Malaysian Journal of Sustainable Environment
Vol.10.No.2 (2023) 273-304
doi: 10.24191/myse.v10i2.23641

VIRTUAL ENVIRONMENT FOR SUSTAINABLE HOUSING DEVELOPMENT: EXPLORING SATISFACTION AND ENJOYMENT IN IMMERSIVE VISUALIZATION

Athira Azmi*[1], Rahinah Ibrahim[2], Maszura Abd Ghafar[3] & Ali Rashidi[4]
***Corresponding Author**
[1,2,3]Department of Architecture, Faculty of Design and Architecture, Universiti Putra Malaysia
[4]Department of Engineering, La Trobe University, Melbourne, Australia

*athira.azmi@upm.edu.my, rahinah@upm.edu.my
maszu@upm.edu.my & a.rashidi@latrobe.edu.au
Received: 12 July 2023
Accepted: 08 August 2023
Published: 31 August 2023

ABSTRACT

One of the objectives of sustainable development is to create a world of interconnected spaces that incorporates smart technologies such as virtual reality (VR) in every phase. This includes the use of virtual environment to replace physically built show units for sell-then-built housing development. With this vision, it is vital to evaluate how the virtual environment impacted satisfaction and perceived enjoyment, which are the two key predictors of purchase intention. This paper hypothesized on the relationships between the atmosphere, satisfaction, and perceived enjoyment in the virtual environment with purchase intention. An experiment with 60 real potential homebuyers was conducted to test the hypotheses. Results analyzed using paired samples t-test indicate that the atmosphere, satisfaction, perceived enjoyment, and purchase intention is statistically different ($p < 0.05$) in the physical and the virtual environment, while the PLS-SEM analysis revealed that the atmosphere in virtual environment positively effect satisfaction and perceived enjoyment, which subsequently positively effect purchase intention. The results presented in this paper would lead towards an

enhanced development using virtual reality in smart cities that incorporates intelligence in human-computer interactions and consumer experience. This study extends the theory of consumer behaviour in architecture design for a smarter design that incorporates human emotions and behaviour in decision-making.

Keywords: *Sustainable Housing Development, Virtual Reality, Virtual Environment, Environmental Psychology, Human-Computer Interactions*

INTRODUCTION

The Industrial Revolution (IR 4.0) has directed different industries to revolutionize their strategies towards the application of innovative technologies and virtual commerce. In smart property development and real estate, virtual commerce and marketing would be part of the engagement approach to engage with potential homebuyers all over the world that are connected virtually through the internet. Virtual reality (VR) was found to positively influence emotions and generates positive consumer responses that impacted purchase intention in smart marketing (Martínez-Navarro et al., 2019, Pizzi et al. 2019, Ball et al. 2021 and Schiopu et al. 2021).

For example, Martínez-Navarro et al., 2019 found that virtual stores are more effective in generating customer behavioural and evaluative responses, while Pizzi et al. 2019 proved that VR technology offers greater advantage in product presentation compared to conventional marketing techniques, as well as contributing towards positive consumer experiences and facilitate purchase decision. Additionally, Ball et al., 2021 found that the use of VR has significantly increased post-Covid-19 pandemic, which leads to an industry boom in various sectors, especially the consumer market. VR was also proved to benefit the tourism sector in times of the Covid-19 pandemic and positively influence users' intention to travel.

With the current trend towards digital visualisation technologies and the increasing interest in connections and interactions within the virtual world, this paper foresees the potentials of these digital technologies to achieve sustainable development through design intelligence within the architectural design process that leverages efficient and sustainable digital

technologies. To achieve this, it is vital to assess how the virtual environment impacted human behaviour. Furthermore, to fully realize the advancement of built environment in the digital world, five essential features of user experience need to be thoroughly examined – identity, attractiveness, novelty, usability, and interaction (Jeon, 2021). This study specifically investigates human-environment interactions within the virtual environment for housing development.

Moreover, after conducting literature review, it was observed that there is limited research that investigates human-environment interaction in VR within a residential context and how their behaviour is impacted in the virtual environment (Ibrahim et al., 2023; Wrase et. al, 2023 and Sihi, 2018). Prior study by the authors has proven the relationship between the atmosphere in the virtual environment with potential homebuyers' pleasure and arousal emotions, and the subsequent influence of pleasure towards home purchase intention (Azmi et al. 2021).

In addition, various marketing research has also investigated the influence of the atmosphere towards satisfaction and perceived enjoyment; and how these two constructs influenced consumer behaviour such as purchase intention (Park et al., 2018 and Shuhaiber & Mashal, 2019). As a continuation to the prior research, this paper focuses on the influence of atmosphere towards satisfaction and perceived enjoyment, which are the key predictors for residential purchase (Andrew & Larceneux, 2018).

LITERATURE REVIEW

Sustainable Design Intelligence

Over the past decade, emotional intelligence has been the focus of research from different disciplines of studies to explore the advantage of applying the concept to benefit their respective fields. According to Salovey & Grewal (2011), emotional intelligence is the skill that brings together the fields of emotions and intelligence by viewing emotions as useful sources of information that help one to make sense and navigate the social environment. Emotional intelligence is proven by researchers to be a critical success

factor in different fields such as education, business, medicine, and nursing (Kozlowski et al., 2018). However, this concept remains largely unexplored in the AEC industry (Zhang & Fan, 2013; Pryke, Lunic, & Badi, 2015).

There is a considerable gap in studies that examine how emotional intelligence is applied in design (Heydarian et al., 2015), specifically for the built environment in the industrial revolution 4.0 era. In architecture, particularly for housing design, emotional intelligence could be portrayed through the design that meet its occupants' need and preferences as it has a substantial impact on the well-being of its inhabitants (Narendra & Navitas, 2022).

In this paper, the authors define sustainable design intelligence as design that incorporates the emotional needs and satisfaction of end-users using digital visualisation technologies. Sustainable design intelligence in architectural design process requires architects to not only have skills to solve technical problems, but also understanding how the design would affect the occupants' emotions and behaviour by using digital technologies that is more efficient and sustainable. Azmi et. al (2021) proves that human emotion in the virtual environment is similar compared to the real environment.

Digital visualization technologies such as VR offer sustainability benefits compared to conventional architectural representations. Visualization of housing design using VR would eliminates the need for physical models, prototypes, and printed drawings, which significantly reduces resource consumption. This would help minimizes wastes, energy consumption and environmental impact associated with the production and disposal of these physical materials. Visualization through VR would also allow for remote collaboration and communication among project stakeholders and end users, thus eliminating the need for physical meetings and travels. This would reduce carbon emissions and promote sustainable business practices.

The Virtual Environment

The duality of the real and virtual world or digital twins that allow realistic virtual representation of the natural and built environment (Bolton

et al., 2018) would revolutionize the way human connect, socializes, and conduct businesses through VR technology. According to Lee, Chung, and Lee (2013), VR allows for the immersion between the physical and virtual environment through simulation that imitates the real world. In recent years, the VR technology market has expanded tremendously with an expected value of $6 billion in 2020 (Pizzi et al., 2019). Studies have shown the vast potential of VR for application in various fields and industries including architecture, engineering, and construction (AEC) (Du, Zou, Shi, & Zhao, 2018), consumer products (Meißner, Pfeiffer, Pfeiffer, & Oppewal, 2017; Van Kerrebroeck, Brengman, & Willems, 2017), and psychology (Shin, 2018).

