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Evaluation of Digital's Role in Sustainable Built Environment

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ABSTRACT

The construction industry has been evolving, embracing the delicate balance between the Fourth Industry Revolution and sustainable construction to create a sustainable and resilient built environment. Integrating digital tools and technologies in a renowned conventional construction industry is challenging, mainly due to the complex interaction between heterogeneous but heuristic construction processes, building systems, and workflows in achieving a common goal. This study took the initiative to review digital tool adoption and its role in the sustainable built environment by examining the impact of digital adoption in a sustainable built environment in terms of societal and industry impacts. A quantitative analysis is conducted, collecting 63 industry practitioners analysed through regression analysis. The result reveals that energy conservation is the most significant element in the sustainable built environment, which brought the greatest impact on both society and industry in Malaysia. Based on the results, it is found that the digital adoption level in the Malaysian construction industry is still at a minimal level. Through the introduction of Indutry4wrd, National 4IR and Construction 4.0 Strategic Plan (2021–2025), the importance of digital tools and technologies is slowly being acknowledged. The result of the study is significant to benchmark the current digital tools adoption in the Malaysian sustainable built environment. Moreover,

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the contribution could be made in terms of better understanding and facilitating, where relevant, greater usage of digital tools in the construction industry to promote efficiency.

Keywords: Digital role, evaluation, quantitative research, sustainable built environment

INTRODUCTION

Visions for cities are more important than ever. It is expected that the migration trend will never stop any time soon, leading to an increase in population. More than half of the world's population lives in cities and urban areas, and this figure will likely increase to 70% by the year 2050 (Daniel, 2020). Thus, sustainable development practices help countries grow in ways that adapt to the challenges posed by climate change, which will help protect important natural resources for ours and future generations. Generally, the backbone of sustainable development is the interplay of three main pillars: economy, society, and environment. Daniel (2020) implied that the three main pillars enhancing the welfare of the entire society force us to reconsider the current urban practices to make sustainable city planning a dominant principle.

One of the key aspects is the necessity of sustainable development in the sphere of society's life to ensure that future generations' needs are not compromised. Establishing the Sustainable Development Goals (SDGs) plays a vital role in sustainability issues as the aim of the SDGs are to end poverty, protect the planet and ensure prosperity for all. Sustainability is a visionary objective that the construction industry and many individuals are gradually working towards. The construction sustainability objectives in the construction industry are always within the building design and construction materials. The shift to sustainability can be seen as a new paradigm where the sustainable objective lies in digital transformation.

Recently, the way humans live their lives and working environment has been transformed digitally. Digital technologies in any industrial process are directly concerned with the quality and productivity of the systems. Among the various fields within the industry, the construction industry has struggled the most with digital adoption and twining (Ahuja et al., 2009). The construction industry is difficult, with legacy processes that span architects, contractors, regulators, and building owners. Bridging different elements of every participant's field and their relationship is necessary for digital transformation (Ubarte & Kaplinski, 2016).

Most past studies in digital construction are focused on infrastructure development which can be seen in areas such as structural, material, and environmental disciplines and the use of design or planning software for the earlier stages of construction. By contrast, relatively little attention has been given to investigating the factors affecting these technologies' infiltration into the construction and project management lifecycle, even less in building sustainability (Rohana, 2008). This study primarily relies on literature from previous researchers. Thereby, it is hard to disentangle the essential elements of a sustainable built environment and how digital tools can help facilitate a sustainable built environment. There is little evidence from previous research to determine the digital's role in a sustainable built environment. Accordingly, to bridge the knowledge gap of this issue, this study aims at enhancing the built environment through digital adoption by examining the sustainable built environment elements and their adoption impact in the Malaysian construction industry.

LITERATURE REVIEW

Sustainable Development and Built Environment

The general definition of sustainable development is the current generation's use of resources not to jeopardise future generations' ability to meet their needs. Curwell and Cooper (1998) suggested three additional terms for sustainable development which current researchers widely use: 'environment' refers to the protection of local and global ecosystems to support all life; 'public participation' recognizes the need for all people to engage in positive change; and 'equity' refers to an equal distribution of global wealth for human and non-human life. Besides, Sustainable Development Goal 11-Sustainable cities and communities did highlight the necessity of sustainable development- aiming to offer the opportunity to all human settlements by providing transportation, green public places, and affordable housing (UN News Centre, 2015). Therefore, it is important to address the importance of balancing human socio-economic activities and the environment's ability to absorb global waste and provide natural resources.

