



**UNIVERSITI PUTRA MALAYSIA**

***USE OF VIRTUAL REALITY IN RESIDENTIAL ESTATE MARKETING  
TOWARD HOUSE PURCHASING INTENTION***

**ATHIRA BINTI AZMI**

**FRSB 2021 15**



**USE OF VIRTUAL REALITY IN RESIDENTIAL ESTATE MARKETING  
TOWARD HOUSE PURCHASING INTENTION**

By

**ATHIRA BINTI AZMI**

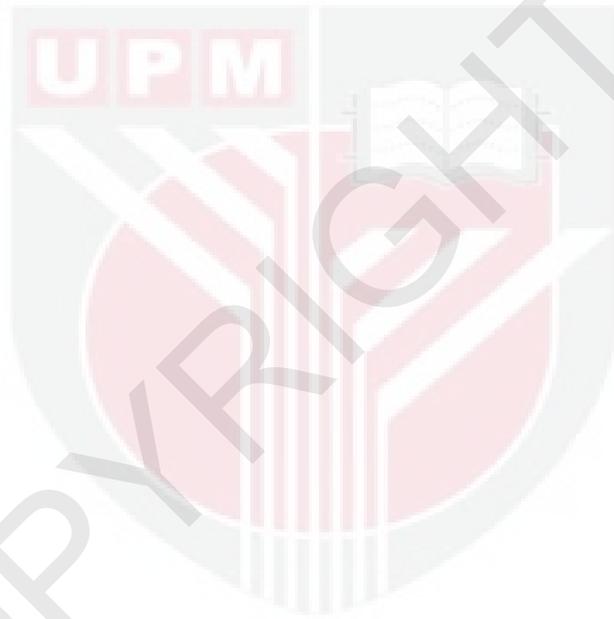
**Thesis Submitted to the School of Graduate Studies,  
Universiti Putra Malaysia, in Fulfilment of the Requirements for the  
Degree of Doctor of Philosophy**

**January 2021**

## COPYRIGHT

All material contained within the thesis, including without limitation text, logos, icons, photographs and all other artwork, is copyright material of Universiti Putra Malaysia unless otherwise stated. Use may be made of any material contained within the thesis for non-commercial purposes from the copyright holder. Commercial use of material may only be made with the express, prior, written permission of Universiti Putra Malaysia.

Copyright © Universiti Putra Malaysia



## DEDICATION

To my beloved parents

Ar. Azmi Luddin

Dr. Sharifah Mastura Syed Mohamad,

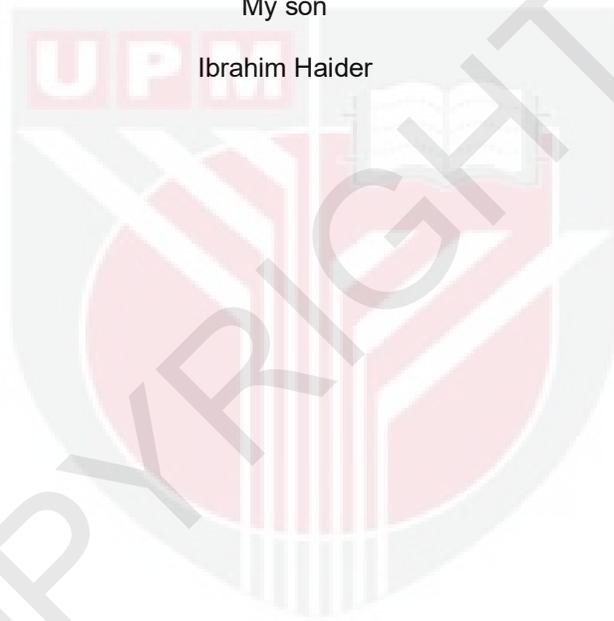
My beloved husband

Muhammad Hanif Aziz,

and

My son

Ibrahim Haider



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in  
fulfilment of the requirement for the degree of Doctor of Philosophy

## **USE OF VIRTUAL REALITY IN RESIDENTIAL ESTATE MARKETING TOWARD HOUSE PURCHASING INTENTION**

By

**ATHIRA BINTI AZMI**

**January 2021**

**Chairman : Professor Hajah Rahinah binti Ibrahim, PhD**  
**Faculty : Design and Architecture**

The provision of adequate housing is one of the key Malaysian government agenda for the growth and well-being of society. Despite the government 's endeavours to provide sufficient, affordable, and quality housing, research has found that this form of housing has not been satisfactory in terms of the living environment among its inhabitants. The lack of study on homebuyers' emotion and behaviour within the housing industry motivates this research. This study believes in the potentials of virtual reality technology for facilitating home purchase decisions as part of the marketing tool in the residential real estate industry. This study reviewed extensive literature focusing on the role of emotions in homeownership, consumer behaviours and virtual reality applications in marketing. This study proposed that the atmospheric evaluation, perceived emotional values, perceived usefulness and perceived ease of use are the stimuli that could influence pleasure, arousal and satisfaction emotions, which in turn, could influence home purchase intentions in the virtual environment. In this study, an experiment was conducted to determine whether virtual reality could be an adequate representation of the real environment for potential homebuyers to evaluate housing choices. The relationships between the proposed stimuli components, their effect on emotional states and purchase intention was assessed using Partial Least Squares- Structural Equation Modelling. Results indicated that there is a significant difference in the atmospheric evaluations, perceived emotional values, perceived usefulness, perceived ease of use, satisfaction and purchase intention between the real environment and the virtual environment. Only the pleasure and arousal emotions evoked in the real and virtual environment have no significant differences. Statistical analysis also revealed that atmospheric evaluations significantly and positively affect pleasure and arousal emotions. Perceived usefulness and perceived ease of use both have a significant positive effect on satisfaction. Pleasure and satisfaction were found to positively influence home purchase intention. Based on the findings, this study highlights the

recommendations to enhance the application of virtual reality to be strategically applied in the residential real estate marketing for facilitating emotional experience and home evaluation. This study also serves as a benchmark for future studies in residential estate marketing using virtual reality focusing on users' emotion and behaviour.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

## **PENGUNAAN REALITI MAYA DALAM PEMASARAN KEDIAMAN BAGI MEMPENGARUHI NIAT PEMBELIAN KEDIAMAN**

Oleh

**ATHIRA BINTI AZMI**

Januari 2021

**Pengerusi : Profesor Hajah Rahinah binti Ibrahim, PhD**  
**Fakulti : Rekabentuk dan Senibina**

Peruntukan perumahan yang mencukupi adalah salah satu agenda utama kerajaan Malaysia bagi pertumbuhan dan kesejahteraan masyarakat. Kajian telah membuktikan bahawa harga dan lokasi kediaman adalah faktor utama yang mempengaruhi pembelian kediaman. Walau bagaimanapun, kajian telah mendapati bahawa pembeli rumah masih tidak berpuas hati akan kediaman mereka. Kajian ini percaya akan potensi teknologi realiti maya untuk memudahkan pembeli rumah membuat keputusan dan mempengaruhi tujuan pembelian kediaman. Kajian ini mencadangkan untuk mengintegrasikan teknologi realiti maya sebagai sebahagian daripada kaedah pemasaran bagi mempengaruhi pembelian kediaman. Tinjauan literatur dan penelitian terperinci ke atas peranan emosi dalam pemilihan rumah, tingkah laku pembeli dan aplikasi realiti maya telah dijalankan dalam kajian ini. Satu eksperimen telah dijalankan untuk menentukan sama ada teknologi realiti maya adalah memuaskan untuk menggantikan persekitaran sebenar bagi membolehkan bakal pembeli rumah membuat penilaian rumah untuk dibeli. Pemodelan Persamaan Struktur – Kuasa Dua Terkecil Separa digunakan untuk menilai model hipotesis yang menghubungkan antara komponen ransangan yang dicadangkan, kesannya terhadap emosi dan niat pembelian rumah. Hasil analisis menunjukkan bahawa terdapat perbezaan yang signifikan antara persekitaran sebenar dan persekitaran maya dalam penilaian persekitaran, persepsi nilai emosi, persepsi kebergunaan, persepsi mudah guna, kepuasan dan niat membeli. Faktor emosi keseronokan dan keghairahan bakal pembeli rumah dalam persekitaran sebenar dan persekitaran maya tidak mempunyai perbezaan yang ketara. Analisis statistik juga menunjukkan bahawa penilaian suasana persekitaran telah secara signifikan dan positif mempengaruhi emosi keseronokan dan keghairahan. Andaian kepenggunaan dan andaian kemudahan penggunaan didapati mempunyai kesan positif yang signifikan terhadap kepuasan. Emosi keseronokan dan kepuasan didapati mempengaruhi niat pembelian rumah secara positif. Berdasarkan penemuan, kajian ini telah

mencadangkan bagaimana teknologi realiti maya boleh digunakan secara strategik bagi mempengaruhi niat pembelian rumah. Kajian ini juga berfungsi sebagai penanda aras bagi kajian masa hadapan penggunaan teknologi realiti maya bagi pemasaran kediaman yang menjurus kepada emosi dan tingkah laku pengguna.



## ACKNOWLEDGEMENTS

First and foremost, I praise to Allah for all the blessings, knowledge and strength granted from Him for me to complete this study. Nothing can be achieved without His blessings and rahmah.

My heartfelt appreciation to my supervisor Prof. Dr. Hajah Rahinah Ibrahim, whose expertise was invaluable in guiding me throughout the journey. I truly appreciate the endless support, feedback, and encouragement to complete this study. She is truly the best role model and mentor for me in this research journey.

My gratitude to the supervisory committee, Dr. Maszura Abdul Ghafar and Dr. Ali Rashidi for their insightful guidance for my research. Also, a heartfelt thanks to the members of the Built Environment Informatics research group – Mohsen, Norhayati, Mohamad Kamal, Mustafa, and Maznah for all the valuable input given during our weekly group discussions.

I am extremely grateful to my husband, Muhammad Hanif Aziz, for the never-ending love, kind understanding and immeasurable sacrifices while I complete this study. To my son, Ibrahim Haider, for being the sunshine whenever I needed a smile. I also truly appreciate my parents, Azmi Luddin and Sharifah Mastura, parents in-law, Aziz Awang and Halijah Bakar, my brothers and sisters that never fails to lift me up and encouraged me to pursue my dreams. I would like to also thank my loyal friends for always being there to provide support and happy distractions.

