THE EFFECTS OF INTERFACE FACTORS AND STORE ENVIRONMENT ON CONSUMERS' PURCHASE AND REVISIT INTENTION IN AN ONLINE VIRTUAL REALITY STORE

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ผลของปัจจัยส่วนต่อประสานและสภาพแวดล้อมร้านค้าที่มีต่อความตั้งใจในการซื้อและการกลับมาที่ร้านค้าออนไลน์แบบความจริงเสมือนของผู้บริโภค

นายสถิตย์โชค โพธิ์สอาด

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรดุษฎีบัณฑิต
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Thesis Title	THE EFFECTS OF INTERFACE FACTORS AND STORE ENVIRONMENT ON CONSUMERS' PURCHASE AND REVISIT INTENTION IN AN ONLINE VIRTUAL REALITY STORE
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สถิตย์โชค โพธิ์สอาด: ผลของปัจจัยส่วนต่อประสานและสภาพแวดล้อมร้านค้าที่มีต่อความตั้งใจในการซื้อและการกลับมาที่ร้านค้าออนไลน์แบบความจริงเสมือนของผู้บริโภค (The Effects of Interface Factors and Store Environment on Consumers' Purchase and Revisit Intention in an Online Virtual Reality Store). อ.ที่ปรึกษาวิทยานิพนธ์หลัก: อ.ดร.พิมพ์มณี รัตนวิชา อ.ที่ปรึกษาวิทยานิพนธ์ร่วม: อ.ดร.วัชรา จันทาทับ, 201 หน้า.

พาณิชย์อิเล็กทรอนิกส์หรืออีคอมเมิร์ซมีพัฒนาการอย่างรวดเร็ว และกลายเป็นแรงผลักดันสำคัญของการค้าโลก พาณิชย์ความจริงเสมือนหรือวีอาร์คอมเมิร์ซเป็นเทคโนโลยีที่ได้รับความนิยมเพิ่มขึ้นเรื่อยๆ แต่ยังขาดการศึกษาถึงความสัมพันธ์ระหว่างปัจจัยหลักของส่วนต่อประสานต่อความตั้งใจในการซื้อและการกลับมาที่ร้านค้าออนไลน์แบบความจริงเสมือนของผู้บริโภค

การศึกษาใช้แบบสำรวจในห้องทดลองในการเก็บข้อมูล และตัวแบบสมการโครงสร้างในการวิเคราะห์ข้อมูล ผลของการศึกษาระบุว่าปัจจัยหลักที่ระบุได้ระบุไว้ ได้แก่ คุณภาพของเว็บ การปรากฏในระยะไกล และสภาพแวดล้อมร้านค้า ที่มีผลกระทบอย่างมีนัยสำคัญต่อความตั้งใจในการซื้อและกลับมาที่ร้านค้าออนไลน์ความจริงเสมือน คุณภาพเว็บและการปรากฏในระยะไกลเป็นปัจจัยที่มีผลมากกว่าสภาพแวดล้อมร้านค้า คุณภาพเว็บสามารถกระตุ้นให้เกิดความรู้สึกว่าร้านค้ามีสมบัติการให้ข้อมูลและการให้ประโยชน์ การปรากฏในระยะไกลสามารถกระตุ้นให้เกิดความรู้สึกว่าร้านค้ามีการให้ข้อมูล การให้ประโยชน์ และความเพลิดเพลิน และสภาพแวดล้อมร้านค้าสามารถกระตุ้นในเกิดความรู้สึกว่าร้านค้ามีการให้ประโยชน์ และความเพลิดเพลิน ผู้วิจัยคาดว่าการศึกษาจะมีประโยชน์อย่างมากในการเติมเต็มวรรณกรรมทางวิชาการ โดยอธิบายด้วยตัวแบบความสัมพันธ์ที่ชัดเจน ตลอดจนแนวปฏิบัติที่สามารถปฏิบัติตามได้ทันที สำหรับผู้ปฏิบัติบนร้านค้าออนไลน์ความจริงเสมือน

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SATIDCHOKE PHOSAARD: THE EFFECTS OF INTERFACE FACTORS AND STORE ENVIRONMENT ON CONSUMERS' PURCHASE AND REVISIT INTENTION IN AN ONLINE VIRTUAL REALITY STORE. ADVISOR: PIMMANEE RATTANAWICHA, D.Tech.Sc., CO-ADVISOR: WACHARA CHANTATUB, Ph.D., 201 PP.

Electronic commerce (e-commerce) has become a fast emerging industry and a significant global economic force. Virtual reality commerce (vr-commerce), where traditional e-commerce and traditional offline commerce are converged, is a promising technology and becoming more popular but there is still lack of research on relationships between principal functional and non-functional interface factors toward consumers' purchase and revisit intention in an online VR store.

This study employed laboratory survey for data collection and structural equation modeling for data analyses. The results from this research suggest that all identified foundation factors, namely web quality, telepresence and store environment, significantly drive consumers' purchase and revisit intention. Web quality and telepresence factors contribute more than store environment. Web quality could induce informativeness and perceived usefulness; telepresence could induce perceived usefulness, informativeness and enjoyment; and store environment can induce consumers' perceived usefulness and enjoyment. It is expected that the research will be a major theoretical piece to fill in the literature gap in VR-commerce by proving a complete and parsimonious framework and a major contribution in the practical arena by providing a concrete guidelines for practitioners in VR store.

Field of Study Information Technology in Business	Student's Signature .....
	Advisor's Signature .....
Academic Year 2012	Co-advisor's Signature .....

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CHAPTER I

INTRODUCTION TO THE STUDY

This chapter presents an overview of the study. It gives a basic knowledge in virtual reality and its applications to online shopping and some of its open issues by discussing the development of e-commerce and research in the related fields of human-computer interaction. The background of the study is given in the first section where the importance of the study is delineated. Then, concepts underpinning of the study is discussed. The problem statement section addresses the literature gaps. The emerging research questions as well as the purpose of the study and expected contributions are determined. Limitations, assumptions, and design controls are stated, and then the key terms of the research are defined.

1.1 Background

Complementary to the increasing popularity of the Internet and world-wide-web (WWW), electronic commerce (e-commerce) has become a fast emerging industry and a significant global economic force. In the United States alone, the retail sales on e-commerce reached at least 31.72 billion dollars in only a period of a quarter in the first quarter of 2009 (U.S. Department of Commerce, 2013). Online retailers usually aim to attract more visitors and convert them into customers who actually purchase the products or services and also return to shop to regenerate revenue. To achieve this goal, these stores need to endeavor to enhance customers' shopping experience. Online retail stores need to continuously evolve themselves by building any competitive advantage to compete. One of promising strategies is to enhance shopping experience by an innovative shopping environment.

The marketing convergence, where information technology, marketing and design orchestrated, in today's e-commerce competitive environment requires rich-media platform (Jones, 2010; Jones, 2011; Wind, Mahajan, & Foreword By-Hagel III, 2001). In traditional e-commerce, World-Wide-Web (WWW) is the prominent standard of the Internet applications. The standard is based on the Hypertext Mark-up Language (HTML) that typically combines texts, images, and other media, and presents

them to users. Virtual reality commerce or VR-commerce (Y. Mass & A. Herzberg, 1999), which sometimes called v-commerce (Jin & Bolebruch, 2012; Jones, 2011; Swierczynska-Kaczor, 2008) driven by the Virtual Reality (VR) technology is one of the promising interfaces emerging as an alternative for e-commerce by offering a highly interactive and rich-media environment.

VR is a human-computer interaction technology that lets the users interact with the computer simulated environment. The generated environment can be an environment of either a real world or an imaginary world (Burdea & Coiffet, 2003). This VR technology has been introduced into and studied in many application areas, such as entertainment and games; medical and education (Boulos, Hetherington, & Wheeler, 2007; Seymour et al., 2002); e-commerce (Jahng, Jain, & Ramamurthy, 2006; Lepouras & Vassilakis, 2006; Li, 2002; Li, Daugherty, & Biocca, 2003; Lu & Smith, 2007; Najihah 2009); or tourism, e.g. Thai Royal Palaces Virtual Tour (Bureau of The Royal Household, 2009). Such highly interactive interface contains several distinct characteristics from general HTML web interface. It has been proven that it can offer superior experiences for certain tasks (Jahng et al., 2006; Li et al., 2003; Lu & Smith, 2007).

The VR technology providing such environment similar to the physical world is anticipated to become more popular, especially in electronic commerce. The technology is under a spotlight for many companies, universities and governments. For example, IBM (IBM Corporations, 2010) conducts ongoing research on this virtual reality related applications. Scholars actively convene in conferences dedicated to 3D and virtual reality, e.g. the ACM SIGGRAPH, WEB3D, etc. An example of a comprehensive review for research opportunities in e-commerce by Shaw, Gardner, and Thomas (1997) also suggested that virtual reality in e-commerce was a good candidate to study and was technically feasible for broad adoption.

Among VR applications, VR-commerce is a potential candidate for wide adoption since its importance and advantages derived from VR interface. E-commerce becomes a common practice for trading. The huge market size and expanding trend

intensify its pivotal role in local and global trading. In the United States alone, the retail sales on e-commerce reached at least 61.17 billion dollars in only a quarter in the first quarter of 2013 (U.S. Department of Commerce, 2013). Early strategic movers have taken the opportunity to implement VR in e-commerce. For example, China, a world's economic giant by the Chinese Government is developing a gigantic online 3D virtual world that is expected to become a massive VR-commerce platform connecting millions of consumers around the world (MSNBC, 2007). In Thailand, a working version of VR store was inaugurated in November 2010 expecting 100 million baht of transactions a year (Leesa-nguansuk, 2010). Moreover, the Gartner Group predicted that, "Eighty percent of active Internet users will have a 'second life' in the virtual world by the end of 2011" (Gartner, 2007). This emerging market of VR commerce could reach billions of dollars in coming years (Metaverse Roadmap, 2010).

Though virtual worlds are increasingly gaining attention in popular media as well as academia, there is still skepticism on whether they will be adopted on a large scale by businesses (Goel & Prokopec, 2009; Nelson, 2007). One reason for this skepticism is technological problems with current virtual worlds (Goel & Prokopec, 2009; Kock, 2008). However, according to 'Moore's Law', the performance to cost ratio of hardware doubles every 18 month, resulting in faster and richer 3D environments (Goel & Prokopec, 2009; Mollick, 2006). It is likely that technology will cease to be an issue. A second reason is the learning curve needed for people to migrate from websites to 3D platforms (Fetscherin & Lattemann, 2008).

However, we see a steady evolution of representation of information from basic text to richer, more intuitive forms that include multimedia such as sound, video, animation, and life-like structures. The new generation is comfortable using virtual platforms for social networking, education, business transactions, and telework (Dede, 2005). Virtual networks and crowd-sourcing platforms (such as Facebook, Wikipedia, epinions, MySpace, and YouTube) are now a prominent source of information (Baird & Fisher, 2005; Curry et al., 2008; Kwai Fun IP & Wagner, 2008). With the required technological development to support them, it seems intuitive that 3D environments

that support networking with richer audio, visual, and textual features will replace the current form of standard two dimensional information representations on the web ("Breakthrough ideas for 2008.," 2008; Wyld, 2010). Hence, studying the business potential of VR in terms of the marketing opportunities presented by them is imperative. However, given the pervasiveness of websites and the relative unfamiliarity with virtual worlds, it is unclear what the current state of affairs is when comparing between the two. Companies are still struggling with what entry strategy they need to adopt when dealing with customers in these new channels (Goel & Mousavidin, 2007).

Many studies have been conducted to outline technical frameworks in implementing VR stores, to figure out what can be applications of VR in e-commerce, and also to understand whether and how virtual reality is superior over traditional e-commerce. Since the major obstacle of VR commerce is the technological limitation on its implementation, many researchers have focus in technical perspectives in constructing VR store and testing their usability. As the development of online VR platforms has evolved, implementations of VR store have been proven more effectively, preferably and maturely (Chang Lee & Chung, 2005; Yosi Mass & Amir Herzberg, 1999; Thai Generation Company Limited, 2010). The viable and wider adoption of the technology enables researchers the opportunities to study VR commerce in social science manners. A study revealed that VR was able to promote consumer perception on products in advertisement (Li, Daugherty, & Biocca, 2001). VR and 3D presentation of products enable consumers to get more insight into the product features leading to better purchase intention (Lu & Smith, 2007; Suh & Lee, 2005).

Interface design and the interaction between customers and computers are factors critical to online business effectiveness. In traditional online e-commerce, it has been suggested that the interface factors are among top antecedents of system adoption (Hausman & Siekpe, 2009; Richard, 2005), as well as suggested in VR-commerce (Fetscherin & Lattemann, 2008). Researchers have extensively studied and suggested necessary and preferred interface for web e-commerce (Aladwani & Palvia, 2002; Hausman & Siekpe, 2009; Liu, Tucker, Koh, & Kappelman, 2003; Loiacono, Watson,

& Goodhue, 2002), but rarely on VR-commerce, which there is only one indeed (Hendaoui & Limayem, 2008b). Thus, to make a VR store success, determining fundamentally important user interface factors for consumers of a virtual reality store is highly important.

1.2 Conceptual Underpinnings for the Study

Fundamental concepts of both online and offline shopping converge in this study. VR store is where traditional e-commerce meets with the traditional retail commerce, thus it is possible to draw principal and matured concepts and practices from both worlds to the stage of the innovative setting of virtual reality. Relevant concepts of e-commerce, VR-commerce , and physical retail store are introduced and discussed below drawing that interface factors in traditional e-commerce (web quality), VR-commerce (telepresence), and artifacts embedded in the interaction environment (store environment) are predictors of consumers' behavior being studied (purchase intention and revisit intention).

In traditional e-commerce environment, there are many studies effectively extended the technology adoption theories, such as Technology Acceptance Model (TAM) (Davis, 1989), Theory of Reasoned Action (TRA) (Ajzen & Madden, 1986), and Theory of Planned Behavior (TPB) (Ajzen, 1991), to better predict consumer behaviors by characteristics of e-commerce. As in traditional e-commerce studies, several factors and characteristics of online shopping settings, e.g. types of products, trust in sellers, e-commerce specific interface features, etc., have been proved to significantly influence consumer behaviors beyond the scope that can capture by principle theories like TAM or TRA (Chang & Chen, 2008; Childers, Carr, Peck, & Carson, 2002; Gefen, 2000; Hausman & Siekpe, 2009; Kim & Lee, 2002; C. Liao, P. Palvia, & H. N. Lin, 2006; Liu et al., 2003; Monsuwé, Dellaert, & De Ruyter, 2004; Park & Kim, 2003). However, for VR commerce, the understanding on characteristics of VR store on consumer behavior is sparse; in fact, there are few studies that have been conducted to understand consumer behavior in virtual reality store usage (Goel & Prokopec, 2009; Hendaoui & Limayem, 2008b). The studies still come short of

practical contributions since the complexity of VR. Several studies investigate aspects of product learning in VR or adoption of general virtual worlds, which are not pertinent to contribute to the real practices and literature gaps of VR store usage (Fetscherin & Lattemann, 2008; Guo & Barnes, 2009; Jin & Bolebruch, 2012).

VR environment is considered more complex in interaction and presentation since the store is presented in submersive 3D environment, where users perceive themselves submerged into an environment, and can provide more realistic feeling rather than flat layout as on the traditional web page. Many VR applications in e-commerce have proven to be more effective than web interface in promoting user's learning on the product leading to higher purchase intention (Lu & Smith, 2007; Suh & Lee, 2005). The author believes that atmosphere, interaction, and presentation of VR settings, will significantly affect consumers' psychology and behavior differently than in traditional e-commerce interface. Such relations between VR store and consumer behaviors might not be possible to fully explain by those theories in traditional e-commerce stores due to its unique setting, which is a hybrid environment between a physical store and an online virtual store. Thus, the study to understand consumer behaviors in VR settings could contribute to the new era of e-commerce.

Nonetheless, VR store (as shown in Figure 1-1) usage can be studied using similar frameworks as in web-based e-commerce. The predictions of antecedents and consumers' adoption behaviors of certain technologies have been primarily and widely based on analyses of causal effect relationships among users' perceptions or believes, their attitude toward the technology which leads to the intention to adopt and actual adoption of the technology. In this case, antecedents of interface factors in online website commerce can be a good candidate for the VR store setting since the interface still carries metaphor of interaction in online website. Web quality (Aladwani & Palvia, 2002) conceptualized and captured all interface antecedents thoroughly. Web quality is users' evaluation of a web site's features meeting users' needs and reflecting overall excellence of the web site. It contributes in 4 dimensions: (1) technical adequacy, (2) content quality, (3) specific content, and (4) appearance.

VR environment holds a unique characteristic of telepresence (Minsky, 1980). Telepresence is defined as the experience of presence in an environment by means of a communication medium (Steuer, 1992), which mimic users' experience as they are in the real environment. To lure users for this reality situation, interactivity and vividness are two main dimensions of telepresence that must be hold. These two main dimensions meticulously defined and extensively tested can be and are needed to be a candidate of a principal interface factor in VR store shopping.

