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The Adoption of Green Buildings among Contractors in Malaysia

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Abstract

Purpose: The proliferation of green buildings is seen as a cost-effective approach to reduce energy use as well as a key construction strategy. However, green building construction has failed to draw the attention of Malaysian contractors because of lack of expertise and awareness as well as uncertainty. Therefore, the purpose of this study is to find the factors that influence the adoption of green building among contractors in Malaysia.

Design/methodology/approach: This study uses Technology Acceptance Model (TAM) by focusing on six variables, namely the external factors, perceived ease of use, perceived usefulness, attitude, behavioural intention, and green building, that influence the adoption of green building in construction. The sample of the study includes 138 contractors in Malaysia. The SMART PLS 3 technique is used to evaluate the factors influencing the adoption of green buildings.

Findings: The findings show that external factor has a significant effect on the perceived usefulness and perceived ease of use; perceived ease of use has a significant effect on perceived usefulness and attitude; perceived usefulness has a significant effect on attitude and behavioural intention; attitude has a significant effect on behavioural intention; and behavioural intention has a significant impact on green buildings.

Research limitations/implications: The implications found involve the requirement of the latest economic and social climate and a tight coordination between the government, local authorities and industry players. The government and local authorities are bound to follow the global moves towards reducing the carbon impact arising out of construction activities, while the industry players are reluctant to follow the effort because of the high starting cost when initiating the green practice.

Practical implications: The government and local authority in Malaysia may take an active role as both controller and leading supporter of green building adoption among contractors. By implementing the needed legislation, the technical codes, and the guidelines to manage building environmental performance, the government may be able to respond to the industry's sustainable trend. In addition, the government may play as the key role in promoting development by identifying and implementing direct financial and non-financial incentive policies.

Originality/value: From the TAM Model, this study contributes to the factors that influence the adoption of green building among contractors in Malaysia.

Keywords: Green Building, TAM Model, Perceived Usefulness, Perceived Ease of Use, Attitude, Behavioural Intention

Introduction

Compared to traditional buildings, green buildings use less resources and energy. Green buildings aim to minimise the impact on the environment and human health (Aghili et al., 2019). However, due to the need for technological capability, lack of competition, and the fact that it is generally produced abroad, new technology is seen as costly. The construction industry consumes a large number of natural resources and electricity, emits emissions, and produces a lot of waste (Mahat et al., 2019). Therefore, the role of contractors in Malaysia includes being proactive in implementing green buildings in construction.

Green construction is widely related to green technology, particularly to reduce energy consumption, internal cooling, water conservation, and the use of environmentally friendly materials (Mahat et al., 2019). Furthermore, the construction industry in Malaysia contributes greatly to the country's economic and social growth. The industry has contributed to continue the competitiveness of economic and quality of life, providing favourable environment for the development in the future (Mahat et al., 2019).

Green building construction will influence consumer factors, especially contractors as the user s performing the construction. As consumer acceptance of technology has a large impact toward the implementation success, a contractor is a highly significant component to consider while implementing technology. The problem formulated is the suitability of the Technology Acceptance Model (TAM) in measuring the most important factor of green implementation construction, either consumer acceptance or influence.

The research findings were supposed to aid in the resolution of implementation issues in green buildings. The rate of usage acceptability can boost the usefulness of implementation. They may deliver good performance to the application of environmentally friendliness in buildings.

Literature Review

The Need for Green Building Practice

Building and demolition materials are produced throughout the construction of a new building, as well as during the rehabilitation or demolition of an existing structure. For example, concrete, steel and wood are heavy materials commonly used in big quantities in modern construction (Lu et al., 2019). Excess and degraded materials caused by construction activities are referred to as construction waste, also known as construction and demolition (C&D) waste, including new building construction, renovation, and demolition (Lu et al., 2019). The plastics, wood, glass, bricks, tiles and ceramic, and concrete and bricks are divided into eight groups by the "European Waste Directory".

Besides, waste products are produced when being disposed of in one of these ways: landfilling, recycled materials for new applications, waste incineration, or direct on-site reuse. Because of increasing cost of manufacturing, recycling building and demolition of waste materials are always difficult. Businesses that recycle products must deal with landfills and new construction materials regularly. Construction and demolition (C&D) waste

materials accounted for 23 percent of overall solid pollution in the United States, according to a study based on data from 24 states. This amounts to approximately a quarter of all solid garbage produced in the United States, and it excludes the water polluted during the time spent and construction in a landfill, which releases hazardous chemicals into the atmosphere.