I would like to also acknowledge the Tenaga Akademik Muda (TAM) scheme from Universiti Putra Malaysia for providing allowances for my studies. I also gratefully thank and acknowledge the generous funding from Sime Darby Property Sdn. Bhd. that made this research possible.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

**Rahinah binti Ibrahim, PhD**

Professor  
Faculty of Design and Architecture  
Universiti Putra Malaysia  
(Chairman)

**Maszura Abdul Ghafar, PhD**

Senior Lecturer  
Faculty of Design and Architecture  
Universiti Putra Malaysia  
(Member)

**Ali Rashidi. PhD**

Research Fellow  
School of Engineering,  
Monash University Malaysia  
(Member)

---

**ZALILAH MOHD SHARIFF, PhD**

Professor and Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date: 10 June 2021

## TABLE OF CONTENTS

	<b>Page</b>
<b>ABSTRACT</b>	i
<b>ABSTRAK</b>	iii
<b>ACKNOWLEDGEMENTS</b>	v
<b>APPROVAL</b>	vi
<b>DECLARATION</b>	viii
<b>LIST OF TABLES</b>	xiii
<b>LIST OF FIGURES</b>	xiv
<b>LIST OF APPENDICES</b>	xvi
<b>LIST OF ABBREVIATIONS</b>	xvii
<b>CHAPTER</b>	
<b>1 INTRODUCTION</b>	<b>1</b>
1.1 Introduction	1
1.2 Context and Background of Study	1
1.3 Problem Statement	2
1.4 Main Research Question	3
1.5 Research Objectives	6
1.6 Development of Hypotheses	6
1.7 Experimental Research Methodology	8
1.8 Data Analysis and Validation	11
1.9 Scope and Limitations	11
1.10 Organization of Thesis	12
<b>2 LITERATURE REVIEW</b>	<b>14</b>
2.1 Introduction	14
2.2 Affordable Housing Homeownership	14
2.3 Empathic Evaluation in Home Purchase	16
2.3.1 Emotion, Affect and Appraisal Theories	16
2.3.2 Emotional Intelligence and Empathic Evaluation	19
2.3.3 Homeownership and Emotion	21
2.3.4 Summary	22
2.4 Virtual Reality for Facilitating Emotional Experience	22
2.4.1 Virtual Reality Technology	23
2.4.2 Immersion and Presence in Virtual Reality	27
2.4.3 Virtual Reality in Consumer Behavioural Studies	29
2.4.4 Summary	31

2.5	Understanding of Emotional Response and Behaviour In VR	32
2.5.1	Extending the S-O-R Framework: Stimuli (S) Components	38
2.5.2	Organisms (O) Components	43
2.5.3	Response (R) Component	46
2.6	Summary	47
<b>3</b>	<b>RESEARCH METHODOLOGY</b>	<b>48</b>
3.1	Introduction	48
3.2	Research Methodology Design Overview	48
3.3	Experimental Research Design	50
3.3.1	Within-subjects Experimental Design	51
3.4	Components of an Experimental Research Design	53
3.4.1	Variables	54
3.4.2	Participants	60
3.4.3	Measuring Instrument	64
3.4.4	Model and Apparatus	69
3.4.5	Experiment Procedure	80
3.5	Data Analysis	84
3.6	Summary	87
<b>4</b>	<b>RESULTS AND ANALYSIS</b>	<b>89</b>
4.1	Introduction	89
4.2	Demographic Profile of Respondents	89
4.3	Descriptive Results of Respondents' Evaluation	90
4.3.1	Comparison Based on Gender (Male Vs Female)	91
4.3.2	Comparison Based on Marital Status (Single Vs Married)	94
4.4	Paired Sample <i>t</i> -test Results	97
4.5	PLS-SEM Structural Model Assessments	99
4.5.1	Assessment of Measurement Model	100
4.5.2	Assessment of Structural Model	103
4.5.3	Summary of the Structural Model Assessment Results	109
4.6	Research Findings	111
4.7	Participants' Sense of Immersion and Presence Evaluation	114
4.8	Summary	121
<b>5</b>	<b>CONCLUSION</b>	<b>123</b>
5.1	Introduction	123
5.2	Answer to Research Question	123
5.2.1	The Answer to Sub-Research Question 1	123
5.2.2	The Answer to Sub-Research Question 2	124

5.2.3	The Answer to Sub-Research Question 3	126
5.2.4	The Answer to Main Research Question	128
5.3	Knowledge Contributions	130
5.4	Impact on the Industry	132
5.5	Research Benefits	133
5.6	Limitations of Study	134
5.7	Future Research Possibilities	134
<b>REFERENCES</b>		137
<b>APPENDICES</b>		155
<b>BIODATA OF STUDENT</b>		176
<b>LIST OF PUBLICATIONS</b>		177



## LIST OF TABLES

Table	Page	
1.1	PHD Eagle Research Design Framework Table	5
2.1	Concepts and definitions of immersive technology	24
3.1	Part I - Hypotheses overview and variables	56
3.2	Description and operational definition for each variable in hypotheses Part I	57
3.3	Questionnaire items	67
3.4	Reliability test results for questionnaire items	86
4.1	Participants' demographic profiles	89
4.2	Group statistics based on gender (Male Vs Female)	92
4.3	Independent sample <i>t</i> -test results (Male vs Female)	93
4.4	Group statistics based on marital status (Single Vs Married)	95
4.5	Independent sample <i>t</i> -test results (Single vs Married)	96
4.6	Paired sample <i>t</i> -test result summary	98
4.7	Assessment results of the convergent validity	101
4.8	Discriminant validity using Fornell and Larcker (1981) Criterion	102
4.9	PLS-SEM hypothesis testing results	104
4.10	Coefficient of Determination ( $R^2$ )	106
4.11	Effect Size ( $f^2$ )	107
4.12	Predictive relevance ( $Q^2$ )	107
4.13	Predictive relevance effect size ( $q^2$ )	108
4.14	Mean and SD for the quantitative questions in Virtual Presence Questionnaire	115
4.15	Key insights from participants for the open-ended questions	118

## LIST OF FIGURES

Figure		Page
1.1	The hypotheses and the proposed relationships among variables	7
1.2	Relevant situations for different research strategies	9
2.1	The Circumplex Model of Affect	17
2.2	Reality - Virtuality continuum	23
2.3	S-O-R Framework by Mehrabian and Russell (1974)	34
2.4	Model of Aesthetic Response	40
2.5	Proposed theoretical framework and hypotheses.	46
3.1	Example of counterbalancing procedure with two groups	53
3.2	Experiment design	53
3.3	Overall variables from proposed framework	54
3.4	Variables for first part of hypothesis testing	55
3.5	Variables for second part of hypothesis testing	59
3.6a-d	Images of the real show unit	71
3.7a-d	Images of the 3D model in Sketchup	73
3.8a-d	Rendered perspectives of the 3D model	75
3.9	HTC Vive HMD, base stations and controllers	77
3.10	Examples of room-scale base stations setup for HTC Vive	78
3.11	Examples of participants using the HTC Vive during the experiment	79
3.12	HTC Vive base stations setup during the experiment.	79
3.13	Recommended and minimum computer system requirements for HTC Vive	80

4.1	Path coefficients results and coefficient of determination values ( $R^2$ )	104
4.2	Summary of the statistical analysis results	110
4.3	Examples of participant's restricted movements while using the HTC Vive	120



## LIST OF APPENDICES

Appendix		Page
A	PHD Eagle Research Design Framework Table	155
B	Respondent's Consent Form and Questionnaires	158
C	Virtual Presence Questionnaire	169
D	JKEUPM Ethical Approval	176



## LIST OF ABBREVIATIONS

AEC	Architecture, engineering and construction
AR	Augmented Reality
AVE	Average Variance
CR	Composite Reliability
HMD	Head-Mounted Device
MR	Mixed Reality
PLS-SEM	Partial Least Squares Structural Equation Modelling
RQ	Research Question
SD	Standard Deviation
S-O-R	Stimulus- Organism- Response
TAM	Technology Acceptance Model
TCV	Theory of Consumption Values
VR	Virtual Reality

# CHAPTER 1

## INTRODUCTION

### 1.1 Introduction

This chapter discusses the context and background of the study as well as the statement of the research problem. This chapter also addressed the main research question, aim and objectives for the research. Following that, this chapter discusses the experimental research methodology, data analysis and validation technique, scope and limitations of the study, as well as the organisation of the thesis.

### 1.2 Context and Background of the Study

Virtual Reality have become an integral part of the Industrial Revolution 4.0 (Industry 4.0) initiatives in which most industries strived to improve the quality of their services through the use of innovative technologies, digitization and intelligence to ensure higher efficiency and productivity (Petrillo, De Felice, Cioffi, & Zomparelli, 2018). The Industrial Revolution 4.0 would boost the real estate sector through a better personalized services, the applications of big data technologies for real-time information of customer preferences, a highly customized services at lower cost and the digital enhancement of the services that could influence customers' satisfaction and loyalty (Siniak, Shavrov, Marina, & Krajco, 2018).

This study highlights the need to reinvent the real estate sector towards new marketing strategies using digital technologies such as VR for better customer engagement and to elevate potential homebuyers' experience with the built environment. Leading real estate corporations need to understand the latest innovations in VR technology, its current weaknesses and how this technology could be further enhanced to efficiently integrate it to be part of the business strategy in order to stay ahead of the pack.

VR has transformed the current retail and marketing landscape in which retailers, service providers, and advertisers now have the opportunity to effectively reach out to customers through more vivid forms of communications. In the retail and marketing field, VR was found to have successfully provide gateways for marketers to innovatively reach consumers, support better purchasing experiences and enable consumers to make better purchase decisions (Martínez-Navarro, Bigné, Guixeres, Alcañiz, & Torrecilla, 2019; Serrano, Baños, & Botella, 2016; Van Kerrebroeck, Brengman, & Willems, 2017).

With the proven advantages of VR in various fields especially in the retail and marketing industry, this research is focusing on the potentials of VR application for the residential real estate market. This study found that there are very limited studies that focus on the application of VR in the housing context, particularly how the existing VR technology can be strategically utilized by housing developers to facilitate their marketing strategy and support potential homebuyers to make better evaluations of the house they were planning to purchase.

### **1.3 Problem Statement**

In the housing industry, it is well-established from the literature that price, location, and security are key factors in influencing homebuyers' home purchase decisions (Hasanudin & Chandra Sakaran, 2016; Kam, Lim, Al-Obaidi, & Lim, 2018; Olanrewaju & Wong, 2019; Tan, 2012b). However, research has shown that homebuyers are still dissatisfied with the house after it was occupied (Kamaruzzaman, Razali, Ahmad Zawawi, Basir, & Riley, 2018; Mohit, Ibrahim, & Rashid, 2010; Tan, 2012a). This study is questioning whether the current approach of residential real estate market allows for potential homebuyers to comprehensively evaluate the housing choices for a more satisfactory purchase.

