

THE INSIGHTS OF COMPUTER-AIDED MEASUREMENT SOFTWARE FROM UNDERGRADUATE'S PERSPECTIVES

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Abstract: *Construction industry players in Malaysia has recognised and adopted Computer-Aided Measurement (CAM) software in in their activities with the objective to improve quality and accuracy of construction process. CAM software promotes useful and effective results especially in quantity take-off and estimating for construction works and being a component of Building Information Modelling (BIM) ecosystem. Nevertheless, it is important for the construction players to be skilful and knowledgeable in operating the CAM software prior to the extensive adoption of the software for construction projects. As a reflection to the situation, higher learning institutions in Malaysia has progressively embedded CAM software application lesson in the undergraduate's curriculum for students. Hence, this paper discovers the insights of CAM software application from the student's perspective. Quantitative research has been conducted to gather the consensus among students and analysed through statistical analysis. The findings shows that students are optimistic with the CAM software capabilities and look forward on its application in the real-time profession in the future. It is believed the findings manage to raise the attention among other higher learning institutions toward the adoption of CAM software as well as to address the construction industry players on the undergraduate's readiness on the CAM software knowledge and skill in the future.*

Keywords: *Computer-aided measurement, Building Information Modelling, Construction industry.*

Introduction

Construction industry is claimed as the most troublesome industry because of over-budgeting, delays, poor production quality and intensive labour before the technology being adopted into the construction sector (Ann & Ahamad, 2016). In the context of quantity surveying profession, the reason behind this is due to the lack of technical knowledge among quantity surveyor on regarding to technological skills particularly on measurement and estimating software; the company's availability software is in the lowest proportions that give the construction industry the most challenges (Ibironke et al., 2011). The quantity surveying firms need to ensure that the software is used to increase output efficiency and that the customers meet high expectations. Based on the research from Alghazzawi (2016) and Keng & Ching (2011), companies that are using measurement software also need to spend high capital on purchasing the software, requiring highly trained staff and staff time to learn and remember the procedures, steps of consumption before using the software efficiently. These setbacks have put the progress of Computer-Aided Measurement (CAM) software at the stagnant position.

In meeting the demand of construction industry towards the software adoption, learning institution is significant in playing major role by providing the required skills and knowledge in using CAM software. However, previous researcher identifies that some schools offer only general Quantity Surveying software training rather than specialized training (Oyediran & Odusami, 2005).

Therefore, this paper aims to establish the undergraduate's perception on Computer-Aided Measurement (CAM) software to be practically utilised by Institute of Higher Learning (IHL) and construction industry. To achieve this, there are two objectives to achieve namely, to identify the benefits of CAM software and to investigate the potential of CAM software to be used by IHL and construction industry.

Literature Review

Malaysia Construction Industry: Overview

The building industry in Malaysia is expanding and applying computers used in the operation and procedure by integrating the software in an era after the Construction Industry Professionals (CIPs) were awakened (Ibironke et al., 2011). This shows that the Malaysian Construction Industry is moving from the traditional normal construction method to the more environmentally friendly, especially in the technology that is being used today. This is because Malaysians live in a dynamic world that is explosive as information technology grows. The scenario become apparent since the outbreak of coronavirus disease (COVID-19) which has changed the project stakeholder's routine. Project stakeholders must engage themselves into technology by working remotely and cooperatively managing projects (Syed Jamaludin, S. Z. H, et al, 2022).The construction industry is the most important sector in economies where it will have a larger impact on the country's GDP than any other service industries (Mawunyo, 2018). If the construction sector shares a large percentage of the global construction sector, construction plyers need to be involved in globalisation to compete internationally (Zainon, Mohd-Rahim, Aziz, Kamaruzzaman, & Puidin, 2018).

