it third, stressing the need for practitioners to enhance their measurement skills by gaining exposure to various civil engineering construction methods.

The fifth-ranked factor, with a mean value of 3.89, is a lack of awareness of the benefits of standard measurement methods. Many professionals remain unaware of the advantages of using reliable SMMs, such as improving Bill of Quantities (BQs) and overall contract management. Experts view this as the least critical barrier, emphasizing that awareness will increase only when SMMs are mandated by

regulatory bodies.

To promote the adoption of Malaysian SMMs, experts recommend expanding training opportunities and integrating these topics into Continuous Professional Development (CPD) programs organized by the Malaysian Board of Quantity Surveyors and the Malaysian Institute of Engineers. Finally, experts identified the time required for full adoption of new SMMs as another barrier. This issue is attributed to senior practitioners' slower learning curves and newer staff's lack of measurement skills. Addressing these challenges requires a focus on both professional development and organizational support.

The mean value for each human barrier factors mainly between 3.89-4.04 which are high level. The discussion highlighted that, even though the governing body delivers the latest SMMs, end-users have yet to fully adopt them. The findings suggest that, although the governing body consistently provides updated SMMs, end-users are not fully leveraging these resources. This is largely due to human nature's resistance to change, particularly when such changes do not yield immediate physical or material rewards.

CONCLUSION

CESMM offers significant advantages in standardizing measurement and cost estimation in civil engineering projects. However, its adoption is influenced by factors such as awareness, expertise, regulatory support, organizational readiness, and client demand. To overcome these challenges, a concerted effort involving training, policy reform, and stakeholder engagement is necessary. This paper's conceptual model provides a foundation for future empirical research, focusing on testing and refining strategies to promote CESMM adoption.

The adoption of CESMM in construction project management offers significant advantages in achieving cost efficiency, standardization, and transparency. However, barriers such as knowledge gaps, regulatory shortcomings, and financial constraints limit its widespread implementation. This paper highlights critical factors influencing CESMM adoption and provides a framework to address these challenges, especially human barrier factors. Future research should focus on empirical testing of the proposed framework and exploring regional variations in adoption patterns.

ACKNOWLEDGEMENT

The author would like to extend the utmost appreciation to Dr. Anis Rosniza Nizam Akbar and all respondents who took part in the survey; this work would not have been possible without their help and time.

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