Most housing developments in Malaysia are based on the sell-then-build concept (Aris, Fathi, Harun, & Mohamed, 2018). This sell-then-build concept allows the property developers to advertise and sell houses through their development proposal to potential homebuyers, using 2D plans, rendered perspective images and artist's impressions to influence the purchase prior to constructing the house. However, through this off-plan marketing method, prospective homebuyers were often unable to properly visualise themselves living inside the house (Andrew & Larceneux, 2018) and to evaluate whether the house could satisfy their lifestyle, needs and preferences. This study claims that the poor understanding of the house while making a purchase decision is one of the reasons that contributes to the dissatisfactions among homeowners after the house has been occupied.

This study believes that VR technology has the potential in revolutionizing the residential real estate market and enables home purchase satisfaction. This study proposed that VR could be applied to facilitate potential homebuyers make better home purchase decisions and become part of marketing tool the housing industry. Furthermore, this study seeks to understand the concept of environmental psychology that has been widely applied in the retail and marketing industry to influence consumers' purchase behaviour to enhance the application of VR in the residential real estate industry in order to influence home purchase intention.

However, the environmental psychology concept in the residential real estate context has not been widely studied. The researcher found a dearth of studies

in the housing industry specifically those related to potential homebuyers' behaviour and emotions that affect their purchase decisions. This thesis therefore seeks to resolve the gaps in literature regarding the use of VR for the study of consumer behaviour in residential real estate marketing and to examine the impact of the virtual environment on potential homebuyers' emotion and their purchase intention.

#### 1.4 Main Research Question

This study describes an attempt to investigate whether VR could be applied to influence house purchase intentions as an alternative to a real show unit. It is crucial to analyse the assessments of the virtual environment of the house in VR by potential homebuyers and benchmark them to a similar physical built environment based on the factors influencing the intention of house buying from consumer behaviour theories. In addition, this study also focused on determining the key predictor that influences emotions and purchase intentions in the virtual environment in order to enhance the current VR technology if it were to be used as part of the residential estate marketing as an alternative to a real show unit.

This study adopted the Eagle Research Design Table (Ibrahim, 2011) technique that rationalises the research question's constructs to set the research objectives, strategy of inquiry, targeted outputs and expected contribution of the study. These research question's construct (or RQ Construct) categorisation of technique identifies three different RQ Constructs – "WHO", "WHAT" and "HOW", in formulating the main research question. Ibrahim (2011) defines "WHO" construct as the element used or impacted by research, "WHAT" construct as the information required to solve a research problem, and "HOW" construct as the action or impact on the element or information of the research. The researcher chose a PhD research question's formula based on Ibrahim (2011) consisting of one "WHO", one "WHAT", and two "HOW" RQ Constructs. The main research question for this study is:

**How to enhance the application of VR <sub>[HOW1]</sub> in residential real estate marketing in a virtual environment <sub>[WHAT]</sub> in order to stimulate emotions <sub>[HOW2]</sub> towards house purchase intention <sub>[WHO]</sub>?**

Table 1.1 is part of the Eagle Research Design Table adapted from Ibrahim (2011) that illustrates the research constructs, sub-research questions and research objectives that follow. This method has systematically guided the researcher to achieve the research objectives based on the formulated sub-research questions. Table 1.1 demonstrates that three sub-research questions were further developed from the Eagle Table to address the main research questions. They are:

1. What are the factors influencing house purchase intention among potential homebuyers?
2. What are the aspects of a virtual environment that could influence house purchase intention?
3. How to stimulate emotions for influencing house purchase intention in a virtual environment?



Table 1.1 : PHD Eagle Research Design Framework Table

RQ CONSTRUCT	CONSTRUCT DESCRIPTION	ACTIVATING INQUIRY APPROACH (Sub-RQ/RO)
WHO (Element used in/impacted by the study)	house intention purchase	<p><b>Sub-RQ1:</b> What are the factors influencing house purchase intentions among potential homebuyers?</p> <p><b>RO1:</b> To understand factors influencing house purchase intentions among potential homebuyers.</p> <p><b>Sub-RQ2:</b> What are the aspects of a virtual environment that could influence house purchase intention?</p> <p><b>RO2:</b> To analyse the aspects of a virtual environment that could influence house purchase intention.</p> <p><b>Sub-RQ3:</b> How to stimulate emotions for influencing house purchase intention in a virtual environment?</p> <p><b>RO3:</b> To analyse the factors that could stimulate emotions for influencing house purchase intention in a virtual environment.</p> <p><b>Main Research Question:</b> How to enhance the application of VR in residential real estate marketing in a virtual environment in order to stimulate emotions towards house purchase intention?</p> <p><b>Main Research Objective:</b> To recommend how the application of VR technology in residential estate marketing could be enhanced to stimulate emotions towards house purchase intention.</p>
WHAT (Body of knowledge required to solve problem)	virtual environment	
HOW 1 (Action/impact)	Stimulate emotion	
HOW 2 (Action/impact)	Enhance the application of VR	

(Adapted from Ibrahim, 2011)

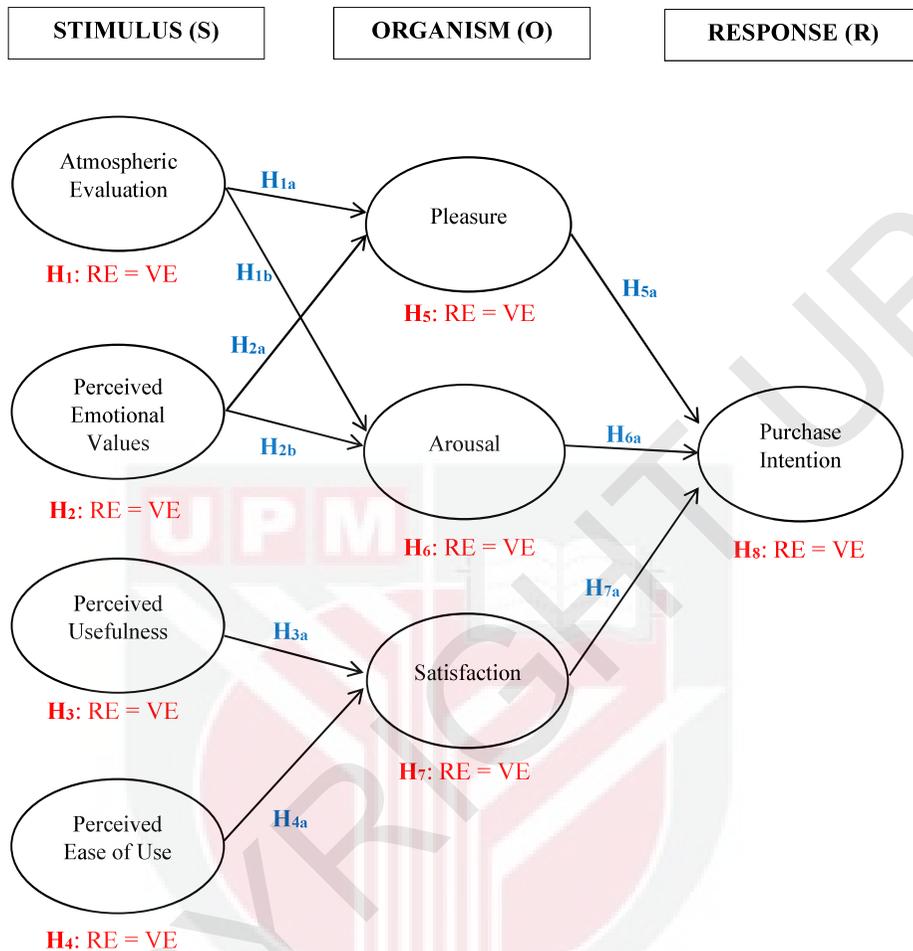
## 1.5 Research Objectives

Referring to Table 1.1, the research objectives of the study are:

- 1) To understand the factors influencing house purchase intention among potential homebuyers.
- 2) To analyse the aspects of a virtual environment that could influence house purchase intention.
- 3) To analyse the factors that could stimulate emotions for influencing house purchase intention in a virtual environment.
- 4) To recommend how the application of VR technology in residential estate marketing could be enhanced to stimulate emotions towards house purchase intention.

## 1.6 Development of Hypotheses

Based on literature analysis, the researcher proposed to investigate whether the VR technology could become an adequate representation of a real show unit as the pre-purchase house evaluation tool for the residential estate marketing. In order to determine whether this technology could become part of the real estate marketing strategy, it is imperative to evaluate potential homebuyers' evaluations of the virtual environment of the house in VR and benchmark them to a similar physical built environment based on the factors influencing house purchase intention. Following prior literature that compared the virtual environment and the real environment, for VR to be adequate in representing the real environment, this study hypothesised that there should not be a significant difference between the representation of the house in the virtual environment with the real environment (real show unit) for the different factors that could stimulate emotions for influencing home purchase intention as identified in Chapter 2 (hypothesis H1 – H8). Furthermore, this study also hypothesised on the relationships between the variables (hypotheses H1a – H7a). to determine the key predictor that influences emotions and purchase intentions in the virtual environment that were based on prior literature as discussed in Subsection 2.5.



**Figure 1.1 : The hypotheses and the proposed relationships among variables.**

Subsection 2.5 has further details of the literature review that allows the researcher to identify and build upon the findings from previous studies to state the research hypotheses for this study. The hypotheses are illustrated in Figure 1.1. In general, this study hypothesised that:

**Hypothesis 1:** There is no significant difference in the atmospheric evaluation of the house between the real environment and a virtual environment.

**Hypothesis 1<sub>a</sub>:** Atmospheric evaluation has a positive effect on potential homebuyers' pleasure emotion.

**Hypothesis 1<sub>b</sub>:** Atmospheric evaluation has a positive effect on potential homebuyers' arousal emotion.

**Hypothesis 2:** There is no significant difference in the perceived emotional values between the real environment and a virtual environment.

**Hypothesis 2<sub>a</sub>:** Perceived emotional values have a positive effect on potential homebuyers' pleasure emotion.

**Hypothesis 2<sub>b</sub>:** Perceived emotional values have a positive effect on potential homebuyers' arousal emotion.

**Hypothesis 3:** There is no significant difference in perceived usefulness between the real environment and a virtual environment for house evaluation.

**Hypothesis 3<sub>a</sub>:** Perceived usefulness has a positive effect on satisfaction.

**Hypothesis 4:** There is no significant difference in perceived ease of use between the real environment and a virtual environment for house evaluation.

