The usage of building information modelling (BIM) towards reducing the unethical issues in the Malaysian construction industry

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Abstract: Misconduct often happens in the construction industry because of its scale, complex contract structure, competitive and fragmented nature. It leads to an unethical issue. The unethical issues and the impacts hindered the development of the construction industry in Malaysia and affected the national growth development. As the construction industry is now moving forward to the 4th industrial revolution, it is worth investigating whether the adoption of digital transformation can make some changes to the unethical issues in the Malaysian construction industry. This research paper aims to examine the construction players' perception of the usage of Building Information Modelling (BIM) in reducing the unethical issues in the Malaysian construction industry. A quantitative research method is adopted and the data is collected by a questionnaire survey. There were a total of 101 responses received from the construction industry practitioners in Malaysia. Data collected was analysed by reliability test and descriptive test for further evaluation and analysis. The finding shows the usage of BIM through its function of 3D project visualization, clash detection, better communication flow, and centralised single repository data storage are potentially reduced unethical issues. This research provides a better understanding to the construction industry practitioners on the possibility of BIM implementation as a potential tool in reducing unethical issues in the construction industry.

1 Introduction

Professional ethics of the involved professions is a pre-requisite condition to maintain and enhance the quality of the construction projects [1]. Professional ethics means a group of people that apply special professional knowledge in the service to their customers or clients in a moral way in everyday practice according to their code of conduct. In contrast, unethical behaviour means the professional acting in an immoral way and misconducting their professional duties.

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Unethical issues commonly happen in the construction industry because of their scale [2], complex contract structure, competitive and fragmented nature which long plagued the construction industry, especially in a developing country [3]. In Nigeria, the primary factor that affects national development is corruption [4]. Pakistan's construction industry had experienced a certain degree of unethical practices such as bribery, favouritism, and unfair conduct [5]. A research study in South African construction industry have claimed 30%-55% or their respondent have witnessed or experience violates their professional liability [6].

Malaysia ranks 51st in the global ranking of 180 countries in the 2019 Corruption Perceptions Index (CPI), which is ten steps increased compared to 2018 [7]. Malaysian Anti-Corruption Commission urged cooperation from the construction industry to inhibit unethical corruption behaviour. The unethical issues commonly found in the industry are under-priced bidding, collusion, bid shopping, bribery, negligence, front-loading, claims game, and conflict of interest [1]. Consequently, these unethical practices cause the project delay, incur extra project cost, and substandard quality of construction work. This shows an urgent need to combat unscrupulous conduct in the industry. Therefore, it is vital for business owners and stakeholders in the construction industry to identify which misconduct situation has a greater likelihood of occurring [8].

2 Professional ethics in the construction industry

Professionals are bound by the principles and regulations from professional institutions to ensure they act with integrity and honesty in daily work practice [2,9]. Each profession such as architects, engineers, and quantity surveyors shall comply with their own Code of Professional Conduct set by the professional institutions, such as Board of Engineers Malaysia, Board of Architects Malaysia, and Board of Quantity Surveyors Malaysia. The code of conduct has stipulated explicitly that the professional shall discharge his duties with complete honesty, competence, responsible, deliver the obligation with integrity, perform and complete the works according to the contract with due care and diligence. The professional also shall practice ethically and was prohibited from accepting any bribe, benefits, compensation, consideration, or financial from any party in connection with the work.

2.1 Unethical issue and its impact on the construction industry

All the professionals shall abide by their professional code of conduct and ethics. Any breach shows misconduct of their profession and can lead to unethical issues such as collusion, under-pricing tender, front-end loading, and fraud in the construction industry. Collusion in a competitive tender, cover bidding, collusive tendering, and bid cutting is frequent forms of collusion in the industry [9,10]. It happens when the competitors of a construction project collaborate surreptitiously to submit a specific bid price or include unacceptable special terms to the client in the bid document [11,12]. Collusion creates a non-competitive bidding environment that detriment the client, brought a bad image to the industry, and degrades the public's trust in the industry [10,12]. The under-pricing tender was often found in the industry when the contractor submits an under-pricing tender to secure a project [13]. The contractor will then recoup the losses from the under-pricing bid by charging extra claims on the variations, reducing the quality of work and the material used. This will lead to poor project quality and possibly cause an abandoned project due to insufficient finances for the contractor to complete the work. Under-pricing also is expected to cause reputation damage to the contractor and trust issues between the contractor and the client [13].

