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SUSTAINABLE BUILT ENVIRONMENT

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ADOPTION OF ARTIFICIAL INTELLIGENCE IN QUANTITY SURVEYING PRACTICE

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ABSTRACT

Artificial Intelligence (AI) is a transformative technology in various industries, yet the Malaysian construction sector lags in its adoption. Quantity Surveyors (QS) play a crucial role in construction projects, but the practice is prone to human errors due to repetitive work and large numbers of data. Hence, progressive advancements are required for the practice to remain relevant. Implementing AI in QS practice offers numerous benefits, including faster processes, reduced errors, increased efficiency, improved accuracy, and enhanced decision-making. This research aims to improve the implementation of AI-related software into the QS practice. To gather data, a questionnaire survey was conducted among QS firms registered under the Board of Quantity Surveyor Malaysia (BQSM) in Kuala Lumpur. SPSS v.27 will be used to analyse the obtained data to form a discussion. The findings revealed that QS professionals are aware of AI adoption and the majority agreed on its significant impact on practice.

Keywords: *Artificial Intelligence, Quantity Surveyor, QS Roles and Practice, AI Software, AI Implementation.*

INTRODUCTION

The idea of artificial intelligence (AI) is based on human intelligence, with the exception that AI does not restrict itself to biologically observable limitations (Ting et al., 2021). With the rapid advancement of technology during the Fourth Industrial Revolution (IR 4.0), AI has gained significant traction, particularly in the Construction Industry. Quantity surveyors are professionals responsible for advising on construction costs and contractual administration and have seen changes in their practice due to evolving client demands and market requirements. The environments for quantity surveying practice today have changed along with the country's rapid economic development (Kee et al., 2012).

Thus, quantity surveyors have been requested to improve efficiency in their roles related to measuring and planning costs and schedules (Pyung & Sungho, 2016). To meet client expectations and achieve efficiency, tools like Building Information Modelling (BIM) and AI are being employed in the construction industry. The construction industry has seen the emergence of software utilising Building Information Modeling (BIM) and Artificial Intelligence (AI) to enhance efficiency, particularly for quantity surveyors. BIM adoption has impacted quantity surveying practices, offering solutions to improve measurement, cost planning, and scheduling. Human errors often occur when handling extensive datasets, leading to negative consequences. AI can alleviate these challenges by assisting quantity surveyors with data analysis and providing reliable outcomes.

However, the construction industry is still in the early stages of digitalization compared to other sectors, hindering technology implementation. This industry is one of the least digitised globally due to its fragmented, complex nature and resistance to change. Despite the construction sector's economic importance, its adoption of new technologies, including AI, has been slower compared to other industries. However, Malaysia aims to embrace these innovations by targeting an 80% adoption rate of BIM by 2025, as outlined in the Public Works Department (JKR) Strategic Plan 2021-2025. Therefore, there is a need to conduct research on the benefits such implementations can bring to the practice. In line with the aim of this paper, the research objectives were established, to determine the benefits of AI adoptions for QS practices.

LITERATURE REVIEW

Artificial Intelligence

John McCarthy, the father of Artificial Intelligence (AI) in his proposal for the 1956 Dartmouth Conference, the first artificial intelligence conference, describes the terminology as "Science and Technology of Smart Machines, in particular, Advanced Computer Programs". It focuses primarily on the transmission of anthropomorphic intelligence and thinking into machines that can assist humans in many ways in the form of machinery or software that can use the information of data to achieve a certain result. Due to this advancement, an immense shift toward implementing AI can be seen in various fields, especially in an industry that requires calculation and a huge amount of data to foresee outcomes which humans will have a hard time doing. AI has slowly sprung up and grown stronger in many fields such as engineering, mathematics, physics, and technology all of which have led to the current tremendous shift in this field which we are witnessing now (Ting et al., 2021).

Machine learning involves algorithms that enable AI to learn from the internet of data, while deep learning is a specialised neural network-based machine learning. It is a recent accomplishment in AI technologies that have allowed image and language processing to make a breakthrough and open doors to numerous advanced applications. This is an idea that proposes that machinery can acquire intelligence. It encompasses areas like machines can learn on their own, adapt to a specific circumstance and self-correct their own mistakes, i.e., Machinery may think on its own without being encoded with commands (Ting et al., 2021).