Over the years, there has been a greater awareness of the importance of sustainable construction because it represents the extensive promise to promote sustainable development globally and locally by preserving the natural environment while improving the built environment. It is the method for establishing a long-term coexistence balance between nature and humans (Jenkin & Zari, 2009). Sustainable development and buildings of the built environment have become dominant principles for sustainability (Conte, 2018). Three factors are emphasised: the consolidation of activities such as construction and manufacturing are responsible for sustainable development, creating a sustainable built environment is the main goal, and nature preservation serves as the starting point for those activities. Holden et al. (2017) suggested that the environment acts as the basis for achieving a sustainable environment through economic activities in the construction sector. As a result, construction became a unique field for testing sustainable practices through the sustainable development of the built environment.

"Sustainability" has a very broad meaning because it encompasses all aspects of development that go beyond the 1987 Brultand report on sustainable development, which focused on the environment, economy, and society (Holden et al., 2017). As various types of scholars have published to propose and explicate sustainable development, this vague concept has caught the interest of a wide range of disciplines. According to Conte (2018), sustainability has become a popular issue in various industries because it is the latest trend and initiative to reduce environmental impacts in terms of resource waste and energy use. Hence, these indicators assess an organization's ability to meet sustainability goals in the built environment.

Digital Role in Facilitating Sustainable Built Environment

Manyika et al. (2016) define that digitalisation in business covers creating value at new frontiers, creating value in core businesses, and building foundational digital capabilities. Digitalisation allows stakeholders to make informed decisions, reduce decision-making speed and minimise errors. Besides, digitalisation refers to transforming systems and data architecture from siloed legacy systems to support connecting devices, objects, and people (Dörner & Edelman, 2015). Digital approaches in the construction industry allow an integrated approach to development that extends beyond the design profession to include project stakeholders, professional institutions, and governing bodies. By doing so, such approaches become a means of bridging the gap between current working methods and the desired outcomes of a sustainable built environment (Yang et al., 2005).

Digital has multiple roles in facilitating a sustainable built environment, for instance, catalysing enhanced health and the prosperity of humans and the environment and establishing mutually beneficial interactions that self-replicate to generate inclusive resilience (Jenkin & Zari, 2009; Changsaar et al., 2022). To ensure the viability and acceptance of technological advancements in the construction industry, they must respect and have a profound regard for local settings, whether cultural, economic, or ecological, for development to be appropriately tailored to local culture, ecosystems, and economic situations and ensure development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

By recognising the great power of technology, it is possible to shift the solution to an operational level. Tools such as Building Information Modelling (BIM), which are data-related, high-fidelity modelling, or model-based simulation, are employed in digital twin applications and are beneficial to the industry. It can enhance building sustainability, manage different stages of construction processes, allow users to visualise design efficiently, and identify the optimum design and unforeseeable efficiencies of a project (Bratuškins et al., 2020). Therefore, a project can stray away from flaws. Hence, it is clear that digital tools are important in facilitating a sustainable built environment. However, digitalisation is a technological process that is able to integrate into any of the application, defined as neither good nor bad, viewed as neither desirable nor to be prevented; digitalisation is simply a tool used to achieve a wide range of different objectives (Eling & Lehmann, 2018; Jiancheng et al., 2021). Therefore, there is a need to examine the impact of digitalisation towards the construction industry, especially in terms of the sustainability concept.

Elements of a Sustainable Built Environment

The urban design aims mainly to counter the sprawl of urbanisation, thus channelling it into sustainable design. Akadiri et al. (2012) implied that populations that live in sustainable development would not disperse in different territories as the city is compactly designed. Mondejar et al. (2021) further supported it, highlighting five categories of the sustainable built environment: (1) agricultural and food production, (2) clean water for all, (3) energy challenges, (4) industry and social well-being, and (5) climate research. However, the sustainably built environment should consider the land, natural resources, and adverse environmental conditions when expanding the settlement. Asif et al. (2007) proposed a multi-disciplinary approach to create a sustainable future in the construction sector, including energy conservation, better material utilisation, material waste reduction, pollution, and emissions control. Therefore, this study adopted Asif et al. (2007) due to its wider coverage of the elements of the sustainable built environment in evaluating energy conservation (EC), water management (WM), innovation (IN), indoor environmental quality (IE), sustainable materials (SM) and land use (LU) as shown in Figure 1.

