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RESEARCH ARTICLE

Embracing Digital Transformation for Sustainable Business in the Construction Industry

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ARTICLE INFO	ABSTRACT
	In the current digital era, the adoption of digital transformation in construction industry is still slow as compared with other industries and construction company still encounters numerous challenging issues such as project delayed, cost overrun, quality of work and environmental issues to meet client expectation as well as regulatory compliance. This study is conducted to find out the ways for implementing the innovation and digital transformation in Malaysia construction industry in order to gain the competitive benefits in stiff working environment for business sustainability as desired by contractor company .The purpose of this research is to explore how innovation can lead to business sustainability and on time delivery of projects in the construction industry and explore what type of digital transformation can enhance the business sustainability in the construction industry. Quantitative research methodology is used with Six -point Likert scale method for data collection. The structured questionnaire is sent to 20 selected professional personnel working in the Malaysian construction industry. This methodology is used for collecting and quantifying data on the factors of innovation and adoption of digital transformation in construction industry and the impact on the business sustainability. The originality of this study focuses on the evolution of the construction industry in digital era. With the innovation ideas and creativity driven by construction players, practitioners and collaboration effort with government and private organizations, numerous digital transformation technologies emerge in construction industry such as Building Information Modelling (BIM), IoT (Internet of things), project tracking software, etc. for integrating all digitalisation system into central networking platform, for providing fast and accurate information in real time connection to all the stakeholders, for earlier detection of design risks prior to implementation, for providing impressive work planning and emergency plan to tackle the uncertainty challenges issues. This study will contribute useful knowledge and key factors to construction players, practitioners and stakeholders for driving the innovation and leveraging digital transformation for construction company to stay competitive in international arena. Embracing the innovation and digital transformation culture, not only enhances company productivity, cost and time saving but also leads the construction company into sustainability of economic, social, environment, digital culture and profitability. This research also provides practical guidelines to all construction players for achieving business sustainability.

INTRODUCTION

1.1 Research background

The construction industry is a main global economy driver for developed and emerging countries. As reported by Oxford Economics 2021, the construction spending in worldwide accounted 13% of the global GDP in 2020 and to be reached to 13.5% in year 2030. However, the construction industry is facing numerous challenges such as project delayed, unable to handover project on time to client, accident issues happening at site, and heavily depend on foreign labour work force, human error in reporting, serious impact for the environmental & etc. As informed by Ibrahim (2021), the construction industry in Malaysia is very important industry which contribute large portion of the Gross Domestic Product (GDP) and support other related sector to increase the productivity and construct multi-type of buildings and facility centres. However, by using the traditional practices, it will take long time duration to complete. As mentioned by Yaser et al. (2021), in construction sector, involved workers from different cultures, languages and way of lifestyle and lack of communication, it causes a lot of problem in the quality works, time lose and incurred unnecessary cost for rework. As mentioned by Abanda, et al. (2024), in the entire project lift cycle, all the stakeholders ae playing key role by communication and collaboration which able to achieve through digitalisation approaches.

In additional, as cited by Calderon-Monge and Ribeiro-Soriano (2024), mentioned that digitalisation able providing to all the stakeholders by sharing the information in the central network system, avoiding paper distribution, real time updating and response. In the construction industry, the terms of innovation and digital transformation are referring to the integration and adoption of the new product, new design technologies, effective system procedural process and sustainability business model which are able to enhance the company objective in terms of quality, cost effectiveness, competitiveness and profitability (Khalil & Haque, 2022). As mentioned by Bygballe & Ingemansson Havenvid (2014), the innovation in construction industry is related with new product, services, process or activities which able to accept in market for enhance performance. Product innovation is referred to material component enhancement with better characteristics for creating a new product. OECD (2015). As quoted by Bygballe & Ingemansson Havenvid (2014), construction industry being labelled as old way to do the works and facing barrier to implement the innovation in terms of products, services or product.

According sources CIDB (2022), construction industry needs to adopt new ways of doing business with emerging of advanced digital technology by implement new standard operational procedure in order to remain competitive in the digital era. In additional, Ministry of works also implementing construction policy called " National Construction Policy 2030", for the purpose leading all the construction players towards sustainability and national achievement in year 2023. Digital transformation adoption requires construction company for changing process system by using new data resources for better communication, collaboration, safety, security, productivity, efficiency, environment and real time connection with all the stakeholders and also are able to help company leading for business growth and profitability in the world stiff competitive environment and reducing dependence of labour work forces (Chawdhury et al., 2022).

As quoted by Gerald, et al. (2015), digital transformation is a strategic approach related with business digitalization model which involving company management commitment and support in order to transform company, enhance technical competence and stay competitive in the digital era and uncertainty risk encounters. As per study conducted by Noori et al. (2022), the advanced information technology system able to enhance construction company performance by improving the accountability in the entire supply distribution. In additional, as mentioned by Alraja et al. (2022), information technology system enhances company performance by collecting data and analysis for

energy electricity consumption, emissions of carbon and environmental issues for sustainable growth.