Another factor that has been overlooked but should be one of the principal for VR store adoption study that should be one of principal factors is specific artifacts created by VR store interface that is store environment. Store environment is a profoundly important concept which practitioners in retails store business always systematically define and creatively design to please customers (Spangenberg, Crowley, & Henderson, 1996). It is the characteristics, i.e. design, ambience, and social characteristics, that shoppers perceive from physical store that affects sales and consumers' shopping behavior and revisit preference (Spangenberg et al., 1996; Turley & Milliman, 2000). VR environment is the only means that can deliver virtually real experience of physical store environment. The store environment is needed to be addressed and carefully crafted appropriately from the onset of the services to successfully achieve adoption and use in a similar manner as a physical store. However, there is no existing investigation on the effects of this principal element in the VR setting.

Figure 1-1. Virtual reality shopping mall and stores (http://virtual.popwebplanet.com).

1.3 Problem Statements

Previous studies failed to achieve the ultimate goal of providing practical guidelines to incorporate basic interface features and filling literacy gap of relationships of user interface factors and consumer behavior in VR store environment due to the following short falls.

Firstly, previous studies were limited in its application contributions while on another end several studies focused on VR interface features were failed to be backed-up by theories, resulting in the curiosity in their validity. For the first set of research (Goel, Johnson, Junglas, & Ives, 2011; Goel & Prokopec, 2009; Hendaoui & Limayem, 2008b), the studies drew high level conceptualization from limited sets of VR store or virtual world features. Thus practitioners still have to work a lot to figure out which basic or advanced functionalities they should implement for a successful VR store. Several studies on VR interface features (S. Phosaard & P. Rattanawicha, 2010) may successfully addressed a set of potential VR interface features. However, the exploratory nature of the research still needs repetitions, which might fluctuate along the phase of the VR store adoption. As a result, more studies to conceptualize VR store features, both functional and non-functional, and their consumers' behavior constructs

meticulously conceptualized are required to better guide practitioners and fill the theoretical gaps.

Secondly, none of research took into account of basic functionalities of the system which carried over from the web-based e-commerce. Those basic functionalities and characteristics, such as the use of fonts, colors, searching capability, and so on, are essential for users to successfully go through an online shopping process. It is arguable that such features and characteristics might not hold in the new settings of VR, but according to their importance, it is worthwhile to study.

Thirdly, besides those theoretical studies which did not examine these basic functionalities, the research work seems to fail in stating the existence of other artifacts or activities in the VR store. In such a unique environment of VR store that could offer virtually any real-world experience over a remote distance, one could say that activities that occur in the real world could be performed over the VR store. Physical expressions through avatars, marketing promotion, store decorations, etc., are possible for the first time in this study to integrate into the online shopping platform. The limitation in VR interface and the real-world artifacts is a potential candidate for examining its role in consumer shopping behavior. Besides the opportunity for further research, the lack of explanation and rationale of leaving these basic functionalities and artifacts offered in the VR store left doubts in the completeness as well as parsimoniousness of the model.

Understanding principal factors of VR store in consumer shopping intention for theoretical and practical contributions can be achieved by tackling the discussed problems. Exhaustive literature reviews and systematically analyses could frame a model with appropriate level of conceptualization, also comprehensive and parsimonious. Web quality, telepresence, and store environment are basic elements that should be scrutinized for their roles in VR store shopping intention.

1.4 Research Questions

Being drawn from the problem statements, the overarching research question is:

"What factors affect consumers' purchase and revisit intention in an online VR store?"

From the theoretical concepts introduced, the study aims to answer the following sub research questions compiled from the importance and problems discussed in the previous section:

1. To what extent does web quality contribute to consumers' purchase and revisit intention in an online VR store?
2. To what extent does telepresence contribute to consumers' purchase and revisit intention in an online VR store?
3. To what extent does store environment contribute to consumer's purchase and revisit intention in an online VR store?

1.5 Purpose of the Study and Expected Contributions

The purpose of the study is to examine the effects of a set of essential interface factors, i.e. web quality and telepresence, and the fundamental feature induced from the interface as artifacts, the store environment, to a VR store on potential consumers. This research tries to understand such relationships of VR-commerce characteristics and consumer behaviors from the ground-up by answering the listed research questions above, and the contributions can be briefly outlined as follows.

It is the first time that the basic interface factors and store environment factor are taken into consideration to provide a better understanding of VR store shopping intention and basic implementation guideline. It can provide managerial guidelines in offering a set of appropriate features to be implemented from the onset of the store for successful VR store services. On the theoretical side, it is a major step to bring matured concepts in commerce from different popular platforms to synchronize and effectively explain rational behind consumers' behavior in adoption. The study encourages further VR store studies where virtually all marketing activities can be implemented.

1.6 Limitations, Assumptions, and Design Controls

This study is not without limitations. A first limitation of this study is that it is cross sectional. However, websites are dynamic in their developments. Therefore, a longitudinal survey is needed to identify the changing roles of Internet features as perceived by consumers alongside Internet technology advancements and consumer continued usage of the Internet services. The use of students as a population also posts a limitation. This study recognizes that student samples have often been criticized for their lack of generalizability and their inability to represent the population of interest (Gordon, Slade, & Scmitt, 1987), but may be valid in this case where online shoppers tend to be younger and more educated than the general population (Hausman & Siekpe, 2009).

It is reasonable to assume that other e-commerce markets might react differently to some of the factors identified in this study. For example, enjoyment might be of lesser importance for the business-to-business (B2B) market relative to the consumer market. Investigating B2B market behavior, therefore, would improve the understanding that managers have of how to attract potential customers to their shopping sites. Finally, there are many other factors that can influence the shopping experience. For example, with the proliferation and speed of broadband technologies, the marketing activities and interface become richer and more engaging.

1.7 Definition of Key Terms

Table 1-1. Definition of Key Terms and Synonyms

Term	Definition	Synonyms
Virtual Reality (VR)	A real or simulated environment in which a perceiver experiences telepresence (Steuer, 1992)	virtual environment, virtual world, 3D virtual world (3DVW)
Virtual Reality Store (VR Store)	An electronic environment that visually mimics complex physical spaces, where people can interact with each other and with virtual objects, and where people are represented by animated characters (Bainbridge, 2007)	VR-shop, virtual reality mall, virtual shopping mall, 3D virtual reality store
Web Quality	Users' evaluation of a web site's features meeting users' needs and reflecting overall excellence of the web site (Aladwani & Palvia, 2002)	
Telepresence	The experience of presence in an environment by means of a communication medium (Steuer, 1992)	
Store Environment	The surroundings or conditions in which a person experiences in a retail store—compiled definition (Anderson, 1986; Baker, 1987; Fisher, 1974)	store atmosphere
Purchase Intention (in an online VR Store)	Intention to shop and make purchase transactions in the VR store.	intention to purchase, intention to shop, intention to use
Revisit Intention (in an online VR Store)	Intention to return to shop and make other transactions in the VR store	intention to return, re-use
VR-commerce	E-commerce conducted using virtual reality (Jones, 2011; Y. Mass & A. Herzberg, 1999)	virtual reality commerce, v-commerce, virtual commerce

1.8 Summary

VR-commerce is a promising technology and becoming more popular but there is lack of research on relationships between principal functional and non-functional factors toward consumer shopping intention. VR store setting is where traditional e-commerce and traditional offline commerce are converged in a virtual reality setting. Web quality (a fundament and matured interface factor carried from the traditional online e-commerce), telepresence (the main and distinct characteristic of interface in VR-commerce) and store environment (the principal element of the traditional offline retail commerce) are extracted as the essential functional and non-functional factors, which are posited to be predictors for consumer purchase intention in and revisit to a VR store.

To achieve the research objectives, this study tries to answer the following research questions: (1) To what extent does web quality contribute to consumers' purchase and revisit intention in an online VR store? (2) To what extent does telepresence contribute to consumers' purchase and revisit intention in an online VR store?, and (3) To what extent does store environment contribute to consumer's purchase and revisit intention in an online VR store? It is expected that this research will be a major theoretical piece to fill in the literature gap in VR-commerce by proving an extensive and parsimonious framework and a major contribution in the practical arena by providing good guidelines for practitioners in VR store.

CHAPTER II

REVIEW OF RELATED LITERATURE

In this chapter, related theories and literatures are reviewed. The relationship between user interface of online virtual reality (VR) store and consumer decisions in VR shopping is at the center stage of the research. Thus, the development in e-commerce research focusing on the user interface issues is reviewed first. Then, e-commerce in the context of virtual reality commerce (vr-commerce) is defined. Principle concepts and related literatures are introduced and reviewed where needed. Those major relevant concepts are Theory of Reasoned Action (TRA) and Theory of Acceptance Model (TAM), web quality, telepresence, store environment, quality factors of VR store user interface, purchase intention, revisit intention, etc. The concepts introduced are believed to play important roles in the framework expanded from the core framework of e-commerce interface and consumer behavior in purchasing decision.

2.1 E-Commerce: Online Shopping

2.1.1 E-commerce Website Shopping

Research studies in e-commerce explore vast areas in both computer and human factors (Monsuwé et al., 2004; Nah & Davis, 2002; Ngai & Wat, 2002; Shaw et al., 1997; Turban, Lee, King, Liang, & Turban, 2009). The focus in finding predictors leading to purchase intention or actual purchase is a popular topic due to its real-world contribution. An example and comprehensive framework is shown in Figure 2-1 and Figure 2-2. Those factors repeatedly confirmed under repeated research for online buying adoption cover both endogenous factors, attitudes derived from the system, as well as exogenous factors that moderate the intention to shop online. Perceptions of shoppers towards the e-commerce website features are main predictors. E-commerce website shopping features can be either consumers' perceptions of functional and utilitarian dimensions, e.g. "usefulness" and "ease of use", or their perceptions of emotional and hedonic dimensions, e.g. "enjoyment" (Childers et al., 2002; Mathwick, Malhotra, & Rigdon, 2001; Menon & Kahn, 2002).

In addition to these significant online shopping features, exogenous factors also exhibit their roles to moderate the relationships between the main predictor constructs. Prominent exogenous factors in the context are "consumer traits" (Brown, Ganesan, & Challagalla, 2001; Burke, 2002; Dabholkar & Bagozzi, 2002; Eastin & LaRose, 2000), "situational factors" (Avery, 1996; Wolfinbarger & Gilly, 2001), "product characteristics" (Eastlick & Lotz, 1999; Elliot & Fowell, 2000), "previous online shopping experiences" (Grewal, Iyer, & Levy, 2004; Shim, Eastlick, Lotz, & Warrington, 2001), and "trust in online shopping" (Lee & Turban, 2001; McKnight, Choudhury, & Kacmar, 2002; Yoon, 2002). Several other categorization have been posits base on their underlying theories, nonetheless, in the technical and, psychological and socio-psychological fields.

To understand the big picture of those factors and online consumers' intention to shop and purchase, an exhaustive, yet parsimonious, model is preferred. Many studies try to put these predictors together (Chang & Chen, 2008; Chiu, Lin, & Tang, 2005; Frost, Goode, & Hart, 2010; Hausman & Siekpe, 2009; Jahng et al., 2006; Loiacono et al., 2002; Monsuwé et al., 2004; Van der Heijden, Verhagen, & Creemers, 2003), providing several alternatives that can effectively and applicably conceptualize and explain the relationships. Most of them build up such frameworks similar to the previous research on consumer adoption of new self-service technologies and Internet shopping systems (Childers et al., 2002; Dabholkar & Bagozzi, 2002; Davis, 1993; O'cass & Fenech, 2003). They have posit that consumers' attitude toward Internet shopping first depends on the direct effects of relevant online shopping features, which based primarily on the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975), Theory of Planned Behavior (Ajzen, 1991), and Theory of Acceptance Model (TAM) (Davis, 1993).

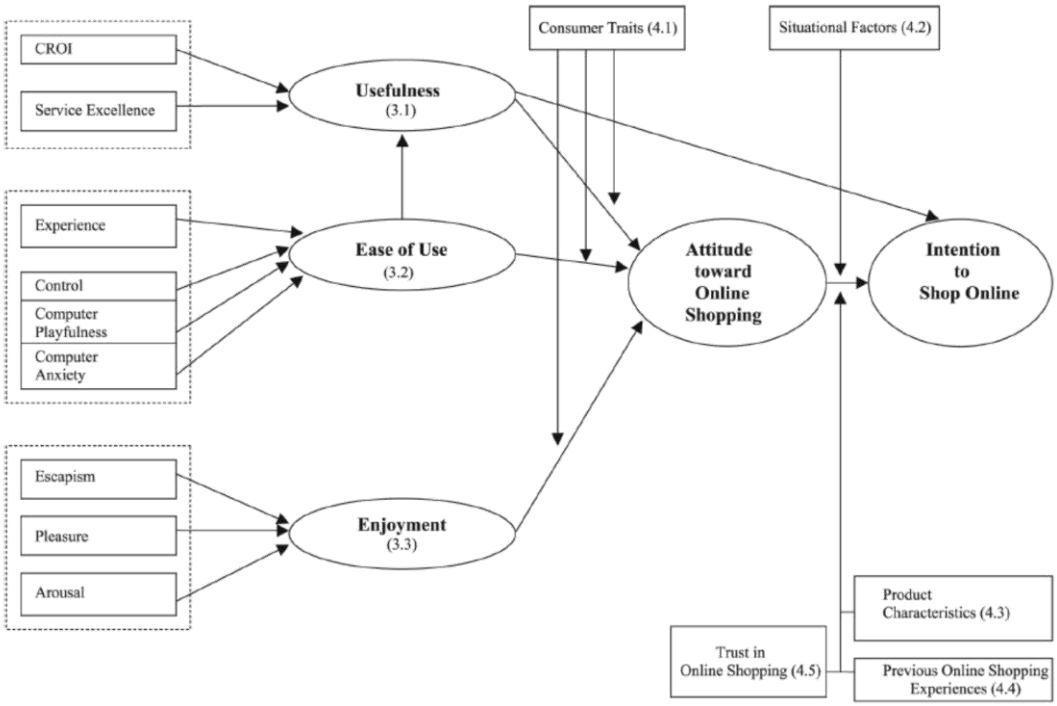

Figure 2-1. What drive consumers to shop online (Monsuwé et al., 2004).

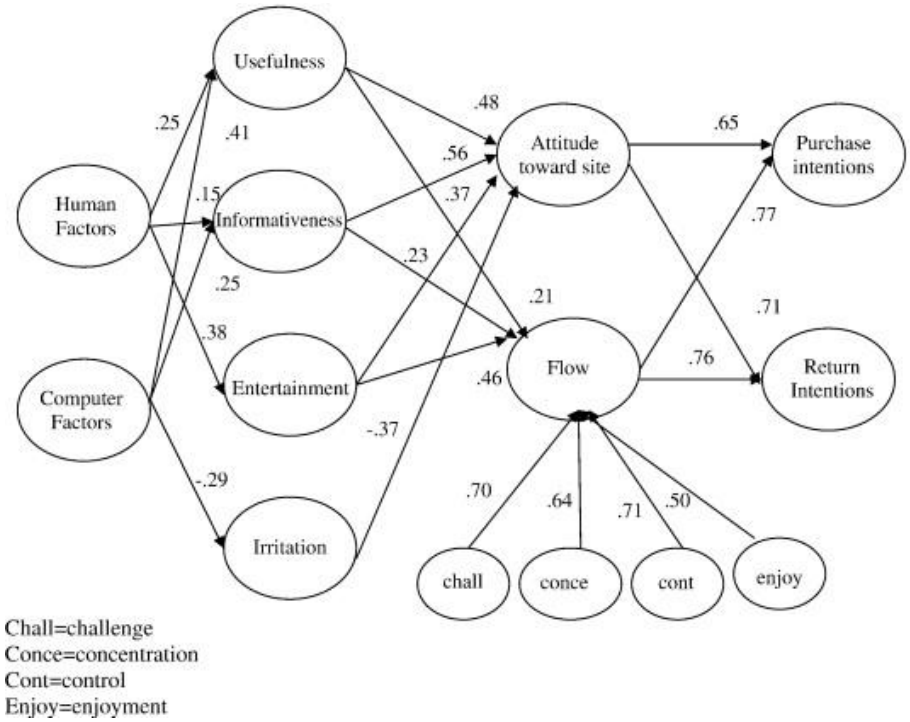

Figure 2-2. Effect of interface features to consumers' purchase and return intention in online store (Hausman & Siekpe, 2009)

Literature gap in the traditional e-commerce area is not of this research focus but crucial one in VR commerce. The development of the literature review leads to provide a big picture of online e-commerce consumer usage, however, in a new setting of VR store which employ additional sets of user interface and shopping experience, as well as simulated the real-world environment, these reviewed literatures should be used as guidelines for the topic being focus in VR commerce. The following topic introduces and explains in detailed of VR-commerce and its relatively new area of research in consumer behavior.

2.2 VR-commerce: Virtual Reality Shopping

2.2.1 Virtual Reality and Telepresence

Virtual Reality (VR) is a human-computer interaction technology that let the users interact with the computer simulated environment (Burdea & Coiffet, 2003; Steuer, 1992). The generated environment can be either a real world or an imaginary world. To imitate the real-world experience, special visual devices are used, such as mask, wall-projected room, and so on. Nonetheless, common monitors can provide a certain level of VR experience. In this case of VR in general monitors, it is commonly referred as Virtual Environment (VE) or Virtual World (VW). Generally, VR in computer screen generates environments that the users found themselves submersed into the environment. Several VR interfaces just present objects in three-dimension or 3D without user's submersive sense (Li, 2002). Users can use special input device or a common keyboard and mouse to interact with the environment. Understanding concepts underlying virtual reality is important to the study since it is the settings being explored. Principal of VR concepts are introduced and discussed as stated next (Steuer, 1992).