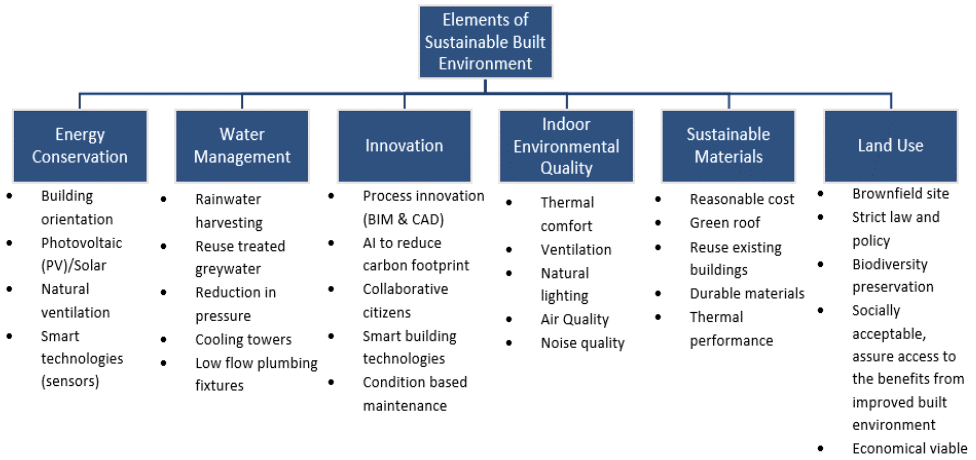

Figure 1. Six elements of a sustainable built environment (Asif et al., 2007)

Impediments and Challenges of Implementing Digital Innovations

Digitalisation brought a new set of tools and technologies which need to be carefully balanced to ensure a smart adoption in the sustainability context. The capability of using the tools and technologies to make a well-informed decision by using more efficient resources and services has a significant impact on sustainability (Appio et al., 2021; Elshafey et al., 2020; Ardito et al., 2018), but several challenges cannot be neglected to ensure achievement of these targets.

The configuration and organisation of the digital innovation process significantly affect delivery, leading to organisational challenges due to process or performance management becoming an issue (Whyte & Levitt, 2011). Widespread organisational changes across company boundaries have occurred due to utilising new digital tools and processes. Several challenges hinder the adoption of digital approaches in the construction industry (Table 1).

Table 1
Challenges of digital adoption

Challenges	Description
Slow in Generating 3D Information	Some computer operating systems are unable to process much information at once.
High Cost of Investment	Lack of financial resources and support in an organisation
Psychological Barriers	Employees or managers fear failure, work change, and process change with digital adoption.
Technological Barriers	Lack of skill, lack of training, unavailability of new digital tools
Inability to Achieve Unified Goals	Project stakeholders have different perspectives on digital technologies.

Note. Adopted from Whyte and Levitt (2011), Bratuškins et al. (2020), Ramilo and Embi (2014), Rusu et al. (2020), Elmustapha et al. (2018) and Linderoth et al. (2018).

Recently, there has been an ongoing discussion on the qualitative treatment of the power of digital technology development on SDGs. Some scholars highlighted the impact of digital technologies in sustainable construction, considering the high initial cost and ecological cost of economic growth threaten digital change negatively. Digital technologies have been one of the main vectors of economic growth in recent years and will retain this role in the long term, up to 2030 and, according to specific estimates, even up to 2050 (Popkova et al., 2022).

Impact of Digital Innovations in Sustainable Built Environment

Digital approaches allow an integrated approach to development that extends beyond the design profession to include project stakeholders, professional institutions, and governing bodies. By doing so, such approaches become a means of bridging the gap between current ways of working and the desired outcomes of a sustainable built environment (Yang et al., 2005).

Over the years, there have been limitless discussions over the impacts of digital adoption or innovations in a sustainable built environment. For example, Keeys and Huemann (2017) acknowledged the benefits of digital adoption through innovation, change and value creation; meanwhile, Kempt et al. (2007) and Roome (2013) highlighted the value of integrative collaboration in supporting sustainable pillars (economic, environmental, and social). On the other hand, this study suggested looking into the impact of digital adoption from societal and industry perspectives. The impacts of digital innovation in the sustainable built environment are tabulated in Figure 2.