1.2 Problem statement

In Malaysia construction industry, the adoption of new technologies was slow due to cost expensive, system complexity, lack of knowledge, government regulatory and security aspect and also preserve the traditional way and away for changing or transform to new era. As mentioned by Zhang, et al. (2023), the construction industry is one of the less digitalized industries as compared with other industries. As reported by Enegbuma, et al. (2015), the adoption BIM rate in construction Malaysia still slow and from the survey, found that 22% of respondents still reluctant to adopt the BIM in the construction industry. As mentioned by Opoku et al., (2023), the construction industry slow in adoption the digital tools due to short term business model as set, practicing old method for procurement contracts and unwilling to change.

In additional, according to Brockmann, et al., (2016), construction industry still lacks innovation, the hindering factor due to company organization structure and project complexity. Besides, as mentioned by Heinze and Heinze (2018), the company organization culture is affecting the innovation adoption rate. As of today, the industry still not yet completed the IR 4.0 execution which leading to a lot of projects delayed and lack of productivity. As reported by Bonanomi, et al. (2019), construction industry ranked second last as compared to other industry in the category of digitalisation index in the world. In additional, as mentioned by Ibrahim et al. (2021), construction industry is facing difficulties to adopt the IoT technologies due to lack of technical knowledge and company management not aware the benefits or value that can contributing into industry.

As quoted by Walasek & Barszcz, et al. (2017), adoption rate of IBM in construction industry still low due to various challenges and barrier. As mentioned by Bernold et al. (2012), construction players facing difficulty to understanding the system operation and technical know-how. In additional, according to Abdul-Rahman, et al. (2009), approximately 50 percent of the construction sites in Malaysia caused the work delayed and resulting client suffered huge loss and damaged which leading to country economic impact.

Due to the problem, construction players and all stakeholders need work together by collaboration to create new innovation services or digital transformation tools to stay competitive advantages and to complete with other players locally and international arena (Chowdhury et al., 2023).

1.3 Significance of the study

The significant of this research study will contribute to construction industry players, practitioners, academic professional contributions, policy makers and managers. Survey reveals 48% of construction rework stems from poor communication; adoption of cloud-based apps enhances stakeholder connectivity and information clarity (Ramalingam et al., 2024). Digital tools like sensors in construction enhance safety, provide vital data, and monitor worker health, preventing accidents effectively. Digital transformation tools boost construction accuracy, productivity, and safety, while optimizing time and cost management in project lifecycles. With the digital transformation tools, it will help the construction players able to track the work progress easily and current site issues or obstruction happen at site for earlier resolving. As reported by World Economic Forum (2016), with adoption of digital transformation tools, it will generate total 1% decrease in global construction expenses and have cost saving USD 100 billion in worldwide.

As mentioned by Chen, et al.,(2023), in recent years, digital technologies are adopted in AEC industry during design stage, construction stage and system operation stage for increase productivity, enhance quality product and etc. However, according to Arifin et al. (2022), construction industry always faces the challenges such as productivity, higher cost, quality and time issues in many years.

Previously, construction players treated innovation spending as waste of resources. However, with increased construction players adopted the advanced tools, it now becoming a core focus for investment and utilize these advance tools to complete with others in new digital era. As mentioned by Wang et al. (2024), company with adequate of technical competence personnel and with advanced technology equipment adoption rate which are able to enhance the innovation rate for success implementation. However, according to Ng, et al (2020), construction industry still lacks of innovation, the hindering factor due to company organization structure and project complexity. Besides, as mentioned by Shayah & Zehou (2019), the company organization culture is affecting the innovation adoption rate.

According to sources, Budget (2020), Malaysia government allocated 5G ecosystem development grant with value at RM 50 million and additional RM 25 Million to support an accelerate the growth of 5G and new technologies in Malaysia and collaboration with Construction Industry Development Board (CIDB) for providing training and courses for digital transformation programme such as Building Information Modelling (BIM) , construction tracking software, etc to lead construction players align with road map set for the achieving success.

1.4 Objective of the study

1. To explore how innovation can lead to business sustainability and on time delivery of projects in the construction industry.
2. To explore the type of digital transformation that can enhance the business sustainability in the construction industry.
3. To investigate the factors that influence the company commitment by arranging training for employee upskilling in digital technologies in construction projects.
4. To investigate the role of government initiatives in promoting awareness programs for digital transformation in the construction industry.