**Hypothesis 4<sub>a</sub>:** Perceived ease of use has a positive effect on satisfaction.

**Hypothesis 5:** There is no significant difference in pleasure emotion between the real environment and a virtual environment.

**Hypothesis 5<sub>a</sub>:** Pleasure has a positive effect on purchase intention.

**Hypothesis 6:** There is no significant difference in arousal emotion between the real environment and a virtual environment.

**Hypothesis 6<sub>a</sub>:** Arousal has a positive effect on purchase intention.

**Hypothesis 7:** There is no significant difference in satisfaction emotion between the real environment and a virtual environment.

**Hypothesis 7<sub>a</sub>:** Satisfaction has a positive effect on purchase intention.

**Hypothesis 8:** There is no significant difference in purchase intention between the real environment and a virtual environment.

## **1.7 Experimental Research Methodology**

This study attempts to measure potential homebuyers' behaviour in two different environments – real and virtual environments. The researcher considers that it is appropriate for this study to conduct a quantitative approach such as experiment, since it helps researchers to control the variables more accurately and guarantees that the outcomes produced by the treatment are due to the control of the independent variable (Chrysochou, 2017). In addition, experimental research is selected as the research methodology in this study to test and refine the theory proposed by the researcher. While qualitative approach like focus group or in-depth interviews will enable researchers to obtain a greater understanding of the topic being studied, these methodologies do not include statistical data that can be used to be generalised to the population.

Furthermore, according to Yin (2014) in Figure 1.2, the recommended parameters of a suitable inquiry strategy dictates that an experimental research design is reasonable for this study. The form of this study's main research question starts with a "HOW" and requires control over the behavioural event (real environment and virtual environment). Thus, an experimental research design was chosen.

Strategy	Form of Research Question	Requires Control over Behavioral Events?	Focuses on Contemporary Events?
Experiment	How, Why	Yes	Yes
Survey	Who, What, Where, How many, How much	No	Yes
Archival Analysis	Who, What, Where, How many, How much	No	Yes/No
History	How, Why	No	No
Case Study	How, Why	No	Yes

**Figure 1.2 : Relevant Situations for Different Research Strategies**  
(Source: Yin, 2014)

In this study, an experimental research method is adopted by referring to the four components of the experimental method by Creswell (2014). The four components of an experimental research method include: (1) variables, (2) instrumentation and materials, (3) participants, and (4) experimental procedures.

### 1.7.1 Variables

According to Creswell (2014), a variable refers to a characteristic or attribute that can be measured or observed. In quantitative research, variables are related to answer the research question or to make predictions about what the researcher expects the result to show. Independent variables are the treatment or manipulation that probably cause, influence or affect outcomes, whereas the dependent variables are the outcomes of the influence of the independent variables. In Chapter 2, the researcher extensively analysed literature in consumer behaviour research and proposed a theoretical framework to explain the factors that could influence potential homebuyers' emotions and home purchase behaviour. In this study, the first part of hypothesis testing is to compare and evaluate participants' responses between two different environments. The independent variables are the treatment conditions – real environment and virtual environment. The dependent variables are atmospheric evaluation, perceived emotional values, perceived ease of use, perceived usefulness, pleasure emotion, arousal emotion, satisfaction, and purchase intention. The second part of hypothesis testing is to examine the hypothesised relationship between the variables proposed in Chapter 2. A detailed explanation for the variables is discussed in Chapter 2 and Chapter 3.

### **1.7.2 Instrumentation and Materials**

In an experiment, the researcher makes an observation and obtains measures using instruments (Creswell, 2014). The key material for this study is a real show unit or mock-up model of an apartment built by a local property developer. It represents the real environment. The researcher created a 3D model similar to the show unit for the virtual environment to corroborate the comparison of the experiments. The 3D virtual model was attached to display equipment called HTC Vive and formed the VR system environment. A self-reported questionnaire was developed as the data collection instrument. The questionnaire instrument was designed to measure participants' response from both experimental conditions. A detailed explanation for the instrumentation and materials components is discussed in Chapter 3.

### **1.7.3 Participants**

Potential homebuyers were selected as the target population in this study. The study population was limited to Malaysian homebuyers eligible for the Rumah Selangorku scheme in order to match the properties of homebuyers eligible for the apartment unit used for the experiment. Hence, Malaysian adults between the age of 20 and 40, have never purchased a house before, household income of between RM 3,000 and RM 10,000, and are not physically or mentally impaired were the inclusion criteria of participants for the experiment. Participants were recruited using purposive sampling technique, which allowed the researchers to select participants who were valid, informative, and deemed appropriate for analysing the effect under study (Sarstedt, Bengart, Shaltoni, & Lehmann, 2018; Ting, 2019). In this study, 65 participants were recruited for the experiment. A detailed explanation for the selected participants is discussed in Chapter 3.

### **1.7.4 Experimental Procedures**

The experiment in this study was conducted on 22 and 23 February 2020. The experimental procedures follow a within-group design where participants are exposed in both experimental conditions – real environment and virtual environment. Randomised crossover design was adopted to minimise the order effect in a within-group experimental design. Participants were called to the property developer's sales gallery where the real show unit of the apartment was built for the real environment condition; whereas for the virtual environment condition, VR equipment was set up in an empty meeting room located nearby. A detailed explanation for participants IS discussed in Chapter 3.

## **1.8 Data Analysis and Validation**

In the data analysis procedure, the data obtained from the experiment were analysed using two different statistical analysis methods – paired samples *t*-test using SPSS software version 25 and partial least squares structural equation modelling (PLS-SEM) using SmartPLS software version 3.2.8. A paired-samples *t*-test is a statistical procedure used to test hypotheses concerning the differences between the two related samples in the two conditions - real environment and virtual environment. The second data analysis procedure was conducted using PLS-SEM method to assess the hypothesised relationships between the variables in the developed framework.

The internal consistency of the multiple items in the measuring instrument was examined using the values of the Cronbach's Alpha in SPSS. In this study, all measuring items have Cronbach's Alpha values of higher than 0.70, which is the sufficient value. In addition, an analysis of the measurement model was conducted in PLS-SEM to determine the appropriateness of the theoretically defined construct and to ensure that the questionnaire items measured what they were supposed to measure and were reliable. The assessment of the measurement model involves evaluating internal consistency and convergent validity. Results of the assessment of internal consistency reliability and convergence validity performed in PLS-SEM revealed that all the CR coefficients in the path model were greater than 0.70 which indicates that the measurement model had acceptable reliability. The convergent validity was established based on the AVE values which are higher than 0.50 for all constructs. The discriminant validity of the measurement model was also assessed using PLS-SEM. The results indicated that all the constructs had established discriminant validity, where the square root of AVE was greater than the correlations for all reflective constructs. Further details are discussed in Chapter 4.

## **1.9 Scope and Limitations**

This study investigates whether the VR technology can replace the actual show unit to influence potential homebuyers' home purchase intention through the virtual environment and help property developers reduce their marketing costs as well as having the competitive advantage of utilising the digital market. Usually, the property developers will only build the show unit at the real scale for higher-priced housing projects, complete with interior decorations and furniture. The show units for affordable housing projects for middle- and lower-income potential homebuyers are often not available for potential homebuyers within this group of income to view the house before purchasing. Hence, this study concentrates its scope about the application of VR as a platform to market affordable housing projects.

Furthermore, this study limits its scope of this research for the most affordable VR solution for non-specialist in the real estate industry to easily and

conveniently use the VR technology and visualisation software as a marketing tool in the housing market. This study used *Sketchup* software, which is a free software and easy for 3D modelling, *Enscape* software as a VR plug-in that can be used with Sketchup for the VR visualisation, and HTC Vive, which is the one of the most affordable VR equipment in the market.

In addition, this study limits its scope on one of the *Rumah Selangorku* affordable housing projects by a property developer as the real show unit was already available to be used as the experiment location and convenient for research participants to participate in the study. Furthermore, the volunteers recruited to participate in the study were limited to the prospective homebuyers who meet the household income eligibility and other requirements for this type of housing scheme.

### **1.10 Organisation of the Thesis**

The content of each chapter is structured as follows:

#### **Chapter 1: Introduction**

Chapter 1 presents the context and background of the study, statement of the problem, main research question and sub-research questions, research objectives, overview of the research methodology, as well as the research scope and limitations.

#### **Chapter 2: Literature Review**

Chapter 2 reviews the literature in the study based on the constructs described in the Eagle Table (Table 1). The first part of the literature review includes relevant literature study regarding the problems in the current housing industry, virtual reality technology and the virtual environment application in various fields. The second part includes a review on various theories of consumer behaviour, particularly on the role of emotions in influencing purchase intention. The third part discusses the theoretical framework proposed based on the literature review conducted, and the hypotheses posed to be tested in the experiment conducted.

#### **Chapter 3: Experiment Research Methodology**

This chapter discusses the four components of experiment research methodology used in this study, which includes – variables, instrumentation and materials, participants, and experimental procedures. The data collected from the experiment were analysed using two different statistical analysis methods –

paired samples *t*-test using SPSS software version 25 and partial least squares structural equation modelling (PLS-SEM) using SmartPLS software version 3.2.8.

#### **Chapter 4: Results and Analysis**

This chapter presents the results and findings of the experiment that has been carried out. The data analysis consists of two parts. The first part includes results of the statistical analysis using a paired sample *t*-test while the second part discusses the results of statistical analysis using PLS-SEM that was employed to analyse the structural paths of the proposed framework. This chapter also includes discussions and recommendations based on the results from the paired samples *t*-test and PLS-SEM results, including the analysis of the participants' quantitative and qualitative evaluations of the sense of immersion and presence in the virtual environment to support the findings in this research in order to address the main research question presented in this study.

#### **Chapter 5: Conclusion**

The final chapter provides the overall discussion of the research's major findings which also includes the theoretical and practical implications of the study. The knowledge contributions and recommendations for future studies are also discussed in this chapter.