Malaysia's construction industry is critical to the country's economic and social growth. The industry has contributed to sustaining the competitiveness of the economy and quality of life, providing a good built environment for the future (Isa et al., 2019). The government, private companies, and the general public have paid more attention to partnering with the industry to encourage the realisation of green building technology in the built environment, uniform design of energy-efficient buildings, and barrier-free entry (Isa et al., 2019).

Green Building

The concept of green building (GB) emerged from the growing awareness of sustainable development in the 1960s. It provides a plan to decrease the impact of the buildings on the environment, as well as improving human well-being, the communities, environmental health, and overall cost of life. GB is the overall practice of achieving sustainability throughout the life cycle of a project (Raouf & Al- Ghamdi, 2019).

With the objective to expand the area of green buildings throughout the world, the World Green Building Council (World Green Building Council) emphasized that the built environment's physical design and construction process could save energy, water, and carbon emissions, promote health and well-being, provide education, and create green buildings. The world has plenty of resources and the effort is focused on saving the resources (Raouf & Al-Ghamdi, 2019).

Green building minimizes or destroys negative effects on our climate and nature while also having the ability to build positive ones through construction, design, or service. The green buildings not only improve our quality of life, but also help to protect the environment. It is also worth noting that not all green buildings are – or need to be – the same. Climate, culture, and traditions differ by country and area, building types and ages, as well as social, economic, and environmental concerns, all of which influence how they approach green construction.

Furthermore, the ideal green building project would protect most of the natural environment while still allowing the development of a useful structure. The design and operation of the structure would promote a sustainable environment for all parties concerned, with minimum interruption to the soil, water, services, or energy in and around the structure. That is what a green construction really means (Solla et al., 2020).

Barrier of Green Building Implementation

Political considerations include a lack of official backing and promotion. One of the top three most essential impediments to the growth of green building, according to a Ghanaian professional surveyor, is the lack of government incentives, stressing the government's position as a vital component of the process (Chan et al., 2018).

Other impediments, such as a lack of market demand and the risks and uncertainties associated with the deployment of new technologies, were also identified as critical variables in a study done in the United States (Darko et al., 2017). In their analysis, the most significant barrier was reluctance to change, followed by lack of information and understanding the

benefits of sustainable buildings. Furthermore, according to the report, resistance to change may influence the success of green buildings in the United States (Darko et al., 2017).

Theoretical Framework and Hypothesis Development

TAM has gained widespread acceptance as a reliable model for use. External factors, such as personal values and trusts, lead to actual acts, according to the theory's fundamental premise (Kim et al., 2017). External variables, for example, personal fbeliefs, and standards, have a significant effect in an individual's desire to do an action, according to this hypothesis (Kim et al., 2017).

Improving water capability, productivity, human health and welfare, interior environmental quality, and property profit have all been proven to be some of the environmental, economic, and social benefits of green building adoption, according to numerous studies. This study depicts the theoretical domain of the TAM model, external factors (political, social and culture, and economic), perceived usefulness, perceived ease of use, attitude, and behavioural intention to develop a non-segregated framework including the variables influence on the acceptance of green building practice.

i. External Factors

The external factors consist of economic, political, social, and cultural aspects. The government is assisting the development of a capable and viable local construction sector by encouraging green building products. The government has given a tax break equivalent to 100% of the additional capital investment required to receive the GBI credential, as well as a RM1.5 billion Green Technology Financing Scheme as part of a soft loan to encourage developers and owners to use green technology and materials (Solla et al., 2020). The important roles in shaping a person’s behaviour are social and cultural. Providing developers and buyers with appropriate education on the economic viability of green building development will increase interest in green project execution and demand.

H1: External factor has a significant effect on the perceived usefulness. H2: External factor has a significant effect on the ease of use.

ii. Perceived Ease of Use

PEOU stands for "perceived ease of use," which is described as "the degree to which a person believes that utilizing a certain technology would be painless". Experience and beliefs have an impact on PEOU. PEOU, as an external variable, influences behaviour and intention indirectly via PU. A past study has confirmed the causal link between PU and PEOU (Rajaee et al., 2019). PEOU has also been linked to actual use or behavioural intention, according to research (BI). Some academics question PEOU's direct impact on actual consumption or BI. People's perceptions of ease of use are linked to their previous experiences. According to recent study, perceived ease of use does not directly increase the intention. However, it has an influence on attitude and perceived usefulness.