2. LITERATURE REVIEW

2.1 Definition of innovation, digital transformation and business sustainability

2.1.1 Innovation

As mentioned by Alves, et al. (2016), innovation defined as the execution of new product, new process, new marketing practices or new business model in a stipulated area. According to Agazu and Kero, (2024), in order for construction company successful, it involved innovations and embracing for new technologies as to stay competitive advantages in the external environment. As mentioned by Loosemore, (2013), in order for construction company to innovate in organized manners in terms of product or process, working environment need to be conducive for innovation ideas and express freely by employee. Allocation of fund resources is required for supporting the innovation efforts according to Saxena, et al. (2024). As mentioned by Kozioł-Nadolna, (2020), at the organization level, leadership is playing important role for creating working environment for employee innovation. In the process of innovation, organization also need to meet customer requirements and to delivery as expected Gundars et al. (2021). According to Lavikka, et al. (2020), in order for construction company stay in competitive advantages and enhance industry productivity and safety, the process innovation required to be implemented for continual meeting client requirements.

2.1.2 Digital transformation

As informed by BCG, Boston Consulting Group (2024), the adoption of digital transformation in the company needs have a culture of change in the mindset and it will enhance the company fundamental on the objectives in implementation on strategy for success. As quoted by CIDB (2022), in the construction industry, the adoption technology is at slow speed as compared with other sectors like education, commerce, entertainment and wellness. As mentioned by Lu, et al (2021), in order to stay

in advance with other sectors, these construction industries continual searching innovative ways in order to increase productivity by using the technology.

However, construction industry still facing a lot of challenges and uncertainty and one of the reasons is low investment of technologies as reported by Blanco et al. (2018). In additional, as informed by Verina and Titko (2019), The Organization of Economic Cooperation and Development (OECD) organized a campaign in order to let policy makers have a better understanding regarding digital transformation for the purpose to make create awareness that by increasing the digital technology adoption, it will make the environment, society and bring bright future for the economic as well. In additional, as mentioned by Xiaowen, H. et al. (2024), digital transformation enables for enhance organization improvement, sustainability in terms of economic, environment and social aspect.

As mentioned by Sampaio (2023), Building Information Modelling (BIM) is a collaborative methodology that centralizes and shares project information among experts involved in a building project. BIM platforms enhance coordination, collaboration, and integration across all disciplines. Despite challenges related to software interoperability, BIM offers advantages such as 3D visualization, model overlapping, easy database access, streamlined coordination, and improved collaboration (Fei et al., 2024). Pan and Isnaeni (2024) propose an innovative model that integrates Augmented Reality (AR) with Building Information Modelling (BIM) to enhance construction inspection. By replacing traditional paper-based methods with digital solutions, this approach revolutionizes monitoring processes (Haibao & Haque, 2023).

2.1.3 Business sustainability

As reported by Stephenson, et al. (2010) due to the factors of world population continuous increased, limitation resources and climate change, all these factors are posing serious problem in the environment and society in the word. To minimise this global impact, the concept of sustainability needs to be in place and incorporate in project management as mentioned by Gilbert, et al. (2014). And as mentioned by Sancha, et al., (2022), the companies need to incorporate the sustainability consideration in the daily operation for the decision making. In additional, as research by Moshood, et al. (2020), the sustainability through the process of three stages in terms of environmental, social & economic are able to achieve provided the construction company adopt the healthy ecosystem policies and using the modern technologies 4.0 which will generate out a lot of benefits and extended employment duration in the industry (Rana et al., 2023).

On the other hand, as mentioned by Gupta, et al. (2016), sustainability is inclusive such as 1. Stability of development in terms of political, economic, social and cultural aspects. 2. All human with equal right for quality of life 3. environment control to minimize waste 4. enjoy city life standards. As mentioned by Ben, et al. (2018), sustainability defined that in the development process, it complies with the current requirements and did not affecting future generation needs and requirements. As informed by Kordi, et al. (2022), social sustainability is inclusive all processes integrating between systems, business which related with society and human relationship for achieving healthy living standard at this moment and also future generations. However, according to Ma, et al. (2023), future exploration not only limited to sustainable development of the construction industry but also focus in resilience, human -centricity and economic efficiency.

2.1.4 Training arrangement

The training arrangement variables is one of the mediators impact the adoption of digital transformation in construction industry (Francis et al., 2023). Proper training arrangement for employee, will equip them with technology knowledge on how to operate the digitalization system in clearer and effectively. In additional, it also able to lead employee attitude to digitalisation era in positive direction for sustainability operation (Haque et al., 2024b).

2.1.5 Government initiative

Besides, the government initiatives act as mediator variable is one of the main factors that impact on the adoption of digital transformation in Malaysia construction industry (Jing et al., 2023). Government allocation for grant or funding will definitely support numerous construction players and enhance the degree adoption rate in the digital transformation in construction industry (Mien et al., 2023). In additional, with established clear policies and requirements spelt out in road map requirements, will pave the way to lead all construction players and practitioners leading to the right path for achieving the sustainability with digitalization in construction industry (Wahab et al., 2024).