There are several studies that prove the advantage of VR in marketing. For example, Scarpi, Pizzi, and Visentin (2014) and Martínez-Navarro et al. (2019) found that stores that applies VR technology could enhance shopping efficiency and generates positive customer behaviour. On the other hand, in the real estate market, Sihi (2018) found that VR is convenient for buyers and realtors to experience houses in different geographical locations. Despite the extensive research in VR, this study found that most research focused mainly on the VR equipment. With the growth of VR users, the direction of current research trend towards the IR 4.0, and the rapidly evolving digital age that takes control of every aspect of human life, this study emphasizes on the need for understanding how the VR impacted human emotion and behaviour. This proposition is in line with Suh and Prophet (2018) who argue that the study on human aspects and behaviour in the virtual world seems to be overlooked.

The expanding virtual technologies development has driven companies to radically reinvent new business model that aim to deliver their businesses digitally through simulated environment such as VR (Kraus, Kanbach, Krysta, Steinhoff, & Tomini, 2022). Digital business transactions would significantly extend the scope and extent of economic activities to reach out to more customers from different geographical locations. As VR became an integral part of the IR 4.0, this study calls to enhance the housing development industry towards a more enhanced and sustainable business models by taking advantage of VR technology. With that, effective strategies to integrate these technologies into their business could be implemented efficiently to garner the potentials of the virtual technologies.

Thus, the study presented in this paper is the first step towards achieving the seamless and coherent approach to the virtual environment for a more sustainable housing industry. It is paramount to investigate factors that are influential in marketing using VR. Accordingly, this research believes that it is pertinent to compare and analyse user interactions between the two different environment – real and virtual, to recommend future trend in consumer behaviour within the virtual environment.

Sustainable Marketing in Virtual Commerce

Virtual commerce can be defined as the activities involving commerce held in the virtual world (Shen, Tan, Guo, Zhao, & Qin, 2021). Virtual commerce is one of the most important potentials of the digital world as it would allow for a more sustainable business activities and transactions with no limitations of the physical boundaries. The integration of VR as an immersive technology infrastructure to evoke the sense of presence in the virtual environment is vital in virtual business and marketing (Shen et al., 2021). This study argues that for virtual commerce to be realized effectively, it is vital to evaluate how consumer behaviour is influenced by the virtual environment.

In marketing research, various studies were done regarding the effect of environment on consumer behaviour. Most research focused on how purchase decisions are motivated by the consumers' emotions (Shen et al., 2021). For example, in a restaurant setting, Horng and Hsu (2021) found that restaurant environment with aesthetic simulations influences the customers' behaviour. In addition, research has found that immersive virtual store impacted consumers' perceptions and buying behaviour (Lombart et al., 2020). In a home-buying context, the environment of the house that influences emotion also plays a crucial role in influencing purchase decision. Studies shown that the perceptions of family life portrayed by the house environment have strong relationship with emotions, which influences purchase decision (Jørgensen, 2016). In addition, Andrew and Larceneux (2018) demonstrates that homebuyers' emotions were dominated and significantly affected by the visual evaluation of the house's environment. Furthermore, research also shown that visual representations of houses for sale can generate desired consumer behaviour (Skrede & Andersen, 2020).

However, this paper found a gap in the literature concerning virtual marketing for the housing development context. In their research, Tseng and Giau (2022) proved that immersive VR could evoke a higher sense of presence and detailed spatial recognition as housing pre-occupancy evaluation tool. However, this paper argued that more study is needed to investigate the potential homebuyers' acceptance of this technology as pre-occupancy evaluation tool. The practicability of VR as a marketing medium for real estate to influence potential homebuyers' emotion and purchase behaviour found to be the gap in the existing literature.

Based on the different theoretical perspectives in consumer behaviour, this paper examine how purchase intention was influenced by emotions. This paper specifically applies the stimulus-organism-response (S-O-R) framework as the theoretical foundation in this study because this framework has been widely used as the theoretical foundation in consumer behaviour studies (Chan, Cheung, & Lee, 2017). Henceforth, the authors aim to extend this theory to understand the impact of virtual environment on consumer behaviour, which has not been extensively done in prior research in the literature.

Stimulus-Organism-Response (S-O-R) Model

The S-O-R model (Mehrabian & Russell, 1974) originates from the field of environmental psychology that suggests the environment is the stimuli (S) that influence individual's emotional states (O), which then influences their behavioural response (R). It has been extensively applied in various marketing research to study the influence of the environment on consumer behaviour, including research related to the virtual environment (Dozio et al., 2022; Han, Chandukala, & Li, 2021; Jin, Kim, Moore, & Rothenberg, 2021; Kim, Lee, & Jung, 2020). In what follows, this study proposed research hypotheses based on the theory and findings in prior literature.

Atmosphere refers to the environmental features that is apprehended through human senses, which can be tangible and intangible aspects (Liu & Jang, 2009). Various research have proven the use of atmosphere as part of the marketing tool in businesses to influence consumers' emotion such as pleasure, arousal and satisfaction, including consumer behaviour such

as purchase intention (Kotler, 1973; Calvo-Porral, Faíña-Medín, & Nieto-Mengotti, 2017; Pantano & Servidio, 2012; Van Kerrebroeck et al., 2017; Verhagen, Feldberg, Van Den Hooff, Meents, & Merikivi, 2011; Azmi et al., 2021). In housing, atmosphere plays a significant role on the occupants's behaviour and needs. Furthermore, the Covid-19 pandemic has caused consumers to significantly impact how human behave and their needs for a better home design (Ching & Abdul Rani, 2023).

Satisfaction can be defined as a state evoked from individual's cognitive evaluation. In this paper, the authors posits that the atmosphere in the virtual environment could influence potential homebuyers' satisfaction, which in turn influences their purchase intention. In addition, perceived enjoyment is defined in this research as the extent to which the virtual environment in VR is perceived to be enjoyable (E. Park, Kim, Kim, & Kwon, 2018; Shuhaiber & Mashal, 2019), which in turns would stimulate positive behavioural response. Perceived enjoyment was proven in prior research to be a significant determinant of consumer behaviour to influence purchase intention (Chen, Lu, & Wang, 2016; Jang & Park, 2019). Thus, the following hypotheses are proposed and illustrated in Figure 1:

H1: Atmospheric positively effect satisfaction.
H2: Atmospheric positively effect perceived enjoyment.
H3: Satisfaction positively effect purchase intention.
H4: Perceived enjoyment positively effect purchase intention.