Front-end loading practice is also unethical behaviour in the industry. This practice is a technique used in the industry, where the contractor overpriced the works executed at the early stage such as in the preliminary construction works, and under-priced the works to be carried out in the later stage [14]. Front-loading puts higher risk and greater financial pressure on the client if the project standstill, delays in later works, or the contractor is bankrupt [15]. Furthermore, the significant forms of fraud in the industry are intentionally concealed the poor workmanship during the inspection, constructing the work with materials not stated in the bill of quantities, over purchase the materials, tampering of signed contract documents and falsifying payment [16]. Fraud brings financial loss and reputation loss to the party to initiate fraud, delays, and project cost overruns. Negligent or failure to perform duty with care, competence, and diligence is also one of the misconduct issues in the construction industry that leads to unethical behaviour [6]. Negligence can occur in many forms, such as a human error in the design stage, poor judgement in preparing the Bill of Quantity, lousy workmanship, poor quality of material, improper documentation, and deficient information flow from clients or consultants to contractors [17,18,19]. Design errors impact the construction project by causing delays, rework, increased original contract value, and cost overruns [19,20]. Misconduct in preparing a Bill of Quantity in the pre-tender impacted the BQ accuracy [21]. Improper documentation leads to poor information accessibility for the parties involved in the project and negatively impacts project efficiency. Poor documentation inhibits the communication between the parties and increases the possibility of rework causing redundancy, delays, and extra costs incurred for rework.

2.2 BIM usage in the Malaysian construction industry

Building information modelling (BIM) is used widely in building work and infrastructure work [22,23,24]. The implementation now is a world concern. It can be seen not only in developed countries but also in developing countries. In the US and UK, BIM is mandated [25], and rapid BIM adoption in European countries such as Sweden, Denmark, Norway, Finland, Austria, Brazil, France and Germany and in other developed countries overseas, including Japan, New Zealand, and Australia. Australia has shown strong adoption of BIM in SMEs and moving to level 3 [26]. Meanwhile, Singapore now has required all projects to be submitted via BIM e-submissions [25]. In Pakistan, the demand for BIM was apparent and a roadmap of 10 years' timeline for education and training institutions was established [27]. In Nigeria, even though the BIM implementation is low as limited government support, there is demand for it from private building owners and corporate organizations [28]. Similarly, in Malaysia, BIM implementation level is still low. However, there is significant improvement with the government intervention by organizing the programme and training through CIDB. Furthermore, the mandate to use BIM in public projects budgeted at RM100 million and above led to the improvement of BIM implementation rate in Malaysia [29].

The BIM implementation has proven to bring huge benefits to the industry. The benefit occurs in all stages of construction works throughout its project life-cycle. BIM provides extra transparency and accountability to the construction project [30], which is the essential factor needed to combat unethical issues in the industry. BIM provides a single repository cloud storage that stores all documents in one place. Hence, the same information is shared with all stakeholders, which allows for transparency. This cloud storage is considered a communication tool that can be utilised for collaboration purposes and is useful in decision-making and problem-solving [31]. The shared single repository storage can reduce miscommunication and ultimately reduce conflict and discrepancy. Furthermore, BIM offers the most substantial benefit whereby allows for better project visualisation in the earliest stage. With the ability to visualize the building design before the project starts is possible to

reduce the under-prices tender and charge extra claims for a variation order. The designers' team was collaborated to produce and visualize the BIM model in 3D, 4D and 5D. It allows for clash detection in the pre-construction phase. Clash detection can reduce misconduct during the design stage, create better design coordination, and enhance the accuracy in multidisciplinary designs [18,19]. Updating the progress on site visually in 4D and 5D models of BIM allows faster access to the data, assessing all requests for information (RFIs) in real-time, and reduces time to evaluate the claim [32]. This reduces the possibility of the architect to certify fraud claims and late payment in the industry. 5D BIM benefits the client to conduct an estimation on the cost incurred throughout the project activities [33] and create greater cost estimation accuracy [34]. Accurate cost estimation will reduce the client's risk of awarding a project to an under-priced tender, collusion tender, or front-end rate loading tender since the client has an accurate estimate of the overall costs required to complete the construction project. Thus, it shows the importance of implementing BIM as it offers a best practice to combat unethical issues in the construction industry.