2.2 Conceptual framework

According to Musarat et al. (2024), the conceptual framework created for understanding and identification the challenges and opportunities of the digitalization in Malaysia construction industry shown. One of the main difficulties facing by construction players for adoption the digitalization technologies (Senathirajah et al., 2023). It is huge investment required for embracing the technologies and most of the company not willing to incur additional cost for this technology (Adetayo et al., 2022). The other challenges issues are cybersecurity system, professional trainer availability, employee degree acceptance of digitalisation and key digitalisation tool identification (Osman et al., 2024).

2.3 Research framework

The proposed framework shown below: Figure 2: Proposed Framework Conceptual as table below:
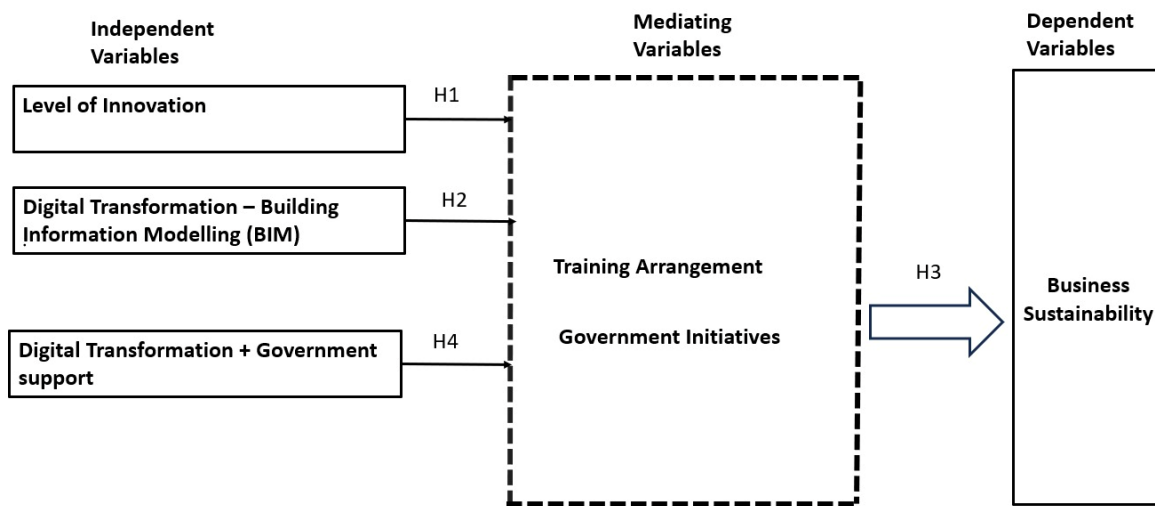

Figure 1: Proposed conceptual framework

2.4 Hypothesis of the study

In the research context, the terms of hypothesis are an assumption statement for two or more variables relationship with each other. And to derive some explanation for observation or situation phenomenon which able to be tested for further investigation. In this the hypothesis as below:

H1: The level of innovation in the construction industry has a positive effect on business sustainability

H2: The adoption of digital transformation - Building Industrial Modelling (BIM) in the construction industry has a positive effect on business sustainability

H3: Training arrangements and government initiatives have a synergistic effect on the impact of digital transformation on business sustainability in the construction industry.

H4: The effect of digital transformation on business sustainability is stronger in construction companies that have supportive government initiatives compared to those without such frameworks

3. RESEARCH METHODOLOGY

For this study, Quantitative research methodology is used with Six -point Likert scale method for data collection (Roopa & Menta Satya (2012); Taherdoost, 2021,). The structured questionnaire is sent to 25 selected professional personnel working in the Malaysian construction industry and received 21 filled up questionnaires. This methodology is used for collecting and quantifying data on the factors of innovation and adoption of digital transformation in construction industry and the impact on the business sustainability (Liaw et al., 2024).

The targeted population for research study are comprise of Project Manager and Engineers whom working in Malaysia engineering firms, involving in Mechanical, Electrical, Plumbing services and etc in the Malaysia construction company (Haque et al., 2024a).

4. DATA ANALYSIS

4.1 Demographics data

There are totally 21(N) respondents with valid answers provided. From the respondents, 11 respondents (52.4%) are working in Mechanical, Electrical & Plumbing services in Malaysia construction projects and the secondly group of respondents are working in construction company which consist of 48.1%. Regarding the profession held by the respondent, majority is Project Manager which consists of 47.6% and secondly, followed by engineer which consists of 38.1%. From the total number of respondents (N=21), there are totally 14 respondents, more than 10 years working experiences which consist of 66.6% and the remaining are less than 10 years.