In the design phase, there are several areas of this construction industry that have been computerised to boost their productivity (Wong et al., 2000). Based on Kumar & Rajak (2015) findings, building industry undergoes wide-ranging mechanisation where construction management is the most important part of the construction activity, with rapid changes and

advances in practices. Hamid, Taib, Razak, & Embi, (2018) research, with an innovative approach, Building Information Modelling (BIM) has developed the global architecture, engineering, and construction from crossways. This is due to the rapid development between many parties such as stakeholders and industry players and the adoption of the technology in advance. The BIM systems have a high potential in revolutionising the existing methods of calculation for the quantities referred to in the construction drawing industry (Olatunji, Sher, & Gu, 2010). Among the advantages promoted by BIM are enhanced buildability, enhanced construction visualisation, better output, minimised conflicts, enhanced quality and accuracy, boosted client’s satisfaction, encouraged competitiveness, improved information sharing, improved sustainability (Newton & Chileshe, 2012; Al-Ashmori et al, 2020; Li, P., Zheng et al, 2019) and improve collaboration among project stakeholders and business performance (Wang,W. et al, 2021).

Computer-Aided Measurement (CAM) Software

Construction measurement is normally being handled by a party known as the Quantity Surveyor, where the roles are included for cost control and estimating, assessing and estimating the tender, generating the quantity bill, etc., during the construction process or after construction (Chandramohan, et al., 2018; Chamikara, et al., 2020). In other words, Quantity Surveyor is responsible for the project costs (Salleh, et al., 2020). According to Ibrahim (2011), the conventional approach is where the QS must take off works based on the standard measurement system (SMM) where SMM1 and SMM2 are commonly used in the building industry in Malaysia. Then, the quantities will be transferred manually to the bills of quantities after they have been done to take off the works. The traditional method is where bids are prepared by the QS in the contractor firm or known as bids to compete to get a project contract award. To determine the costs and to determine the prices, the cost estimate is prepared by calculating the direct and indirect cost of construction. Direct costs are the measured quantities with the component prices whereas indirect costs and profit are added to the total amount (Frederick S. Merritt, M. Kent Loftin, 1996).

CAM or known as Computer-Aided Measurement is the term used to refer to any software that being used by the quantity surveyor that supported by the plans or design documents of Architects and Engineers of the new building either in two dimensional or three-dimensional models. Bills of quantities production and measurements process are the key tasks that CAM is claimed to able to facilitate (UKEssays, 2018). CAM software are formulated by the developers to provide the solutions to quantity surveyors by offering lesser time spent for tasks beside ensuring high accuracy. CAM software manages to handle key tasks in construction.

Table 1: CAM Software Capabilities

No.	CAM software capabilities	Operation/Tasks
1.	Measurement	Taking-off process
2.	Bills of quantities preparation	Timesing and squaring, checking and abstracting
3.	Tender documents preparation	Preparation of bidding schedule, tender advertisements, method statements
4.	Project cost control	Feasibility studies, cash flow estimating
5.	Valuation	Progress claim valuation, variation works justification, fluctuation of prices identification
6.	Final Account	Final cost calculation

Source: UKEssays (2018)

There are many types of CAM software are present in the industry. Among the most used CAM software as per reported by Ann & Ahamad (2016) are as stated in Table 2:

Table 2: Type of CAM Software Used in Construction Industry

No.	Software
1.	CAD Measure
2.	Atlespro
3.	Buildsoft
4.	Binalink
5.	Revit
6.	Glodon
7.	Cost X

Source: Ann T.H., & Ahamad (2016)

CAM software offers various benefits to the construction industry i.e. higher accuracy, easier measurement editing, simplify and speed up measurement process and reduce workforce. Besides, it can eliminate the proceed of multiplication of drawing reproduction. This is important to note because multiplication of drawing reproduction may lead to accuracy issues. In addition, human error is also eliminated due to scale and dimension of drawings are being taken up by CAM software to process and interpret (UKEssays, 2018).