H3: Perceived ease to use has a significant effect on perceived usefulness.
H4: Perceived ease to use has a significant effect on attitude.

iii. Perceived Usefulness

Perceived usefulness (PU) is the extent on how a person feels that using a given strategy increases their performance to achieve a desired goal. Another definition by Davis (1989) outlines that the degree to which a person feels that employing a certain system would increase his or her job performance. PU is described as a benefit of new technology that has a considerable positive impact on people's attitudes and intentions to adopt it (Rajaee et al., 2019). It is a predictor to detect a person's intention to use technology and their definite use of technology.

H5: Perceived usefulness has a significant effect on attitude.
H6: Perceived usefulness has a significant effect on behavioural intention.

iv. Attitude

Attitude is a psychological term when one deals with something pleasant or unattractive. It is a long-term appraisal of a problem. According to the TAM model, one's attitude toward technology influences one's desire to use it (Rajaee et al., 2019).

H7: Attitude has a significant effect on behavioural intention.

v. Behavioural Intention

The potential that a person's perceived or "subjective likelihood that he or she would engage in a given behaviour" is defined as behavioural intention (BI). This refers to the motivational factors that affect a specific action, with the greater the intention to perform the behaviour, the more likely it will be done.

H8: Behavioural intention has a significant impact on green building.

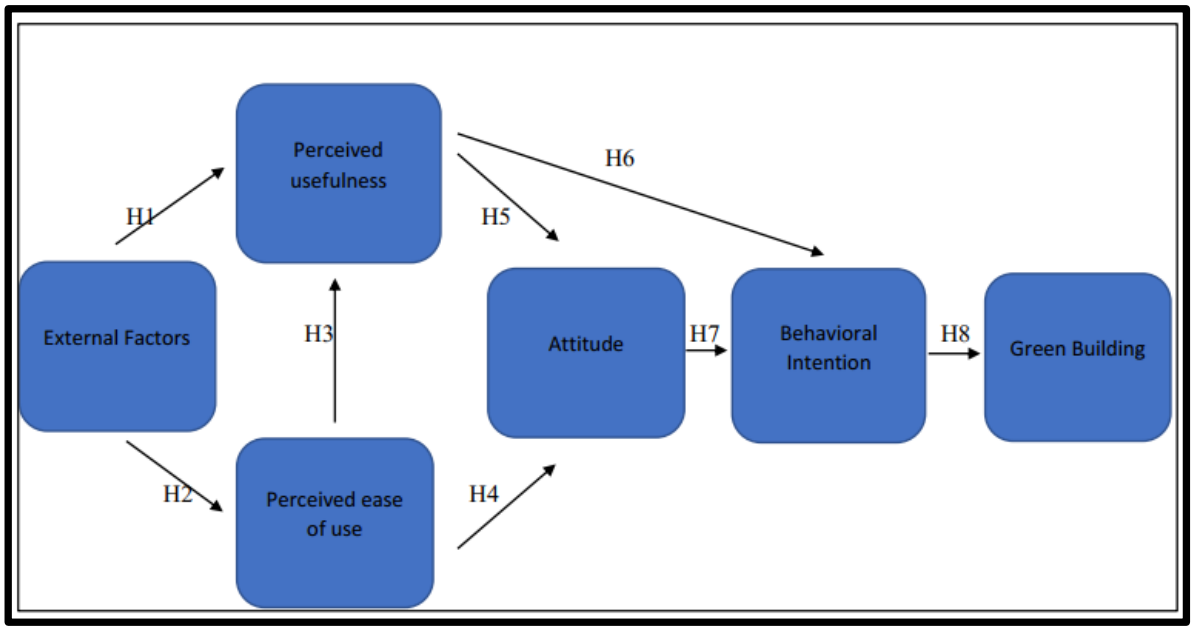

Figure 1: Theoretical Framework

Method

Research Design

The data for this study were collected via online survey. Online survey was done by using the Google Form to examine the adoption of green buildings among contractors in Malaysia. This research employed the cross-sectional descriptive design. The cross-sectional design studies the sample at any point of time and focuses on numerical values where the sample can be collected at any given time. The ability for the data to be quantified and the elements of time and cost were the reasons for choosing this research design. The data collection took three months.