4.2 Reliability test

Table 4.2 (a): Reliability status

Section	Cronbach's Alpha	Reliability/Internal consistency
A1 to A5	0.855	Good
B1 to B5	0.903	Excellent
B6 to B10	0.806	Good
B11 to B15	0.914	Excellent
C1 to C5	0.847	Good
D1 to D5	0.839	Good
E1 to E5	0.849	Good

As mentioned by Taber, (2018), Cronbach's alpha is used to measure the consistency of a set of survey items, the standardized scale from 0 to 1. If the high Cronbach's alpha values, (close to 1), it shows the test result is more reliable. If low values, indicating that set of items is not reliable for measurement the construct. In additional, Cronbach's alpha is a statistical measurement to access the reliability or internal consistency of the survey items or questionnaire survey questions. It will be providing information the items collected whether is within consistency measurement of the same construct or characteristic.

4.2.1 Questionnaire response from participant

H1: The level of innovation in the construction industry has a positive effect on business sustainability

From the data analysis of Section A-Innovative, it concluded Item A1 received 100% positive response (4,5 & 6) from the participant (N=21) and 61.9% of the respondents is agreed (=5) with the statement that "Managers shall constantly accept the new innovative way of doing work for business sustainability." And Item A2 received 100% positive response from the participant and 61.9% of the respondents is agreed (=5) with statement "Innovative playing important role by improving business sustainability within the construction industry." In additional, form the data analysis, it concluded that this Item A3 granted 100% positive response (4,5& 6) from the participant and 42.9% of the respondents is agreed (=5) with the statement "Innovation has positively influence business sustainability in the construction industry." And Item A4 received 100% positive response from the participant and 61.9% of the respondents is somewhat agreed (=4) with statement "Company is implementing innovation method in the construction projects and services." In additional, it also concluded that this Item A5 received 100% positive response (4. 5 & 6) from the participant (N=21) and 52.4% of the respondents is somewhat agreed (=4) with the statement "Innovation department shall be set up for creativity and system solution."

H2: The adoption of digital transformation - Building Industrial Modelling (BIM) in the construction industry has a positive effect on business sustainability

From the data analysis as generated under Section B-BIM, it concluded Item B1 have received 100% positive response (3,4,5 & 6) from the participant (N=27). Participant selected Agree (=5) and Strongly Agree (=6) which consist of 33.3% each with total 66.6% by adding up which agreeable with statement that "Manager shall adopt new technologies tool such as BIM for carry our work with more efficiency". In additional, form the data as generated, it concluded Item B2 received 100% positive respondence (4, 5 & 6) from the participants. There are 8 participants out of 21 selected Agree (=5) which consist of 38.1% and there are 7 participants Strongly Agree (=6) with the statement that "BIM able to improve communication among all project management team members for sharing information and project progress status.". Besides, from the data as generated, it concluded Item B3 granted 100% positive respondence (4, 5 & 6) from the participants. There are 12 participants out of 21 selected Agree (=5) which consist of 57.1% and agreed with the statement that "BIM providing overall project stages simulation and with clear visualization". In additional, it concluded Item B4 granted 95.3 % positive respondence (4, 5 & 6) and 4.8% with negative response from one participant whom Somewhat Disagree (=3) the statement. However, it concluded that majority participant (20) still response positively with the statement that "BIM is a power tool software to incorporate all services into the platform to avoid any clashing during design stage. In additional, from the data as generated, it concluded Item B5 granted 95.3 % positive respondence (4, 5 & 6) and 4.8% with negative response, Somewhat Disagree (=3) from one participant. However, it concluded that majority participant (20) still response positively with the statement that "BIM able to predict hazard and to modify the design options for safety aspects".

H3: Training arrangements and government initiatives have a synergistic effect on the impact of digital transformation on business sustainability in the construction industry.

From the data as analysis under Section C – Training Arrangement, it generated that Item C1 granted 100% positive respondence (4, 5 & 6) from the participants. There are 12 participants out of 21 selected Agree (= 5) with the statement "Training arrangement regularly for employee able to improve planning capabilities and accessibility into digital platform.". Besides, Item C2 also granted 100% positive respondence (4, 5 & 6) from the participants. There are 11 participants out of 21 selected Agree (= 5) with the statement "Training arrangement for cultivate digital mindset among employees will help to enhance adoption of digital transformation.". In additional, from the data as

analysis, it generated that Item C3 granted 100% positive respondence (4, 5 & 6) from the participants. There are 15 participants out of 21 selected Agree (= 5) with the statement "Employee learn digital transformation skills by attending workshop or online will enhance digital transformation adoption rate." Moreover, Item C4 granted 100% positive respondence (5 & 6) from the participants. There are 12 participants out of 21 selected Agree (= 5) with the statement "Allocate budgetary for employee attending digital transformation course is a wise decision." In additional, Item C5 also granted 100% positive respondence (4, 5 & 6) from the participants. There are 9 participants out of 21 selected Agree (= 5) with the statement "Management shall attend digital transformation training for leading all employees in digital era."