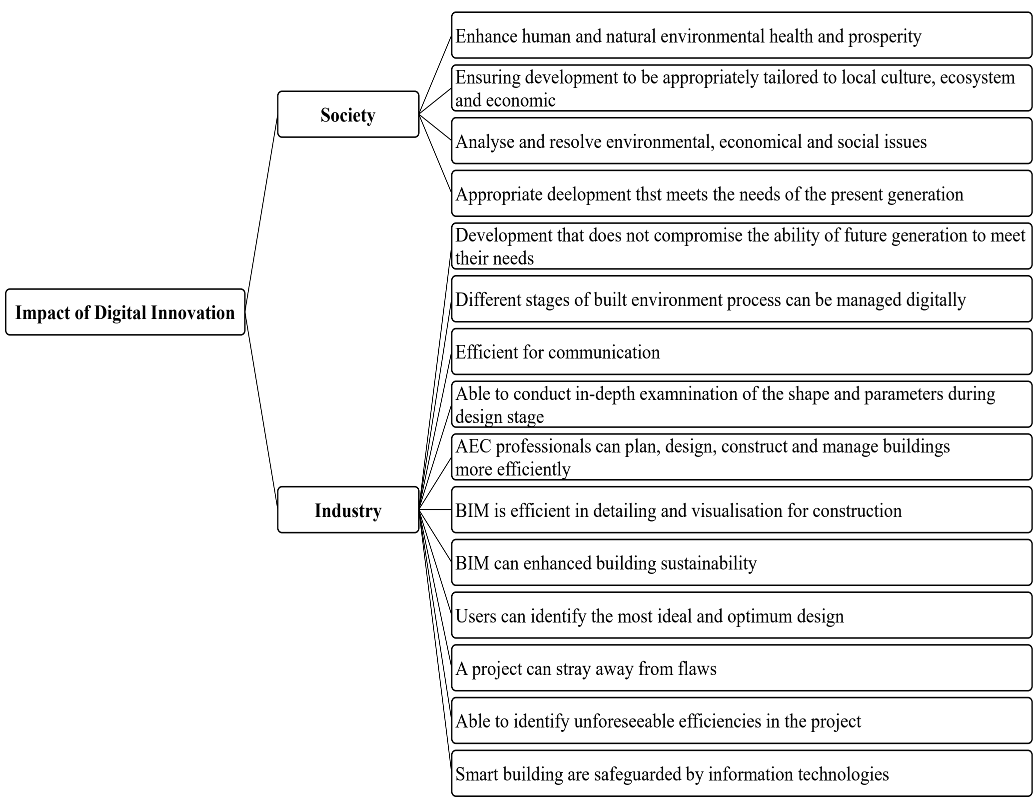

Figure 2. Impacts of digital innovation on the sustainable built environment

Sources. Adopted from Kempt et al. (2007), Juujärvi and Pesso (2013), Aleta et al. (2017), Keeys and Huemann (2017) and Downey (2020).

This study evaluates the digital's role in a sustainable built environment. A quantitative approach will be conducted to examine the causal relationship among the elements of a sustainable built

RESEARCH METHODOLOGY

This study adopted a quantitative approach mainly due to the explorative character of the study. A questionnaire survey with Likert Scale and purposive sampling method is selected to collect the data. Purposive sampling is a non-probability method where the samples are selected based on the researcher's judgement (Etikan et al., 2016). In this study, the samples are selected by screening the LinkedIn profile, where civil and non-civil engineers (construction professionals) were selected as targeted respondents. There were two criteria in selecting the samples: (1) experience in digital construction and (2) experience in sustainable construction. However, the limitation of purposive sampling is prone to researcher bias because the sampling judgement might be too subjective. In order to reduce procedural bias, a thorough research plan was created before the study was conducted. Besides, the questionnaire questions were designed in separate sections, giving clear instructions to the respondents. Moreover, internal reliability and validity were tested before detailed analysis.

There were 200 sets of questionnaire surveys distributed on LinkedIn, received 86 with 63 valid responses contributing to a 31.5% response rate. From the collected data, it is discovered that 65% of the respondents are from Peninsular Malaysia. Kuala Lumpur, Sarawak and Selangor recorded the highest response rate, contributing 28.6%, 27.0% and 17.5% to the sample, respectively.