## REFERENCES

- Abidin, S. Z., Effendi, R. A., Ibrahim, R., & Idris, M. Z. (2014). A Semantic Approach in Perception for Packaging in the SME's Food Industries in Malaysia: A Case Study of Malaysia Food Product Branding in United Kingdom. *Procedia - Social and Behavioral Sciences*, 115, 115–130. <https://doi.org/10.1016/j.sbspro.2014.02.420>
- 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>
- Agag, G., & El-Masry, A. A. (2016). Understanding consumer intention to participate in online travel community and effects on consumer intention to purchase travel online and WOM: An integration of innovation diffusion theory and TAM with trust. *Computers in Human Behavior*, 60, 97–111. <https://doi.org/10.1016/j.chb.2016.02.038>
- Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
- Altaf, S. N., Perumal, S., & Hussin, Z. (2017). Consumption values and consumer attitude towards automobile purchase. *Paradigms*, 11(1), 1–5. <https://doi.org/10.24312/paradigms110101>
- 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>
- Appio, F. P., Lima, M., & Paroutis, S. (2019). Understanding Smart Cities: Innovation ecosystems, technological advancements, and societal challenges. *Technological Forecasting and Social Change*, 142, 1–14. <https://doi.org/10.1016/j.techfore.2018.12.018>
- Aris, N. A. B. M., Fathi, M. S., Harun, A. N., & Mohamed, Z. (2018). An overview of housing purchase and delivery system in Malaysia. *International Journal of Engineering and Technology(UAE)*, 7(3), 57–60. <https://doi.org/10.14419/ijet.v7i3.21.17096>
- Ashkanasy, N. M., & Daus, C. S. (2005). Rumors of the death of emotional intelligence in organizational behavior are vastly exaggerated. *Journal of Organizational Behavior*, 26(4), 441–452. <https://doi.org/10.1002/job.320>
- Attiq, S., Rasool, H., & Iqbal, S. (2017). The Impact of Supportive Work Environment, Trust, and Self-Efficacy on Organizational Learning and Its Effectiveness: A Stimulus-Organism Response Approach. *Business & Economic Review*, 9(2), 73–100. <https://doi.org/10.22547/BER/9.2.4>
- Babbie, E. (2015). *The Practice of Social Research* (14th ed.). Boston: Cengage Learning.

- Bagozzi, R. P., Gopinath, M., & Nyer, P. U. (1999). The role of emotions in marketing. *Journal of the Academy of Marketing Science*, 27(2), 184–206. <https://doi.org/10.1177/0092070399272005>
- Bakker, I., van der Voordt, T., Vink, P., & de Boon, J. (2014). Pleasure, Arousal, Dominance: Mehrabian and Russell revisited. *Current Psychology*. <https://doi.org/10.1007/s12144-014-9219-4>
- Baños, R. M., Botella, C., Alcañiz, M., Liaño, V., Guerrero, B., & Rey, B. (2004). Immersion and Emotion: Their Impact on the Sense of Presence. *CyberPsychology & Behavior*, 7(6), 734–741. <https://doi.org/10.1089/cpb.2004.7.734>
- Bengtsson, A., Hägerhäll, C., Englund, J.-E., & Grahn, P. (2015). Outdoor Environments at Three Nursing Homes: Semantic Environmental Descriptions. *Journal of Housing For the Elderly*, 29(1–2), 53–76. <https://doi.org/10.1080/02763893.2014.987863>
- Besbris, M. (2016). Romancing the home: Emotions and the interactional creation of demand in the housing market. *Socio-Economic Review*, 14(3), 461–482. <https://doi.org/10.1093/ser/mww004>
- Bickman, L., Rog, D., Lipsey, M., & Hurley, S. (2014). Design Sensitivity: Statistical Power for Applied Experimental Research. In *The SAGE Handbook of Applied Social Research Methods* (pp. 44–76). <https://doi.org/10.4135/9781483348858.n2>
- 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>
- Bleize, D. N., & Antheunis, M. L. (2019). Factors influencing purchase intent in virtual worlds: a review of the literature. *Journal of Marketing Communications*, 25(4), 403–420. <https://doi.org/10.1080/13527266.2016.1278028>
- Bouchlaghem, D., Shang, H., Whyte, J., & Ganah, A. (2005). Visualisation in architecture, engineering and construction (AEC). *Automation in Construction*, 14(3), 287–295. <https://doi.org/10.1016/j.autcon.2004.08.012>
- Brunswik, E. (1952). The conceptual framework of psychology. *Psychological Bulletin*, 49(6), 654–656.
- Bullinger, H.-J., Bauer, W., Wenzel, G., & Blach, R. (2010). Towards user centred design (UCD) in architecture based on immersive virtual environments. *Computers in Industry*, 61(4), 372–379. <https://doi.org/10.1016/j.compind.2009.12.003>
- Calvo-Porrá, C., Faiña-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>

- Camero, A., & Alba, E. (2019). Smart City and information technology: A review. *Cities*, 93, 84–94. <https://doi.org/10.1016/j.cities.2019.04.014>
- Campbell, D. T., & Stanley, J. C. (1963). Experimental and quasi-experimental designs for research. *Handbook of Research on Teaching*, 171–246.
- Caneparo, L. (2001). Shared virtual reality for design and management: The Porta Susa project. *Automation in Construction*, 10(2), 217–228. [https://doi.org/10.1016/S0926-5805\(99\)00032-1](https://doi.org/10.1016/S0926-5805(99)00032-1)
- Cao, X., & Sun, J. (2018). Exploring the effect of overload on the discontinuous intention of social media users: An S-O-R perspective. *Computers in Human Behavior*, 81, 10–18. <https://doi.org/10.1016/j.chb.2017.11.035>
- Carmeli, A. (2003). The relationship between emotional intelligence and work attitudes, behavior and outcomes. *Journal of Managerial Psychology*, 18(8), 788–813. <https://doi.org/10.1108/02683940310511881>
- Chan, C. (2005). How Real is the Sense of Presence in a Virtual Environment?: Applying Protocol Analysis for Data Collection. *Proceedings of the 10th International Conference on Computer Aided Architectural Design Research in Asia*, 188–197.
- 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>
- Chang, S. H., Chih, W. H., Liou, D. K., & Hwang, L. R. (2014). The influence of web aesthetics on customers' PAD. *Computers in Human Behavior*, 36, 168–178. <https://doi.org/10.1016/j.chb.2014.03.050>
- Charness, G., Gneezy, U., & Kuhn, M. A. (2012). Experimental methods: Between-subject and within-subject design. *Journal of Economic Behavior and Organization*, 81(1), 1–8. <https://doi.org/10.1016/j.jebo.2011.08.009>
- Cheah, J. H., Sarstedt, M., Ringle, C. M., Ramayah, T., & Ting, H. (2018). Convergent validity assessment of formatively measured constructs in PLS-SEM: On using single-item versus multi-item measures in redundancy analyses. *International Journal of Contemporary Hospitality Management*, 30(11), 3192–3210. <https://doi.org/10.1108/IJCHM-10-2017-0649>
- Chin, W. W. (2010). *How to Write Up and Report PLS Analyses BT - Handbook of Partial Least Squares: Concepts, Methods and Applications* (V. Esposito Vinzi, W. W. Chin, J. Henseler, & H. Wang, eds.). [https://doi.org/10.1007/978-3-540-32827-8\\_29](https://doi.org/10.1007/978-3-540-32827-8_29)
- Cho, M. E., & Kim, M. J. (2017). Measurement of User Emotion and Experience in Interaction with Space. *Journal of Asian Architecture and Building Engineering*, 16(1), 99–106. <https://doi.org/10.3130/jaabe.16.99>
- Choi, H., & Kandampully, J. (2019). The effect of atmosphere on customer engagement in upscale hotels: An application of S-O-R paradigm. *International Journal of Hospitality Management*, 77, 40–50. <https://doi.org/10.1016/j.ijhm.2018.06.012>

- Chrysochou, P. (2017). Consumer Behavior Research Methods. In G. Emilien, R. Weitekunat, & F. Lüdicke (Eds.), *Consumer Perception of Product Risks and Benefits* (pp. 409–428). [https://doi.org/10.1007/978-3-319-50530-5\\_22](https://doi.org/10.1007/978-3-319-50530-5_22)
- Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences Second Edition* (2nd ed.). <https://doi.org/https://doi.org/10.4324/9780203771587>
- Coleman, N. V., & Williams, P. (2013). Feeling Like My Self: Emotion Profiles and Social Identity. *Journal of Consumer Research*, 40(2), 203–222. <https://doi.org/10.1086/669483>
- Creswell, J. W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (4th ed.). California: SAGE Publications, Inc.
- Das, G., & Varshneya, G. (2017). Consumer emotions: Determinants and outcomes in a shopping mall. *Journal of Retailing and Consumer Services*, 38, 177–185. <https://doi.org/10.1016/j.jretconser.2017.06.008>
- Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, 13(3), 319–340. <https://doi.org/10.2307/249008>
- de Kort, Y. A. W., Ijsselstein, 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>
- De Nisco, A., & Warnaby, G. (2014). Urban design and tenant variety influences on consumers' emotions and approach behavior. *Journal of Business Research*, 67(2), 211–217. <https://doi.org/10.1016/j.jbusres.2012.10.002>
- Demir, E., Desmet, P. M. A., & Hekkert, P. (2009). Appraisal Patterns of Emotions in Human-Product Interaction. *International Journal of Design*, 3(2), 41–51.
- Dempsey, P. (2016). The teardown: HTC Vive VR headset. *Engineering & Technology*, 11(7–8), 80–81. <https://doi.org/10.1049/et.2016.0731>
- Desmet, P. (2003). A Multilayered Model of Product Emotions. *The Design Journal*, 6(2), 4–13. <https://doi.org/10.2752/146069203789355480>
- Desmet, P., & Hekkert, P. (2007). Framework of Product Experience. *International Journal of Design*, 1(1), 13–23. <https://doi.org/10.1210/en.2017-00348>
- Diemer, J., Alpers, G. W., Peperkorn, H. M., Shibani, Y., & Mühlberger, A. (2015). The impact of perception and presence on emotional reactions: A review of research in virtual reality. *Frontiers in Psychology*, 6(JAN), 1–9. <https://doi.org/10.3389/fpsyg.2015.00026>
- Disztinger, P., Schlögl, S., & Groth, A. (2017). Technology Acceptance of Virtual Reality for Travel Planning. In *Information and Communication Technologies in Tourism 2017* (pp. 255–268). <https://doi.org/10.1007/978->

- Donovan, R. J., & Rossiter, J. R. (1982). Store Atmosphere: An Environmental Psychology Approach. *Journal of Retailing*, 58(1), 34. <https://doi.org/Article>
- Douglas, D., & Gifford, R. (2001). Evaluation of the physical classroom by students and professors: A lens model approach. *Educational Research*, 43(3), 295–309. <https://doi.org/10.1080/00131880110081053>
- 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>
- Escalas, J. E. (2004). Imagine Yourself in the Product: Mental Simulation, Narrative Transportation, and Persuasion. *Journal of Advertising*, 33(2), 37–48. Retrieved from <http://www.jstor.org/stable/4189256>
- Faas, D., Bao, Q., Frey, D. D., & Yang, M. C. (2014). The influence of immersion and presence in early stage engineering designing and building. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing*, 28(02), 139–151. <https://doi.org/10.1017/S0890060414000055>
- 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. Retrieved from <https://link.springer.com/content/pdf/10.3758/BF03193146.pdf>
- Fishbein, M., & Ajzen, I. (1977). Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research. *Philosophy and Rhetoric*, 10(2).
- Floh, A., & Madlberger, M. (2013). The role of atmospheric cues in online impulse-buying behavior. *Electronic Commerce Research and Applications*, 12(6), 425–439. <https://doi.org/10.1016/j.elerap.2013.06.001>
- 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>
- Franz, G., Von Der Heyde, M., & Bühlhoff, H. H. (2005). An empirical approach to the experience of architectural space in virtual reality-exploring relations between features and affective appraisals of rectangular indoor spaces. *Automation in Construction*, 14(2 SPEC. ISS.), 165–172. <https://doi.org/10.1016/j.autcon.2004.07.009>
- Franz, G., & Wiener, J. M. (2008). From Space Syntax to Space Semantics: A Behaviorally and Perceptually Oriented Methodology for the Efficient Description of the Geometry and Topology of Environments. *Environment and Planning B: Planning and Design*, 35(4), 574–592. <https://doi.org/10.1068/b33050>
- Frijda, N. H. (1986). *The Emotions*. Cambridge University Press.