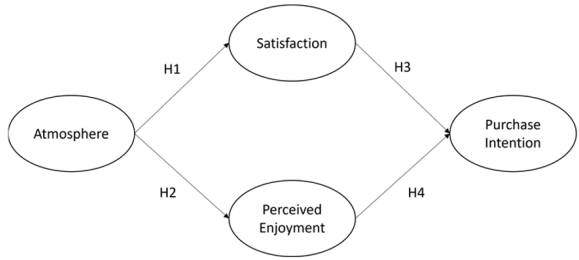

Figure 1. Proposed Theoretical Framework

Source: Author

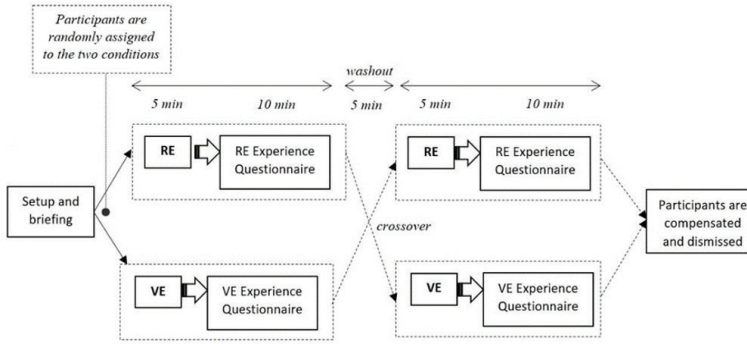

Figure 2. Experiment Procedure

Source: Azmi et al.(2021)

Before conducting the main experiment, a pilot study involving ten participants was carried out to ensure that the VR equipment, computer settings, and experimental procedures were appropriately designed and set up. The actual experiment took place over a weekend, spanning two days, at the sales gallery of a local property developer in Selangor, Malaysia. Both days of the experiment used the same physical and virtual environments of the house, ensuring consistency for all participants.

Upon obtaining their consent, participants were randomly divided into two groups. One group experienced the real environment first, followed by the virtual environment, while the other group experienced the virtual environment first, followed by the real environment. After completing the questionnaire for the first environment, participants were given a five-minute break or washout period before moving on to the next environment. This five-minute break was implemented based on similar previous experiments conducted by Azmi et al. (2021), Heydarian et al. (2015) and Hong et al. (2019).

Participants

60 real potential homebuyers were recruited as participants for this study using purposive sampling method. Through purposive sampling method, the researchers could select participants that fit the inclusion criteria of the study (Sarstedt, Bengart, Shaltoni, & Lehmann, 2018; Ting, 2019). In this study, a call for participation was advertised via social media

in addition to manually distributed flyers that were given out to the public around Kuala Lumpur and Selangor, Malaysia with invitation to volunteer as participants in the study. This is to avoid any possibilities of non-coverage bias and to give each potential first-time homebuyer who was eligible an equal chance to be included in the study, should they have missed either the email invitation, social media advertising and the manual invitation (Aday & Cornelius, 2006).

G*Power 3.1 was employed to conduct an a priori power analysis to estimate the size of the sample for this study (Faul, Erdfelder, Lang, & Buchner, 2007; Lanier et al., 2019; Maxwell, 2000). The power analysis results indicated that sample size of 27 was the minimum number of samples required in a paired samples t-test analysis to achieve a statistical power of 80% with a medium effect size of Cohen's $d = 0.5$ ($\alpha = .05$), which is adequate for this study to produce a statistically significant result (Price, Jhangiani, & Chiang, 2014).

In addition, the minimum sample size for this experiment was estimated based on prior research in literature that adopt a similar experimental design. An experiment was performed by Heydarian et al. (2015) with a sample size of 120 participants, randomly divided for study into groups of 30 participants. In addition, Paes, Arantes, and Irizarry (2017) also used a sample of 30 participants for a comparative experiment between virtual and non-virtual environment, which is also the rule of thumb when deciding on a suitable sample size for experiments and is advisable for effective statistical analyses (Privitera, 2018).

The required sample size for this study also considers an additional provision of 10% anticipated for dropout rate (Deng, 2006; Julious & Freeman, 2008; Kuller & Wetterberg, 1993). Based on the G*Power 3.1 post-hoc power analysis conducted for within-subjects experiment design, the study would have 99% power to detect medium-sized effect of differences between the physical environment and the virtual environment. Furthermore, considering the practicality of the experiment, 60 participants were believed to be adequate for this study.

3D Model and VR Equipment

In consumer behaviour research, it is important for the researcher to evaluate the behaviour of users in a real consumption context (Morales, Amir, & Lee, 2017). According to Morales et al. (2017), the more identical the context, environment, and experimental manipulation are to represent the real-life consumption experience, the dimension of realism of the experiment is higher. In this experiment, a show unit of a 1000 square feet apartment with three bedrooms and two bathrooms were used as the model. The show unit was already built at a one-to-one scale by the developer company, complete with furniture and interior decorations as part of their marketing purpose. For the experiment, a 3D model of the similar apartment was modelled in Sketchup Pro 2019 (version 19.3). The real-time rendering in VR device used Enscape software (version 2.6.1).

The VR equipment used in the experiment was HTC Vive and the computer used in this study follows Azmi et al. (2021) which satisfy the minimum system requirements for HTC Vive. After comparing several VR plugins for Sketchup, Enscape was found by the authors to be a practical and easy VR-plugin to use with HTC Vive. The software conveniently created a realistic virtual environment for the purpose of this experiment. Enscape also provides integration with various VR devices, including Oculus Rift, and Windows Mixed Reality headsets which could be used for future studies. Figure 3a and Figure 3b depicts the real and virtual environments of the house that were developed for this study.

Figure 3a. Real Environment

Source: Author

Figure 3b. Virtual Environment

Source: Author

Measuring Instrument

Participants' responses in the virtual and physical environment were measured using self-reported questionnaires that was developed based on questions from previous consumer behaviour studies which are summarized in Table 1.

A seven-point Likert scale was used in this study to quantify the participants' answer. To confound participants about the answers that they provided in the previous treatment condition, the questionnaire was arranged differently, following similar procedure by Paes et al. (2017). The summary of questionnaire items is summarized in Table 1.

Table 1. Questionnaire Items

Variable	Measurement Items	Adapted From
ATMOSPHERE		
ATM1	Cosy – Not cosy	De Kort et al. (2003); Kuliga et al. (2015); De Kort et al. (2003); Kuliga et al. (2015); Westerdahl et al. (2006); Franz and Wiener (2008)
ATM2	Pleasant – Unpleasant	
ATM3	Inviting – Uninviting	
ATM4	Interesting – Boring	
ATM5	Varied – Monotonous	
ATM6	Impressive - Meaningless	
PERCEIVED ENJOYMENT		
ENJ1	I am satisfied with the experience of viewing this house.	

ENJ2	I am satisfied with the information received about the physical characteristics of this house from this viewing experience.	Andrew & Larceneux (2018) Calvo-Porral, Faíña-Medín, & Nieto-Mengotti (2017) Bigneá et al. (2005), Van Kerrebroeck et al. (2017); Yoke, Mun, Peng, & Yean (2018)
ENJ3	I have really enjoyed myself with the experience of viewing this house.	
PUR1	After viewing this house, I become interested in purchasing a house like this in the future.	
PUR2	From this viewing experience, I have a desire to own a house like this.	
PUR3	If I am going to purchase a house over the next few years, I would consider a house like this.	