The preliminary analysis of the reliability and validity tests shows significant internal consistency. Cronbach's Alpha is recorded at 0.929, indicating the presence of a high internal correlation between the items or items based on the same principle. This finding revealed that the questions were appropriately connected, and the factors created the ground for the very reliable outcomes of the following analyses. On the other hand, the Kaiser-Meyer-Olkin (KMO) value of 0.828 implied that factor analysis of variables was feasible for this data. Furthermore, Bartlett's test of sphericity was found to be statistically significant, suggesting that the null hypothesis of the correlation matrix is an identity matrix that can be rejected. On the whole, findings from Cronbach's Alpha and KMO were found to be in the highly acceptable range (Pallant, 2000; Hair et al., 2010), and Bartlett's Test of Sphericity was statistically significant, inferring that sampling adequacy was meritorious and variables were related and therefore ideal for structure detection in factor analysis. Next, we tabulate the demographic profile of the respondents by cross-tabulating the profession category by age, and the finding is illustrated in Table 2.

The respondents are classified into civil engineers and non-civil engineers. The category of non-civil engineers includes architects, quantity surveyors, mechanical and electrical engineers, and project management consultants. This study examines the digital's role in a sustainable built environment, which in many studies identified the important role of civil engineers in sustainable areas. It is further emphasised in the American Society of

Table 2
Demographic profile of respondents

		Age						Total
		< 25	25 - 30	30 - 35	35 - 40	40 - 45	> 45	
Profession	Civil engineers	11	12	9	4	2	1	39
	Non-civil engineers	3	4	7	3	3	4	24
Total		14	16	16	7	5	5	63

Civil Engineers (ASCE) Policy Statement 418 highlights the role of civil engineers in sustainable development (ASCE, 2021). Although this study emphasises the role of civil engineers in sustainable development, the opinions of other construction professionals are relatively important. Thus, a comparison of the civil engineers and non-civil engineers in the sustainable development concept will be made in the next section.

Besides, a three-way cross-tabulation (contingency table analysis) was conducted to demonstrate the relationships within company size, digital tools, and managerial level of the respondents. The cross-tabulation result (Table 3) shows that small enterprises (5 < 75 employees) recorded 30 respondents. Meanwhile, medium enterprises (75 ≤ 200 employees) consist of 33 respondents. There are no micro and large enterprise respondents in this study. Table 3 reveals that junior executives in the small enterprise are keen on digital tools compared to middle and senior executives, especially in using BIM, GPS, QR code, GIS, and AI. The three-way contingency table analysis result allowed multiple options to infer that the young generation in the small enterprise has more exposure to the latest digital tools. Many studies revealed that Generation Z is tech savvy, prefers visual form, fast acquisition of knowledge and is used to social media (Wahab et al., 2018). Digital tools are, to a certain extent, drawn the attention of this generation, leading to such results.

However, the situation is different in the medium enterprise, where senior executives are more informed about digital tools than middle and junior executives. It is mostly because the senior executives in the medium enterprise have a bigger picture in company development and extensive growth strategy. Besides, medium enterprise has recorded higher exposure to digital tools than small enterprise. It can be seen from the medium enterprise BIM (total entry) 31 compared to 28 (small enterprise), GIS 23:20, and GPS 27:23, among others. In most cases, the medium enterprise construction company in Malaysia are CIDB G6 and G7, where the project amount is at least RM5 mil and above. Digital tools have become a strategic tool to improve competitiveness in the construction market. As such, digital tools are not limited to enhancing the sustainable built environment, but they also play an important role in ensuring project productivity and efficiency, which are essential for a company's development.

Table 3

Results of three-way cross-tabulation between company size, digital tools and managerial level