Methodology

This research focus on establishing the consensus among undergraduates towards the benefit and potential of CAM software to be used in universities and construction industry particularly for built environment courses. Quantitative research has been carried out which focussing on undergraduate students in public universities which offering accredited bachelor’s degree in quantity surveying. 30 numbers of students were randomly selected in every university to be the respondents for the research. A set of questionnaires was developed based on literature review. The questionnaires comprise of 3 sections. Section A was designed to gather the background of respondents; Section B evaluated respondents’ knowledge on the benefits of CAM Software and Section C investigates respondent’s perceptions on the potential of CAM software can offer. For Section B and C, 5-point Likert scale is used to collect data accordingly and analysed by using Average Index (A.I) which computed using equation (1) and the interpretation of A.I were made according to Table 2.

$$Average\ Index\ (AI) = \frac{\Sigma (1X_1 + 2X_2 + 3X_3 + 4X_4 + 5X_5)}{\Sigma (X_1 + X_2 + X_3 + X_4 + X_5)} \tag{1}$$

Where,

X₁ = Number of respondents for Strongly Disagree

X₂ = Number of respondents for Disagree

X₃ = Number of respondents for Neutral

X₄ = Number of respondents for Agree

X₅ = Number of respondents for Strongly Agree

Table 3: Level of Agreement of Average Index Analysis (A.I)

Average Index	Level of Agreement of Evaluation
1.00 < Average Index < 1.50	Very Poor
1.50 < Average Index < 2.50	Poor
2.50 < Average Index < 3.50	Moderate
3.50 < Average Index < 4.50	High
4.50 < Average Index < 5.00	Very High

Source: Ghani (2006)

Analysis and Findings

Section A of the questionnaire briefly discovers the background of the respondents. The respondents are evenly coming from 3 public universities in Malaysia namely International Islamic University Malaysia (IIUM), Universiti Teknologi Malaysia (UTM) and Universiti Teknologi MARA (UiTM) with 30 numbers of respondents respectively and build-up of the total 90 numbers of total respondents. Majority of respondents (76.67%) are aged between 22 to 25 years old which depicts the group of undergraduates who are currently at the middle of their bachelor's degree study plan. As for the type of CAM software learned in University, Revit (29.49%) is the most popular CAM software and followed by Cubit (17.95%) and Cost X (17.31%). From these findings, it shows that Revit as commonly used as BIM Software is also being commonly used by undergraduates for measurements and estimating of construction works. Revit software provides solutions of integrated building modelling platform across expertise in construction industry and have the ability to provide quantities of components in construction works. While for Cubit and Cost X, both softwares are clearly dedicated for measurement and estimating purposes.

Table 4: Respondent's Enrolled University

University	Frequency	Percentage (%)
International Islamic University Malaysia (IIUM)	30	33.33
Universiti Teknologi Malaysia (UTM)	30	33.33
Universiti Teknologi MARA (UiTM)	30	33.33
Total	90	100

Table 5: Respondent's Age Range

Range of Age	Frequency	Percentage (%)
19 – 21 years old	17	18.89
22 – 24 years old	69	76.67
25 years old and above	4	4.44
Total	90	100

Table 6: Type of CAM Software Learned in University

Software	Frequency	Percentage (%)
Cubit	28	17.95
Binalink	6	3.85
Cost X	27	17.31
Cubicost	25	16.03
Revit	46	29.49
Buildsoft	19	12.18
Others	5	3.21
Total	156	100

Section B of the questionnaire is designed to identify the level of agreement of respondents towards the benefits of CAM software with 10 variables were identified through literature review. Average index is used to analyse and interpret the data. All variables were rated as high for the level of agreement of evaluation.

Table 7: Average Index (A.I) Analysis on Agreement Level on Benefits of CAM Software Among Respondents

Benefits of CAM Software	Average Index (A.I)	Rank	Level of Agreement of Evaluation
Immediate reporting is available (Bills of Quantities, Take-off reports, etc.)	4.13	1	High
CAM Software can speed up estimating tasks, budgets and tender estimates	4.12	2	High
CAM software manages to provide measurement tracking on take-off items	4.09	3	High
Enhance the quality of measurement works by reducing error	4.09	4	High
CAM Software capable in producing visualisation assist in measurements and estimating	4.08	5	High
CAM Software supports collaborative environment among multiple users	4.00	6	High
CAM software can make alterations and modification to specific areas and updated schedule accordingly.	3.96	7	High
Redundancy such as double measurement can be avoided	3.93	8	High
High accuracy level of measurement scale by using CAM software as compared to traditional method.	3.93	9	High
CAM Software provides easy learning experience	3.81	10	High