The questionnaire internal consistency was assessed using Cronbach's alpha in SPSS Version 25 software package. The results in Table 2 showed that internal consistency was achieved as every questionnaire item exceeded the acceptable value of 0.70.

Table 2. Reliability Test Results for Questionnaire Items

Construct/ Associated Items	Cronbach's Alpha	Corrected Item-Total Correlation	Cronbach's Alpha if Item is Deleted
Atmospheric			
ATM1	0.873	0.741	0.841
ATM2		0.669	0.852
ATM3		0.681	0.850
ATM4		0.661	0.854
ATM5		0.635	0.858
ATM6		0.675	0.852
Perceived Enjoyment			
ENJ1	0.930	0.794	0.947
ENJ2		0.914	0.851
ENJ3		0.864	0.892
Satisfaction			
SAT1	0.899	0.844	0.818
SAT2		0.776	0.877
SAT3		0.785	0.870
Purchase Intention			

PUR1	0.938	0.885	0.906
PUR2		0.876	0.913
PUR3		0.870	0.910

Source: Author

RESULT AND ANALYSIS

Demographic

The participants' demography is presented in Table 3. 27 of the participants are male (45.0%), while 33 participants are female (55.0%) aged between 23 and 38 years old (Mean age ± SD = 29.25 ± 2.81). From the 60 participants, only two of them (3.3%) have prior experience using VR for house viewing by a property developer; the remaining participants (96.7%) have no prior experience using VR for residential real estate viewing.

Table 3. Participants' Demographic Profiles

Attribute		Value (n = 60)	
		Frequency	Percentage
Gender	Male	27	45.0%
	Female	33	55.0%
Age	20-24	2	3.30%
	25-29	34	56.70%
	30-34	21	35.0%
	35-39	3	5.0%
Marital Status	Single	28	46.7%
	Married	32	53.3%
Race	Malay	57	95.0%
	Chinese	3	5.0%
Level of Education	Degree	41	68.3%
	Masters	15	25.0%
	Others	4	6.7%
Profession	Private Sector	47	78.3%
	Government Sector	8	13.3%
	Others	5	8.4%

Household Income	< RM 3,000 per month	11	18.3%
	RM 3,001 to RM 5,000	30	50.0%
	RM 5,001 to RM 8,000	17	28.3%
	RM 8,001 to RM 10,000	2	3.3%
Number of Children	0	39	65.0%
	1	12	20.0%
	2	8	13.3%
	3	1	1.7%
Prior VR experience for viewing house	Yes	2	3.3%
	No	58	96.7%

Source: Author

Paired Samples t-test Results: Real vs. Virtual Environment

To compare the participants' evaluation in all variables described in this study – atmosphere, satisfaction, perceived enjoyment, and purchase intention in physical and virtual environment, statistical analysis using paired samples t-test was employed. For paired sample t-test analysis, results will show a statistically significant difference between the two environments if the p-values are below 0.05. If the p-values are above 0.05, there is no statistically significant difference between the evaluations of the two environments.

Table 3 illustrates the paired samples t-test results. Based on Table 4, there is a significant difference between the two environments for atmosphere, with $p = 0.001 < 0.05$, satisfaction ($p = 0.003 < 0.05$), perceived enjoyment ($p = 0.024 < 0.05$) and purchase intention ($p = 0.015 < 0.05$).

Table 4. Result Summary for Paired Samples T-test

Variables	Mean (SD)		Mean diff.	p-value	Significant difference between PE -VE
	PE	VE			
ATM	6.04 (0.80)	5.53 (1.22)	0.511	0.001	Yes
SAT	5.67 (0.99)	5.27 (1.21)	0.400	0.003	Yes
ENJ	5.57 (1.12)	5.28 (1.14)	0.294	0.024	Yes
PUR	5.93 (1.04)	5.58 (1.20)	0.356	0.015	Yes

Source: Author

These statistical analysis results most importantly showed that participants' evaluations of the atmosphere, satisfaction, perceived enjoyment, and purchase intention were significantly different in the physical environment and the virtual environment. The participants in general were less satisfied with the virtual environment and rated lower perceived enjoyment in VR compared to the physical environment. The participants also had lower intention to purchase the house when viewed in VR as compared to the real environment.

PLS-SEM Analysis: Measurement Model Assessment

PLS-SEM in this study was conducted using SmartPLS software (v3.2.8) to validate the proposed hypotheses (Hair, Hult, Ringle, & Sarstedt, 2017). The analysis of data using PLS-SEM involved two parts. The first part was the measurement model assessment, followed by the second part, which was the structural model analysis (Hair et al., 2017; Sarstedt & Cheah, 2019).

The assessment of measurement model was conducted by assessing the reliability of the model through the value of Cronbach's α and the composite reliability (CR). To establish reliability, the value of Cronbach's α and CR should surpass 0.70, which is the threshold value (Hair, Ringle, & Sarstedt, 2011; Nunnally, 1978). Secondly, this study evaluated the model's convergent validity. A value of average variance extracted (AVE) that exceeded the cut-off value of 0.50 showed that the convergent validity has been established (Hair et al., 2011). Table 5 illustrates the reliability and convergent validity assessment results of the measurement model done for the study. From the table, it can be discerned that all constructs in this study met the reliability and convergent validity requirements.

Table 5. Measurement Model Assessment

Construct	Loading	Cronbach's α	CR	AVE
Atmospheric Evaluation		0.951	0.961	0.804
ATM1	0.854			
ATM2	0.886			
ATM3	0.920			
ATM4	0.909			
ATM5	0.920			

ATM6	0.889			
Satisfaction		0.942	0.963	0.896
SAT1	0.930			
SAT2	0.948			
SAT3	0.962			
Perceived Enjoyment		0.917	0.948	0.858
ENJ1	0.907			
ENJ2	0.929			
ENJ3	0.942			
Purchase Intention		0.944	0.964	0.899
PUR1	0.954			
PUR2	0.953			
PUR3	0.937			

Source: Author

Thirdly, the Fornell-Larcker Criterion (Fornell & Larcker, 1981) was employed to assess the discriminant validity of the measurement model. Table 6 shows that the discriminant validity was attained where the AVE square roots were larger than the correlations among constructs.

Table 6. Discriminant Validity

	ATM	ENJ	PUR	SAT
ATM	**0.897***			
ENJ	0.575	**0.926***		
PUR	0.625	0.863	**0.948**	
SAT	0.495	0.904	0.854	**0.946***

Source: Author

PLS-SEM Analysis: Structural Model Assessment

As the measurement model assessment conducted earlier is satisfactory, structural model assessment was then conducted for the PLS-SEM analysis (Hair, Risher, Sarstedt & Ringle, 2019). In this step, the path coefficients' significance and relevance was evaluated. The results are illustrated in Table 7.