3 Methodology

Quantitative research was conducted and 500 questionnaires have been distributed to the target respondents via a social media platform. Background checking has been done on the LinkedIn working profile to ensure the questionnaire will reach a targeted respondent. Since the study investigates the perception of construction players towards the usage of BIM in reducing unethical issues in the construction industry, it is important to collect responses from the person who has used BIM and survey their level of BIM implementation into their works. Their intense hands-on experience can shed light the perception on the ability of BIM to reduce unethical issues. The questionnaire consists of twelve multiple choices questions. Targeted respondents vary from those who work in developer firms, consulting firms, and contracting firms. The sample size was compared with the recommended sample size by Krejcie and Morgan [35] and were pilot tested.

Five hundred questionnaires were distributed and 101 returned questionnaires met the criteria of having BIM experience. 58 responses from the consultant companies, 32 from the contractors, 8 from developers, and 3 from subcontractors. The primary data collected from the questionnaires were analysed by descriptive analysis. Descriptive statistics refer to the range, minimum, maximum, and frequency of the data set. It focuses on describing, summarizing, and explaining the data based on the mean ranking [36]. This method was able to identify the BIM implementation level and perceive the industry players' perception of BIM usage in reducing the unethical issues.

4 Research finding

The data from returned questionnaires were sorted out and analysed using SPSS Version 16. Cronbach's coefficient alpha values obtained are greater than 0.70, therefore the data collected is proved to be consistent and reliable.

Table 1. Percentage of Agreement on BIM Implementation Level of Each Task. (N = 101)

List of Tasks	Percentage (%)				
	Level 0	**Level 1**	**Level 2**	**Level 3**	**BIM Implementation level**
3D Model Visualization	9.90	21.8	27.7	**40.6**	Level 3
Architectural Design	12.9	22.8	**35.6**	28.7	Level 2
Bill of Quantity Taking-Off	19.8	19.8	25.7	**34.7**	Level 3
As-Built Drawings	20.8	21.8	**35.6**	21.8	Level 2
Clash Detection	16.8	**34.7**	25.7	22.8	Level 1
Cost Estimating	22.8	23.8	**32.7**	20.8	Level 2
Demonstration of Construction Process	22.8	25.7	**37.6**	13.9	Level 2
Sustainability Analysis	26.7	28.7	**33.7**	10.9	Level 2
Construction Planning	25.7	**34.7**	25.7	13.9	Level 1
Documentation Management	21.8	**40.6**	26.7	10.9	Level 1
Site Analysis	28.7	**35.6**	25.7	9.9	Level 1
Construction Safety Planning	27.7	**43.6**	16.8	11.9	Level 1
Claim Management	27.7	**44.6**	18.8	8.9	Level 1
Project Lifecycle Information Management	**43.6**	31.7	14.9	9.9	Level 0
Facility Management	**43.6**	30.7	19.8	5.9	Level 0

Table 2. Common unethical issues in the industry.

Common Unethical Issues	Mean
Design Error due to misconduct	3.753
Inaccurate Estimating due to misconduct	3.515
Improper Documentation due to misconduct	3.500
Under-pricing Tender	3.436
Poor Site Safety	3.347
Overbilling	3.257
Claim Game	3.218
Cover Pricing	3.050
Front-End Rate Loading	3.020
Falsify Payment Claim	2.960
Change Order Game	2.891
Bid Rigging	2.782
Bribery	2.723
Collusion	2.703

Table 1 shows the respondents' feedback on their BIM implementation level based on Level 0 to Level 3 of the Bew-Richards BIM Maturity Model. This model has been adopted by the Malaysian Construction Industry Board (CIDB). The highest number of rates represents the BIM implementation level of each task listed in Table 1. It shows the respondents have a deep engagement of BIM level 3 for 3D Model Visualization and Bill of Quantity Taking-Off. Their deep engagement for these tasks has reflected the result of common unethical issues in Table 2.

Table 2 presents the mean value of common unethical issues. The results revealed that misconduct issues were the top three common issues. The design error, inaccurate estimating, and improper documentation was ranked top 3 with a mean value of 3.753, 3.515, and 3.500. These three issues are commonly occurring in 3D model development and Bill of Quantity Taking off preparation. Surprisingly, the analysed data unveiled bid-rigging, bribery, and collusion with a mean of were ranked the three least common unethical issues experienced by the respondents. Most of the respondents disclosed that they experienced bid-rigging, bribery, and collusion occasionally in the industry.