Quantity Surveyor Roles and Practice

Quantity Surveyor is a field of work that is involved in cost management, procurement, and contractual issues in a construction project (Olanrewaju & Anahve, 2015). They are mostly involved in all phases of a project's life cycle such as feasibility, design, construction, extension, refurbishment, maintenance, and demolition (Olanrewaju & Anahve, 2015). However, their roles and responsibilities nowadays have evolved more than the traditional practices, because of clients' additional needs and market requirements (Kee et al., 2012). The figure below revealed the common quantity surveyor's services that are involved throughout the project stages. Following what

Olanrewaju & Anahve (2015) state, a QS is mostly involved in all phases of a project's lifecycle from feasibility stage, designing, tendering, construction phase, extension, refurbishment, maintenance, and until demolition.
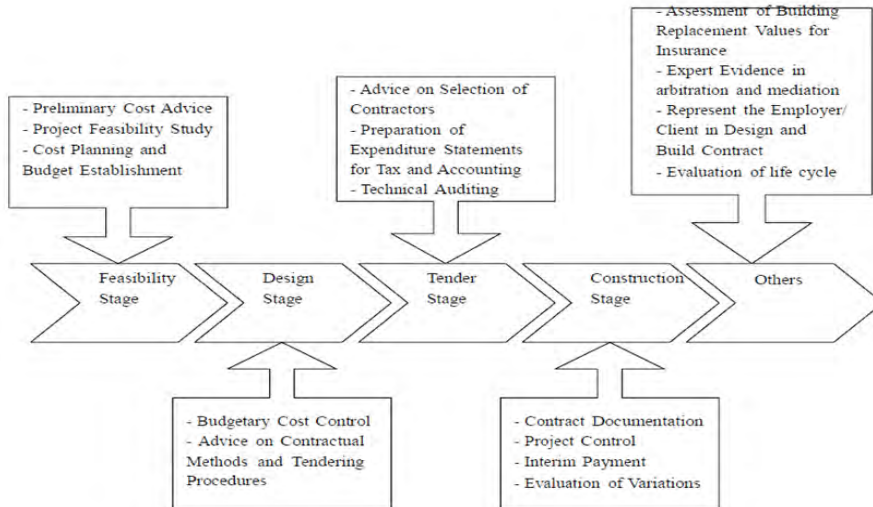
Figure 1 : Common QS service in various project's stages

The innovations brought by Building Information Modelling (BIM) and Artificial Intelligence have affected the QS practice nowadays. AI can assist QS in their tasks such as automatically carrying out quantity take-off and automatically drafting a bill of quantities with an accurate description. Previous research has found that AI could be used to predict the accuracy of the pre-tender building cost estimate, predict construction cost and accurately compare cost estimate models based on regression analysis, neural networks and case-based reasoning (Seidu et al., 2020).

Benefits of AI Applications To QS services

There are various types of benefits that we could get from the application of artificial intelligence in QS practices such as faster processes. AI is highly beneficial in handling calculations and analyzing large amounts of data, significantly speeding up the services process. Unlike humans, AI does not require rest, sleep, or breaks, making it capable of performing tasks without fatigue (Ting et al., 2021). This advantage can assist quantity surveyors in completing their tasks more quickly. AI-based software, such as Togal.Ai and

KREO, has simplified quantity take off by automating the process. These tools utilize AI to process 2D and 3D drawings, automatically detecting, labelling, and measuring project spaces.

The second benefit of AI is error reduction. Humans cannot avoid making mistakes, especially when under stress and pressure. AI has several benefits, one of which is that its judgements are backed up by evidence rather than feelings. Even despite our best attempts, it is a well-known reality that our sentiments always influence our decisions in a negative manner (Ting et al., 2021). Thus, AI can assist quantity surveyors by complementing these human imperfections. Ting et al., (2021) also mentions that Artificial Intelligence can handle demanding and complicated tasks that humans may find difficult or impossible to do and there are likely fewer mistakes and flaws created.

As stated earlier, QS have been requested for improving efficiency in their roles related to the measurement and planning of cost and schedule (Pyung & Sungho, 2016). With take-off and estimating becoming automatic through AI, it can enable QS to focus more on their advisory role rather than spending most of their time doing simple measuring works. It can increase the time QS spend supplying advice based on the detailed cost analysis, thus helping clients achieve value more efficiently (Seidu et al., 2020).

In addition, by implementing AI also can increase the accuracy of cost data. A QS would rely on historical data, experience, and knowledge in preparing an initial cost estimate (Seidu et al., 2020). But due to its reliance on the surveyors' experience and knowledge, it can be a challenge in improving the accuracy of such estimation. Through implementation of AI, large datasets of historical cost and quantity data can be analysed to identify patterns and make predictions about the likely quantity and cost requirements for the project. Artificial Intelligence technology makes it possible to improve accuracy in ways simply not feasible with manual processes (Wiktoria, 2022).