Category of Company Size			Managerial level			Total
			Senior executive	Middle executive	Junior executive	
Small enterprise: 5 < 75 employees	Digital tools	Building Information Modelling (BIM)	6	7	15	28
		Geographic Information Systems (GIS)	4	6	10	20
		Augmented Reality (AR)	3	0	7	10
		Virtual Reality (VR)	5	4	7	16
		3D Laser Scanning	3	2	6	11
		Global Positioning Systems (GPS)	7	4	12	23
		Radio Frequency Identification Devices (RFID)	3	2	8	13
		Photogrammetry	1	1	2	4
		Quick Response Code (QR)	4	3	11	18
		Robotics	2	1	6	9
		Artificial Intelligence (AI)	4	3	10	17
		Onsite mobile devices	1	3	4	8
		Wearable safety devices	2	3	2	7
	Total within group		8	7	15	30
Medium enterprise: 75 ≤ 200 employees	Digital tools	Building Information Modelling (BIM)	13	11	7	31
		Geographic Information Systems (GIS)	10	8	5	23
		Augmented Reality (AR)	7	7	2	16
		Virtual Reality (VR)	10	7	3	20
		3D Laser Scanning	7	7	1	15
		Global Positioning Systems (GPS)	10	10	7	27
		Radio Frequency Identification Devices (RFID)	7	7	4	18
		Photogrammetry	4	2	1	7
		Quick Response Code (QR)	8	8	5	21
		Robotics	7	2	3	12
		Artificial Intelligence (AI)	9	5	4	18
		Onsite mobile devices	3	5	3	11
		Wearable safety devices	5	6	2	13
	Total within group		13	12	8	33

RESULTS AND DISCUSSION

Comparison of Civil Engineers and Non-Civil Engineers in Digital Adoption Impacts

As discussed in the previous section, the respondents in the study are divided into civil engineers and non-civil engineers due to several studies highlighting the importance of civil engineers in a sustainable built environment. An independent sample *t*-test is conducted to examine the significant differences between civil and non-civil engineers in digital adoption. The results of *t*he t-test for equality means and the Levene's homogeneity assumption test are reported in Table 4.

Table 4

Results of independent sample t-test for impacts of digital adoption by category of a profession

		Levene's Test for Equality of Variances		*t*-test for Equality of Means	
		F	*p* value	*t*	*p* value
Impact towards the industry	Equal variances assumed	0.18	0.673	0.922	0.361
	Equal variances not assumed			0.973	0.335
Impact towards the society	Equal variances assumed	0.017	0.896	0.019	0.985
	Equal variances not assumed			0.019	0.985

Table 4 illustrates that there is no significant difference between civil and non-civil engineers in terms of digital adoption impacts on the industry and society. With the outcome of Levene's homogeneity assumption test suggesting non-rejection of the null hypothesis of equal variances, we proceed to compare the means of two independent groups (civil engineers and non-civil engineers) under the condition of "equal variances assumed", both *p* values of the *t*-test for equality of means recorded for impact towards industry (0.361) and impact towards society (0.985) are exceeding the conventional levels of significance ($p < 0.10$). This result indicated that both respondent groups (civil and non-civil engineers) have similar opinions towards digital adoptions in the sustainable built environment. It is probably due to the respondents being recruited from the same industry (construction). The intention to examine the differences among both respondent groups is due to the digital adoption agenda being significantly different. Based on the ASCE Policy Statement 418 highlights, civil engineers' role in life cycle assessments, use resources wisely and plan for resilience and validation through rating tools. Meanwhile, an architect's agenda in a sustainable built environment aims to transform architecture practice holistically, firm-wide, project-based, and data-driven (American Institute of Architects, 2022). By prioritising energy performance, AIA is mandating that highly inefficient existing buildings undergo detailed audits and upgrades to reduce their energy use, moving towards an energy transparency protocol. Civil engineers and architects focus on different agendas but ultimately work towards embracing a sustainable built environment.

Effects of Sustainable Built Environment on the Impact of Digital Tools Adoption

As suggested in the literature, the adoption of digital tools brought two important impacts: impact to the industry and society. Hence, we examine how the elements of a sustainable built environment shape the impact of digital tools adoption towards the industry and society via the multiple regression analysis. Table 5 reported the multiple regression analysis result for the impact towards the industry, while Table 6 depicted the outcome of the impact towards society. As shown in Table 5, energy conservation (EC) is the only significant sustainable element that impacted the industry. The EC element is statistically significant at a 1% level, indicating the presence of a positive relationship between energy conservation and the impact of digital tools adoption towards the industry. In addition, the F-test of overall significance (F-statistic=6.728) is statistical significance at a 1% level (p value = 0.000), whereas the R^2 is recorded at 0.473, suggesting that 47.3% of the variance found in the dependent variable (impact of digital tools adoption towards industry) is explained by the elements of the sustainable built environment. Therefore, measures of goodness-of-fit for the regression model reported in Panel B of Table 5 revealed that the regression model has a significant predictive capability, implying the existence of a relationship between the dependent variable (impact of digital tools adoption towards industry) and predictors (elements of the sustainable built environment).