2.2.1.1 Presence

"The key to defining virtual reality in terms of human experience rather than technological hardware is the concept of presence" (Steuer, 1992). Presence can be considered as the experience of one's physical environment. It refers not to one's

surroundings as they are in the physical world, but to the perception of those surroundings as mediated by both controlled and automatic mental processes (Gibson, 1986):

"Presence is defined as the sense of being in an environment." (Steuer, 1992)

Many perceptual factors contribute to generating this sense of presence. This can include input from some or all sensory channels, as well as more mindful, attentional, perceptual, and other mental processes that assimilate incoming sensory data with current concerns and past experiences (Gibson, 1966). Presence is closely associated to the phenomenon of distal attribution or externalization, which refer to the referencing of our perceptions to an external space beyond the limits of the sensory organs themselves (Loomis, 1992).

2.2.1.2 Telepresence

In unmediated perception, presence is taken for granted. However, when perception is mediated by a communication technology, one is required to perceive two separate environments simultaneously: the physical environment in which one is actually present, and the environment presented via the medium (Steuer, 1992). The mediated settings can be shown in Figure 2-3.

The term "telepresence" can be used to portray the precedence of the latter experience in favor of the former. Thus, telepresence is the extent to which one feels present in the mediated environment, rather than in the immediate physical environment (Steuer, 1992).

"Telepresence is defined as the experience of presence in an environment by means of a communication medium." (Steuer, 1992)

This environment can be either a temporally or spatially distant "real" environment, e.g., a distant viewed through a video camera, or a non-existent virtual world synthesized by a computer, e.g., the animated "world" created in a game.

By employing the concept telepresence, "virtual reality" can now be defined without reference to any particular hardware system:

"A *virtual reality* is defined as a real or simulated environment in which a perceiver experiences telepresence." (Steuer, 1992)

Telepresence holds two major properties: "vividness," and "interactivity."

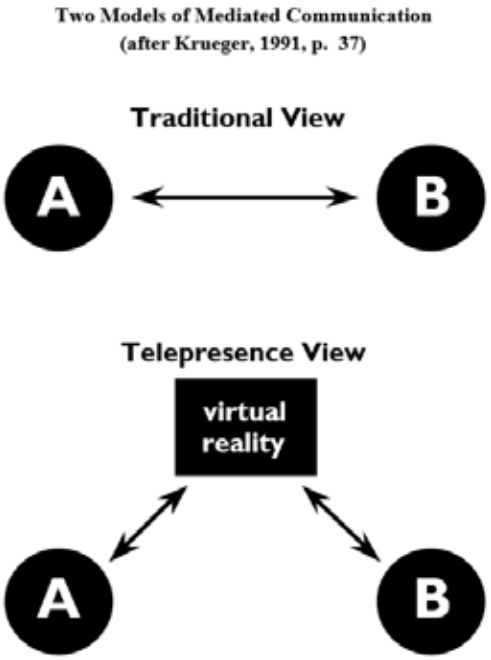

Figure 2-3. Two Model of Mediated Communication (Krueger, 1991)

2.2.1.2.1 Vividness: Breath and Depth

One variable property of media technologies that affects their ability to induce a sense of presence is vividness:

"Vividness means the representational richness of a mediated environment as defined by its formal features, that is, the way in which an environment presents information to the senses." (Steuer, 1992)

According to Steuer, two generalized but important dimensions are: sensory breadth, which refers to the number of sensory dimensions simultaneously presented, and sensory depth, which refers to the resolution within each of these perceptual channels.

Breadth is a function of the ability of a medium to present information across the senses. It is possible to define five distinct perceptual systems: the basic orienting system (which is responsible for maintaining body equilibrium), the auditory system, the haptic (touch) system, the taste–smell system, and the visual system (Gibson, 1966).

Depth is the information available in each perceptual channel. It can be described in terms of "quality": an image with greater depth is generally perceived as being of higher quality than one of lesser depth; the same is true for auditory representation.

2.2.1.2.2 Interactivity:

Communication media can also be classified in terms of interactivity:

"Interactivity is defined as the extent to which users can participate in modifying the form and content of a mediated environment in real time." (Steuer, 1992)

Interactivity is a variable of great concern to researchers in human-computer interaction. "Three factors that contribute to interactivity will be examined here (although many others are also important): speed, which refers to the rate at which input can be assimilated into the mediated environment; range, which refers to the number of possibilities for action at any given time; and mapping, which refers to the ability of a system to map its controls to changes in the mediated environment in a natural and predictable manner." (Steuer, 1992)

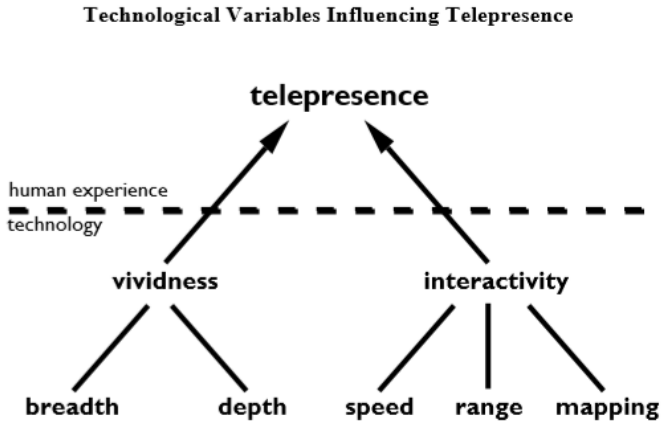

Figure 2-4. Technological Variables Influencing Telepresence (Steuer, 1992)

Figure 2-4 illustrates the dimensions of telepresence. The understanding of dimensions of telepresence delineated is important since it is the integral part of theoretical constructs and practical virtual reality features which will be discussed in the coming topics.

2.2.2 Virtual Reality Store

The abilities of virtual reality to enhance the consumer experience are based on properties which are not agreed on consensus. It is suggested that there are three main properties: high media richness, interactivity and telepresence (Suh & Lee, 2005). While it can be defined by another three: submersive, telepresence and interactivity (Stone, 1992). Media richness theory (Daft, Lengel, & Trevino, 1987) claims that high uncertainty or ambiguity tasks need higher interaction or higher media richness to reduce the uncertainty or ambiguity. In this case, VR can provide such high media richness through the interactivity; thus the two are combined in the study. Such interactivity is achieved when the e-commerce site users travel around. In traditional e-commerce website, interactivity contributes to ease-of-use interface characteristic in this research, but in VR, interactivity is a major characteristic of the interface that has to be specially studied.

Through VR, users can feel the existing of telepresence (Biocca, 1997; Klein, 2001), which indicates a sense of "being there," in the remote environment through a mean of communication (Steuer, 1992). The dimensions of telepresence are even more arguable. Subjective presence and objective presence are commonly referred as dimensions of telepresence. Subjective presence is the sense of the user "being there" remotely. While, objective presence is the sense of objects those are "being there" in the same virtual environment. This telepresence characteristic should cover the submersive property, sense of submersing oneself into the virtual environment, of VR interface already, thus the submersive property is combined with telepresence.

Virtual Reality commerce or VR-commerce or VR-commerce is a type of e-commerce. The major difference of this type of e-commerce from general e-commerce sites is that its user interface is presented in a VR, virtual world or virtual environment

manner. The VR-commerce site can incorporate VR capability. We can say that, in general, a VR-commerce site looks like a virtual shopping mall which users walk around a simulated shopping mall as they immerse into the screen, which we call this kind of interface where VR-commerce takes place as Virtual Reality store (VR store). This virtual reality store should not be confused with a virtual store. A virtual store refers to an online store which it is frequently used to contrast the traditional physical store to electronic virtual store, making a VR store a virtual store as well.

An example of a VR store studied in this study can be referred back to Figure 1-1 (see page 8). A store in Second Life is also another example of a VR store. General VR-commerce sites or VR stores try to provide user interfaces that the users will get shopping experiences as realistic as possible. From VR store examples given, the latter one is more realistic. VR-commerce is getting attention from researchers and business practitioners because of its uniqueness and abilities which former types of e-commerce cannot accomplish. There are various ways for the VR-commerce customers to interact with a VR-commerce system. In this study where relationships between characteristics of VR store and potential buyers are in focused, the term VR-commerce and VR store are usually interchangeable. The scope of study is also limited to the VR in the form of VR store presented in flat screens, but including the emerging 3D flat screens.

The arguments in characteristics of virtual reality and telepresence encourage an exploratory research determining their characteristics. Thus this study will also employ exploratory research to determine characteristics of VR interface which are absent from literatures. Telepresence-related and VR interface characteristics or factors should emerge from the study. A preliminary study suggest promising results in that it discovered several important VR interface factors believed to represent other VR characteristics (Satidchoke Phosaard & Pimmanee Rattanawicha, 2010). On top of traditional e-commerce interface characteristics effecting on the attitude toward VR store, the interactivity and telepresence characteristics of VR store is believed to affect the attitude toward the VR store of consumer. Moreover, many important features of VR store exhibit characteristics of interactivity and telepresence.

2.2.3 Consumer Shopping Behavior in VR Stores

Prior research in website e-commerce investigated user's interactions with vendors that occur through web-based mediated technologies (Pavlou et al. 2007). IS researchers rarely investigate consumers' shopping behaviors in the specific context of VR store. Accordingly, it becomes urgent that IS researchers gain a systematic understanding of VR store consumer behaviors, and inform practitioners with clear guidelines on how to design effective and efficient VR store. Many theories such as the Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975), Theory of Planned Behavior (TPB) (Ajzen, 1991) or the Theory of Acceptance Model (TAM) (Davis, 1989), have been extended and empirically validated in the context of online shopping behaviors (Pavlou & Fygenson, 2006). The investigation of literatures in the previous topic reveals that, actually, IS research studies successfully identified various factors (perceptions, beliefs, attitudes, intentions, traits, subjective norms, trust, etc.) that impact online consumers' behaviors (Pavlou & Fygenson, 2006).

Here, the importance of the research as discussed and the scarce number of studies understanding user behavior in VR store suggesting research topics to fill the gaps in literatures and for application contributions. The study of (Hendaoui & Limayem, 2008b) was indeed early research in the field, which posited a sound model for explaining consumer behavior in the VR store. Hendoui & Limayem's model, as shown in Figure 2-5, emphasized on the relations of presence dimensions, as well as several of their constructs, such as role playing and flow, towards decision making in VR shopping. There were several gaps in the research of Hendoui and Limayem.

First, the research did not take into account of basic functionalities of the system, which carried over from the web-based e-commerce. Those basic functionalities and characteristics, such as the use of fonts, colors, searching capability, and so on, are essential for users to successfully go through an online shopping process. It is arguable that such features and characteristics might not hold in the new settings of VR, but according to their importance, it is worthwhile for the study.

Second, besides their intention not to examine these basic functionalities, the researchers seems to fail in stating the existence of other artifacts or activities in the VR store. In such a unique environment of VR store that could offer virtually real-world experience over a remote distance, one could say that activities that occur in the real world could be performed over the VR store. Physical expressions through avatars, marketing promotion, store decorations, etc., are possible for the first time to integrate into the online shopping platform. The limitation in VR interface and the real-world artifacts is a potential candidate for examining its role in consumer shopping behavior. Besides the opportunity for further research, the lack of explanation and rationale of leaving these basic functionalities and artifacts offered in the VR store left doubts in the comprehensiveness, as well as parsimoniousness of the model.

Third, the study is limited in its application contributions. The study drew high level conceptualization from limited sets of VR store features, thus practitioners still have to work a lot to figure out which basic or advanced functionalities they should implement for a successful VR store. As a result, more studies to conceptualize VR store features, both functional and non-functional, and their consumers' behavior constructs are required to better guiding practitioners and fill the theoretical gaps.

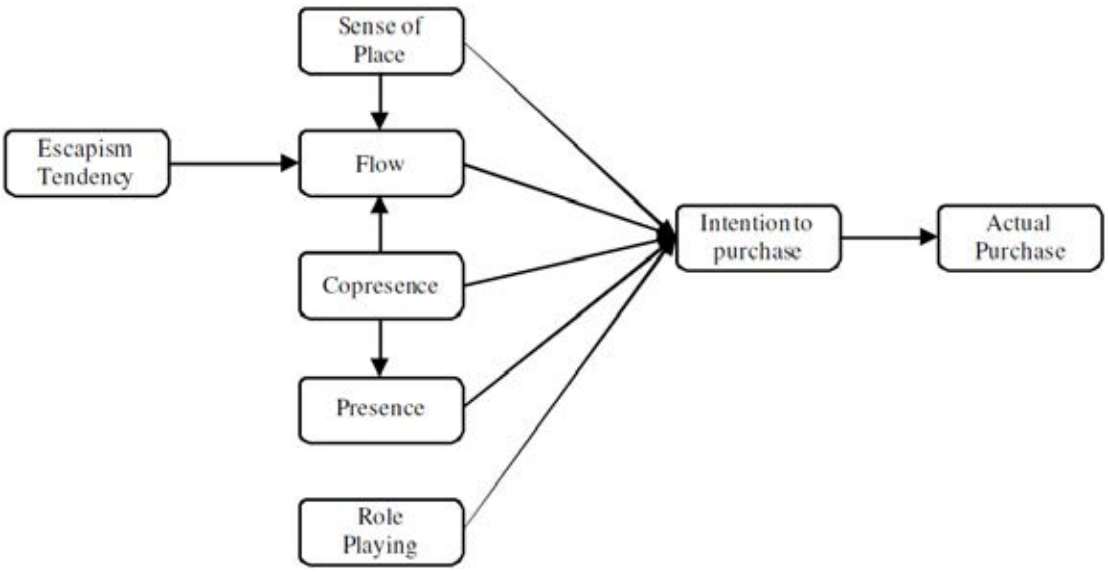

Figure 2-5. A Consumer Behavior in a Virtual World Research Framework (Hendaoui & Limayem, 2008b)

2.2.4 Quality Factors in VR-commerce Interface

On the practitioners' side, the study of (S. Phosaard, P. Rattanawicha, & W. Chantatub, 2010) revealed that there were eight quality factors affecting adoption and use of online VR commerce interface. The first one, the most important one, is basic virtual reality experience dealing with the basic experience that users expect in a VR interface. The features/elements associated with the factor are overall reality, touch screen interface capability and animated elements. By looking at a particular item in this most important factor, Touch screen interface capability, it suggested that the VR interface can be more widely adopted by implementing touch screen interface. The finding can be effortless to utilize since touch screens are becoming a more common household computer device, nowadays.

The second most important factor is aspect fit. The features/elements associated with this factor are: proper product size and proper use of camera's view. Besides the overall reality experience and the ease of manipulating the VR interface that the user expects, which we found in the previous factor, the user expected a VR interface that appropriately visualizes items fitting their eyes. The factor covered proper use of product size and proper use of camera's view, which we noticed that this visualization-fit characteristic dealt with the way the users try to capture 3D objects into their brain. The result suggested opportunity to explore about product and virtual world visualization.

The third factor is acceleration capability. The features/elements associated with the factor are: zoom in/out and speed-up capability of the interface. It sounded logical that when the VR interface features met basic requirements of the user (those requirements are the first and the second factor), they try to gain more control of the interface. Although the use of navigation map did not make it into a member of the final stable factor of the study, it might gain importance if it is used to speed-up the navigation. Several other alternatives could be proposed to improve this factor of the interface.

The fourth factor is Standard appearance. The associated features/elements are: proper use of colors, proper use of fonts, and layout customization. It was the standard factor dealing with proper use of visual elements for the purpose of function and aesthetic. As expected, this emerging factor was aligned with other studies regarding user interface quality factors. The result suggested that even basic guidelines for interface should be carried for VR interface.

The fifth factor is Atmospheric experience. The associated features/elements are: seasonal activities, cashier counter, event synchronization and elevator. This factor might be one of the most unique features associated with VR interface, especially VR commerce interface. It also showed that telepresence, the sense of being there, was really exhibited as a unique feature in VR interface. Moreover, not only the sense of being there was important, in this study, it was interested to discover that VR commerce users attached their time into the interface. They synchronized their period of the year expecting real-world event-synchronized treatments from the VR commerce store.

The sixth factor is Decorative elements. The features/elements in this feature are: innovative elements, decorative elements and scenic view points. It was one of another feature that can attract users, mostly, emotionally. These aesthetic elements cannot be effectively implemented in standard 2D web interface as in VR. The result suggested that the existing of aesthetic elements was important in the VR interface acceptance.

The seventh factor is Place familiarity. The features/elements in this feature are: layout familiarity and product department familiarity. It was one of another unique feature of VR interface since the interface had capability to imitate and link itself to the real-world place. For marketing purposes, real-world stores can utilize benefits from this feature. The study of VR might ease e-commerce user regarding their memory and cognitive effort on spatial activities could be explore.

The eighth factor is Content finding tool. It fact, comparing from means of the factors, it is the fourth of the most important factors. We put it here since several statistic values were not calculated. Although it is a one item factor, we kept this factor

as it was also perceived as important one. Good VR commerce interface should try to come up with powerful to locate products.

The study provides good guidelines for practitioners, however, it needs further repetition assessment; lack of theoretical connections also limits its generalization and flexibility to be adapted according to evolution of technology. Nonetheless, the study can be further study and integrate into this study for concrete practical guidelines.