Table 7. PLS-SEM Results

Relationships		Std beta (β)	P - value	Hypothesis supported
H1	ATM > SAT	0.495	0.000	Yes
H2	ATM > ENJ	0.575	0.000	Yes
H3	SAT > PUR	0.405	0.019	Yes
H4	ENJ > PUR	0.497	0.008	Yes

Source: Author

Results in Table 7 shows that the proposed relationships in H1, H2, H3 and H4 are statistically significant with $p < 0.05$. Specifically, atmosphere exhibited a significant positive effect on satisfaction ($\beta = 0.495$, $p < 0.05$), and perceived enjoyment ($\beta = 0.575$, $p < 0.05$). Subsequently, satisfaction ($\beta = 0.405$, $p < 0.05$) and perceived enjoyment ($\beta = 0.497$, $p < 0.05$) showed a significant positive effect on purchase intention. The results are summarized in Figure 4.

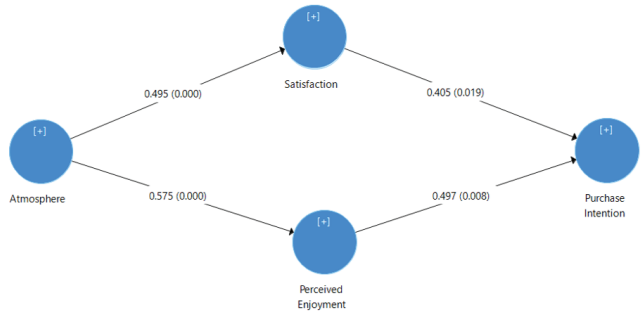

Figure 4. Results of Structural Model Assessment

Source: Author

From the results, atmosphere was the primary explanatory variable for perceived enjoyment ($\beta = 0.575$), while perceived enjoyment was the major explanatory variable for purchase intention ($\beta = 0.497$). Following Azmi et al.'s (2021) study, this research concurred that VR has the restrictions of touch sensation which could explain for the lower effect of satisfaction towards purchase intention.

Besides, the result proved that perceived enjoyment was more influential compared to satisfaction to influence purchase intention in the virtual environment. Therefore, it is vital for marketing strategies in

real estate using VR to focus on enjoyable environment for the potential homebuyers. This could include additional function such as human avatars (Yoon et al., 2020) and interactive decision-making accessibilities integrated with building-information modelling (BIM) to provide users with information and options to change materials or accessories in the virtual environment (Rahimian et al., 2019).

Satisfaction in VR for house evaluation could also be enhanced through better position tracking sensors and wireless HMD for a more effective experiential-spatial human experience (Azmi et al., 2021). In this experiment, HTC Vive VR sets were used. This VR system includes two controllers and two wall-mountable base-sensors, enabling users to freely move around within their personal physical space. However, the wires attached to the HMD limits their movement. The controllers of the HTC Vive have five buttons: 'Menu', 'Touchpad', 'Grip', and 'Trigger'.

While using the HTC Vive, users' actual walking and turning movement will be reflected in the virtual environment. Users can also 'walk' in VR by using the 'Trigger' button which allows users to 'teleport" to the pointed spot in the virtual environment, facilitating interaction with the virtual environment. According to Rahimian et al. (2019), this 'teleport' function was aimed to reduce motion sickness in the virtual environment. However, due to the limitations of the VR equipment used, the current study was unable to identify whether wireless HMD could enhance users' satisfaction in the virtual environment. Thus, this would be future research possibilities that the researchers could investigate in future studies.

DISCUSSION

In line with the current industrial revolution towards digitalization and a more sustainable development, the impact of virtual environment as compared to the physical environment towards users' emotions and behaviour within the context of house evaluation and purchase intention were analysed in this study. As such, this paper extends the current knowledge in consumer behaviour research which focuses on the role of atmosphere towards emotions and behaviour. The S-O-R framework, which is a widely used theoretical foundation emerged from the environmental psychology field

was extended in this study to the virtual environment context.

The experiment results from this study proved that there was a significant difference between the participants' evaluations of the atmosphere between the physical and virtual environment, their satisfaction, perceived enjoyment as well as their purchase intention. These results indicate that the virtual environment does not adequately represent the physical environment. Thus, this study offers insights into the digital visualization platform VR and would allow future research in this realm to focus on enhancing the atmosphere of the virtual world for better users' satisfaction and enjoyment.

Further analysis using PLS-SEM technique proved the relationships between the atmosphere, satisfaction, and purchase intention in the virtual environment, which has not been widely proven in literature, especially within the housing context. The significant influence of atmosphere towards satisfaction and perceived enjoyment, and the subsequent significant influence of satisfaction and perceived enjoyment towards purchase intention suggested the importance of the realism in the virtual environment for better user experience.

The findings presented in this paper would allow property developers and architects to develop strategies to enhance the design of new housing developments that is more sustainable and intelligent by incorporating VR experiences that engages users' emotional, cognitive, and physical reactions (Jeon, 2021).

CONCLUSION

This paper highlights the capabilities of digital technologies in fostering sustainable development through design intelligence within the architectural design process. It recognizes the potential of leveraging efficient and sustainable digital technologies by investigating how users evaluate the atmosphere of the virtual environment in comparison to a physical environment and the subsequent emotional reactions and behavioural response evoked from that evaluation.

The findings in this study confirmed the need for further enhancement

of the virtual reality environment for a more satisfactory and enjoyable user experience that would influence purchase intention. The results of this study confirmed the proposed relationships which are statistically significant with $p < 0.05$. Specifically, atmosphere exhibited a significant positive effect on satisfaction ($\beta = 0.495$, $p < 0.05$) and perceived enjoyment ($\beta = 0.575$, $p < 0.05$). Subsequently, satisfaction ($\beta = 0.405$, $p < 0.05$) and perceived enjoyment ($\beta = 0.497$, $p < 0.05$) showed a significant positive effect on purchase intention.

This study makes significant contributions to the revitalization of the housing development and marketing to be more efficient and sustainable by using digital technologies. First, by proving that potential homebuyers' perceived enjoyment and satisfaction influenced purchasing behaviour of houses that are viewed in virtual environments. In addition, this study allows property developers to develop interactive design and visualization applications to expand their business. As discussed by Rahimian et al. (2019), by allowing an interactive and immersive design environment, potential homebuyers will be better able to make design decisions and are more likely to proceed to purchase. Thus, this would streamline and make the purchasing process more sustainable by meeting the potential homebuyers' expectations to reduce unnecessary costs and travel time associated with home purchase decision.

In addition, the current expanding BIM software that integrates information with visualization could be integrated with VR not only for design and construction, but also for end-users' decision-making processes. This study too contributes towards expanding BIM into the consumer market, by allowing the integration into the property and real estate industry for potential homebuyers to delve in the technology.

Furthermore, this study bridges the gap between sustainable housing development and virtual visualization technologies. By exploring satisfaction and enjoyment in immersive visualization, it sheds light on how virtual environments can enhance the understanding of the housing design among consumers and stakeholders in the sell-then-build housing development more sustainably without the need to construct physical show units that consumes more cost and energy.