- Frijda, N. H. (2010). Impulsive action and motivation. *Biological Psychology*, 84(3), 570–579. <https://doi.org/10.1016/j.biopsycho.2010.01.005>
- Garson, G. D. (2016). Partial Least Squares: Regression & Structural Equation Models. In G. David Garson and Statistical Associates Publishing.
- Gifford, R. (2007). *Environmental psychology: Principles and practice*. Optimal books Colville, WA.
- Gifford, R., Hine, D. W., Muller-Clemm, W., Reynolds, D. J., & Shaw, K. T. (2000). Decoding Modern Architecture: A Lens Model Approach for Understanding the Aesthetic Differences of Architects and Layperson. *Environment and Behavior*, 32(2), 163–187. <https://doi.org/10.1177/00139160021972487>
- Gonçalves, H. M., Lourenço, T. F., & Silva, M. (2016). Green buying behavior and the theory of consumption values: A fuzzy-set approach ☆. *Journal of Business Research*, 69, 1484–1491. <https://doi.org/10.1016/j.jbusres.2015.10.129>
- Gram-Hanssen, K., & Darby, S. J. (2018). “Home is where the smart is”? Evaluating smart home research and approaches against the concept of home. *Energy Research and Social Science*, 37, 94–101. <https://doi.org/10.1016/j.erss.2017.09.037>
- Grewal, D., Monroe, K. B., & Krishnan, R. (1998). The Effects of Price-Comparison Advertising on Buyers’ Perceptions of Acquisition Value, Transaction Value, and Behavioral Intentions. *Journal of Marketing*, 62(2), 46–59. <https://doi.org/10.2307/1252160>
- 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., Hult, G. T. M., Ringle, C. M., Sarstedt, M., & Thiele, K. O. (2017). Mirror, mirror on the wall: a comparative evaluation of composite-based structural equation modeling methods. *Journal of the Academy of Marketing Science*, 45(5), 616–632. <https://doi.org/10.1007/s11747-017-0517-x>
- 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>
- Hansen, J. M., Saridakis, G., & Benson, V. (2018). Risk, trust, and the interaction of perceived ease of use and behavioral control in predicting consumers’ use of social media for transactions. *Computers in Human Behavior*, 80, 197–206. <https://doi.org/10.1016/j.chb.2017.11.010>
- Hasanudin, M. T. T., & Chandra Sakaran, K. (2016). Prioritisation of key attributes influencing the decision to purchase a residential property in Malaysia: An analytic hierarchy process (AHP) approach. *International Journal of Housing Markets and Analysis*, 9(4), 446–467. <https://doi.org/10.1108/IJHMA-09-2015-0052>

- Hashim, A. H. (2003). Residential satisfaction and social integration in public low cost housing in Malaysia. *Pertanika Journal of Social Sciences & Humanities*, 11(1), 1–10.
- Helander, M. G., & Khalid, H. M. (2006). Affective and Pleasurable Design. In G. Salvendy (Ed.), *Handbook of Human Factors and Ergonomics* (Third, pp. 543–569). John Wiley & Sons, Inc.
- 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., & Jeong, K. (2019). Occupant responses on satisfaction with window size in physical and virtual built environments. *Building and Environment*, 166. <https://doi.org/10.1016/j.buildenv.2019.106409>
- Houtkamp, J. M. (2012). *Affective appraisal of virtual environments*. Utrecht University.
- Hsieh, J. K., Hsieh, Y. C., Chiu, H. C., & Yang, Y. R. (2014). Customer response to web site atmospherics: Task-relevant cues, situational involvement and PAD. *Journal of Interactive Marketing*, 28(3), 225–236. <https://doi.org/10.1016/j.intmar.2014.03.001>
- Huang, Y. C., Backman, K. F., Backman, S. J., & Chang, L. L. (2016). Exploring the Implications of Virtual Reality Technology in Tourism Marketing: An Integrated Research Framework. *International Journal of Tourism Research*, 18(2), 116–128. <https://doi.org/10.1002/jtr.2038>
- Hui, T. K. L., Sherratt, R. S., & Díaz Sánchez, D. (2017). Major requirements for building Smart Homes in Smart Cities based on Internet of Things technologies. *Future Generation Computer Systems*, 76, 358–369. <https://doi.org/10.1016/j.future.2016.10.026>
- Ibrahim, R. (2011). Demystifying the Arduous doctoral journey: The eagle vision of a research proposal. *Electronic Journal of Business Research Methods*, 9(2), 130–140. <https://doi.org/10.1049/iet-cvi.2014.0261>
- Ilbeigi, M., & Ghomeishi, M. (2017). An assessment of Aesthetics in Conceptual Properties and its Relation to Complexity among Architects and Non-Architects in Residential Façade Design in Iran. *Journal of Buildings and Sustainability*, 2(1).
- Ioannidou F, Konstantikaki, V. (2008). Empathy and emotional intelligence : What is it really about? *International Journal of Caring Sciences*, 1(3), 118–123. <https://doi.org/10.4236/psych.2010.11008>

- Izard, C. E. (2010). The many meanings/aspects of emotion: Definitions, functions, activation, and regulation. *Emotion Review*, 2(4), 363–370.
- Japutra, A., Loureiro, S. M. C., Molinillo, S., & Ekinci, Y. (2019). Travellers' mindsets and theory of planned behaviour. *Tourism Management Perspectives*, 30, 193–196. <https://doi.org/10.1016/j.tmp.2019.02.011>
- 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>
- Juan, Y. K., Chen, H. H., & Chi, H. Y. (2018). Developing and evaluating a virtual reality-based navigation system for pre-sale housing sales. *Applied Sciences*, 8(6). <https://doi.org/10.3390/app8060952>
- Kaltcheva, V. D., & Weitz, B. A. (2006). When Should a Retailer Create an Exciting Store Environment? *Journal of Marketing*, 70(1), 107–118. <https://doi.org/10.1509/jmkg.2006.70.1.107>
- Kam, K. J., Lim, A. S. H., Al-Obaidi, K. M., & Lim, T. S. (2018). Evaluating Housing Needs and Preferences of Generation Y in Malaysia. *Planning Practice and Research*, 33(2), 172–185. <https://doi.org/10.1080/02697459.2018.1427413>
- Kamaruzzaman, S. N., & Azmal, A. M. (2019). Evaluation of occupants' well-being and perception towards indoor environmental quality in Malaysia affordable housing. *Journal of Facilities Management*, 17(1), 90–106. <https://doi.org/10.1108/JFM-11-2017-0070>
- Kamaruzzaman, S. N., Razali, A., Ahmad Zawawi, E. M., Basir, S. A., & Riley, M. (2018). Residents' Satisfaction Towards the Indoor Environmental Quality of Re-engineered Affordable Housing Scheme in Malaysia. *International Journal of Technology*, 9(3), 501–512.
- Karlsson, B. S. A., Aronsson, N., & Svensson, K. A. (2003). Using semantic environment description as a tool to evaluate car interiors. *Ergonomics*, 46(13–14), 1408–1422. <https://doi.org/10.1080/00140130310001624905>
- Ke, F., Lee, S., & Xu, X. (2016). Teaching training in a mixed-reality integrated learning environment. *Computers in Human Behavior*, 62, 212–220. <https://doi.org/10.1016/j.chb.2016.03.094>
- Khedekar, D. C., Truco, A. C., Oteyza, D. A., & Huertas, G. F. (2017). Home Automation—A Fast - Expanding Market. *Thunderbird International Business Review*, 59(1), 79–91. <https://doi.org/https://doi.org/10.1002/tie.21829>
- Khoo, C., & Ndubisi, N. (2008). Emotion, involvement and home purchase decision-making process: emerging propositions for marketing to international and local buyers. In N. Ndubisi (Ed.), *International Business: Theory & Strategy: Large and Small Firms Perspectives* (pp. 115–133). Arah Pendidikan Sdn Bhd.
- Kim, K., Byon, K. K., Baek, W., & Williams, A. S. (2018). Examining structural