Moreover, by examining the factors emerged, it helps substantiating the conceptualization of this research. *Basic virtual reality experience, aspect fit*, and *acceleration capability* factor can be preliminary associated with telepresence, both interactivity and vividness dimensions. *Standard appearance* and *content finding tool* factor can be preliminary associated with web quality. *Atmospheric experience*, *decorative elements*, and *place familiarity* factor can be preliminary associated to the factor of store environment. The last three factors also reveal further interesting issues. Some of features in the last three factors related to store environment exhibits marketing concepts and activities which can, indeed, be provided in physical store. This open for opportunities to study for further characteristic of marketing tools in VR store settings.

2.3 The Convergence of Shopping Platform

VR store offers a unique feature over online shopping in that it can imitate several physical stores shopping experience due to the artifacts generated on the computer screen and the interface. While several VR commerce researchers focus mainly on overcoming technological implementation issues and investigating technology-enabled features, such as consumer interaction on goods, telepresence, and avatar interaction (Chittaro & Ranon, 2002; Fomenko, 2006; Hendaoui & Limayem, 2008b; Lee & Chung, 2008; Suh & Lee, 2005), or consumer constructs, such as shopping process in VR commerce (Goel & Prokopec, 2009; Lee & Chung, 2008), and so on; they left one of the most basic and important investigation in VR store, store environment.

Store environment in physical retailed store is one of a “fundamentally principal” and matured field in marketing (Baker, 1987; Fisher, 1974; Martineau,

1958); however, there is no investigation in the VR store. Several researchers might fell short of recognizing the phenomenon in this emerging VR commerce areas, nonetheless, several recognize it but treat it in a way that VR stores can virtually offer any activities and artifacts a physical store can. The merit of studying the effects of the store environment in VR stores in consumers' behaviors hold for several reasons. First, in physical world, it is profoundly important. It is inevitable for shop owners to pour considerable amount of time designing a shopping mall to attack consumers buy carefully crafting basic elements in store environment, as well as innovative and distinctive features to create their own store characters (Hansen & Deutscher, 1975; Martineau, 1958). Second, it is important that these basic features in a VR store have to be properly implemented from the onset of the implementation. The practitioners' guidelines of offering an appropriate element set of store environment in VR store and theoretical concepts underpin it is needed.

2.3.1 Traditional Commerce: Retail Store Shopping

Since an appropriate store environment might be crucial for VR store acceptance; it should be one of the best candidates of VR artifacts to be examined. The following reviewed related research in the field. Due to its matured field, several studies can be examined and selected to logically corroborate the conceptualization of the study. The studies, usually studies in marketing research that can systematically be integrated into the study to fill the literature gap and reasonably explain relationships among constructs are visited as follows.

Studies in real world store suggested that a consumer's emotions can be a mediating factor in the purchase process. Several studies identified and explored how store environment and emotional states may influence various dimensions of purchase behavior. It is confirmed that although cognitive factors may largely responsible for store selection and for most planned purchases within the store, the environment in the store and, evidently, the emotional state of consumers may be important determining factors of shopping behavior (Sherman, Mathur, & Smith, 1997).

The emotional nature of shopping has been characterized by researchers quite well-established. Consumers' behavior research has greatly reflected the influence of cognitive psychology, focusing and relying upon the traditional information processing theory to explain or predict consumer decision making processes (Bettman, 1979). Mood was also studied by psychologists, and much of what we know about the concept has come from those studies (Bower, 1981; Clark, 1982; Clark & Isen, 1982; Hearst, 1979; Isen, Means, Patrick, & Nowicki, 1982). An individual's mood can also apparently influence behaviors without impending with other cognitive processes, in this case shopping behaviors (Clark, 1982; Clark & Isen, 1982; Sherman et al., 1997).

Based on multi-dimensional perspectives of environmental psychology Mehrabian and Russell (1974), a approach-avoidance concept by Wundt (1905), and a three-dimensional schema of pleasure, arousal, and dominance by Russell (1978), (Donovan, Rossiter, Marcoolyn, & Nesdale, 1994) blended these concepts into the stimulus–organism–response (SOR) framework and tested the linkage between the O and the R variables, with promising results. Figure 2-6 shows an example framework of a study regarding store environment and consumer behavior mediated by consumer state of emotion.

Since the human-computer interaction in e-commerce studies usually capture the linkages between the interface features and the attitude toward the system, the reviewed studies in the field of store environment would be implied and made a linkage between the store environment and consumer behavior, through emotion, in VR store as the next session will conceptualize it.

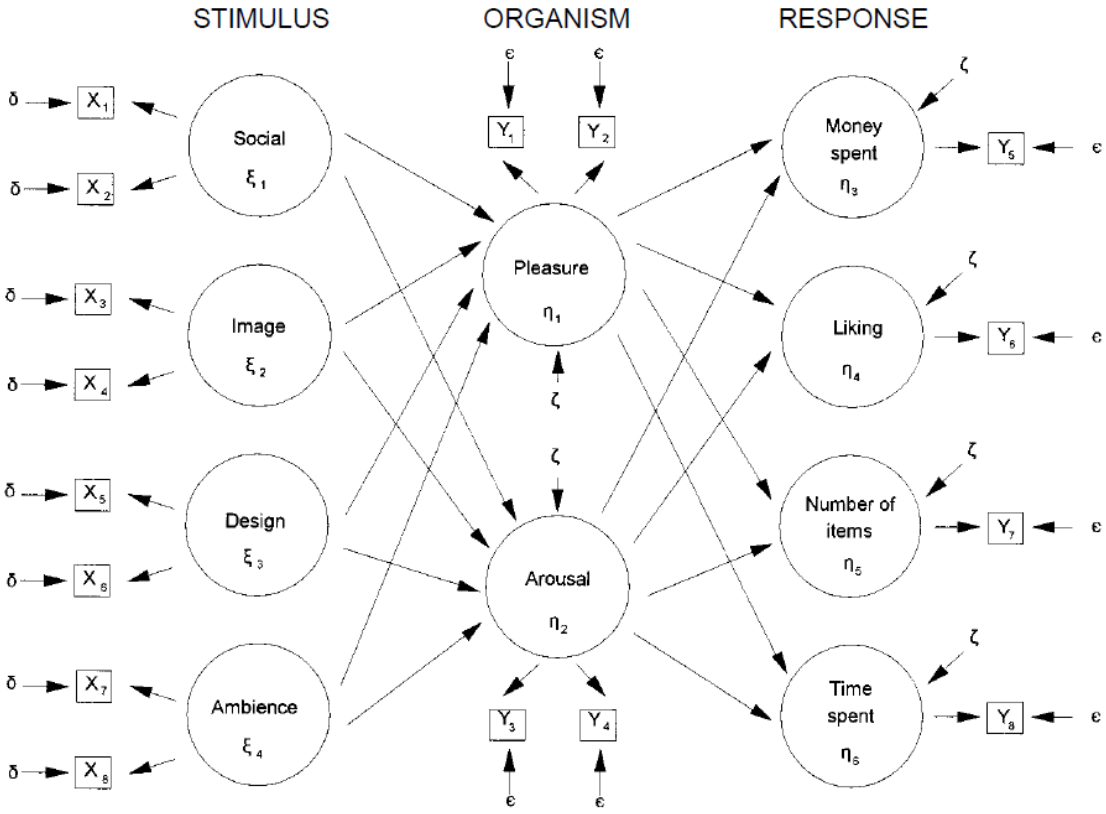

Figure 2-6. An SOR model of retail shopping behavior (Sherman et al., 1997).

All of the visited literatures clarify in details the progress of work in the topic, relations among concepts and field, and especially their gaps, proposals for filling the gap, and be potentially used to fill the literature gap. The big picture of the research is recapped as follows before the conceptualization will be fabricated in the next section.

The study of relationships between VR store interface and potential buyers will reveal a better prediction model of consumer behaviors in this unique setting for business benefits. In studies of traditional e-commerce websites, the actual purchase is one of the top constructs with user interface factors are the enablers or inhibitors of the actual purchase action. However, the direct effects between interface factors and consumer actions are better explained by moderate constructs, attitude toward e-commerce websites and intention to purchase by many studies extending TAM, TRA or TPB listed above.

The intention to return is also a consumer behavior that marketing people are interested in studying since it can generate incurring purchase, which eventually adds more revenues to the store and better attitude toward the site increases higher tendency of consumer intention to return to the site (Jiang & Rosenbloom, 2005; Koufaris, 2002; Koufaris, 2003; Koufaris, Kambil, & LaBarbera, 2001). VR store adds another visual dimension to e-commerce, thus interface factors effecting consumer behaviors in traditional e-commerce websites should also be captured in VR store.

Studies revealed that interface factors of websites consisting of three dimensions: (1) informativeness, (2) ease-of-use and (3) appearance are common main quality factors (Aladwani & Palvia, 2002; Kim & Stoel, 2004; Yoo & Donthu, 2001). A study tried to investigate relationship between VR store characteristics and potential consumer behaviors solely on VR but it did not take some basic functionalities, as well as basic artifacts crated by the VR interface (such as the store environment), in to account (Hendaoui & Limayem, 2008b). It is important to confirm whether the explanations in traditional e-commerce websites are hold in the new VR setting.

2.4 Constructs and Research Framework Conceptualization

The big picture of the research framework conceptualization will be discussed first by providing a skeleton of the cause-effect relationships of construct being studied. Related literatures supporting relations among constructs will be discussed and drawn in to build the framework.

2.4.1 Underlying Theories: Theory of Reasoned Action (TRA) and Theory of Acceptance Model (TAM)

The predictions of antecedents and consumers' adoption behaviors of certain technologies have been primarily and widely based on analyses of causal-effect relationships among users' perceptions or believes, their attitude towards the technology which leading to the intention to adopt and actual use of the technology. Theory of Acceptance Model (TRA) (Fishbein & Ajzen, 1975), Theory of Planned Behavior (TPB) (Ajzen, 1991), and Theory of Acceptance Model (TAM) (Davis, 1989)

are among top theories that are extensively applied for effective predictions of technology adoptions, which is align with the purpose of the study. TRA posited that several salient believes on the consequences or likelihood from an action or usage leads to their attitude on it and finally can predict the real usage through their intention. Besides attitude, subjective norm induced by believes in perception of others, is also an antecedent to the usage intention. TPB is an extended version of TRA with another antecedent, perceived behavioral control.

TAM replaces various measures of TRA by two measures: believe in usefulness and believe in ease of use of the technology. Attitude was dismissed providing a more parsimonious and effective model to predict and explain users' technology adoption. In many studies, especially in the online e-commerce context, researchers combine these models together, in various ways, to better explain the phenomenon and effectively address the research objectives (Chang & Chen, 2008; Childers et al., 2002; Gefen, 2000; Hausman & Siekpe, 2009; Kim & Lee, 2002; Klopping & McKinney, 2004; C. Liao et al., 2006; Liu et al., 2003; Loiacono et al., 2002; Monsuwé et al., 2004; Park & Kim, 2003).

For this study, the TRA and TAM are combined by maintaining beliefs in usefulness and other relevant categories of beliefs that can capture essential concepts and well explain the phenomenon being studied in a specific setting of VR store. The attitude toward the VR store has been dropped from the framework hence it is not in the focus of the study and its contribution might not be significant, and to simplify for a more parsimonious model. An overview of the construct relationships will be provided as follows.

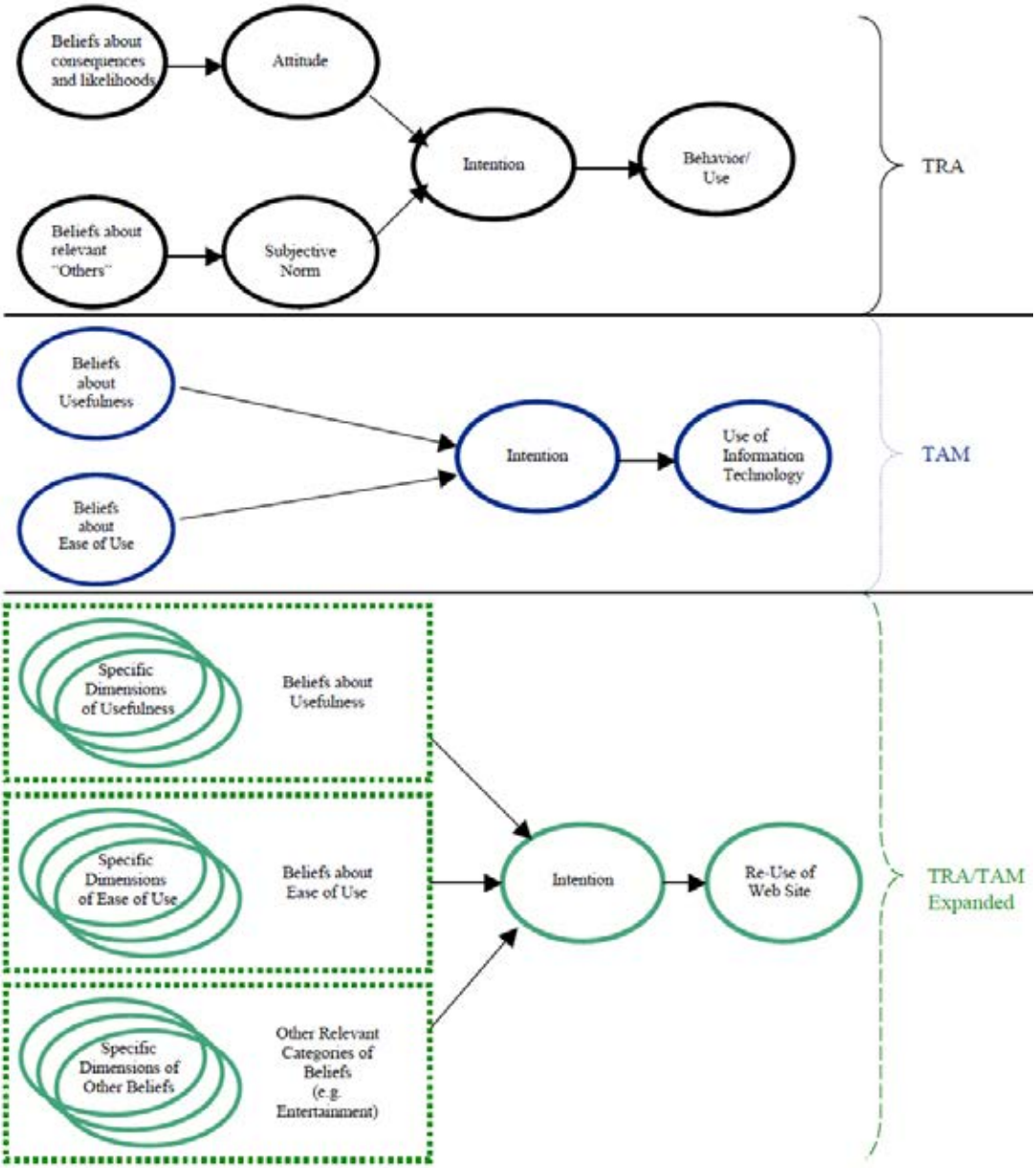

Figure 2-7. Extended TRA and TAM for online e-commerce. (Loiacono et al., 2002).

The research framework is supported by the structure shown in Figure 2-7. In online e-commerce interface studies, conceptualization of factors derived from interface features, both functional and non-functional, plays an important role in the contributions, especially practical, of the research; while relationships between salient believes and intention to use the system theorizes and explain the rationale behind the settings. In this study, interface factors, including web quality and telepresence, and

store environment of a VR store are conceptualized as factors that can predict the use of the system.

Web quality with dimensions of (1) technical adequacy, (2) content quality, (3) specific content and (4) appearance, is posited to be positively related to purchase intention in an online VR store mediated by beliefs in usefulness and informativeness. Telepresence, which are the foundation concept underlying virtual reality environment, with dimensions of (1) interactivity and (2) vividness, is posited to be positively related to the purchase intention mediated by beliefs in usefulness, informativeness, and enjoyment. Store environment, a fundamental retail store component, is posited to positively related to intention to purchase in the VR store mediated by the construct of enjoyment. The following topics will substantiate the claims. Relevant categories of beliefs will be introduced and discussed first, following by discussions and arguments of the roles of web quality, telepresence, and store environment, being mediated by relevant beliefs, in VR store shopping intention.

2.4.2 Usefulness

TAM is among the most commonly employed theories for examining technology acceptance (Davis, 1989). TAM is based on two specific behavioral beliefs that affect behavioral intentions, specifically perceived ease of use (PEOU) and perceived usefulness (PU). PEOU is the perception that a particular system or application is easy to use (Davis, 1989). Regularly, PEOU diminishes its roles according to the progressing phase of technology adoption; much of the effect of PEOU on behavioral intentions is mediated through PU (Kaplan, Schoder, & Haenlein, 2007) or it will have no impact on behavioral intentions (Venkatesh & Morris, 2000). Additionally, the effect of PEOU diminishes as users become familiar with a technology (Gefen, 2004). In this context, widely-use of computer games and virtual worlds suggest familiarity of the system; it is expected that the impact of PEOU will be minimal.

Thus, this study excludes PEOU's mediating role, conforming to recent research (Flavián, Guinalíu, & Gurrea, 2006). PU is defined as the degree to which a person

believes that using a technology would enhance his or her performance (Davis, 1989). Unlike PEOU, PU does have a substantial impact on behavioral intentions. Indeed, Venkatesh and Morris (2000) found that the effect of PU was much greater than the effect of PEOU on behavioral intentions. Believe in usefulness plays a mediating role between the VR store factors and shopping intention, which will discuss as follows.