Whereas, under Section D- Government Initiatives, Item D1 granted <u>100%</u> positive respondence (5 & 6) from the participants. There are 13 participants out of 21 selected Agree (= 5) with the statement "Clear government policies important for encourage digital transformation adoption in construction industry.". In additional, Item D2 granted 100% positive respondence (5 & 6) from the participants. There are 12 participants out of 21 selected Agree (= 5) with the statement "Government shall allocate funding for researcher to explore the digital transformation technology and R&D.". Besides, Item D3 granted 100% positive respondence (5 & 6) from the participants. There are 11 participants out of 21 selected Strongly Agree (= 6) with the statement "Government shall provide incentives to company which embracing the digital transformation.". Item D4 also granted 100% positive respondence (4, 5 & 6) from the participants. There are 12 participants out of 21 selected Strongly Agree (= 6) with the statement "Government funding for University or Institute's Research and Development is important to support more innovative products created in construction industry.". In additional, Item D5 granted 100% positive respondence (5 & 6) from the participants. There are 12 participants out of 21 selected Agree (= 5) with the statement "Government's play key role with CIDB by promoting and digital transformation in construction industry."

H4: The effect of digital transformation on business sustainability is stronger in construction companies that have supportive government initiatives compared to those without such frameworks

From the data generated, under Section E – Business Sustainability, Item E1B granted 100% positive respondence (4, 5 & 6) from the participant. There are 6 participants out of 21 selected Strongly Agree (= 6) with statement "Our company's reputation for sustainability has improved due to digital initiatives." Besides, from the data generated, Item E2B granted 100% positive respondence (4, 5 & 6) from the participant. There are 6 participants out of 21 selected Strongly Agree (= 6) with statement "Our organisation has the ability to comply with sustainability regulations and standards." In additional, from the data generated, Item E3B granted 100% positive respondence (4, 5 & 6) from the participant. There are 6 participants out of 21 selected Strongly Agree (= 6) with statement "Our company is better prepared to adapt to future sustainability challenges." And moreover, Item E4B also granted 100% positive respondence (4, 5 & 6) from the participant. There are 6 participants out of 21 selected Strongly Agree (= 6) with statement "Our business has experienced growth in market share due to sustainability efforts." In additional, from the data generated, Item E5B granted 100% positive respondence (4, 5 & 6) from the participant. There are 6 participants out of 21 selected Strongly Agree (= 6) with statement "The adoption of digital tools has led to innovative sustainable practices in our business operations."

4.3 Multiple linear regression

As mentioned by Trunfio, et al. (2022), in order to find out the relationship in between the dependent variables and independent variables, the statistical method of Regression analysis was conducted and with reference to the hypothesis.

H1: The level of innovation in the construction industry has a positive effect on business sustainability

Table 4.3.1 (a) Model summary of regression

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.173	.030	-0.21	.83973

Predictors: (Constant), innovation

Table 4.3.1 (b) ANOVA results

Model		Sum of Squares	Df	Mean Square	F	Sig
	Between Groups	3.768	7	.538	.697	.675
	Within Groups	10.042	13	.722		
	Total	13.810	20			

Dependent variable: Business sustainability

Independent variable: Innovation

As shown in above analysis, the significant value is 0.675 means that the probability of observing the data or something more extreme, assuming that the null hypothesis is true is 67.5%. A common threshold for significance is ($p < 0.05$), which means there's less than a 5% chance that the observed results are due to random variation alone. Since the significance value is 0.675, which is much greater than 0.05, it suggests that there is no statistically significant difference in business sustainability based on the levels of innovation as defined. In other words, the variation in business sustainability cannot be confidently attributed to the different levels of innovation, according to ANOVA results.

H2: The adoption of digital transformation - Building Industrial Modelling (BIM) in the construction industry has a positive effect on business sustainability

Table 4.3.2 (a) Model summary of regression

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.0.46	.002	-0.50	.85165

Predictors: (Constant), BIM

Table 4.3.2 (b) ANOVA results

Model		Sum of Squares	df	Mean Square	F	Sig
	Regression	.029	1	.029	.039	.845
	Residual	13.781	19	.725		
	Total	13.810	20			

Dependent Variable: Business Sustainability
Predictors: (Constant), BIM

As shown in above analysis, a significance (sig) value 0.845 means that the probability of observing the data or something more extreme, assuming that the null hypothesis is true, is 84.5%. A common threshold for statistical significance is ($p < 0.05$), which means there's less than a 5% chance that the observed results are due to random variation alone. Since the sig value is 0.845, which is much greater than 0.05, it suggests that there is no statistically significant relationship between the independent variable (BIM - Building Information Modelling) and the dependent variable (Business Sustainability) based on ANOVA results.

H3: Training arrangements and government initiatives have a synergistic effect on the impact of digital transformation on business sustainability in the construction industry.