It is also important to note that the utilization of immersive visualization in real estate sets this research apart from conventional methods of architectural visualization for end-users. The VR-based approach allows for a more realistic and interactive experience, potentially eliciting more authentic responses from potential homebuyers compared to conventional visualization methods or non-immersive simulations by using 2D plans and printed 3D perspectives on promotional brochures or websites.

Recognizing that time waits for no one, the housing and architecture industry should actively embrace the rapid advancements in visualization technologies. By doing so, it can harness the advantages of conducting business in the limitless virtual universe, while promoting a sustainable environment.

ACKNOWLEDGEMENT

The authors would like to express their gratitude for all individuals who contributed to the successful completion of this research and the subsequent publication of this paper. We are also grateful to the participants who generously shared their time and insights, enabling us to gather valuable data. Additionally, we thank the journal editors and reviewers for their constructive feedback and contributions towards improving the quality of this paper.

FUNDING

There is no funding for this research.

AUTHOR CONTRIBUTIONS

All authors contributed to the design of the research, the questionnaire, and the write-up. All authors have read and approved the final manuscript.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Aday, L. A., & Cornelius, L. J. (2006). *Designing and Conducting Health Survey: A Comprehensive Guide* (3rd ed.). https://doi.org/10.1007/s13398-014-0173-7.2

Andrew, M., & Larceneux, F. (2018). The role of emotion in a housing purchase: An empirical analysis of the anatomy of satisfaction from off-plan apartment purchases in France. *Environment and Planning A: Economy and Space, 51*(6), 1370–1388. https://doi.org/10.1177/0308518X18817539.

Azmi, A., Ibrahim, R., Abdul Ghafar, M., & Rashidi, A. (2021). Smarter real estate marketing using virtual reality to influence potential homebuyers' emotions and purchase intention. *Smart and Sustainable Built Environment, 11*(4), 870-890.

Ball, C., Huang, K. T., & Francis, J. (2021). Virtual reality adoption during the COVID-19 pandemic: A uses and gratifications perspective. *Telematics and Informatics, 65*(9), 101728. https://doi.org/10.1016/j.tele.2021.101728.

Bigneá, J. E., Andreu, L., & Gnoth, J. (2005). The theme park experience: An analysis of pleasure, arousal, and satisfaction. *Tourism Management*, 26, 833–844. https://doi.org/10.1016/j.tourman.2004.05.006.

Calvo-Porral, C., Faíña-Medín, A., & Nieto-Mengotti, M. (2017). Exploring technology satisfaction: An approach through the flow experience. *Computers in Human Behavior*, 66, 400–408. https://doi.org/10.1016/j.chb.2016.10.008.

Chan, T. K., Cheung, C. M., & Lee, Z. W. (2017). The state of online impulse-buying research: A literature analysis. *Information and Management, 54*(2), 204–217. https://doi.org/10.1016/j.im.2016.06.001.

Chen, A., Lu, Y., & Wang, B. (2016). Enhancing perceived enjoyment in social games through social and gaming factors. *Information Technology and People, 29*(1), 99–119. https://doi.org/10.1108/ITP-07-2014-0156.

Ching, L. S., & Rani, M. F. A. (2023). The Impact of Covid-19 Pandemic on Home Spatial Design. *Malaysian Journal of Sustainable Environment, 10*(1), 207-224.

Choi, H. soo, & Kim, S. heon. (2017). A content service deployment plan for metaverse museum exhibitions—Centering on the combination of beacons and HMDs. *International Journal of Information Management, 37*(1), 1519–1527. https://doi.org/10.1016/j.ijinfomgt.2016.04.017.

de Kort, Y. A. W., Ijsselsteijn, W. A., Kooijman, J., & Schuurmans, Y. (2003). Virtual Laboratories: Comparability of Real and Virtual Environments for Environmental Psychology. *Presence, 12*(4), 360–373. https://doi.org/10.1162/105474603322391604.

Diemer, J., Alpers, G. W., Peperkorn, H. M., Shiban, Y., & Mühlberger, A. (2015). The impact of perception and presence on emotional reactions: A review of research in virtual reality. *Frontiers in Psychology,* 6, 1–9. https://doi.org/10.3389/fpsyg.2015.00026.

Dozio, N., Marcolin, F., Scurati, G. W., Ulrich, L., Nonis, F., Vezzetti, E., … Ferrise, F. (2022). A design methodology for affective Virtual Reality. *International Journal of Human-Computer Studies, 162*(1), 102791. https://doi.org/10.1016/j.ijhcs.2022.102791.

Du, J., Zou, Z., Shi, Y., & Zhao, D. (2018). Zero latency: Real-time synchronization of BIM data in virtual reality for collaborative decision-making. *Automation in Construction,* 85, 51–64. https://doi.org/10.1016/j.autcon.2017.10.009.

Faul, F., Erdfelder, E., Lang, A., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods, 39*(2), 175–191.

Fornell, C., & Larcker, D. F. (1981). Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research, 18*(1), 39–50. https://doi.org/10.2307/3151312.

Hair, J.F., Risher, J.J., Sarstedt, M. and Ringle, C.M. (2019), "When to use and how to report the results of PLS-SEM", *European Business Review, 31*(1), 2-24. https://doi.org/10.1108/EBR-11-2018-0203.

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2017). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM).* In SAGE (2nd ed.). USA: SAGE Publications, Inc.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice, 19*(2), 139–151. https://doi.org/10.2753/MTP1069-6679190202.

Han, Y., Chandukala, S. R., & Li, S. (2021). Impact of different types of in-store displays on consumer purchase behavior. *Journal of Retailing* , https://doi.org/10.1016/j.jretai.2021.10.002.

Heydarian, A., Carneiro, J. P., Gerber, D., Becerik-Gerber, B., Hayes, T., & Wood, W. (2015). Immersive virtual environments versus physical built environments: A benchmarking study for building design and user-built environment explorations. *Automation in Construction,* 54, 116–126. https://doi.org/10.1016/j.autcon.2015.03.020.

Homer, P. M. (1990). The Mediating Role of Attitude toward the Ad: Some Additional Evidence. *Journal of Marketing Research, 27*(1), 78–86. https://doi.org/10.1177/002224379002700108.

Hong, T., Lee, M., Yeom, S. and Jeong, K. (2019), "Occupant responses on satisfaction with window size in physical and virtual built environments", *Building and Environment*, 166, 106-409, doi: 10.1016/j.buildenv.2019.106409.

Horng, J.-S., & Hsu, H. (2021). Esthetic Dining Experience: The relations among aesthetic stimulation, pleasantness, memorable experience, and behavioral intentions. *Journal of Hospitality Marketing & Management, 30*(4), 419–437. https://doi.org/10.1080/19368623.2021.1859425.

Ibrahim, F. A., Boying, W., Abdul Rahim, N. S., Mohd Shafiei, M. W., & Zainol, N. Z. (2023). *The Influence of Augmented Reality on Purchase Intention in the Housing Industry*. Human Behavior and Emerging Technologies, 2023.