2.4.3 Uses and gratifications

Shoppers are motivated by a variety of psychosocial needs besides from those strictly related to purchasing products. Hence, a growing body of literature employs the uses and gratifications (U&G) approach to study the use of the Internet as shopping venues according to Chen, Clifford, and Wells (2002), for example. U&G theory posited that individuals use particular forms of mass communication to meet particular needs. If these needs are gratified, it is expected that users will repeat the experience (Katz, Haas, & Gurevitch, 1973).

In case of a confirmation in this setting, for uses and gratification, it is straightforward that information system users will use the system or consumers will shop online since they found that information from websites is useful to achieve the goal of shopping. Thus, this study posited to confirm the U&G theory that:

H8) **Informativeness** is positively related to **perceived usefulness** in an online VR store.

2.4.4 Enjoyment

Studies find that enjoyment value is a significant factor driving consumer to shop online besides believe in functionality or utilitarian (Babin, Darden, & Griffin, 1994; Hirschman & Holbrook, 1982; Holbrook, 1994; Monsuwé et al., 2004). A website's enjoyment property is said to be important through its ability to enhance the experience of visitors to the site. U&G research indicates that the entertainment value of a commercial exchange lies in its ability to satisfy the audiences' needs for escapism, diversion, aesthetic enjoyment, or emotional release (McQuail, 1987).

2.4.5 Web Quality and VR Store

Web interface is one of the most prominent online interfaces of the era. The shifting of information system technology from the primitive years of standalone, PC-based computers and mainframes triggered a handful of framework or guideline proposals for good quality webs as explained in (Aladwani & Palvia, 2002; Koyani et al., 2004), for example. As discussed, the superiority of VR interface could be a promising alternative for online interfaces. The study of determining good quality factors for this highly interactive interface can follow the studies or research in web quality.

According to an extensive review and analysis by Aladwani and Palvia (2002), web quality consisted of four major dimensions: appearance, specific content, content quality and technical adequacy. Only the user interface was our focus in this study, we roughly expected that the emerging factors should be more correlated with the dimensions of appearance and technical adequacy, along with unidentified factors exclusively for online VR commerce interface rather than content dimensions.

Recently, Calisir and Calisir (2004) examined various usability factors affecting end-user satisfaction and found that system capability and user guidance (computer factors) are determinants of PU. Van der Heijden (2003) similarly supports the role of human factors on PU. Further, website design features such as menus, icons, and links (computer factors), and colors, graphics, and music (human), are specifically intended to enhance usability (Song and Zinkhan, 2003). In other words, well-constructed sites containing positive computer factors may make transaction processes easy; increasing perceived usefulness. Web quality which captured all dimension of an integrated interface to the VR store has been proven to be positively related to usefulness in e-commerce (Ahn, Ryu, & Han, 2007; Aladwani & Palvia, 2002; Chang & Chen, 2008; C. Liao et al., 2006) may also increase the usefulness of the site. Thus the study hypothesizes that:

H1a) **Web quality** is positively related to **perceived usefulness** in an online VR store.

Informational content is considered one of the need-satisfying functions derived from media communications, according to the extended U&G theory (Ducoffe, 1996). A website is informative if it allows prospective customers to evaluate among alternatives to reach satisfying exchanges (Montoya-Weiss, Voss, and Grewal, 2003; Ducoffe, 1996). Human factors, such as using terminology familiar to users, rather than computer jargon, allow users to get desired information in less time. Web quality which captured all dimension of an integrated interface to the VR store is important in determining informativeness (Ahn et al., 2007; Aladwani & Palvia, 2002; Chang & Chen, 2008; C. Liao et al., 2006). This study, therefore, hypothesizes that:

H1b) **Web quality** is positively related to **informativeness** in an online VR store.

From the proven significant effects driving consumer to shop online besides believe in functionality or utilitarian (Babin et al., 1994; Hirschman & Holbrook, 1982; Holbrook, 1994; Lin, Duh, Parker, Abi-Rached, & Furness, 2002; Monsuwé et al., 2004), enjoyment as hedonic view of a system. Hedonic web quality, such as appearance should stimulate consumers' enjoyment of using such system (Monsuwé et al., 2004). This study, therefore, hypothesizes that:

H1c) **Web quality** is positively related to **enjoyment** in an online VR store.

However, appearance of web contributes to only a fraction of web quality which is dominated by utilitarian dimensions. The researcher cautious that this relation might not be significant but is meaningful to explore.

2.4.6 Telepresence in VR Store

Recently, Calisir and Calisir (2004) examined various usability factors affecting end-user satisfaction and found that system capability and user guidance (computer factors) are determinants of PU. Van der Heijden (2003) similarly supports the role of human factors on PU. Further, website design features such as menus, icons, and links (computer factors), and colors, graphics, and music (human), are specifically intended to enhance usability (Song and Zinkhan, 2003). In other words, well-constructed sites

containing positive computer factors may make transaction processes easy; increasing perceived usefulness. Factors that make websites fun, attractive, and appealing (human factors) may also increase the usefulness of the site (Chen and Wells, 1999). Interactivity, vividness and telepresence itself has been proven to affect users' adoption in several VR commerce interface. Thus, this study hypothesizes that:

H2a) **Telepresence** is positively related to **perceived usefulness** in and online VR store.

Informational content is considered one of the need-satisfying functions derived from media communications, according to the extended U&G theory (Ducoffe, 1996) in the same manner as web quality. Especially in VR-commerce environment, VR can increase consumer interactivity and consumer learning (Suh & Lee, 2005) and for gathering products' information (Li, 2002; Li et al., 2001; Salzman, Dede, Loftin, & Chen, 1999) which can eventually lead to higher chance of purchase. This study, therefore, hypothesizes that:

H2b) **Telepresence** is positively related to **informativeness** in an online VR store.

According to the proven significant effects driving consumer to shop online besides believe in functionality or utilitarian (Babin et al., 1994; Hirschman & Holbrook, 1982; Holbrook, 1994; Lin et al., 2002; Monsuwé et al., 2004), enjoyment as hedonic view of a system, in this case the VR store is expected to play significant role in shopping intention. Especially in VR environment, telepresence exhibits high interactivity and vividness induces enjoyment of users promoting them to use the system (Faiola & Smyslova, 2009; Hendaoui & Limayem, 2008b; Lin et al., 2002; Nah, Eschenbrenner, & DeWester, 2011; Weibel, Wissmath, Habegger, Steiner, & Groner, 2008; Youngblut, 1998). This study, therefore, hypothesizes that:

H2c) **Telepresence** is positively related to **enjoyment** in an online VR store.

2.4.7 Store Environment and VR Store

The elements of store environment can be classified into three categories: social factors, design factors, and ambient factors (Baker, 1987; Baker, Grewal, & Parasuraman, 1994). Social factors relate to other people existing in the store. Of all such people, salespeople are the most important because, according to components of the marketing mix, a vender has a significant control over their number, type, and behavior. Ambient factors relate to nonvisual elements of a store environment (e.g., feeling, smell, lighting, etc.). Design factors are visual in nature (e.g., layout, color, clutter, cleanliness, space, etc.). Thus, the stimulus is represented by various elements of store atmosphere and is expected to influence consumer's mood while shopping. Studies indicated that a consumer's emotional state affected, arousal and pleasure, which leads to different shopping behaviors.

In e-commerce, atmospheric has been studied to influence consumer behavior (Dailey, 2004; Sautter, Hyman, & Lukosius, 2004; Siomkos, Vrechopoulos, & Magganari, 2006; Wu, Cheng, & Yen, 2008). Arousal and pleasure has been proven to affects enjoyment which leads to adoption (Monsuwé et al., 2004). Thus, this study hypothesizes that:

H3) **Store environment** is positively related to **enjoyment** in an online VR store.

2.4.8 Potential Consumers in VR Store: Purchase Intention and Revisit Intention

Studies in consumer behavior in e-commerce commonly try to determine enablers and inhibitors contributing to the ultimate goal of selling, the consumer real purchase. Consumers with a certain degrees of product interests and an ability to use e-commerce sites are potential consumers. Interface quality, product characteristics, trust in sellers and previous e-commerce shopping experience are major confirmed factors that can predict the success of consumer buying (Bellman, Lohse, & Johnson, 1999; Koufaris, 2002; Monsuwé et al., 2004; Pavlou & Fygenson, 2006; Vijayasarathy, 2004). Since VR store is different from traditional e-commerce website mainly on the

interface, the study will take the interface factors into the center stage of the study. Moreover, it is important to aware of those controlled factors mentioned since VR has proven to affect trust of service providers (Hoffman, Novak, & Peralta, 1999; McKnight et al., 2002) and the corresponding of VR interface types and products characteristics affects consumer buying intention (Suh & Lee, 2005).

The study of relationships between VR store characteristics and potential buyers will reveal a better prediction model of consumer behaviors in this unique setting for business benefits. In studies of traditional e-commerce websites, the actual purchase is one of the top constructs with user interface factors are the enablers or inhibitors of the actual purchase action. However, the direct effects between interface factors and consumer actions are better explained by moderate constructs and intention to purchase by many studies extending TAM, TRA or TPB listed above. The revisit intention is also a consumer behavior that marketing people are interested in studying since it can generate incurring purchase, which eventually adds more revenues to the store and better attitude toward the site increases higher tendency of consumer intention to return to the site (Jiang & Rosenbloom, 2005; Koufaris, 2002).

VR store add another visual dimension to e-commerce, thus interface factors effecting consumer behaviors in traditional e-commerce websites should also be captured in VR store. The study tried to investigate relationship between VR store characteristics and potential consumer behaviors solely on VR and did not capture actual purchase prediction in VR settings (Hendaoui & Limayem, 2008b). It is important to confirm whether the explanations in traditional e-commerce websites are hold in the new VR setting, as indicated clearly in this study's problem statements, which will be a major theoretical contribution.

A person's intention to revisit a website is seen as a result of his/her attitude toward using the technology involved in the site (Koufaris, 2002). Song and Zinkhan (2003) specifically identified behavioral intentions associated with website usage as: repeat purchases; repeat visits to the website; recommendation of website to others; and positive remarks or comments about the website. This study focuses on the most

commonly referenced online behavioral intentions—purchase intention and revisit intention—as these relate more directly to successful e-tailing and have been validated in several studies. In many studies, more parsimonious linkages can be drawn by omitting attitude constructs and directing salient believes to intention of behavior directly (Chang & Chen, 2008; Davis, 1993; Hausman & Siekpe, 2009; Hendaoui & Limayem, 2008a, 2008b; Loiacono et al., 2002; Monsuwé et al., 2004). Specifically, this study hypothesizes that:

H4a) **Perceived usefulness** is positively related to **purchase intention** in an online VR store.

H4b) **Perceived usefulness** is positively related to **revisit intention** in an online VR store.

H5a) **Informativeness** is positively related to **purchase intention** in an online VR store.

H5b) **Informativeness** is positively related to **revisit intention** in and online VR store.

H6a) **Enjoyment** is positively related to **purchase intention** in an online VR store.

H6b) **Enjoyment** is positively related to **revisit intention** in and online VR store.

2.4.9 Place Familiarity

A preliminary study exploring important VR store interface factors suggested eight important factors (Satidchoke Phosaard & Pimmanee Rattanawicha, 2010). Most of them can be considered as dimensions of telepresence and interactivity. However, there are two characteristics, place familiarity and atmospheric experience, which the author believes them to be independent characteristics besides previous constructs.

Place familiarity including features such as layout familiarity and product department familiarity. It was one of another unique feature of VR interface since the

interface had capability to imitate and link itself to the real-world place. For marketing purposes, real-world stores can utilize benefits from this feature. The two characteristics have not finally defined; however, they capture features explained as such.

Moreover, place familiarity can promote activities that related to places such as tourism (Hammitt, Backlund, & Bixler, 2006). It is also related to the preference of superior choices by inducing trust (Gefen, 2000). This study focuses mainly on the familiarity of the layout of the store. It is hypnotized that:

H7a) **Place familiarity** is positively related to **purchase intention** in a VR store.

H7b) **Place familiarity** is positively related to **revisit intention** in a VR store.

The research framework is shown in Figure 2-8.

2.5 Conceptual Research Framework

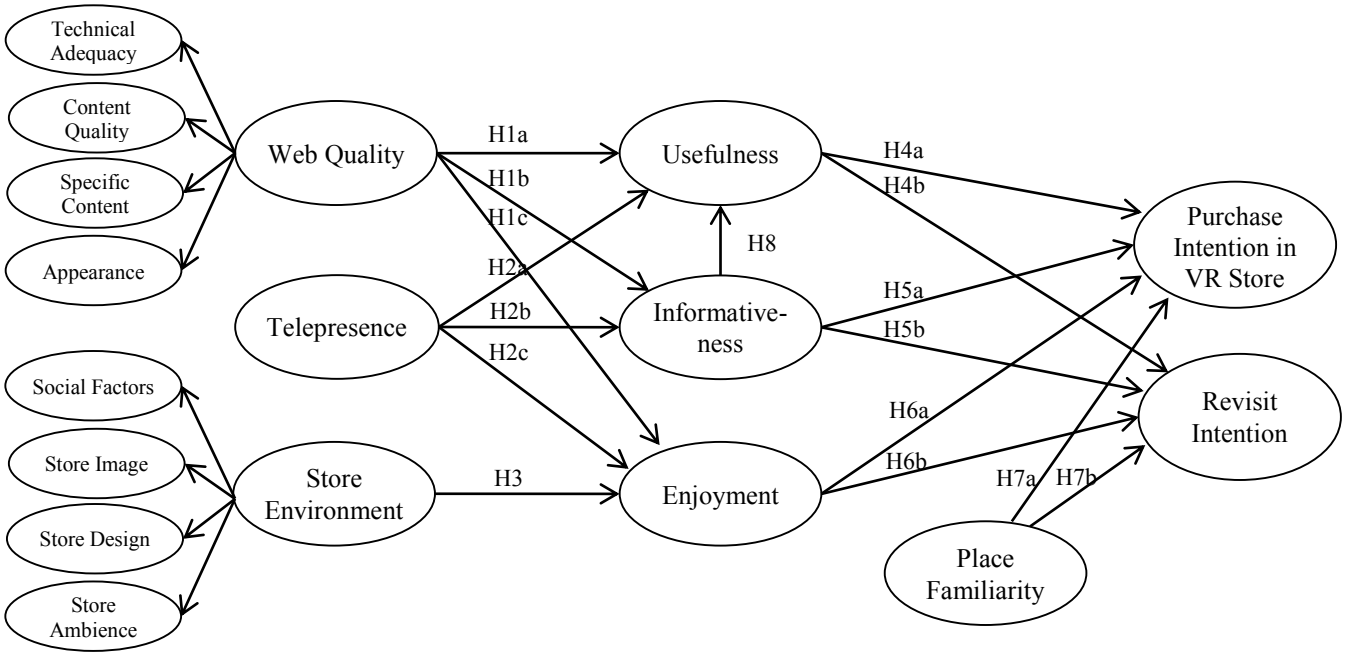

Figure 2-8. Conceptual Research Framework

2.6 Summary

VR-commerce is a promising technology and becoming more popular but there is lack of research on relationships between principal functional and non-functional factors toward consumer adoption. Fundamental concepts of both online and offline shopping converge in the study. VR store is where traditional e-commerce meets with the traditional retail commerce, thus it is possible to drawn principal and matured concepts and practices from both worlds to the stage of the innovative setting of virtual reality. Relevant concepts of e-commerce, VR-commerce, and physical retail store are introduced and discussed, drawing that interface factors in traditional e-commerce (web quality), VR-commerce (telepresence), and artifacts embedded in the interaction environment (store environment) are predictors of consumers' behavior being studied. Relations between constructs are based primarily on the joining of Theory of Acceptance Model (TAM), Theory of Reasoned Action (TRA), stimulus-organism-response theory (S-O-R), and use and gratification.

To achieve the research objectives, this study, hence, tries to answer the following research questions: (1) To what extent does web quality contribute to consumers' purchase and revisit intention in an online VR store? (2) To what extent does telepresence contribute to consumers' purchase and revisit intention in an online VR store? (3) To what extent does store environment contribute to consumer's purchase and revisit intention in an online VR store?

Web quality with dimensions of (1) technical adequacy, (2) content quality, (3) specific content and (4) appearance, is posited to be positively related to purchase intention in an online VR store mediated by beliefs in usefulness, informativeness and enjoyment. Telepresence, which are the foundation concept underlying virtual reality environment, with dimensions of (1) interactivity and (2) vividness, is posited to be positively related to the purchase intention mediated by beliefs in usefulness, informativeness, and enjoyment. Store environment, a fundamental retail store component, with dimensions of (1) social factors, (2) image, (3) design and (4) ambience, is posited to positively related to intention to purchase in the VR store

mediated by the construct of enjoyment. Revisit intention is posited to be predicted from the purchase intention on the VR store. Moreover, place familiarity with the physical store is posited to moderate consumers' purchase intention from VR store. The operationalized of the conceptual framework of the study is discussed in the next chapter.

CHAPTER III

RESEARCH DESIGN AND METHODOLOGY

The chapter detailed research methodology for legitimate explanations to the research outcomes. VR-commerce is a promising technology and becoming more popular but there is lack of research on relationships between principal functional and non-functional factors toward consumer adoption. VR store setting is where traditional e-commerce and traditional offline commerce are converged in a virtual reality setting. Web quality (a fundament and matured interface factor carried from the traditional online e-commerce), telepresence (the main and distinct characteristic of interface in VR-commerce) and store environment (the principal element of the traditional offline retail commerce) are extracted as the essential functional and non-functional factors, which are posited to be predictors for consumer purchase intention in and revisit to a VR store.