As stated by Seidu et al., (2020), the use of artificial intelligence in preparing construction cost estimates of a project can enable the stakeholders to make more accurate decisions. With AI aided software, it can help a QS in estimating costs more accurately, while reducing risks of error and improving the speed and efficiency of the estimation process. This can ensure that a project is delivered on time and within the proposed budget, ultimately improving the overall performance of the project.

RESEARCH METHODOLOGY

A questionnaire survey will be utilized for this research and distributed to Quantity Surveyor firms under the Board of Quantity Surveyor Malaysia (BQSM) that is currently active in W.P. Kuala Lumpur. The purpose of the survey is to gain their insights into the research questions based on the respective sections in the questionnaires. During the writing of this study, a total of 107 firms are registered under BQSM that is in W.P. Kuala Lumpur. By using the Krejcie & Morgan (1970) table, a sample size of around 86 respondents can be determined through the population size. Through the obtained data, SPSS version 27 will be used to run a frequency and descriptive analysis to form the results findings and finally the research discussions.

FINDINGS AND DISCUSSION

Respondents Demographic

Table 1 shows the summary for each respondent's profile. It entails the as respondents job positions, working experience, and their level of literacy in technology and software. Based on the table,

Table 1: Respondents Profile

	Description	Frequencies	Percentage (%)
A	Job Position		
	Senior Quantity Surveyor	5	12.5
	Quantity Surveyor	13	32.5
	Assistance Quantity Surveyor	13	32.5
	Contract Manager	3	7.5
	Principal Quantity Surveyor	4	10.0
	Director	2	5.0
B	Working Experience		
	1 – 3 Years	11	27.5
	4 – 5 Years	15	37.5
	5 – 10 Years	2	5.0
	More than 10 Years	12	30.0

C	Level of literacy in technology and software		
	Poor	0	0.0
	Fair	2	5.0
	Good	9	22.5
	Very Good	20	50.0
	Excellent	9	22.5

Based on the table, the majority of the respondents are Quantity Surveyors and Assistance Quantity Surveyors with both percentage of (32.5%), including Senior Quantity Surveyors at (12.5%). The other respondents also consist of Principal Quantity Surveyors (10.0%), Contract Manager (7.5%) and lastly, Director with (5.0%).

Furthermore, the majority of the respondents has adequate working experience in the industry. The majority being 4 – 5 Years (37.5%) of experience, followed by respondents with More than 10 years of experience (30.0%). The other respondents has working experience of 1 – 3 Years (27.5%) and 5 – 10 Years (5.0%).

Lastly, majority of the respondents are literate in terms of technology and software as the majority of them respond with Very good (50.0%). The other being both Excellent and Good respectively with (22.5%) and Fair with (5.0%).

The Level of Significance of AI Adoption

Table 2 illustrates the opinions of the QS firms in the industry. The questions query the QS firms in terms of the level of significance such tools and software that adopt AI can bring to their company.

Table 2: The level of significance of AI adoptions into QS practices

	Description	Frequencies	Percentage (%)
A	The significance of these tools and software		
	Not Significant	0	0.0
	Slightly Significant	0	0.0
	Moderately Significant	7	17.5
	Significant	22	55.0
	Strongly Significant	21	27.5

Based on the table, majority of the respondents agreed that adoption of AI in software related to the QS practice brings a significant benefits to ease the

work of QS services through their respond of Significant at (55.0%), Strongly Significant at (27.5%) and Moderately Significant at (17.5%).

The Benefits of AI Implementation Towards QS Practices

Table 3 shows the benefits of AI towards QS practices. Four main benefits that are highlighted are faster process, reduce errors and increase efficiency, improve accuracy, and enhance decision-making.

Table 3: Benefits of AI implementation to the QS services

Benefits of Implementation	No.	Description	Std. Deviation	Mean	Rank
Faster Process	1.	Quantity Take-off	0.709	4.40	1
	2.	BQ Preparation	0.757	4.13	3
	3.	Cost Estimation	0.749	4.05	4
	4.	Cost Management	0.620	3.77	7
	5.	Cost Modelling	0.816	4.28	2
	6.	Feasibility Studies	0.712	3.83	5
	7.	Payment Preparation	0.733	3.78	6
	8.	Variation Order	0.740	3.63	8
Reduce Errors & Increase Efficiency	1.	Quantity Take-off	0.846	4.45	1
	2.	BQ Preparation	0.859	4.33	2
	3.	Cost Estimation	0.906	4.00	3
	4.	Cost Management	0.784	4.00	4
	5.	Cost Modelling	0.829	3.93	5
	6.	Feasibility Studies	0.834	3.85	6
	7.	Payment Preparation	0.847	3.73	7
	8.	Variation Order	0.834	3.65	8
Improve Accuracy	1.	Quantity Take-off	0.580	4.65	1
	2.	BQ Preparation	0.679	4.48	2
	3.	Cost Estimation	0.774	4.38	3
	4.	Cost Management	0.480	4.03	5
	5.	Cost Modelling	0.672	4.10	4
	6.	Feasibility Studies	0.876	3.95	6
	7.	Payment Preparation	0.723	3.70	7
	8.	Variation Order	0.694	3.68	8
Enhance Decision-making	1.	Quantity Take-off	0.709	4.40	2
	2.	BQ Preparation	0.712	4.43	1
	3.	Cost Estimation	0.784	4.28	3
	4.	Cost Management	0.660	3.98	5
	5.	Cost Modelling	0.716	4.00	4
	6.	Feasibility Studies	0.802	3.85	6
	7.	Payment Preparation	0.776	3.75	7
	8.	Variation Order	0.628	3.68	8