- relationships among sport service environments, excitement, consumer-to-consumer interaction, and consumer citizenship behaviors. *International Journal of Hospitality Management*.  
<https://doi.org/10.1016/j.ijhm.2018.10.004>
- Kim, M. J., Wang, X., Love, P. E. D., Li, H., & Kang, S. C. (2013). Virtual reality for the built environment: A critical review of recent advances. *Journal of Information Technology in Construction*, 18(August), 279–305.
- Koo, D. M., & Lee, J. H. (2011). Inter-relationships among dominance, energetic and tense arousal, and pleasure, and differences in their impacts under online vs. offline environment. *Computers in Human Behavior*, 27(5), 1740–1750. <https://doi.org/10.1016/j.chb.2011.03.001>
- Kotler, P. (1973). Atmospherics as a marketing tool. *Journal of Retailing*, 49(4), 48–64.
- Kozlowski, D., Hutchinson, M., Hurley, J., & Browne, G. (2018). Increasing nurses' emotional intelligence with a brief intervention. *Applied Nursing Research*, 41(December 2017), 59–61. <https://doi.org/10.1016/j.apnr.2018.04.001>
- 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>
- Kumar, A., & Kim, Y.-K. (2014). The store-as-a-brand strategy: The effect of store environment on customer responses. *Journal of Retailing and Consumer Services*, 21, 685–695. <https://doi.org/10.1016/j.jretconser.2014.04.008>
- Lang, J. (1988). Symbolic aesthetics in architecture: toward a research agenda. In J. L. Nasar (Ed.), *Environmental aesthetics: Theory, research, and application*.  
<https://doi.org/http://dx.doi.org/10.1017/CBO9780511571213.004>
- Lanier, J., & Biocca, F. (1992). An insider's view of the future of virtual reality. *Journal of Communication*, 42(4), 150–172.
- 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>
- Lazarus, R. S. (1991). *Emotion and adaptation*. Oxford University Press on Demand.
- 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, Y.-C. N., Shan, L.-T., & Chen, C.-H. (2013). *System Development of Immersive Technology Theatre in Museum*. [https://doi.org/10.1007/978-3-642-39420-1\\_42](https://doi.org/10.1007/978-3-642-39420-1_42)
- Levy, D., Murphy, L., & Lee, C. K. C. (2008). Influences and emotions: Exploring family decision-making processes when buying a house. *Housing Studies*, 23(2), 271–289. <https://doi.org/10.1080/02673030801893164>
- Li, C. Y., & Fang, Y. H. (2020). I searched, I collected, I experienced: Exploring how mobile augmented reality makes the players go. *Journal of Retailing and Consumer Services*, 54(151), 102018. <https://doi.org/10.1016/j.jretconser.2019.102018>
- Li, X., Yi, W., Chi, H. L., Wang, X., & Chan, A. P. C. (2018). A critical review of virtual and augmented reality (VR/AR) applications in construction safety. *Automation in Construction*, 86, 150–162. <https://doi.org/10.1016/j.autcon.2017.11.003>
- 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>
- Love, P., Edwards, D., & Wood, E. (2008). Loosening the Gordian knot: the role of emotional intelligence in construction. *Engineering, Construction and Architectural Management International Journal of Managing Projects in Business*, 18(4), 50–65. Retrieved from <https://doi.org/10.1108/09699981111098685>
- Luqman, A., Cao, X., Ali, A., Masood, A., & Yu, L. (2017). Empirical investigation of Facebook discontinues usage intentions based on SOR paradigm. *Computers in Human Behavior*, 70, 544–555. <https://doi.org/10.1016/j.chb.2017.01.020>
- Machleit, K. A., & Eroglu, S. A. (2000). Describing and Measuring Emotional Response to Shopping Experience. *Journal of Business Research*, 49, 101–111.
- Majumdar, T., Fischer, M. A., & Schwegler, B. R. (2006). Conceptual Design Review With a Virtual Reality Mock-Up Model. *Engineering*, (July), 2902–2911.
- Malhotra, N. K., & Birks, D. F. (2012). *Marketing research: An applied approach* (4th ed.). Pearson education.
- Marikyan, D., Papagiannidis, S., & Alamanos, E. (2019). A systematic review of the smart home literature: A user perspective. *Technological Forecasting and Social Change*, 138, 139–154. <https://doi.org/10.1016/j.techfore.2018.08.015>
- Marr, D. (1982). *Vision: A computational investigation into the human representation and processing of visual information*.
- 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.
- Medway, P. (2000). *Writing and design in architectural education* (pp. 89–128). pp. 89–128.
- 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>
- Memon, M. A., Chuah, F., & Ting, H. (2018). Assessing Reflective Models In Marketing Research : A Comparison between PLS and PLSc Estimates. *International Journal of Business and Society*, 19(1), 139–160.
- Milgram, P., & Kishino, F. (1994). Taxonomy of mixed reality visual displays. *IEICE Transactions on Information and Systems*, E77-D(12), 1321–1329.
- Mohit, M. A., Ibrahim, M., & Rashid, Y. R. (2010). Assessment of residential satisfaction in newly designed public low-cost housing in Kuala Lumpur , Malaysia. *Habitat International*, 34(1), 18–27. <https://doi.org/10.1016/j.habitatint.2009.04.002>
- 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>
- Muhanna, M. A. (2015). Virtual reality and the CAVE: Taxonomy, interaction challenges and research directions. *Journal of King Saud University - Computer and Information Sciences*, 27, 344–361. <https://doi.org/10.1016/j.jksuci.2014.03.023>
- Nasar, J. L. (1994). Urban design aesthetics: The evaluative qualities of building exteriors. *Environment and Behavior*, 26(3), 377–401. <https://doi.org/10.1177/001391659402600305>
- Naz, A., Kopper, R., McMahan, R. P., & Nadin, M. (2017). Emotional qualities of VR space. *Proceedings - IEEE Virtual Reality*, 3–11. <https://doi.org/10.1109/VR.2017.7892225>
- Neuman, L. W. (2014). *Social Research Methods: Qualitative and Quantitative Approaches* (8th ed.). Pearson Education.
- Niehorster, D. C., Li, L., & Lappe, M. (2017). The accuracy and precision of position and orientation tracking in the HTC vive virtual reality system for scientific research. *I-Perception*, 8(3), 1–23. <https://doi.org/10.1177/2041669517708205>
- Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). New York: McGraw-Hill

Education.

- Olanrewaju, A. L., & Wong, Hw. C. (2019). Evaluation of the requirements of first time buyers in the purchase of affordable housing in Malaysia. *Journal of Housing and the Built Environment*, (0123456789). <https://doi.org/10.1007/s10901-019-09681-z>
- Olanrewaju, A. L., & Woon, T. C. (2017). An exploration of determinants of affordable housing choice. *International Journal of Housing Markets and Analysis*, 10(5), 703–723. <https://doi.org/10.1108/IJHMA-11-2016-0074>
- 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>
- Palmon, O., Sahar, M., Wiess, L. P., & Oxman, R. (2006). Virtual Environments for the evaluation of human performance: Towards Virtual Occupancy Evaluation in Designed Environments (VOE). *Proceedings of the 11th International Conference on Computer Aided Architectural Design Research in Kumamoto, Japan*, 521–527.
- 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>
- Parsons, T. D., & Rizzo, A. A. (2008). Affective outcomes of virtual reality exposure therapy for anxiety and specific phobias: A meta-analysis. *Journal of Behavior Therapy and Experimental Psychiatry*, 39(3), 250–261. <https://doi.org/10.1016/j.jbtep.2007.07.007>
- Peperkorn, H. M., Diemer, J., & Mühlberger, A. (2015). Temporal dynamics in the relation between presence and fear in virtual reality. *Computers in Human Behavior*, 48, 542–547. <https://doi.org/https://doi.org/10.1016/j.chb.2015.02.028>
- Petrillo, A., De Felice, F., Cioffi, R., & Zomparelli, F. (2018). Fourth Industrial Revolution: Current Practices, Challenges, and Opportunities. In *Digital Transformation in Smart Manufacturing* (pp. 1–15). Retrieved from <https://www.intechopen.com/books/advanced-biometric-technologies/liveness-detection-in-biometrics>
- 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(February), 1–12. <https://doi.org/10.1016/j.chb.2019.02.008>
- Price, M., Mehta, N., Tone, E. B., & Anderson, P. L. (2011). Does engagement

with exposure yield better outcomes? Components of presence as a predictor of treatment response for virtual reality exposure therapy for social phobia. *Journal of Anxiety Disorders*, 25(6), 763–770. <https://doi.org/10.1016/j.janxdis.2011.03.004>

- Price, P., Jhangiani, R., & Chiang, I. C. A. (2014). *Research Methods in Psychology* (2nd Edition).
- Privitera, G. J. (2018). *Research methods for the behavioral sciences*. Sage Publications.
- Pryke, S., Lunic, D., & Badi, S. (2015). The effect of leader emotional intelligence on leader–follower chemistry: a study of construction project managers. *Construction Management and Economics*, 33(8), 603–624. <https://doi.org/10.1080/01446193.2015.1078901>
- Ramayah, T., Cheah, J. H., Chuah, F., Ting, H., & Memon, M. A. (2016). Partial Least Squares Structural Equation Modeling (PLS-SEM) using SmartPLS 3.0: An Updated Guide and Practical Guide to Statistical Analysis. In *Pearson* (2nd ed.). <https://doi.org/10.1108/ebr-10-2013-0128>
- Rasoolimanesh, S. M., Ringle, C. M., Jaafar, M., & Ramayah, T. (2017). Urban vs. rural destinations: Residents' perceptions, community participation and support for tourism development. *Tourism Management*, 60, 147–158. <https://doi.org/10.1016/j.tourman.2016.11.019>
- Ren, A., Wen, Y., Chen, C., & Shi, J. (2004). Modeling of irregular structures for the construction simulation in virtual reality environments based on web. *Automation in Construction*, 13(5), 639–649. <https://doi.org/10.1016/J.AUTCON.2004.04.007>
- Renner, R. S., Velichkovsky, B. M., & Helmert, J. R. (2013). The Perception of Egocentric Distances in Virtual Environments - A Review. *ACM Computing Surveys*, 46(2), 1–40.
- Rochlen, L. R., Levine, R., & Tait, A. R. (2017). First-Person Point-of-View-Augmented Reality for Central Line Insertion Training: A Usability and Feasibility Study. *Simulation in Healthcare*, 12(1), 57–62. <https://doi.org/10.1097/SIH.0000000000000185>
- Roy, S. K., Balaji, M. S., Quazi, A., & Quaddus, M. (2018). Predictors of customer acceptance of and resistance to smart technologies in the retail sector. *Journal of Retailing and Consumer Services*, 42, 147–160. <https://doi.org/10.1016/j.jretconser.2018.02.005>
- Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, 39(6), 1161–1178. <https://doi.org/10.1037/h0077714>
- Russell, J. A., & Pratt, G. (1980). A description of the affective quality attributed to environments. *Journal of Personality and Social Psychology*, 38(2), 311–322. <https://doi.org/10.1037/0022-3514.38.2.311>
- Ryu, K., & Jang, S. C. S. (2007). The Effect of Environmental Perceptions on Behavioral Intentions Through Emotions: The Case of Upscale

- Restaurants. *Journal of Hospitality and Tourism Research*, 31(1), 56–72.  
<https://doi.org/10.1177/1096348006295506>
- Salovey, P., & Grewal, D. (2011). The Science of Emotional Intelligence. *Current Directions in Psychological Science*, 14(6), 281–285.  
<https://doi.org/10.1027/1016-9040.13.1.64>
- 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>
- Scherer, K. R., Schorr, A., & Johnstone, T. (2001). *Appraisal processes in emotion: Theory, methods, research*. Oxford University Press.
- Scherer, R., Siddiq, F., & Tondeur, J. (2018). The technology acceptance model (TAM): A meta-analytic structural equation modeling approach to explaining teachers' adoption of digital technology in education. *Computers & Education*, 128, 13–35. <https://doi.org/10.1016/j.compedu.2018.09.009>
- Schill, M., Godefroit-Winkel, D., Diallo, M. F., & Barbarossa, C. (2019). Consumers' intentions to purchase smart home objects: Do environmental issues matter? *Ecological Economics*, 161(March), 176–185.  
<https://doi.org/10.1016/j.ecolecon.2019.03.028>
- Scholz, J., & Smith, A. N. (2016). *Augmented reality: Designing immersive experiences that maximize consumer engagement*.  
<https://doi.org/10.1016/j.bushor.2015.10.003>
- Scholz, R. W. (2017). Managing complexity: from visual perception to sustainable transitions—contributions of Brunswik's Theory of Probabilistic Functionalism. *Environment Systems and Decisions*, 37(4), 381–409.  
<https://doi.org/10.1007/s10669-017-9655-4>
- Schubert, T. W., Friedmann, F., & Regenbrecht, H. T. (1999). Decomposing the sense of presence: Factor analytic insights. *2nd International Workshop on Presence, 1999*.
- Scott, L. M. (1994). Images in Advertising: The Need for a Theory of Visual Rhetoric. *Journal of Consumer Research*, 21(2), 252–273.  
<https://doi.org/10.1086/209396>
- Serrano, B., Baños, R. M., & Botella, C. (2016). Virtual reality and stimulation of touch and smell for inducing relaxation: A randomized controlled trial. *Computers in Human Behavior*, 55, 1–8.