Measurement Development

This study used a close-ended survey questionnaire to measure the data collection. This research relied on original data. The raw data obtained by the researcher for research purposes was referred to as the primary data. The main data from the respondents were listing the perception of contractors in Malaysia in green building acceptance in construction. The respondents of this study are grade-7 contractors. Each pointer of these variables was used as questions and presented to the respondents as shown in Table 1. The measurement techniques in the data questionnaire in this study used a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree).

The questionnaire was divided into four categories. The first category is the general information including gender, age, and experience. While thar, the second until fourth categories are focusing on the variables of TAM.

Population and Sample

The research was designed to survey the adoption of green building among contractors in Malaysia. The target population of this research is the grade-7 contractors in Peninsular Malaysia. According to the CIDB online directory, Malaysia has 7,322 construction builders in 2021. The sample size was 138 respondents working as contractors.

Procedure

The online survey was created using Google Form, and the link was distributed by using WhatsApp, Facebook, and Instagram. Participants completed the questionnaire either by mobile phone, tab, or computer by accessing the link provided. The data collection technique was difficult because it must be completed during the COVID-19 pandemic. The questionnaire, on the other hand, was distributed to the respondents through Google Form. The data collection method was quite difficult because most respondents were not adequately assisted in answering the researcher's questionnaires. It took a long time to meet the sample size goal.

Data Analysis

The analysis and data were calculated using the Smart PLS 3 to allow complex cause-effect relationship models with latent variables to be measured. Structural Equation Modelling (SEM) is a multivariate method used to test the hypotheses. In addition, Smart PLS is the window software widely used for data entry and analysis that can help in creating tables and graphs. The graphical display and result reports were generated, which made data interpretation easier and convenient.

Findings

The questionnaire was sent to 138 respondents. There are 44.2% or 61 female respondents and 55.8% or 77 male respondents. In terms of working experience, a total of 16 respondents or 11.6% have 2 years of experience while most respondents, 57 or 41.3%, have experience of 3–5 years. For 6–10 years, there are 31 respondents or 22.5%, and 25 respondents or 18.1% have 11–20 years of experience. For respondents with working experience less than 20 years, there are only 9 or 6.5%. Regarding the education level, respondents with PhD have the least number, which is 4 or 2.9%. Most respondents' education level is bachelor's degree, which are 53 or 38.4%. Diploma/ Technical school certificate holders make up to 31 respondents or 22.5%, and SPM/STPM/ Diploma/ A-level has 20 respondents or 14.5%.

The data were collected by the partial least squares (PLS) method. The partial least squares (PLS) approach was used to analyse the data. PLS may also be used to analyse the structural links between constructs and confirm the validity of a given instrument's concept. The measurement and structural models of this study were assessed using an assistive tool, such as the statistical software Smart PLS 3.0. The measurement models (outer models) evaluated indicators' ties to latent variables, whereas structural models (inner model) evaluated the latent variable relationships.

Measurement Models

The indicators on latent variables were evaluated using the PLS measurement model, which looked at convergent and discriminant validity of individual indicators as well as composite reliability of a block indicator. Program is a structural equation modelling tool that allows complex cause-effect relationship models with hidden variables to be measured. Structural Equation Modelling (SEM) is a multivariate method used to test hypotheses. The following three criteria were used as a rule of thumb for measuring scales as suggested by Jogiyanto and Abdillah (2009): (1) all indicator factor loadings should be greater than 0.5%; (2) composite reliability should be greater than 0.7%; and (3) the cross-loading indicator score should be greater than the other indicators.

Convergent validity was determined by looking at loading factors between indicators and PLS scores. Table 1 provides the loading factor score for convergent validity. The value from each outside loading was used to calculate the measurement. If the factor loading scores of an indicator were greater than 0.5, it was considered qualified. Convergent validity also indicated how closely the components of a certain instrument were connected.