For the first benefits, Quantity Take-off (mean = 4.40, SD = 0.709) has been found as the primary types of QS services that can be quicken its process through the adoptions of AI. Next is followed by Cost Modelling (mean = 4.28, SD = 0.816) and BQ preparation (mean = 4.13, SD = 0.757). Furthermore, for the second benefits, Quantity Take-off (mean = 4.45, SD = 0.846) is ranked first in the types of QS services that can reduce its errors and increase the efficiency in its process due to the implementation of AI. Next is followed by BQ preparation (mean = 4.33, SD = 0.859) and Cost Estimation (mean = 4.00, SD = 0.906). Additionally, for the third benefits, it uncovers that through the adoptions of AI into these QS practices, it can improve the accuracy of the work. Particularly for Quantity Take-off (mean = 4.65, SD = 0.580) that is ranked first by the respondents. Furthermore, other practices that is alluded are BQ preparation (mean = 4.48, SD = 0.679) and Cost Estimation (mean = 4.38, SD = 0.774). Lastly, based on the respond for the fourth benefits, the adoption can indeed enhance the services especially for BQ preparation (mean = 4.43, SD = 0.712). Moreover, it can enhance the Quantity Take-off (mean = 4.40, SD = 0.709) process, following by Cost Estimation with (mean = 4.28, SD = 0.784).

As stated by other research, through the adoptions of AI into the industry, applications traditionally inaccessible to automated software have been successfully enabled, in particular, by deep learning technology (Carleo et al., 2019). Furthermore, four benefits of the adoption has been pointed out by previous researcher, faster process, reduce errors and increase efficiency, improve accuracy, and lastly, enhance decision-making (Abioye et al., 2021; Agyekum et al., 2015; Seidu et al., 2020; Stanley & Thurnell, 2014; Wiktoria, 2022). Based on analysis, the table 2 above highlighted the types of QS services that receive the most benefits based on four benefits of AI implementation. Based on the findings, the practices that receive the most values by the adoptions are Quantity Take-off and Bills of Quantity preparation. This is agreed by most of the respondents as these two services have the highest mean answers for all four benefits. Followed closely are Cost Estimation, Cost Modelling and Cost Management that are agreed by the respondents that it receives few of the benefits either directly or indirectly due to the adoptions. Other services receive various responses from the respondents displaying that these services are yet to receive any eminent benefits through the adoption of artificial intelligence in the QS practices.

CONCLUSION

This study has provided valuable insights into the adoption of AI in the QS practices. Through research findings and discussions, this study has found that through the implementation of such technologies, it can bring a significant benefits to the practice. Four benefits have been pointed out in the study to determine whether it has an impact on the types of services in the practice. The benefits are, faster process, error reduction and increased efficiency, improved accuracy, and enhanced decision-making. Based on the findings, the three main types of QS services that gained the most value by the implementation are Quantity take-off, Billing quantities, and Cost Estimation. Through the discussion, it can be concluded that the adoption of AI into the QS practice is still in its early stages, where the adoption only benefits the niche task of professional quantity surveyors, for example quantity take-off, bills of quantities preparation and others. To address these issues, further study on the benefits of adopting such advancement are required for the industry to fully grasp the advantages that such technologies can bring to the practice. During the period of writing this study, the application of AI in the QS tools or software is scarce. But it is a matter of time when software developers begin developing more unique applications that can tackle the specific services of a quantity surveyor. When such time comes, this study hopes to be a pioneer in advocating the use of such technologies and can become a reference for other researchers in the future.

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Prof. Madya Dr. Nur Hisham Ibrahim
Rektor
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Cawangan Perak

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Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

setuju.

27.1.2023

Saya yang menjalankan amanah,

PROF. MADYA DR. NUR HISHAM IBRAHIM
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