Jang, Y., & Park, E. (2019). An adoption model for virtual reality games: The roles of presence and enjoyment. *Telematics and Informatics, 42*(5), 101239. https://doi.org/10.1016/j.tele.2019.101239

Jeon, J.-E. (2021). The Effects of User Experience-Based Design Innovativeness on User-Metaverse Platform Channel Relationships in South Korea. *Journal of Distribution Science, 19*(11), 81–90. https://doi.org/10.15722/jds.19.11.202111.81.

Jin, B., Kim, G., Moore, M., & Rothenberg, L. (2021). Consumer store experience through virtual reality: its effect on emotional states and perceived store attractiveness. *Fashion and Textiles, 8*(1). https://doi.org/10.1186/s40691-021-00256-7.

Jørgensen, C. J. (2016). The Space of the Family: Emotions, Economy, and Materiality in Homeownership. *Housing, Theory and Society, 33*(1), 98–113. https://doi.org/10.1080/14036096.2015.1083052.

Joshua, J. (2017). Information Bodies: Computational Anxiety in Neal Stephenson's 'Snow Crash', *Interdisciplinary Literary Studies, 19*(1), 17–47. https://doi.org/10.5325/intelitestud.19.1.0017.

Kim, M. J., Lee, C. K., & Jung, T. (2020). Exploring Consumer Behavior in Virtual Reality Tourism Using an Extended Stimulus-Organism-Response Model. *Journal of Travel Research, 59*(1), 69–89. https://doi.org/10.1177/0047287518818915.

Kotler, P. (1973). Atmospherics as a marketing tool. *Journal of Retailing, 49*(4), 48–64.

Kraus, S., Kanbach, D., Krysta, P., Steinhoff, M., & Tomini, N. (2022). Facebook and the creation of the metaverse: Radical business model innovation or incremental transformation? *International Journal of Entrepreneurial Behaviour and Research,* 1–27. https://doi.org/10.1108/IJEBR-12-2021-0984.

Kuliga, S. F., Thrash, T., Dalton, R. C., & Hölscher, C. (2015). *Virtual reality as an empirical research tool-Exploring user experience in a real building and a corresponding virtual model.* https://doi.org/10.1016/j.compenvurbsys.2015.09.006 .

Lanier, M., Waddell, T. F., Elson, M., Tamul, D. J., Ivory, J. D., & Przybylski, A. (2019). Virtual reality check: Statistical power, reported results, and the validity of research on the psychology of virtual reality and immersive environments. *Computers in Human Behavior,* 100, 70–78. https://doi.org/10.1016/j.chb.2019.06.015.

Lee, H. G., Chung, S., & Lee, W. H. (2013). Presence in virtual golf simulators: The effects of presence on perceived enjoyment, perceived value, and behavioral intention. *New Media and Society, 15*(6), 930–946. https://doi.org/10.1177/1461444812464033.

Lee, J., Kim, J., & Choi, J. Y. (2019). The adoption of virtual reality devices: The technology acceptance model integrating enjoyment, social interaction, and strength of the social ties. *Telematics and Informatics, 39*(11), 37–48. https://doi.org/10.1016/j.tele.2018.12.006.

Lee, L.-H., Braud, T., Zhou, P., Wang, L., Xu, D., Lin, Z., … Hui, P. (2021). All One Needs to Know about Metaverse: A Complete Survey on Technological Singularity, *Virtual Ecosystem, and Research Agenda. 14*(8), 1–66.

Liu, Y., & Jang, S. C. (Shawn). (2009). The effects of dining atmospherics: An extended Mehrabian-Russell model. *International Journal of Hospitality Management, 28*(4), 494–503. https://doi.org/10.1016/j.ijhm.2009.01.002.

Lombart, C., Millan, E., Normand, J. M., Verhulst, A., Labbé-Pinlon, B., & Moreau, G. (2020). Effects of physical, non-immersive virtual, and immersive virtual store environments on consumers' perceptions and purchase behavior. *Computers in Human Behavior, 110*(3). https://doi.org/10.1016/j.chb.2020.106374.

Martínez-Navarro, J., Bigné, E., Guixeres, J., Alcañiz, M., & Torrecilla, C. (2019). The influence of virtual reality in e-commerce. *Journal of Business Research*, 100, 475–482. https://doi.org/10.1016/j.jbusres.2018.10.054.

Maxwell, S. E. (2000). Sample Size and Multiple Regression Analysis. *Psychological Methods, 5*(4), 434–458.

Mehrabian, A., & Russell, J. A. (1974). *An approach to environmental psychology*. The MIT Press .

Meißner, M., Pfeiffer, J., Pfeiffer, T., & Oppewal, H. (2017). Combining virtual reality and mobile eye tracking to provide a naturalistic experimental environment for shopper research. *Journal of Business Research.* https://doi.org/10.1016/j.jbusres.2017.09.028.

Morales, A. C., Amir, O., & Lee, L. (2017). Keeping it real in experimental research-understanding when, where, and how to enhance realism and measure consumer behavior. *Journal of Consumer Research, 44*(2), 465–476. https://doi.org/10.1093/jcr/ucx048.

Narendra, Y. R., & Navitas, P. (2022). Factors contributing to housing provision in Surabaya: Perspectives from real estate developers. *Malaysian Journal of Sustainable Environment, 9*(3), 181-203.

Narin, N. G. (2021). A Content Analysis of the Metaverse Articles. *Journal of Metaverse, 1*(1), 17–24.

Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). New York: McGraw-Hill Education.

Paes, D., Arantes, E., & Irizarry, J. (2017). Immersive environment for improving the understanding of architectural 3D models: Comparing user spatial perception between immersive and traditional virtual reality systems. *Automation in Construction,* 84, 292–303. https://doi.org/10.1016/j.autcon.2017.09.016.

Pantano, E., & Servidio, R. (2012). Modeling innovative points of sales through virtual and immersive technologies. *Journal of Retailing and Consumer Services, 19*(3), 279–286. https://doi.org/10.1016/j.jretconser.2012.02.002.

Park, E., Kim, S., Kim, Y. S., & Kwon, S. J. (2018). Smart home services as the next mainstream of the ICT industry: determinants of the adoption of smart home services. Universal *Access in the Information Society, 17*(1), 175–190. https://doi.org/10.1007/s10209-017-0533-0.

Park, S. M., & Kim, Y. G. (2022). A Metaverse: Taxonomy, Components, Applications, and Open Challenges. *IEEE Access,* 10, 4209–4251.

https://doi.org/10.1109/ACCESS.2021.3140175.

Pizzi, G., Scarpi, D., Pichierri, M., & Vannucci, V. (2019). Virtual reality, real reactions?: Comparing consumers' perceptions and shopping orientation across physical and virtual-reality retail stores. *Computers in Human Behavior, 96*(2), 1–12. https://doi.org/10.1016/j.chb.2019.02.008.

Privitera, G. J. (2018). *Research methods for the behavioral sciences.* Sage Publications.

Rahimian, F. P., Chavdarova, V., Oliver, S., Chamo, F., & Amobi, L. P. (2019). OpenBIM-Tango integrated virtual showroom for offsite manufactured production of self-build housing. *Automation in Construction,* 102, 1-16.