Convergent Validity

Table 1. Convergent Validity

Construct	Item Code	Item	Outer loading	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
EF	EF1	1.Political factors affecting the green buildings.	0.815	0.817	0.888	0.726
	EF2	2.Social and culture factors affecting the green buildings.	0.87			
	EF3	3.Economic factors affecting the green buildings.	0.871			
PU	PU1	1. Green buildings are useful to protect the environment.	0.704	0.773	0.845	0.525
	PU2	2. Green buildings are useful to conserve building materials.	0.65			
	PU3	3. Green buildings are useful to reduce household expenditures.	0.83			
	PU4	4. Green buildings are useful to improve the resident's living comfort.	0.792			
	PU5	5. Using the green building in construction improves my performance.	0.627			
PEOU	PEOU1	1.The green building is easy to build.	0.571	0.732	0.823	0.542
	PEOU2	2. The construction of green building does not require mental effort.	0.715			
	PEOU3	3. The adoption of green building is clear and understandable.	0.829			
	PEOU4	4. I am familiar with green building in construction.	0.803			
ATT	ATT1	1. I found that using the green building in construction is a good idea.	0.771	0.615	0.778	0.479
	ATT2	2. I found that using the green building in construction is advisable.	0.813			
	ATT3	3. I support the development of green building.	0.685			
	ATT4	4. I found that green building is easier to construct compared to conventional building.	0.437			
BI	BI1	1. I would like to build green buildings.	0.809	0.688	0.828	0.616
	BI2	2. I would like to use green building's material.	0.757			
	BI3	3. I would like to recommend green building to my friends and family members.	0.787			
GB	GB1	1. I prefer the green building in construction approach because it is more efficient and effective on environment	0.663	0.507	0.737	0.496
	GB2	2. I found the green building procedures very interesting.	0.887			
	GB3	3. Malaysia has limited numbers of green building.	0.51			

Note*: EF= External Factor; PU= Perceived Usefulness; PEOU= Perceived Ease of Use; ATT= Attitude;BI= Behavioural Intention; GB= Green Building*

Discriminant validity

According to Hair et al. (2017), the suggested HTMT value is 0.7 and above, and if the value exceeds 0.9, the variable should be reported using the Fornell-Larcker criterion.

After running the calculation using the SMART PLS 3, it was found that the variables of external factor, perceived ease of use, and perceived usefulness did not exceed the value of 0.7. Therefore, the Fornell-Larcker criterion needed to be used as tabulated in Table 2.

Table 2: Fornell-Larcker criterion

	ATT	BI	EF	GB	PEOU	PU
ATT	0.692					
BI	0.528	0.785				
EF	0.115	0.207	0.852			
GB	0.425	0.429	0.066	0.704		
PEOU	0.412	0.507	0.277	0.151	0.736	
PU	0.372	0.411	0.342	0.397	0.267	0.725

The values from Fornell-Larcker criterion mean the second method for determining discriminant validity is the Fornell-Larcker criterion. It compares the latent variable correlations to the square root of the AVE values. The square root of each construct's AVE should be bigger than the greatest correlation with any other construct. Another way to evaluate the Fornell-Larcker criterion's results is to see if the AVE is greater than the squared correlation with any other concepts. The Fornell-Larcker technique is based on the concept that a construct's related indicators share more variations than any other constructs.

Table 3: Summary of Hypothesis Testing

Hypothesis	Path	Std. Beta	Std. Error	t- value	p- value	Confidence Interval			Decision
						Bias	2.50%	97.50%	
H1	ATT -> BI	0.436	0.077	5.682	0	0.008	0.247	0.564	Supported
H2	BI -> GB	0.429	0.072	5.95	0	0.015	0.238	0.55	Supported
H3	EF -> PEOU	0.277	0.095	2.914	0.004	0.004	0.086	0.443	Supported
H4	EF -> PU	0.291	0.082	3.566	0	0.003	0.111	0.436	Supported
H5	PEOU ->ATT	0.337	0.098	3.45	0.001	0.005	0.107	0.492	Supported
H6	PEOU ->PU	0.186	0.101	1.84	0.066	0.01	-0.087	0.346	Not Supported
H7	PU -> ATT	0.282	0.094	3.006	0.003	0.005	0.073	0.435	Supported
H8	PU -> BI	0.249	0.077	3.226	0.001	-0.006	0.109	0.407	Supported

The results of hypothesis testing are shown in Figure 1. H1 and H2 are supported by all hypotheses generated from the primary variable of TAM. External factor is found to have a significant effect on the perceived usefulness and perceived ease of use, and in detail, the political, social and culture, and economic factors.