To achieve the research objectives, this study tries to answer the following research questions:

1. To what extent does web quality contribute to consumers' purchase and revisit intention in an online VR store?
2. To what extent does telepresence contribute to consumers' purchase and revisit intention in an online VR store?
3. To what extent does store environment contribute to consumer's purchase and revisit intention in an online VR store?

This study hypnotized that in an online VR store:

H1a) Web quality is positively related to perceived usefulness.

H1b) Web quality is positively related to informativeness.

H2a) Telepresence is positively related to perceived usefulness.

H2b) Telepresence is positively related to informativeness.

H3) Store environment is positively related to enjoyment.

H4) Perceived usefulness is positively related to purchase intention.

H5) Informativeness is positively related to purchase intention.

H6) Enjoyment is positively related to purchase intention.

H7) Purchase intention in a VR store is positively related to revisit intention.

H8) Place familiarity is positively related to purchase intention.

The independent factors, mediators and consumer behavioral intentions identified from literature reviews suggested that by taking a positivist approach, the convergence of well-established research concepts would be systematically grounded and conform to literatures in the area. This study is a cross-sectional study and employed quantitative approach based mainly on survey conducting on convenience sampling. Structural equation modeling was employed to test the hypotheses and estimate. The details of methodology, e.g. tools and methods, explained as follows.

3.1 Population and Sample

3.1.1 Population

The targeted population in this study is e-commerce consumers in Thailand. The exact numbers are not identified; however, the researcher refer to the major range of internet users, as well as e-commerce shoppers' percentage among internet users, since in e-commerce, consumers do not require any special skills to shop and the internet users who shop online are the targeted customers. According to the data compiled by Thailand's National Statistical Office in 2011 (National Statistical Office, 2012), the major age range of internet users' age that should be able to carry online commerce transaction is 15-24 years, which captures more than half of the country's internet users (51.9%). This trend suggested that internet users are young. Thus, the majority of internet users whose age fall in the range of 15-24 of a total of 14.8 million users is the target population. Among the internet users, 57.2% of them shopped online in the year 2010, increasing form 47.8% in the year 2009 (National Electronics and Computer Technology Center, 2010). The portion of the internet users who shop online

is the targeted population while the remaining portion could represent potential prospective buyers.

For related The-commerce overview, data from the same source suggested that the business to consumer e-commerce has a market value of 84.59 million baht in Thailand (National Statistical Office, 2011). A portion of 6.5 percent of the market are publications and office suppliers, ranked third behind computer and electronics, and fashion goods (National Statistical Office, 2011), while the survey from the National Electronics and Computer Technology Center (2010) recorded that the most frequent merchandises shopped online in the year 2010 are books.

3.1.2 Sampling

Samples are undergraduate students at a university in Thailand named Suranaree University of Technology. The targeted population satisfied research purposes for several reasons. Firstly, the study aimed at theory verification. The population had to be specific, and hence it had to be homogeneity in controlled properties known to the study, yet diverse in general. Typical population's background, such as hometown, field of study, etc., should be diverse, while computer experience and daily usage should be homogeneity. The latter properties could be controlled by specific age range and educational environment.

Secondly, the population's targeted profiles were the same as general computer users. The system did not require users to have experience in 3D manipulation. However, the participants were required to have a good control of the computer mouse and keyboard, which can be represented by the scope of selected population.

Thirdly, all students have experience in buying books. The university required students to buy books for their coursework, which can guarantee students' prior experience of buying books in a physical book store. Next, the VR store used in the study mimicked a real physical book store that has a branch in this university, but with a different layout. This provided a good setting for the study in that the participants had a certain degree of familiarity with the store, while not many of them had been

exposed to the layout used in the study. It helped to control the homogeneity of *place familiarity,* a factor being studied, before the study sessions. Next, the sampling age range is around at the middle of the population age range. E-commerce users tend to be younger and more educated (Hausman & Siekpe, 2009). Lastly, since the convenience sampling was appropriate for the study, the desired population was appropriate for the generalization of the findings.

By considering economic consequences, students are stakeholders in the shopping process since they usually buy books. Books are not expensive merchandize. Moreover, the study was analyzed and rationalized based on the intention not the actual behavior consequences. As such, the selected samples was a sound candidate for the study according the aforementioned justification.

The study employed convenience sampling. It has been popular among studies in HCI field (Hausman & Siekpe, 2009). The survey sessions can be conveniently done in laboratory classes to minimize number of times and difference of settings of system trial. The uniformity of hardware and software fit with the limited control environment.

Sample size was justified by statistical power criteria. The broadly accepted Yamane (1973) sample size of 400 for infinity population did not satisfy this study. Since the study employed Structural Equation Modeling (SEM) as a tool for the hypothesis testing, sampling guidelines of the tool were followed. The appropriate number of cases are dependent on each study's conditions and complexity.

In general, 400 cases are the standard for the SEM analysis (Hox & Bechger, 1998; Tomarken & Waller, 2005). In addition, researchers should take the number of indicators to determine the minimum number of cases required. While five times of the indicators are feasible, those sets of data must be perfectly qualified the analysis assumption, such as multivariate normal distribution. Thus, studies employing SEM were usually based their sample size on the suggested number of 10 to 20 times of the number of the indicators in the study (Garson, 2005). Since there are 68 items in the measurement instrument, thus at least 680-1360 participants are advised for a valid SEM data analysis.

The survey sessions were conducted after the evening sessions of the classes taking place in computer laboratories. The instructors of each class were asked to inform students who were willing to participate in the study to stay. Popular gadgets were selected as incentives. The participants were informed that eight lucky persons among those followed the tasks and filled-in the survey carefully, would be lucky-drawn for the prizes. The prizes included: an iPhone 5, two iPad mini and five Furbies. Each participant also got a pen as a gift at once. In total, the incentives were worth fifty baht per participant, but it was more convenient to manage and should better stimulate interests of the participants. Even so, the students were told to fill-in the survey candidly according to the facts and their opinions.

The laboratory sessions were conducted in twenty-five sessions within one week. Several simultaneous sessions had to be carried out since the schedule of the classes. Trained assistants were assigned to oversee the sessions. The total number of collected surveys was 1,311, which met the suggested sample size criteria. The task and procedures are detailed in the upcoming session.

3.2 Data Collection and Instrumentation

3.2.1 Measurement Instruments

The operationalized survey instruments were developed based on previous published research and were adapted in wording in order to fit in a particular context of the VR store. All of the questionnaire items were translated from the original English language into Thai. The translation was validated using the back-translation method, which the questionnaires were translated back into English by three experts, who are fluent in English, in order to ensure the validity of the translation. Then, another three experts in information technology verified the items. Pilot study sessions were also conducted in order to refine the modified measures. The participants were asked to report any ambiguous questions.

Psychometric assessment of the scales' properties employed reliability assessment, inter-item correlations, and confirmatory factor analysis (CFA). As a final step in scale purification, λ loadings from CFA were evaluated. Reliability analysis

will be assessed using Cronbach's alpha; in addition, the composite reliability (ρ), of the constructs will be evaluated (Bagozzi and Yi, 1988; Nunnally and Bernstein 1994).

The study recorded demographic characteristics, e.g., age, gender, and usage characteristics for reference. All constructs were assessed using 7-point Likert-type scales using 1 for strongly disagree and 7 for strongly agree as anchors for each construct, with only *store environment* and *enjoyment* was assessed using 7-point semantic differential scales using the value of 4 as the middle anchor. *Web quality (WEBQ)* is composed of four factors, in a total of twenty-two items (Aladwani & Palvia, 2002); *telepresence (TELE)* (Goel et al., 2011), four items; *store environment (STOR) (Fisher, 1974; Sherman et al., 1997)*, four factors, twenty items; *perceived usefulness (PU) (Davis, 1989)*, five items; *informativeness (INFO) (Ducoffe, 1996)*, three items; *enjoyment (ENJ)* (Wise, Bolls, Kim, Venkataraman, & Meyer, 2008), four items; *purchase intention (PUR)* (Yoo & Donthu, 2001), four items; *revisit intention (REV)* (Yoo & Donthu, 2001), two items; and *place familiarity* (FAM) (Hammitt et al., 2006), four items. The description of each constructs was discussed in detailed in the previous chapter. The total number of operationalized items are sixty-eight items. The questions of the instruments are given in detailed:

Personal Information

1. Gender
2. Age (in years)
3. Computer usage experience (in years)
4. Computer daily usage (in hours)
5. Online shopping experience (frequency)
6. Book shopping experience (frequency)

Constructs

Web Quality (Aladwani & Palvia, 2002)**, 4 dimensions, 22 items:**

Technical Adequacy, 6 items:

1. Chula VR Book Store looks secured for carrying out transactions (e.g. uses SSL, digital certificates, etc.)
2. Chula VR Book Store looks easy to navigate through
3. Chula VR Book Store has adequate search facilities
4. Chula VR Book Store can be personalized or customized to meet one's needs
5. Web pages load fast in Chula VR Book Store
6. Chula VR Book Store has many interactive features (e.g. online shopping, etc.)

Content Quality, 6 items:

7. The content of Chula VR Book Store is useful
8. The content of Chula VR Book Store is complete
9. The content of Chula VR Book Store is clear
10. The content of Chula VR Book Store is current
11. The content of Chula VR Book Store is concise
12. The content of Chula VR Book Store is accurate

Specific Content, 5 items:

13. In Chula VR Book Store, one can find contact information (e.g. e-mail addresses, phone numbers, etc.)
14. In Chula VR Book Store, one can find firm's general information (e.g. goals, owners)
15. In Chula VR Book Store, one can find details about products and/or services
16. In Chula VR Book Store, one can find information related to customers' policies (e.g. privacy and dispute details)
17. In Chula VR Book Store, one can find information related to customer service

Appearance, 5 items:

18. Chula VR Book Store looks attractive
19. Chula VR Book Store looks organized
20. Chula VR Book Store uses fonts properly
21. Chula VR Book Store uses colors properly
22. Chula VR Book Store uses multimedia features properly

Telepresence (Goel et al., 2011)**, 4 items:**

1. I forgot about my immediate surroundings when I was navigating Chula VR Bookstore.
2. When the shopping ended, I felt like I came back to the "real world" after a journey.
3. During the shopping, I forgot that I was in the middle of an experiment.
4. The computer-generated world seemed to be "somewhere I visited" rather than "something I saw."

Store Environment *(Fisher, 1974; Sherman et al., 1997)***, 4 dimensions, 20 items:**

Social Factors, 4 items:

1. Unlively-Lively
2. Depressing-Cheerful
3. Boring-Stimulating
4. Discourteous salespeople-Courteous salespeople

Store Image, 2 items:

5. Bad-Good
6. Negative-Positive

Store Design, 10 items:

7. Small-Large
8. Cramped-Roomy
9. Drab-Colorful

10. Unattractive-Attractive
11. Dirty-Clean
12. Uncomfortable-Comfortable
13. Cluttered aisles-Uncluttered aisles
14. Cramped merchandise-Well-space merchandise
15. Impressed interior-Unimpressed interior (R)
16. Unorganized layout-Organized layout

Store Ambience, 4 items:

17. Unpleasant-Pleasant
18. Tensed-Relaxed
19. Dull-Bright
20. Unpleasant background music-Pleasant background music

Perceived of Usefulness (PU) *(Davis, 1989)***, 5 items:**

1. Chula VR Book Store improves my performance in book searching and buying
2. Chula VR Book Store enables me to search and buy book faster
3. Chula VR Book Store enhances my effectiveness in book searching and buying
4. Chula VR Book Store makes it easier to search for and purchase books
5. Overall, Chula VR Book Store is useful

Informativeness (INFO) *(Ducoffe, 1996)***, 3 items:**

1. Chula VR Book Store is a good source of product information
2. Chula VR Book Store supplies relevant information
3. Chula VR Book Store is informative about the company's products

Enjoyment (ENJ) (Wise et al., 2008), **4 items:**

1. Uninteresting–Interesting
2. Not fun–Fun
3. Dull–Exciting
4. Not Enjoyable–Enjoyable

Purchase Intention (PUR) (Yoo & Donthu, 2001)**, 4 items:**

1. I will definitely buy products from Chula VR Book Store in the near future
2. I intend to purchase through Chula VR Book Store in the near future
3. It is likely that I will purchase through Chula VR Book Store in the near future
4. I expect to purchase through Chula VR Book Store in the near future

Revisit Intention (REV) (Yoo & Donthu, 2001)**, 2 items:**

1. I am likely to revisit Chula VR Book Store in the near future
2. I am encouraged to revisit Chula VR Book Store in the near future.

Place familiarity (FAM) (Hammitt et al., 2006)**, 4 items**

1. I have many memories of shopping in Chula Book Store.
2. I have been to Chula Book Store many times and I am quite familiar with it.
3. I could draw a rough map of the Chula Book Store.
4. I know Chula VR Book Store like the back of my hand.

Appendix A shows the English language version of the questionnaire. Appendix B shows the questionnaire in Thai language used in the study.

3.2.2 The VR Store

A VR book store was developed by mimicking a physically present book store for the survey. While people are still cruising through retail book store to browse for their books of interests, high percentage of online purchase of books, especially e-books, is increasing (Bosman, 2013). The first and currently biggest in revenue of business-to-consumer online store in the world, Amazon, is also a book store. Experiences in the physical book store such as shoppers walking through bookcases or flipping through several books' pages, as well as experiences in online store like typing in for specific book searching can be provided in the VR book store. In Thailand, books also the third-ranked goods sold with a share of 6.5% of B2C e-commerce (National Statistical Office, 2011). Figure 3-1 demonstrates the VR store environment used in the study (Pimsuwan, Phosaard, Rattanawicha, & Chantatub, 2012). The system is being developed on X3DOM (Behr, Eschler, Jung, & Zöllner, 2009) for VR capability,

which can be operated by WebGL supported web browsers, namely Google Chrome, Mozilla Firefox, etc. The browser used for the development, testing, and data collection sessions, was Google Chrome version 21.

3.2.2.1 Design and Development

The product primarily employed in the implementation is book creating a virtual environment mimicking a real physical book store. Hence, main functionalities of the system include: (1) browsing and navigating through the book store by walking; (2) reviewing a particular book for purchasing by opening and flipping through the limited sample pages; and (3) adding books to a shopping cart and complete the purchase transaction.

The first and the second requirement is critical to the study thus the implementation must consider interaction and presentation functionalities that exhibit the moderate degrees of telepresence, as well as an average store environment. To accomplish this, the interface must mimic the real experience of walking through the book store as well as flipping through the books. Thus, the first person camera viewpoint were chosen representing the real-world experience of customer walking through the store. Books shown in bookcases much match the details of the book customers selected. Flipping through the books are crucial for providing interactivity and vividness, delivering telepresence, of experience of in-store buying experience. Examples of important screens are shown in Figure 3-1 through Figure 3-4.

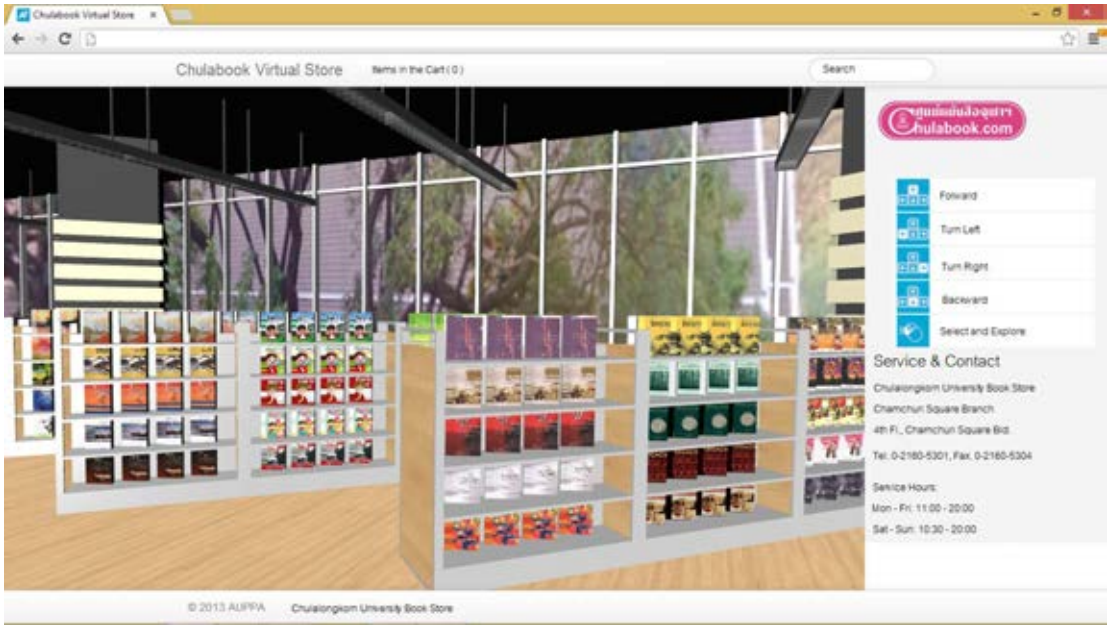

Figure 3-1. The VR Book Store for the Study

A user can navigate throughout the store using keyboard and mouse. The user will perceive oneself immersed into the screen, viewing as the first person. The controls and navigation were implemented by writing a separated module for handling user interactions using X3DOM. When the user select a book for reviewing, a canvas presenting a three-dimensional and close-up book will appear along with the book information allowing the user to place it into the shopping cart in case of he/she decides to buy the book as shown in Figure 3-3 and Figure 3-4. The completion of the purchase transaction employs the same technique as other online e-commerce websites by storing the information in the database. The system was a full-scale and working e-commerce website. It has been proven commercial-ready as the owner of the VR book store layout made public beta testing for the system, a month after the survey sessions. It also claimed an award from the ACM SIGGRAPH Web3D conference in 2012 (Pimsuwan et al., 2012).