In this respect, the importance of renewable energy and its promotion to access the research, technology and investment in clean energy has been well underlined in Sustainable Development Goal 7 (SDG7). Over the years, sustainable policies have been drafted according to UN SDGs, especially SDG7 (affordable and clean energy) and SDG9 (industry, innovation, and infrastructure), embedded into Industry 4.0-related policies. Taking Malaysian's Industry4WRD and National 4IR policies as examples, SDG7 became the foundation of the Industry4WRD policy; meanwhile, the National 4IR policy emphasises ecological integrity. Although most IR4.0 policies highlight the importance of digital adoption in the new era, the sustainable future remains the main agenda in all the policies.

Table 5
Results of multiple regression analysis for the effect of the sustainable built environment on the impact of digital adoption towards industry

Panel A: Parameter estimates			
Independent variables	Coefficients	*t*-statistics	*p*-values
Energy conservation (EC)	0.565	3.681***	0.001
Waste management (WM)	-0.152	-0.986	0.329
Innovation (IN)	0.124	0.523	0.603
Indoor environmental quality (IE)	0.087	0.548	0.586
Sustainable materials (SM)	0.138	0.815	0.419
Land use (LU)	-0.045	-0.217	0.829
Panel B: Measures of goodness-of-fit for the model			
R^2: 0.473			
F-statistic: 6.728*** (0.000)			

Note. Figure in parenthesis is p-value whereas asterisk (***) indicates statistically significant at 1% level.

From a boarder perspective, the sustainable built environment even shapes some larger effect on society when we look at the adoption of digital tools. Two important elements of a sustainable built environment were found to play significant roles in fostering the impact of digital tool adoption in society. These elements are energy conservation (EC) and waste management (WM). The EC element is statistically significant at a 1% level, whereas the WM element is statistically significant at a 5% level, suggesting that energy conservation and waste management are crucial elements of the sustainable built environment that potentially predict the impact of digital tools adoption towards society. Besides, the *F*-test of overall significance (*F*-statistic=9.292) is statistical significance at a 1% level (p value = 0.000), whereas the R^2 is recorded at 0.543, signifying that 54.3% of the variance found in the dependent variable (impact of digital tools adoption towards the society) is explained by the elements of the sustainable built environment. Hence, goodness-of-fit measures for the regression model reported in Panel B of Table 6 revealed that the predictors (elements of the sustainable built environment) have significant predictive capability over the impact of digital tools adoption in society.

Furthermore, the multiple regression results reported in Table 6 also showed that energy conservation brought a higher impact on society compared to waste management. It is further justified by Kumar (2020) highlights the important role of energy conservation in society. Meanwhile, Abdel-Shafy et al. (2018) explained the importance of waste management to society, especially solid waste management. Although the other elements are not significant in this study, the sustainable elements might differ in other industries.

Table 6

Results of multiple regression analysis for the effect of the sustainable built environment on the impact of digital adoption towards society

Panel A: Parameter estimates			
Independent variables	Coefficients	*t*-statistics	*p*-values
Energy conservation (EC)	0.656	4.684***	0.000
Waste management (WM)	-0.319	-2.325**	0.024
Innovation (IN)	0.298	1.374	0.176
Indoor environmental quality (IE)	-0.222	-1.542	0.130
Sustainable materials (SM)	0.209	1.364	0.179
Land use (LU)	0.004	0.019	0.985
Panel B: Measures of goodness-of-fit for the model			
R^2: 0.543			
F-statistic: 9.292*** (0.000)			

Note. Figure in parenthesis is p-value whereas asterisks (***) and (**) indicate statistically significant at 1% level and 5%, respectively.

CONCLUSION

This study intended to examine the digital's role in the sustainable built environment by investigating the relationship between elements of a sustainable built environment and its impact on society and industry. Besides, this study has taken additional steps to look into the construction professional's role, i.e. civil and non-civil engineers, in relation to the digital adoption impacts. There is evidence that both civil and non-civil engineers have a similar perspective on the impact of digital adoption.

This study reveals that energy conservation is the most important element in the sustainable built environment, which impacts society and industry. The analysis result is supported by the highly significant regression model, and the result is tallied with some precedent studies. The study's outcome is important to assist industry practitioners in facilitating sustainable development by formulating new working culture. Besides, based on the digital tools adopted in small and medium enterprises helps the authorities to embrace Construction 4.0 Strategic Plan (2021–2025) implementation more strategically.

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