From the analysis, a total of 7 hypotheses supported while 1 hypothesis did not support. For hypothesis 1, the p-value was 0, which signified the path between the external factor and perceived usefulness. This hypothesis was supported as the t-value was 3.566. For hypothesis 2, the p-value was 0.004, which signified the path between external factor and perceived ease of use. The second hypothesis was supported with the t-value of 2.914. For hypothesis 3, the p-value was 0.066, which relied on the path perceived ease of use and perceived usefulness, with t-value of 1.84. This hypothesis was not supported as the p-value was more than 0.05. For hypothesis 4, the p-value was 3.006, which signified the path between perceived ease of use and attitude. This hypothesis was supported as the t-value was 3.45. Hypothesis 5 was supported by 0.003 for p-value and 3.006 for t-value, which laid on the path of perceived usefulness and attitude.

According to the literature, this is possible because the external factor in TAM recommends that government assistants may pay stakeholders for the higher cost of green construction, which encourages green construction (Darko et al., 2017). Residents will be more likely to accept green buildings if they perceive greater utility (e.g., energy saving and health benefits) and ease of use (e.g., the ease with which green building technology may be operated) (Liu et al., 2018). PU refers to how users perceive technological capabilities in terms of environmental protection, energy management, economic saving, and building upkeep. According to reports, PU is a powerful and favourable predictor of attitude toward technology and intentions to use it (Rajaee et al., 2019).

Hypothesis 6 showed that the p-value of path between perceived usefulness and behavioural intention was 0.001 with a t-value of 3.226, and the hypothesis was supported. For hypothesis 7, the t-value was 5.682, and the hypothesis was supported and showed a strong path between attitude and behavioural intention. Based on literature, this is possible because attitude contributing to the mindset of the contractors may also play a key role in the decision-making process when it comes to using green building materials in construction. The public's willingness to accept green buildings can be guided by a broad environmental mentality (Liu et al., 2018). This is possible because the attitude contributing to the mindset of the contractors may also play a key role in the decision-making process when it comes to using green building materials in construction. It is believed that the public's willingness to accept green buildings can be guided by a broad environmental mentality (Liu et al., 2018).

For hypothesis 8, it was supported with t-value of 5.95 and p-value of 0 that signified the path of behavioural intention and green building. This is possible because the behavioural intention contributing to the advocacy efforts in promoting green building place a greater emphasis on the benefits of green buildings than on their cost for contractors to become more interested in green building development. Promoting environmentally friendly items and promoting green construction plans can produce a powerful operational synergy for the early stages of social adoption of green technologies (Rajaee et al., 2019). The influence in this study indicates that the contractors had the tendency to understand that green buildings in construction benefit the construction industry in Malaysia.