The system was also developed according to each property of constructs being studied. Each instrument item was verified that it was well-implemented in the system. Those features and properties are: (1) *web quality: technical adequacy, content quality, specific content*, and *appearance;* (2) *telepresence* and (3) *store environment: social*

factors, store image, store design, and ambience. For example, basic shopping features and searching capability were implemented to ensure *technical adequacy*. The quality of books' content served the purpose of *content quality*. Store contact and operating hour information were example elements of *specific content*. And appropriate use of design elements, e.g. fonts, layout, color, etc., for web interface delivered the quality of web *appearance.*

Telepresence and store environment properties were features mainly implemented in the virtual reality or the 3D canvas. Appropriate manipulation and graphics design in the virtual reality canvas exhibited vividness and interactivity, delivering *telepresence* of the VR store. Store environment was executed through objects and elements in the VR store. Aesthetic and well-organized properties partly conveyed *store design*. Particular details had been taken care of specially. For example, courtesy of salespeople, a property of the store's *social factors*, was expressed by polite conversion shown by call-out elements as shown in Figure 3-2. In every survey session, a song similar to the one played in the real store was played by central speakers that can be heard by everyone. This demonstrates an operationalized of an element of the store *ambience.*

It is noted here that certain features might not be fully operationalized, e.g. security. A particular item of the instruments assess the encryption of the web using secured-socket layer or https, which did not implemented due to technical issue. Nonetheless, the validity of the implementation, and the correspondence between the operationalized system and the instruments were also assessed later on.

Figure 3-2. Callouts (shown in pink) express salespeople courtesy.

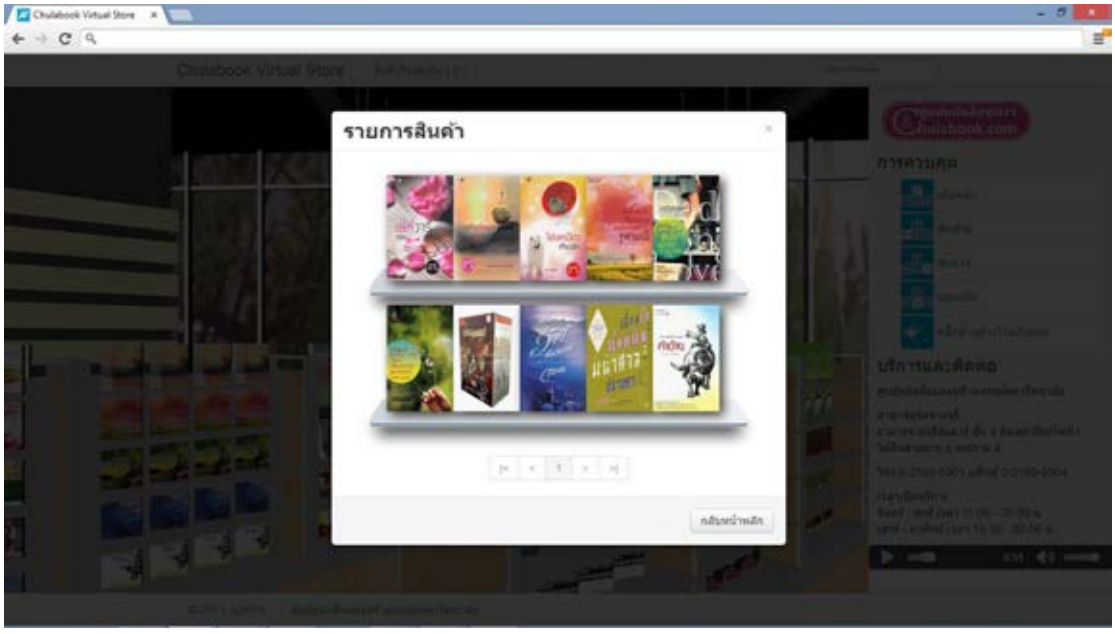

Figure 3-3. A close-up canvas, showing books on the selected shelf for customer to select.

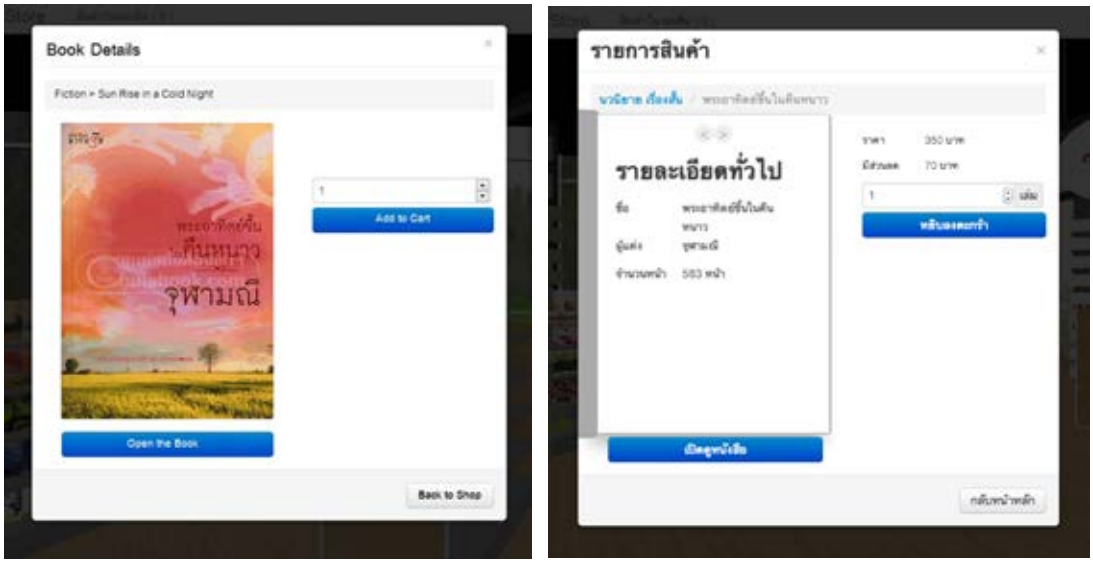

Figure 3-4. Translated (left) and in original language (right), a close-up canvas, enabling customer to flip through sample pages.

Table 3-1 summarizes the operationalization of the VR store according to the constructs and measurement items. The operationalization took care of factors of interest as much as possible to accomplish a commercial-ready system. The explicit executions of items that the researcher handled were highlighted as follows. Several operationalization is illustrated in captured screens referred.

Table 3-1. Summary of the VR Store Operationalization.

Constructs	Measurement Items	Operationalized via
Web Quality		
Technical Adequacy	Chula VR Book Store looks secured for carrying out transactions (e.g. uses SSL, digital certificates, etc.).	SSL did not implemented as discussed. The store's logo should reflect reputation and trustworthiness of the transaction (Figure 3-5), along with bank accounts with the store's name and detailed payment instruction (Figure 3-6), and payment confirmation (Figure 3-7) and notification (Figure 3-8).
	Chula VR Book Store looks easy to navigate through.	Clean web layout and few menus (Figure 3-5, Figure 3-7, etc.).
	Chula VR Book Store has adequate search facilities.	Search box (Figure 3-5).

Constructs	Measurement Items	Operationalized via
	Chula VR Book Store can be personalized or customized to meet one's needs.	No special implementation. Font size and other web properties are handled through the web browser.
	Web pages load fast in Chula VR Book Store.	Optimization of polygon for fast loading; and loading objects within vicinity and vicinity of utilization only, e.g., loading only the near-end bookcases (Figure 3-5), etc.
	Chula VR Book Store has many interactive features (e.g. online shopping, etc.).	Online shopping in VR canvas (Figure 3-4 and Figure 3-5); search box (Figure 3-5).
Content Quality	The content of Chula VR Book Store is useful.	Content of books, e.g., title, author, price, and example contents, etc. (Figure 3-4); information of store, e.g., address and operating hours (Figure 3-5), payment instructions (Figure 3-6), etc.
	The content of Chula VR Book Store is complete.	Similar to the previous item of content usefulness focusing on the completeness of each item, e.g. several pages of example book contents (Figure 3-4), complete payment instructions (Figure 3-6), etc.
	The content of Chula VR Book Store is clear.	Similar to the previous item of content completeness focusing on the clarity of each item, e.g. unambiguous payment instruction (Figure 3-6); amount and value of purchase, and confirmation of purchase (Figure 3-7).
	The content of Chula VR Book Store is current.	All books are the latest editions (Figure 3-4).
	The content of Chula VR Book Store is concise.	The store provides relevant information only when it is needed, e.g. store information is pertinent (Figure 3-5); payment instruction menu explicitly appears when checking out (Figure 3-7), etc.
	The content of Chula VR Book Store is accurate.	Content and information of books and information of the store.

Constructs	Measurement Items	Operationalized via
Specific Content	In Chula VR Book Store, one can find contact information (e.g. e-mail addresses, phone numbers, etc.).	Contact information of the store is provided in the main page (Figure 3-5).
	In Chula VR Book Store, one can find firm's general information (e.g. goals, owners).	General information of the store.
	In Chula VR Book Store, one can find details about products and/or services.	Content of books, e.g., title, author, price, and example contents, etc. (Figure 3-4); information of store, e.g., address and operating hours (Figure 3-5), payment instructions (Figure 3-6), etc.
	In Chula VR Book Store, one can find information related to customers' policies (e.g. privacy, dispute).	Information is shown in the payment instructions (Figure 3-6).
	In Chula VR Book Store, one can find information related to customer service.	Information is shown in the payment instructions (Figure 3-6).
Appearance	Chula VR Book Store looks attractive.	Design of the web layout (Figure 3-5, etc.).
	Chula VR Book Store looks organized.	Design of the web layout and menus (Figure 3-5, etc.).
	Chula VR Book Store uses fonts properly.	Design of the web layout; font size, style, and color is appropriate (Figure 3-5, etc.).
	Chula VR Book Store uses colors properly.	Design of the web layout; moderate color (Figure 3-5, etc.).
	Chula VR Book Store uses multimedia features properly.	Design of the web layout and media (Figure 3-5, etc.).

Constructs	Measurement Items	Operationalized via
Telepresence		
	I forgot about my immediate surroundings when I was navigating Chula VR Bookstore.	Virtual reality canvas by imitating the real store and Second Life (Figure 3-5), and book flipping (Figure 3-4) for all measurement items.
	When the shopping ended, I felt like I came back to the "real world" after a journey.	
	During the shopping, I forgot that I was in the middle of an experiment.	
	The computer-generated world seemed to be "somewhere I visited" rather than "something I saw."	
Store Environment		
Social Factors	Unlively-Lively	Property of the VR store in VR canvas (Figure 3-5).
	Depressing-Cheerful	Property of the VR store in VR canvas (Figure 3-5).
	Boring-Stimulating	Property of the VR store in VR canvas (Figure 3-5); imitating real-world outside environment (Figure 3-5).
	Discourteous salespeople-Courteous salespeople	Salespeople's expression (Figure 3-2 and Figure 3-11).
Store Image	Bad-Good	No special implementation. May refer to the store's reputation through its name and logo (Figure 3-5).
	Negative-Positive	No special implementation. May refer to the store's reputation through its name and logo (Figure 3-5).

Constructs	Measurement Items	Operationalized via
Store Design	Small-Large	Property of the VR store; imitating real store layout (Figure 3-5 in VR canvas).
	Cramped-Roomy	Property of the VR store; imitating real store layout (Figure 3-5 in VR canvas).
	Drab-Colorful	Property of the VR store; imitating real store theme of decoration (Figure 3-5 in VR canvas).
	Unattractive-Attractive	Property of the VR store; imitating real store theme of decoration (Figure 3-5 in VR canvas).
	Dirty-Clean	Property of the VR store; clean environment (Figure 3-5 in VR canvas).
	Uncomfortable-Comfortable	Property of the VR store; imitating real store layout and design (Figure 3-5 in VR canvas).
	Cluttered aisles-Uncluttered aisles	Property of the VR store; imitating real store layout with cluttered aisles (Figure 3-5 in VR canvas).
	Cramped merchandise-Well-space merchandise	Property of the VR store; well-spaced book placement on shelves (Figure 3-3 and Figure 3-5 in VR canvas).
	Impressed interior-Unimpressed interior (R)	Property of the VR store; imitating real store theme of decoration (Figure 3-5 in VR canvas).
	Unorganized layout-Organized layout	Property of the VR store; imitating real store layout (Figure 3-5 in VR canvas).
Store Ambience	Unpleasant-Pleasant	Property of the VR store; imitating real store environment (Figure 3-5 in VR canvas).
	Tensed-Relaxed	Property of the VR store; imitating real store environment (Figure 3-5 in VR canvas).
	Dull-Bright	Property of the VR store; imitating real store ambience with enough lights (Figure 3-5 in VR canvas).
	Unpleasant background music-Pleasant background music	The music box simulating the one used in the real store was played.

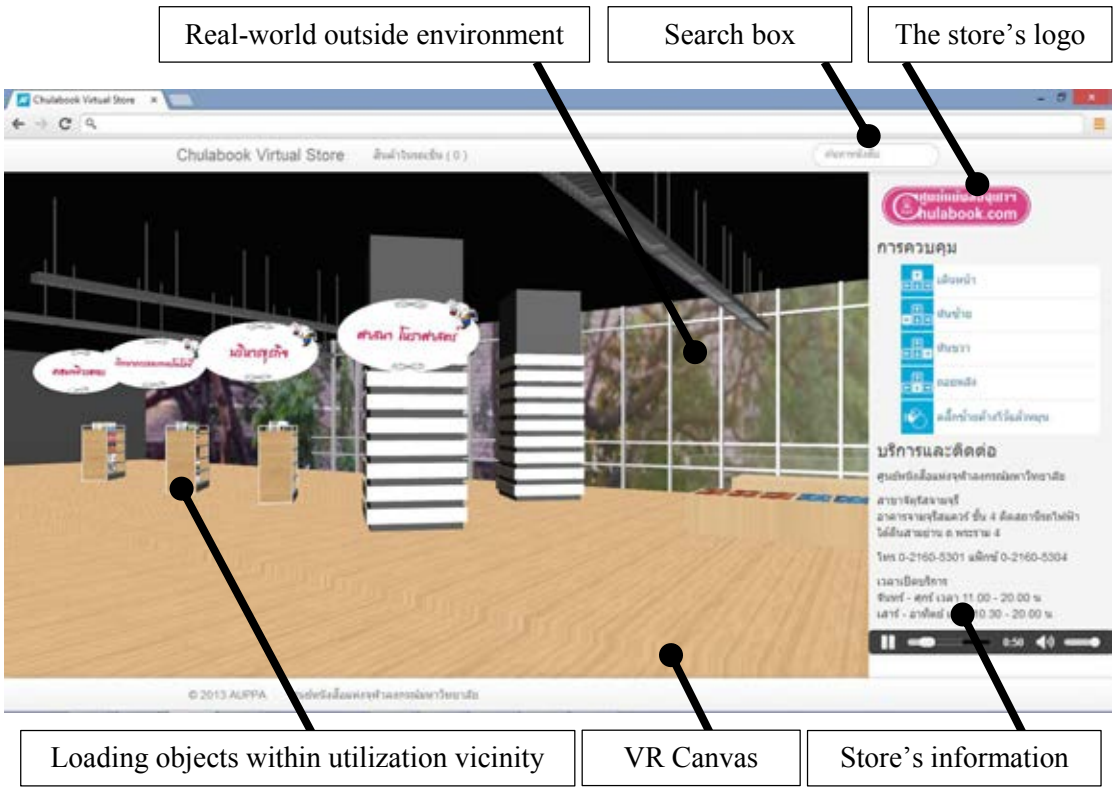

Figure 3-5. Captured screen illustrates the operationalization (main screen).

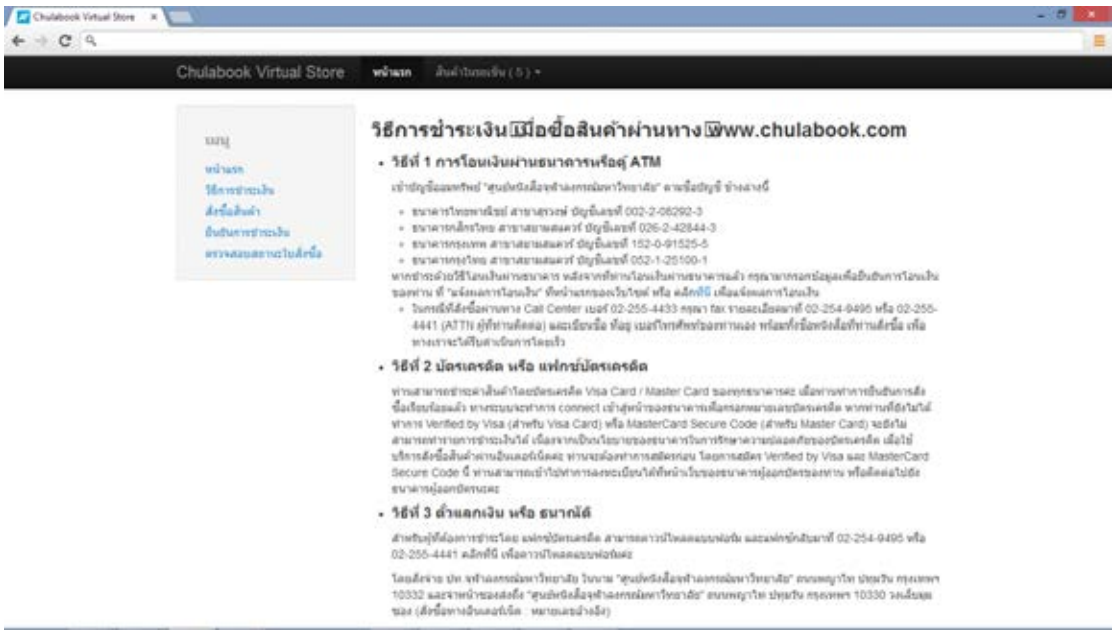

Figure 3-6. Payment instructions along with detailed contact information (in Thai).