Table 4.3.3 (a) Model summary of regression

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.0.538	.289	.252	.62627

Predictors: (Constant). TRGV

Table 4.3.3 (b) ANOVA results

Model		Sum of Squares	df	Mean Square	F	Sig
	Between groups	3.219	3	1.073	2.509	.093
	Within groups	7.269	17	.428		
	Total	10.488	20			

Dependent variable: BIM

Independent variable: TRGV

In shown in above ANOVA analysis, generated sig value of 0.093 means that the probability of observing the data or something more extreme, assuming that the null hypothesis is true, is 9.3%. A common threshold for statistical significance is ($p < 0.05$), which means there's less than a 5% chance that the observed results are due to random variation alone. Since the sig value is 0.093, which is greater than 0.05, it suggests that there is no statistically significant relationship between the independent variables (Training Arrangements and Government Initiatives) and the dependent variable (Digital Transformation) based on ANOVA results.

4.4 Inferential analysis

4.4.1 Pearson correlation analysis

Pearson Correlation Analysis is related with statistical method for measurement the strength and direction in between two continuous variables in terms of liner relationship. The Pearson correlation denoted as "r", from range -1 to +1.

H4: The effect of digital transformation on business sustainability is stronger in construction companies that have supportive government initiatives compared to those without such frameworks

Table 4.4.1 (d)

	Correlations			
			DTGV	BUSSUST
DTGV	**Pearson Correlation**		1	0.064
	Sig. (2-tailed)			0.781
	N		21	21
BUSSUST	**Pearson Correlation**		0.64	1
	Sig. (2-tailed)		0.781	
	N		21	21

As shown in above analysis, a Pearson correlation coefficient of 0.064 indicates a very weak positive linear relationship between the independent variable (Digital Transformation), the mediator variables (Government Initiatives), and the dependent variable (Sustainability). This suggests that as digital transformation and government initiatives increase, there is a very slight tendency for sustainability to increase as well.

5. DISCUSSION AND CONCLUSION

5.1 Discussions of findings

The following sections will discuss the findings of the data analysis generated with reference to the hypothesis:

H1: The level of innovation in the construction industry has a positive effect on business sustainability

Refer to the questionnaire's response given by the participants, there is highly positive response given from participant and agree that the statement "The level of innovation in the construction industry which has a positive effect on business sustainability." However, from the statistical method using ANOVA analysis, the significance value is 0.675, which is much greater than 0.05, it suggests that there is no statistically significant difference in business sustainability based on the levels of innovation as defined. In other words, the variation in business sustainability cannot be confidently attributed to the different levels of innovation, according to ANOVA results. In additional, Pearson correlation coefficient of 0.173 indicates a positive but weak linear relationship between the independent variable (Innovation) and the dependent variable (Business Sustainability). This reflected that as innovation increases, there is a slight tendency for business sustainability to increase accordingly.

H2: The adoption of digital transformation - Building Industrial Modelling (BIM) in the construction industry has a positive effect on business sustainability

Refer to the questionnaire's response given by the participants, there is highly positive response given from participant and agreeable with statement that "The adoption of digital transformation-Building Industrial Modelling (BIM) in the construction industry has a positive effect on business sustainability."

However, from the statistical method using ANOVA analysis, the significance value is 0.845, which is much greater than 0.05, it suggests that there is no statistically significant relationship between the independent variable (BIM - Building Information Modelling) and the dependent variable (Business Sustainability) based on ANOVA results. In additional, a Pearson correlation coefficient of -0.460 indicates a moderate negative linear relationship between the independent variable (BIM - Building Information Modelling) and the dependent variable (Business Sustainability). This means that as BIM usage increases, there is a tendency for business sustainability to decrease (Annathurai et al., 2023).

H3: Training arrangements and government initiatives have a synergistic effect on the impact of digital transformation on business sustainability in the construction industry.

Refer to the questionnaire's response given by the participants, there is highly positive response given from participant and agreeable with statement that "Training arrangements and government initiatives have a synergistic effect on the impact of digital transformation on business sustainability in the construction in the construction industry" (Yi et al., 2018). But the sig value is 0.093 is generated out which is greater than 0.05, it suggests that there is no statistically significant relationship between the independent variables (Training Arrangements and Government Initiatives) and the dependent variable (Digital Transformation) based on ANOVA results. In additional, a Pearson correlation coefficient of -0.074 indicates a very weak negative linear relationship between the mediator variables (Training Arrangement and Government Initiatives),

the independent variable (Digital Transformation), and the dependent variable (Sustainability) (Lee et al., 2023).