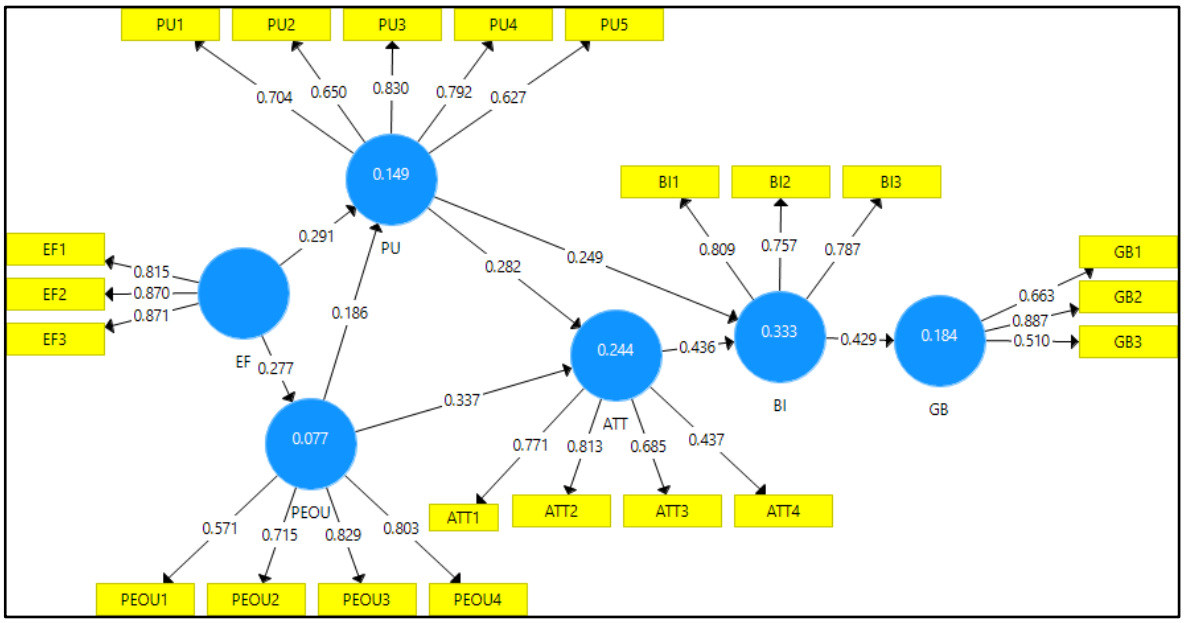

Figure 2: Hypothesized PLS Path Model

Therefore, there are indicators with outer loading less than 0.4 which need to be deleted and there is a need to run the calculation for the second time. The modified PLS-path model is shown below.

The R-squared, also known as the coefficient of determination, is a measure of the overall effect size for a structural model in regression. The variance will display the values calculated from all exogenous variables that are associated with endogenous variables (Hair et al., 2017). The results show that attitude has a value of 0.244, and this value is weak. For the R^2 of behavioural intention, the value is 0.333, this value is suggested to be almost average. The R^2 value for green buildings is 0.184, and this value is weak. This is also the same for perceived ease of use where the value of 0.077 is also considered weak. The R^2 value of perceived usefulness is 0.149, and this value is suggested to be weak. F2 is a measurement that measures a highly precise exogenous variable relationship between endogenous variables, as opposed to Q2, which is a measure that measures all values in the endogenous variable (Hair et al., 2017). When 'attitude' is linked to 'behavioural intention', it gives a value of 0.245. Next, behavioural intention linked with green building gives a value of 0.225, which shows a large effect. Furthermore, external factor linked with perceived ease of use gives value of 0.083. Also, external factor linked with perceived usefulness gives value of 0.092. Then, perceived ease of use linked with attitude gives value of 0.139. Perceived ease of use linked with perceived usefulness gives value of 0.038. Perceived usefulness linked with attitude gives value of 0.097. Finally, perceived usefulness linked with behavioural intention gives value of 0.08. The Q^2 value for perceived usefulness is 0.066, which means the relationship is weak (Hair et al., 2017) between the independent and dependent variables. Next, Q^2 value for perceived ease of use is 0.034. The value of Q^2 for attitude is 0.093. Furthermore, Q^2 for behavioural intention is 0.184. Lastly, value of Q^2 for green building is 0.075.

Two stage model: PLS- SEM

Researchers commonly use PLS-SEM or partial least squares structural equation modelling, also known as PLS path modelling. This software is often used since it can create a route model for the study, as well as measure and estimate each variable simultaneously. The intricacy of the item's model is the key rationale for using PLS-SEM in this study. The association between the variables is explicitly shown using PLS-SEM. Before beginning the analysis using PLS-SEM, the data must first be inspected in Microsoft Excel before being sent to PLS-SEM. The path model is generated and studied after the data has been sent. The convergent validity, which includes outer loading, average variance extract (AVE) construct reliability, and Cronbach's Alpha, is then assessed. The evaluation of discriminant validity, which includes the Fornell-Larcker criterion, is the next stage. The hypotheses proposed earlier in the research are then examined using bootstrapping using a single-tail test type. We may use the t-value or p-value to determine if the hypotheses are accepted or not. The hypotheses are supported if the t-value is greater than 1.65. In the meantime, if the p-value is less than 0.05, the hypotheses are supported.

Discussion and Conclusion

The purpose of this study is to examine the adoption of green building among contractors in Malaysia. The theoretical framework of TAM is adopted using external factors, perceived usefulness, perceived ease of use, attitude, and behavioural intention. According to

the findings, elements in the construction application have an impact on the adoption of green building among contractors. The investigation reveals that external factors, such as perceived ease of use, perceived usefulness, attitude, behavioural intention, and green building, have an impact on contractor acceptance of green building adoption. The behavioural intention of green building, which has a favourable effect on green building, is the most influential TAM variable on user approval. Seven hypotheses are supported, showing that the implementation of green building is accepted among contractors. The contractors are also ready to adopt green building in construction in Malaysia. However, there is one factor that needs to be focused on among contractors and also the government.

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