It is found that majority of respondents agree that CAM software is beneficial due to it can immediately generates report such as Bills of Quantities, take off reports and etc (A.I = 4.13) and followed by the argument that CAM software can speed up estimating tasks, budgets and tender estimates (A.I = 4.12). These variables are intertwined and important for the construction players especially for Quantity Surveyor in speeding up measurements and deriving critical information such as Bills of Quantities for the purpose of cost of building estimates, preparation of tender documents, valuation of work done in preparing payment certificates for the contractor and others. Furthermore, at the rank 3 and 4 are evenly Average Index recorded (A.I = 4.09) for arguments that CAM software manages to provide measurement tracking on take-off items and enhance the quality of measurement works by reducing error. Both arguments signify CAM software manage to provide solutions of human errors by reducing mistakes in the measurement works and provide the opportunity to identify and rectify the error by tracking functions. As compared to traditional methods of measurement which expose the construction players to do errors, CAM software consequently manage to avoid further problem such as project delay, inefficient construction process and discrepancies of information between construction players.

Among all the positive agreements level by the respondents, it is indispensable to note the lowest A.I rated (A.I = 3.81) for argument on CAM software provide easy learning experience. CAM software main purpose is to facilitate the measurement for construction works by means of computer application. Some parties found this is difficult because they need to embark into new computer skills in handling the software besides some might be reluctant to transit into technology in doing measurement.

Table 7: Average Index (A.I) Analysis on Agreement Level on Potential of CAM Software

CAM Software Potential	Average Index (A.I)	Rank	Level of Agreement of Evaluation
Prompt decision making among stakeholders due to faster measurement and estimating process	4.29	1	High
An important skill and need to be associated in the syllabus	4.28	2	High
Intelligent tools in detecting construction components	4.19	3	High
Potential integration with other BIM software.	4.18	4	High
Reduction of production cost due to optimisation of resources	4.17	5	High
A better control towards tasks in construction process which involves measurements and estimating	4.14	6	High
A useful tool for construction players which offers value for money	4.10	7	High
Apart of Building Information Modelling (BIM) which provide visualisation for estimating	4.10	8	High
Software that helps QS to take necessary actions immediately.	4.07	9	High
An improved communication chain among stakeholders in construction	4.03	10	High

Potential of CAM software were investigated in Section C of the questionnaire. There are 10 variables that indicates the potential of CAM software to be used in construction industry. All variables are rated at high level of agreement. Average Index (A.I) indicates that the highest rated variable by the respondents is the potential of CAM software to promote prompt decision making among stakeholders due to faster measurement and estimating process (A.I = 4.29). By referring to the context of time saving, CAM software has a direct potential in ensuring construction projects are delivered on time. Furthermore, respondents identify CAM software as an important skill that need to be equipped and need to be associated with the syllabus by ranking at second place for the Average Index (A.I = 4.28). Since the respondents are currently undergraduates' students, this indicates the positive feedback by the respondents showing their awareness towards the importance of CAM software skills. This is reflective with the current demand by the construction industry that requires graduates to be skilful in using technology particularly on software skill that can enhance productivity.

Conclusion

The research manages to discover that undergraduates' perspective towards the usage of CAM software. Students are optimistic with the offering provided by CAM software and look forward to the future application of the skills that they are currently learning at higher learning institution. It also depicts the readiness of undergraduates to be aligned with the need of CAM software skill as per required by the current and future construction industry. The evolvement of construction industry from conventional way to technological advancement will ensure the productivity of construction players are optimised and the end products are delivered at the right time, cost and quality. It is believed that higher learning institution are currently grooming up undergraduates to meet the construction industry inspiration.

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