Sarstedt, M., Bengart, P., Shaltoni, A. M., & Lehmann, S. (2018). The use of sampling methods in advertising research: a gap between theory and practice. *International Journal of Advertising, 37*(4), 650–663. https://doi.org/10.1080/02650487.2017.1348329.

Sarstedt, M., & Cheah, J. H. (2019). Partial least squares structural equation modeling using SmartPLS : a software review. *Journal of Marketing Analytics,* 1 , https://doi.org/10.1057/s41270-019-00058-3.

Scarpi, D., Pizzi, G., & Visentin, M. (2014). Shopping for fun or shopping to buy: Is it different online and offline? *Journal of Retailing and Consumer Services, 21*(3), 258–267. https://doi.org/https://doi.org/10.1016/j.jretconser.2014.02.007.

Schiopu, A. F., Hornoiu, R. I., Padurean, M. A., & Nica, A. M. (2021). Virus tinged? Exploring the facets of virtual reality use in tourism as a result of the COVID-19 pandemic. *Telematics and Informatics,* 60, 101575 . https://doi.org/10.1016/j.tele.2021.101575.

Shen, B., Tan, W., Guo, J., Zhao, L., & Qin, P. (2021). How to Promote User Purchase in Metaverse ? A Systematic Literature Review on Consumer Behavior Research and Virtual Commerce Application Design. *Applied Sciences,* 11, 1–29.

Shin, D. (2018). Empathy and embodied experience in virtual environment: To what extent can virtual reality stimulate empathy and embodied

experience? *Computers in Human Behavior*, 78, 64–73. https://doi.org/10.1016/j.chb.2017.09.012.

Shuhaiber, A., & Mashal, I. (2019). Understanding users' acceptance of smart homes. *Technology in Society,* 58, 101110. https://doi.org/10.1016/j.techsoc.2019.01.003

Sihi, D. (2018). Home sweet virtual home. *Journal of Research in Interactive Marketing, 12*(4), 398–417. https://doi.org/10.1108/JRIM-01-2018-0019.

Siniak, N., Shavrov, S., Marina, N., & Krajco, K. (2018). *Examining the feasibility of industry 4.0 for the real estate sector with a lens of value and job creation.* 179–186. https://doi.org/https://fsev.tnuni.sk/konferencia2018/Zbornik-industry-4-0.pdf .

Skrede, J., & Andersen, B. (2020). Selling homes: the polysemy of visual marketing. *Social Semiotics*, 1–19. https://doi.org/10.1080/10350330.2020.1767398.

Suh, A., & Prophet, J. (2018). The state of immersive technology research: A literature analysis. *Computers in Human Behavior,* 86, 77–90. https://doi.org/10.1016/j.chb.2018.04.019.

Sweeney, J., & Soutar, G. (2001). Customer perceived value: The development of a multiple item scale. *Journal of Retailing, 77*(2), 203–220.

Cheah, J.-H., Ting, H., Cham, T.H. and Memon, M.A. (2019), "The effect of selfie promotion and celebrity endorsed advertisement on decision-making processes: A model comparison", *Internet Research, 29* (3), 552-577. https://doi.org/10.1108/IntR-12-2017-0530.

Trkman, P., & Černe, M. (2021). Humanising digital life: Reducing emissions while enhancing value-adding human processes. *International Journal of Information Management,* 102443 . https://doi.org/10.1016/j.ijinfomgt.2021.102443.

Tseng, K. C., & Giau, D. T. N. (2022). A feasibility study of using virtual reality as a pre-occupancy evaluation tool for the elderly. *Automation in Construction, 134*(1), 104037. https://doi.org/10.1016/j.

autcon.2021.104037.

Van Kerrebroeck, H., Brengman, M., & Willems, K. (2017). When brands come to life: experimental research on the vividness effect of Virtual Reality in transformational marketing communications. *Virtual Reality, 21*(4), 177–191. https://doi.org/10.1007/s10055-017-0306-3.

Verhagen, T., Feldberg, F., Van Den Hooff, B., Meents, S., & Merikivi, J. (2011). Satisfaction with virtual worlds: An integrated model of experiential value. *Information and Management, 48*(6), 201–207. https://doi.org/10.1016/j.im.2011.02.004.

Westerdahl, B., Suneson, K., Wernemyr, C., Roupé, M., Johansson, M., & Allwood, C. M. (2006). Users' evaluation of a virtual reality architectural model compared with the experience of the completed building. *Automation in Construction, 15*(2), 150–165. https://doi.org/10.1016/j.autcon.2005.02.010.

Wrase, I., Bernegger, H., & Meslec, M. (2023). A real estate life cycle meta-instrument assessing and enabling sustainable decision-making and management for real estate owners and stakeholders. *In IOP Conference Series: Earth and Environmental Science, 1176* (1), 012027. IOP Publishing.

Yoke, C. C., Mun, Y. W., Peng, L. M., & Yean, U. L. (2018). Purchase Intention of Residential Property in Greater Kuala Lumpur, Malaysia. *International Journal of Asian Social Science, 8*(8), 580–590. https://doi.org/10.18488/journal.1.2018.88.580.590.

Yoon, L., Yang, D., Kim, J., Chung, C., & Lee, S. H. (2020). Placement retargeting of virtual avatars to dissimilar indoor environments. *IEEE Transactions on Visualization and Computer Graphics, 28*(3), 1619-1633.

Pejabat Perpustakaan
Library Office

Universiti Teknologi MARA
Cawangan Perak
Kampus Seri Iskandar
32610 Bandar Baru Seri Iskandar,
Perak Darul Ridzuan, MALAYSIA
Tel: (+605) 374 2093/2453 Faks: (+605) 374 2299

UNIVERSITI TEKNOLOGI MARA

Surat kami : 700-KPK (PRP.UP.1/20/1)
Tarikh : 20 Januari 2023

Prof. Madya Dr. Nur Hisham Ibrahim
Rektor
Universiti Teknologi MARA
Cawangan Perak

Tuan,

PERMOHONAN KELULUSAN MEMUAT NAIK PENERBITAN UiTM CAWANGAN PERAK MELALUI REPOSITORI INSTITUSI UiTM (IR)

Perkara di atas adalah dirujuk.

2. Adalah dimaklumkan bahawa pihak kami ingin memohon kelulusan tuan untuk mengimbas (*digitize*) dan memuat naik semua jenis penerbitan di bawah UiTM Cawangan Perak melalui Repositori Institusi UiTM, PTAR.

3. Tujuan permohonan ini adalah bagi membolehkan akses yang lebih meluas oleh pengguna perpustakaan terhadap semua maklumat yang terkandung di dalam penerbitan melalui laman Web PTAR UiTM Cawangan Perak.

Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Setuju.

27.1.2023

PROF. MADYA DR. NUR HISHAM IBRAHIM
REKTOR
UNIVERSITI TEKNOLOGI MARA
CAWANGAN PERAK
KAMPUS SERI ISKANDAR

Saya yang menjalankan amanah,

SITI BASRIYAH SHAIK BAHARUDIN
Timbalan Ketua Pustakawan

nar