<https://doi.org/10.1016/j.chb.2015.08.007>

- Shaouf, A., Lü, K., & Li, X. (2016). The effect of web advertising visual design on online purchase intention: An examination across gender. *Computers in Human Behavior*, 60, 622–634. <https://doi.org/10.1016/j.chb.2016.02.090>
- Sherman, E., Mathur, A., & Smith, R. B. (1997). Store environment and consumer purchase behavior: Mediating role of consumer emotions. *Psychology & Marketing*, 14(4), 361–378. [https://doi.org/10.1002/\(SICI\)1520-6793\(199707\)14:4<361::AID-MAR4>3.0.CO;2-7](https://doi.org/10.1002/(SICI)1520-6793(199707)14:4<361::AID-MAR4>3.0.CO;2-7)
- Sheth, J. N., Newman, B. I., & Gross, B. L. (1991). Why We Buy What We Buy: A Theory of Consumption Values. *Journal of Business Research*, 22(2), 159–170. [https://doi.org/10.1016/0148-2963\(91\)90050-8](https://doi.org/10.1016/0148-2963(91)90050-8)
- 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>
- Shin, J., Park, Y., & Lee, D. (2018). Who will be smart home users? An analysis of adoption and diffusion of smart homes. *Technological Forecasting and Social Change*, 134, 246–253. <https://doi.org/10.1016/j.techfore.2018.06.029>
- Shiratuddin, M. F., Thabet, W., & Bowman, D. (2004). Evaluating the effectiveness of virtual environment displays for reviewing construction 3D models. *CONVR 2004*, 87–98.
- 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>
- Shukor, S. F. A., Stigsdotter, U. K., Lottrup, L., & Nilsson, K. (2012). Employees' Use, Preferences, and Restorative Benefits of Green Outdoor Environments at Hospitals. *ALAM CIPTA, International Journal of Sustainable Tropical Design Research and Practice*, 5(2), 77–92. Retrieved from [www.dst.dk](http://www.dst.dk)
- 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. *The Impact of Industry 4.0 on Job Creation*, (2010), 179–186. <https://doi.org/https://fsev.tnuni.sk/konferencia2018/Zbornik-industry-4-0.pdf>
- Smith, C. A., & Lazarus, R. S. (1990). Emotion and adaptation. *Handbook of Personality: Theory and Research*, 609–637.
- Smith, J. B., & Colgate, M. (2007). Customer value creation: a practical framework. *Journal of Marketing Theory and Practice*, 15(1), 7–23.

- Steuer, J. (1992). Defining Virtual Reality: Dimensions Determining Telepresence. In *Journal of Communication; Autumn* (Vol. 42). Retrieved from <http://steinhardtapps.es.its.nyu.edu/create/courses/2015/reading/steuer.pdf>
- Stockemer, D. (2019). Quantitative Methods for the Social Sciences. In *Quantitative Methods for the Social Sciences*. <https://doi.org/10.1007/978-3-319-99118-4>
- 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>
- Suki, N. (2016). Consumer environmental concern and green product purchase in Malaysia: structural effects of consumption values. *Journal of Cleaner Production*, 132, 204–214. <https://doi.org/10.1016/j.jclepro.2015.09.087>
- Sullivan, G. M., & Feinn, R. (2012). Using Effect Size—or Why the P Value Is Not Enough . *Journal of Graduate Medical Education*, 4(3), 279–282. <https://doi.org/10.4300/jgme-d-12-00156.1>
- Sutherland, I. E. (1964). Sketchpad a Man-Machine Graphical Communication System. *SIMULATION*, 2(5), R-3-R-20. <https://doi.org/10.1177/003754976400200514>
- Sutherland, L. M., Middleton, P. F., Anthony, A., Hamdorf, J., Cregan, P., Scott, D., & Maddern, G. J. (2006). Surgical simulation: a systematic review. *Annals of Surgery*, 243(3), 291–300. <https://doi.org/10.1097/01.sla.0000200839.93965.26>
- Suznjevic, M., Mandurov, M., & Matijasevic, M. (2017). Performance and QoE assessment of HTC Vive and Oculus Rift for pick-and-place tasks in VR. *2017 9th International Conference on Quality of Multimedia Experience, QoMEX 2017*, 3–5. <https://doi.org/10.1109/QoMEX.2017.7965679>
- Sweeney, J., & Soutar, G. (2001). Customer perceived value: The development of a multiple item scale. *Journal of Retailing*, 77(2), 203–220.
- Tan, T. H. (2008). Determinants of homeownership in Malaysia. *Habitat International*, 32(3), 318–335. <https://doi.org/10.1016/j.habitatint.2007.11.006>
- Tan, T. H. (2012a). Housing satisfaction in medium- and high-cost housing : The case of Greater Kuala Lumpur , Malaysia. *Habitat International*, 36(1), 108–116. <https://doi.org/10.1016/j.habitatint.2011.06.003>
- Tan, T. H. (2012b). Meeting first-time buyers' housing needs and preferences in greater Kuala Lumpur. *Cities*, 29(6), 389–396. <https://doi.org/10.1016/j.cities.2011.11.016>
- Tang, Z., Warkentin, M., & Wu, L. (2019). Understanding employees' energy saving behavior from the perspective of stimulus-organism-responses. *Resources, Conservation and Recycling*, 140, 216–223.

<https://doi.org/10.1016/j.resconrec.2018.09.030>

- Tantanatewin, W., & Inkarojrit, V. (2018). The influence of emotional response to interior color on restaurant entry decision. *International Journal of Hospitality Management*, 69, 124–131. <https://doi.org/10.1016/j.ijhm.2017.09.014>
- Thanaraju, P., Mentaza Khan, P. A., Juhari, N. H., Sivanathan, S., & Md Khair, N. (2019). Factors Affecting the Housing Preferences of Homebuyers in Kuala Lumpur. *Journal of the Malaysian Institute of Planners*, 17(1), 138–148. <https://doi.org/10.1017/CBO9781107415324.004>
- Thompson, V. A., & Campbell, J. I. D. (2004). A power struggle: Between-vs. within-subjects designs in deductive reasoning research. *Psychologia*, 47(4), 277–296.
- Thompson, W., Willemsen, P., Gooch, A. A., Creem-Regehr, S. H., Loomis, J. M., & Beall, A. C. (2004). Does the quality of the computer graphics matter when judging distances in visually immersive environments? *Presence: Teleoperators and Virtual Environments*, 13(5), 560–571. <https://doi.org/10.1162/1054746042545292>
- Thomson, J. A., Tolmie, A. K., Foot, H. C., Whelan, K. M., Sarvary, P., & Morrison, S. (2005). Influence of Virtual Reality Training on the Roadside Crossing Judgments of Child Pedestrians. *Journal of Experimental Psychology: Applied*, Vol. 11, pp. 175–186. <https://doi.org/10.1037/1076-898X.11.3.175>
- Ting, H. (2019). *The effect of selfie promotion and celebrity endorsed advertisement on decision-making processes promotion*. <https://doi.org/10.1108/IntR-12-2017-0530>
- Tullis, T., & Albert, B. (2013). Measuring the user experience: Collecting. In *Analyzing and Presenting Usability Metrics*.
- 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>
- Vargas, P. T., Duff, B. R. L., & Faber, R. J. (2017). A Practical Guide to Experimental Advertising Research. *Journal of Advertising*, 46(1), 101–114. <https://doi.org/10.1080/00913367.2017.1281779>
- 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>
- Waly, A. F., & Thabet, W. Y. (2003). A Virtual Construction Environment for preconstruction planning. *Automation in Construction*, 12(2), 139–154. [https://doi.org/10.1016/S0926-5805\(02\)00047-X](https://doi.org/10.1016/S0926-5805(02)00047-X)
- 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>
- Whyte, J. (2003). Industrial Applications of Virtual Reality in Architecture and Construction. *Virtual Reality Technology in Architecture and Construction*, 8(Special), 43–50. Retrieved from <http://www.itcon.org/2003/4>
- Witmer, B. G., & Singer, M. J. (1998). Measuring Presence in Virtual Environments: A Presence Questionnaire. In *Presence* (Vol. 7). Retrieved from <https://nil.cs.uno.edu/publications/papers/witmer1998measuring.pdf>
- Wojciechowski, R., & Cellary, W. (2013). Evaluation of learners' attitude toward learning in ARIES augmented reality environments. *Computers & Education*, 68, 570–585. <https://doi.org/https://doi.org/10.1016/j.compedu.2013.02.014>
- Yin, R. K. (2014). *Case Study Research: Design and Methods* (5th ed.). <https://doi.org/doi.org/10.1097/FCH.0b013e31822dda9e> ©
- 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>
- Zainon, N., Mohd Rahim, F. A., Sulaiman, S., Abd Karim, S. B., & Hamzah, A. (2017). Factors Affecting the Demand of Affordable Housing among the Middle-Income Groups in Klang Valley Malaysia. *Journal of Design and Built Environment*, 1–10.
- Zhang, L., & Fan, W. (2013). Improving performance of construction projects: A project manager's emotional intelligence approach. *Engineering, Construction and Architectural Management*, 20(2), 195–207. <https://doi.org/10.1108/09699981311303044>