H4: The effect of digital transformation on business sustainability is stronger in construction companies that have supportive government initiatives compared to those without such frameworks

Refer to the questionnaire's response given by the participants, there is highly positive response given from participant and agreeable with statement that "The effect of digital transformation on business sustainability is stronger in construction companies that have supportive government initiatives compared to this without such framework." However, in the ANOVA analysis, it generated sig value of 0.708 means that the probability of observing the data or something more extreme, assuming that the null hypothesis is true, is 70.8%. Since the sig value is 0.708, which is much greater than 0.05, it suggests that there is no significant relationship between the independent variable (Digital Transformation), the mediator variable (Government Initiatives), and the dependent variable (Business Sustainability) based on ANOVA results. Moreover, a Pearson correlation coefficient of 0.064 indicates a very weak positive linear relationship between the independent variable (Digital Transformation), the mediator variables (Government Initiatives), and the dependent variable (Sustainability). This suggests that as digital transformation and government initiatives increase, there is a very slight tendency for sustainability to increase as well

5.2 Implication of the study

5.2.1 Theoretical implications

The theoretical implications of embracing digital transformation for sustainable business in construction industry are multifaceted and profound. The innovation and integration of digital tools such as Building Information Modelling (BIM), IoT can foster innovation, leading to new construction methods and revolutionize construction industry in current digital era (Wai et al., 2024). Digital tools can facilitate more business sustainable approach by enabling resource management and waste reduction for enhance company for more effective management and profitability. Besides, with the more training arrangement and supportive from government in terms of funding and incentive given to researcher or practitioners or construction players in will help further enhance the knowledge of digital transformation for operation the system with more efficiency and collaboration among construction players (Kaur et al., 2023). However, other factors of challenges need to be included into variables for enhance the statistical analysis as to support the theoretic framework**.**

5.3 Limitation of the study

The limitation for the study is sample size which only 21 participants and there is limitation for generalizability more accuracy of the finding. With a small sample size, the study may have limited statistical power to detect significant differences or relationships. More larger samples could provide more representative data and analysis through SPSS statistical method. While the 6-point Likert scale can capture range of positive responses and negative response, it may also introduce a middle option for leading to central tendency bias and avoid extreme positions. The use of a Likert scale may also be subject to response bias, where participants may respond in a manner they believe is expected. In additional, this survey only Malaysian's professional and with limitation of geographical areas, it not covering full spectrum of digital transformation globally and result may not be applicable to other regions or country. In additional, this survey conducted using quantitative research method by providing numerical data only and may miss out nuanced understanding of the digital transformation process through qualitative research method.

5.4 Recommendations for future research

The recommendation of future research shall increase the sample size to enhance the statistical power of the study in order to achieve the significant results. Besides, the quantitative research

method, it shall integrate with qualitative research methods as to gain deeper insights into the reasons behind the lack of significant findings (Ahmed et al., 2024). In additional, to utilize other statistical methods that may be suited to the data and research questions. In additional, to conduct investigate the barriers of adoption digital transformation in the construction industry for understanding the challenges that affecting the adoption. Investigate how incorporating Environmental, Social, and Governance (ESG) principles into digital transformation strategies can affect business sustainability. Moreover, to investigate how incorporating Environmental, Social, and Governance (ESG) principles into digital transformation strategies can affect business sustainability. By addressing these areas, future research can address the gaps, and contribute to a more comprehensive understanding of digital transformation in the construction industry.

5.5 Conclusion

As mentioned by Musarat, et al. (2024), digital transformation tools like Building Information Modelling (BIM), it enabling for innovation and leading to more productivity and performance. He also mentioned that digitalization will support the sustainable practices by optimise the resource use and reducing waste. Besides, he also quoted that with the digitalization, it would be able to enhance collaboration among all the stakeholders and construction players via real time connection and streamlined into centralised networking platform for sharing and communication (Narayanan et al., 2023). In addition, as mentioned by Olanipekun, et al. (2021), adoption of digital transformation able to increase construction productivity, higher accuracy of reporting status, higher efficiency of managing time and cost factors and also able to mitigate any risk or hazardous activities to be encounter during project life cycle.

However, there are challenges need to be overcome such as increase awareness regarding the benefits of the digital tools. There are technical skill exists, necessary training arrangement is needed for effective operation of the digital transformation tools. In additional, there is lacking of government mandates and incentives provided for adopting the digitalization practise in Malaysia construction industry (Wickneswary et al., 2024). For achieving the sustainable business, the supportive ecosystem required in order to overcome the challenges, leveraging and embracing the digital transformation for transforming the construction industry on par with other industry for digitalisation and sustainability (Hailong et al., 2022).

Data available on request due to privacy/ethical restrictions: The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Ethical Approval: Formal ethical approval has been waived instate this study adhered to the principles of the strict ethical standards. Participation was anonymous, confidential, and voluntary, with informed consent obtained from all participants. There were no biomarkers or tissue samples collected for analysis. Participants had the freedom to withdraw from the study at any point.

Conflict of interest: Authors declare no conflict of interest.

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