Table 3. BIM usage in diminishing unethical issues.

	BIM Usage in Diminishing Unethical Issues	Mean
a)	BIM allows 3D project visualization before the construction commencement to avert design errors	4.376
b)	BIM enables clash detection in the early design stage of the project to reduce the possibility of variation order works in future	4.307
c)	BIM has enhanced the integration and communication between multidisciplinary team throughout the project life cycle to avert communication lags and ensure smooth communication flow	4.168
d)	BIM can store data in a central place to build up proper documentation	4.149
e)	BIM provides a single repository cloud storage which allows faster access to the data and reports relating to the claim and consume less time in claim evaluation and claim analysis	4.090

Table 3 shows the respondents agree that BIM allows 3D project visualization, enables clash detection, enhances the integration and communication, centralised storage data, and single repository storage as the top five highest ranks with the mean value of 4.376, 4.307, 4.168, 4.149 and 4.090 respectively. These BIM usages were selected based on its ability to reduce unethical issues.

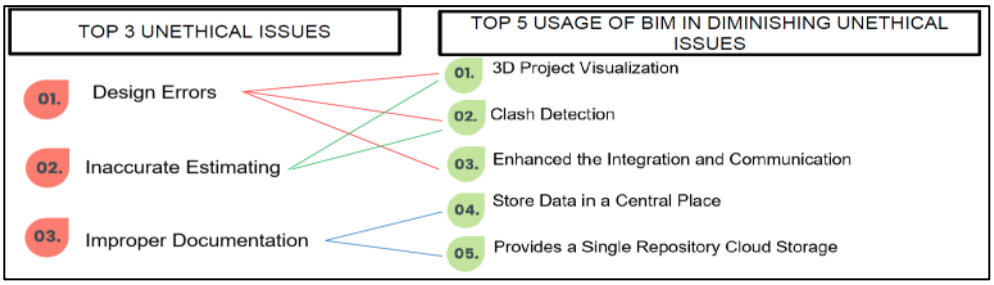

Fig. 1. BIM usage in diminishing unethical issues.

In summary, the common unethical issues found were misconduct in design, inaccurate estimating, and improper documentation. 3D project visualization and clash detection function can be utilized to prevent design errors and improve the accuracy in estimating. Moreover, the BIM allows transparency, better communication, and integration between

teams can refrain the misconduct in the design and estimating stage. Meanwhile, the centralized store data and single repository cloud storage are able to address the improper documentation issues. BIM provides a single repository cloud storage that stores the documents in one place. The centralised single cloud storage can serve as a digital construction document management software to keep track of all requests for information (RFIs) in real-time, store every version of drawings in the database, and provide easy accessibility to the documents within a few mouse clicks. This can help to reduce the misconduct issues in documentation as it was very transparent and well documented.

5 Conclusion

This research contributes to a better understanding of the potential usages of BIM in reducing unethical issues. It is critical to investigate the common unethical issues that occur in the construction industry and the possibility of BIM in reducing the occurrence. This research targeted the person that has experience of implementing BIM in their works. This study concluded that the common unethical issues in the construction industry are from the misconduct that leads to design errors, inaccurate estimating and improper documentation. These three issues are commonly occurring in 3D model development and Bill of Quantity Taking off preparation. The most significant finding of this study; BIM is potentially reducing unethical issues. The respondents have agreed that BIM's ability to provide 3D project visualization and clash detection in the early design stage, better integration and communication, and centralized data storage in a single repository cloud storage are possible to diminish unethical issues in the Malaysian construction industry. Identifying common unethical issues provides an idea to the industry on the most urgent issues to be addressed in the industry. This research also shows the insights of the construction players on the usage of BIM towards reducing unethical issues.

6 Limitation and recommendation

This study has focused on the construction players' perception of the possibility of BIM to diminish the unethical issue. Further research can be done to explain the relationship between BIM and unethical issues by carrying out the correlation test. This test can explain how BIM can be implemented to reduce the unethical issue and assess the correlation among the factors on how different BIM implementation levels affected its usage to combat the unethical issue. It is imperative to seek an effective solution to reduce the unethical issues as these issues have negatively impacted the project and the economic development of a country.

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