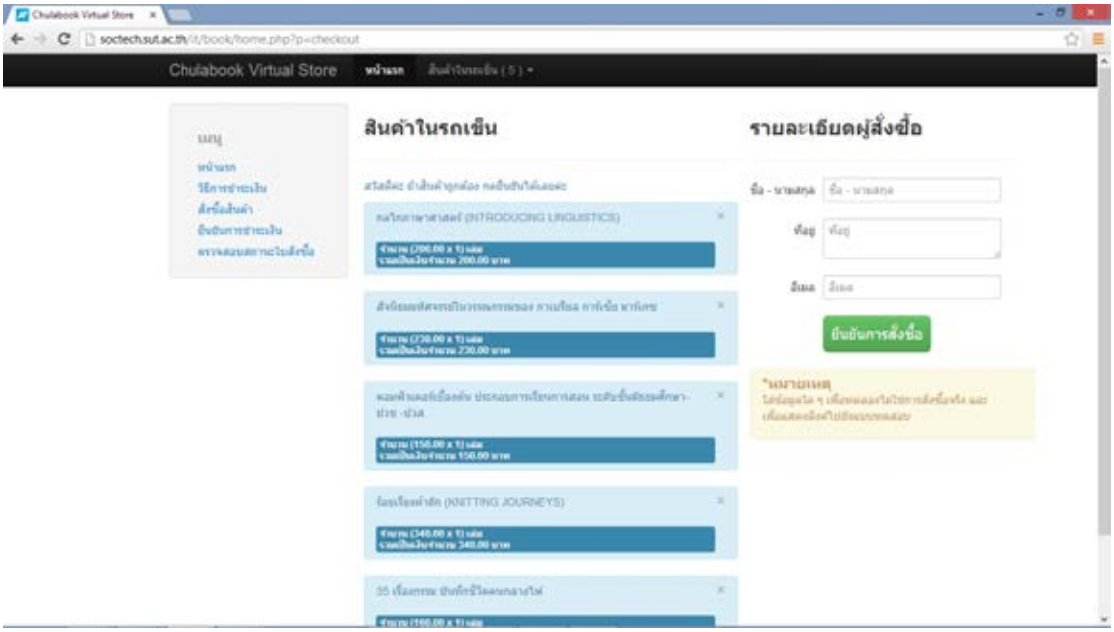

Figure 3-7. Purchase confirmation (in Thai).

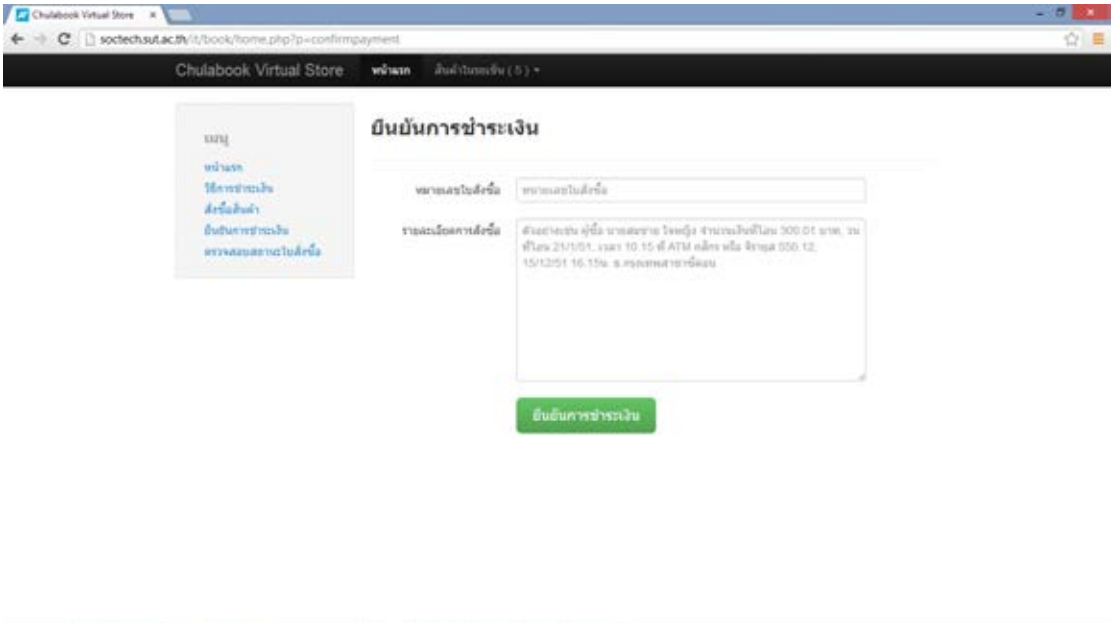

Figure 3-8. Payment notification (in Thai).

3.2.2.2 System Architecture

Unlike the Second Life requiring downloading and installing the whole bunch of the virtual world (Mennecke et. al., 2006), this implementation utilizes the web-based X3DOM for just-in-time loading, which enables a prompt environment for interaction resulting in a more robust browsing experience. It is and upgraded standard from the VRML framework for shopping malls (Lepouras and Vassilakis, 2006).

To accomplish these interface requirements, the X3DOM, calling through JavaScript embed in a main HTML page, and server-sided scripts, PHP, were integrally used. The system firstly loads the virtual world, the book store environment, including shelves. These objects were specified in the X3D standard stored in X3D XML files. Then, the books on the shelves are dynamically generated by the server- and the client-sided scripts. The system architecture is shown in Figure 3-9.

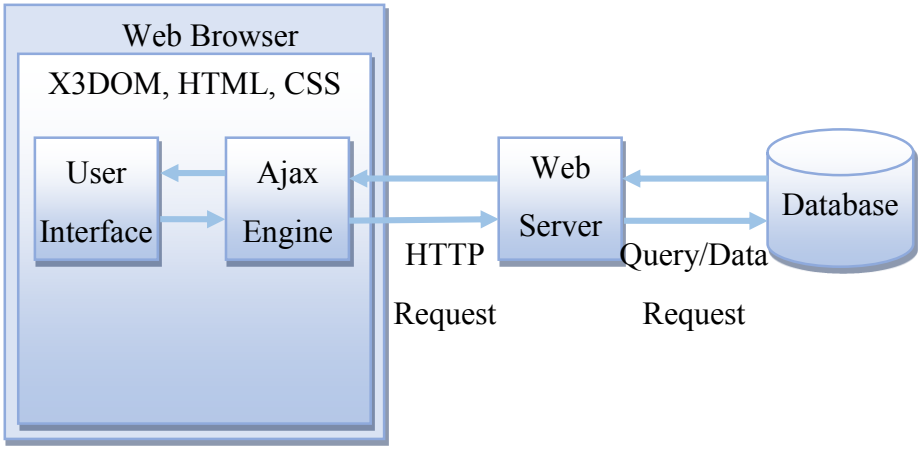

Figure 3-9. System architecture.

3.2.3 Hardware and Software

The survey sessions are conducted by computers with average specification that can operate the VR store smoothly. It will be tested with 1680 x 1050 pixel screen resolution, the native resolution of a 20-inch, flat screen LCD monitors. Standard mice and keyboards were utilized and no other special devices are required. A web browser supporting X3DOM (Behr et al., 2009), Google Chrome version 21 onward, was

required and used. The specifications of computer hardware and the operating environment were controlled and registered. The computer laboratories used in the study had a capacity of 60 identical machines.

3.2.4 Procedures and Tasks

The participants were asked to shop in the developed VR book store according to the tasks and fill-in the survey form carefully after completing the tasks. Students in laboratory classes were given time for the system testing sessions at the end of their regularly laboratory exercise. The proctor, the researcher, will introduce the system. The pilot study determined that approximately thirty-minute time was appropriate for shopping and data collection. One cross-sectional survey, with twenty-five laboratory sessions, were conducted.

The survey sessions began with an introduction to the system and the purpose of the study and incentives. The participants who were undergraduate students were asked to stay after laboratory classes; thus after giving an introduction to the study, participants who were not interested in the study can leave the sessions. Then, the proctor played a two-minute video to introduce the physical book store where the VR store being tested was simulated. The video walked through the book store and gave overall layout of the store. This was for introducing *place familiarity*. Afterward, the participants were asked to shop for books.

The tasks were designed by keeping in mind that the procedures need to be simple, yet the participants did expose to all of the properties and functionalities. In brief, the participants were instructed to explore contents and purchase at least five books from 5 different categories. This can guarantee that the participants' walking coverage was more than half of the store since each side of the store contained four book categories. The store had a two-sided symmetry layout. Participants were also asked to use search functionality. For payment transaction, participants had to walk to salespeople and made a payment there. Constraints were embedded into the system to ensure that the participants had to meet the requirements, e.g. buying five books from

five different categories as shown in Figure 3-12, in order to complete the shopping transaction.

The task covered all aspects of interface features and store environment being studied: *web quality (technical adequacy, content quality, specific content*, and *appearance), telepresence* and *store environment (social factors, image, design* and *ambience*) as also detailed in the development VR store development topic. Participants went through the shopping process assuming that they have unlimited money to buy. They were also asked to explore the store freely as long as they wanted, and the participants seemed to be curious and active in scrutinizing the virtual world. The following lines are the actual instructions and information given to the participants:

1. Watch a video introducing the online VR store
2. Shop for books
    2.1. Launch Google Chrome and browse to the URL shown by the proctor and write down the starting time.
    2.2. Walk around and explore the store by arrow keys.
    2.3. Click at bookshelves and browse for contents of the books.
    2.4. Add five books from different categories into the shopping cart.
    2.5. Try searching for books with the word “karn” (in Thai) and check the box whether it is found or not.
    2.6. Go to and click on the cashier to make a payment
    2.7. Fill-in personal information and confirm purchase.
    2.8. Try to explore and make purchase until satisfied with the exploration.
    2.9. Record the end time
3. Fill-in questionnaire
    3.1. Fill-in the questionnaire according to the facts and actual opinion.
    3.2. The questionnaire will be unusable if each question is not read carefully.
    3.3. Please double check the completeness of the questionnaire.

The Thai translated version is listed in Appendix B.

After shopping tasks, the participants had to complete the questionnaires. The questionnaires was handed out in paper, so that the participants can be conveniently assess the system. They had to check for any missing or redundant answers, or else the participants could not be drawn for incentives. None of the data is confidential except the house whole's monthly income, which the participants can opt for not answering the question. E-mail collected will not be distributed. The proctors double-checked for the completeness of the filled-in questionnaires as well. More examples of screen captures are presented as follows in Figure 3-10, Figure 3-11 and Figure 3-12.

Figure 3-10. Book shelves and category signs (above shelves).

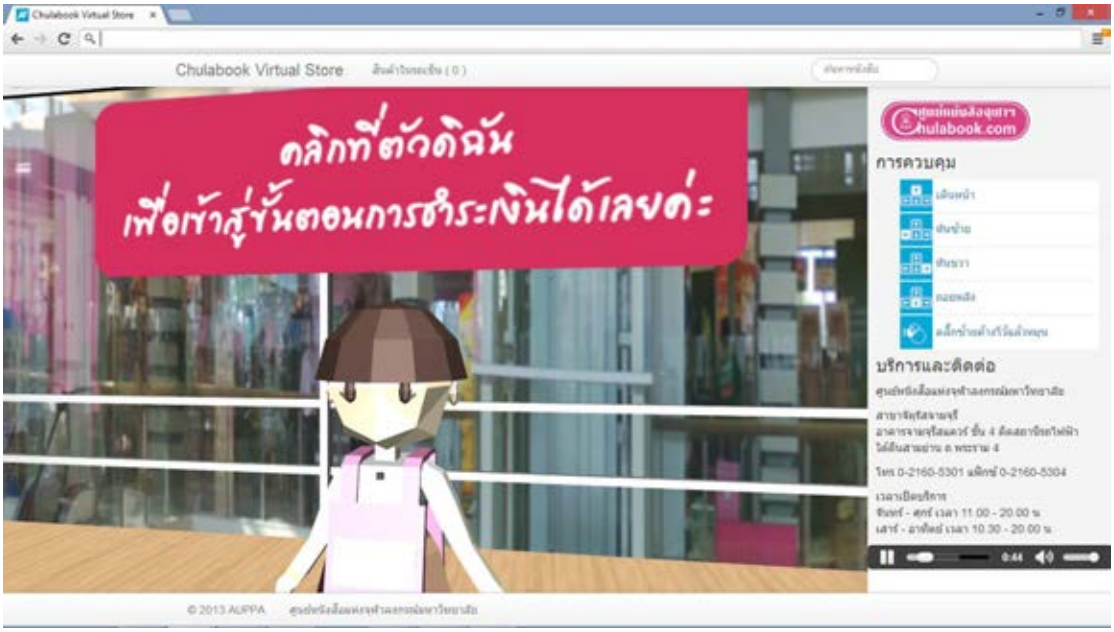

Figure 3-11. A close-up look at a salesperson and a greeting callout.

Figure 3-12. A check-out canvas informs participants to buy books from five different categories (in red area).

3.3 Data analysis

The analysis of the data were done in a holistic manner using Structural Equation Modeling (SEM). The SEM procedure (Byrne, 2010; Kline, 2010) has been gaining interest and use among researchers in recent years. It allows one to both specify the relationships among the conceptual factors of interest and the measures underlying each construct, resulting in a simultaneous analysis of (1) how well the measures relate to each construct and (2) whether the hypothesized relationships at the theoretical level are empirically true. This ability to include multiple measures for each construct also provides more accurate estimates of the paths among constructs which are typically biased downward by measurement error when using techniques such as multiple regression. The detailed analysis and results were discussed in Chapter 4.

3.4 Pilot Study

The study employed an innovative system that has never been used before thus a pilot study is crucial. Besides pretesting the questionnaires, the purposes of the pilot study were to investigate the completeness of the VR store implementation in a commercialized-ready environment, and the capacity of the server; since there would be five hundred concurrence participants according to the planned data collection sessions. Task and procedures were also verified by the pilot study. It was carried out in three laboratory sessions with 120 participants. Convenient sampling was employed and the cases were not included into the final analyses.

The results suggested that the readability of the instruments was unambiguous. The average time used to complete the task was approximately fifteen minutes with forty minutes as upper bound, including the practice session. Formerly, the tasks were designed with a practice session and feature-exposure verification by answering questions. The pilot study revealed that the practice session is unnecessary due to user interface usability. Feature-exposure verification was also unnecessary, since to complete the transaction, participants had to expose to almost all of the features. The instruction, then, had been redesigned to be simpler as given in details in the previous topic of procedures and tasks. The researcher preliminary analyzed the reliability of

the instrument using Cronbach's Alpha, indicating reliable instruments with generally suggested value of above 0.70 (Bagozzi & Yi, 1988; Byrne, 2010). Due to the fact that the instruments were validated and published, the instruments were verified by experts, as well as validated by a pilot study, the researcher proceeded to the next step of field survey. Further measurement assessment on their reliability and validity on the sample was carried out and the results were presented in the next Chapter.

Table 3-2. Chronbach's Alpha Reliability Test for Constructs

Constructs	Cronbach's Alpha	Number of Items
WEBTEC	.749	6
WEBCON	.836	6
WEBSPC	.799	5
WEBAPP	.826	5
TELE	.854	4
STOSOC	.774	4
STOIMG	.861	2
STODES	.856	10
STOAMB	.861	4
PU	.870	5
INFO	.879	3
ENJ	.937	4
PUR	.872	4
REV	.905	2
FAM	.885	4

3.5 Ethical Conduct

Although the university does not require an approval of ethical plan in the study, it has to be appropriately handled. The study strictly followed the ACM Code of Ethics and Professional Conduct (Anderson, 1992). The recruited participants must be willing to participate, and were appropriately appreciated and rewarded. Any inquiry regarding the survey session was explained. They could terminate the tasks at any time. Their information is kept private and no information will be referred individually. The intellectual property rights of the system developed are appropriately credited.

3.6 Summary

To achieve the research objectives, this study tries to answer the following research questions: (1) To what extent does web quality contribute to consumers' purchase and revisit intention in an online VR store? (2) To what extent does telepresence contribute to consumers' purchase and revisit intention in an online VR store? (3) To what extent does store environment contribute to consumer's purchase and revisit intention in an online VR store? It employs experiment method by letting users shop on the develop VR book store. After the tasks, the participants will fill in the survey and SEM is used to test the hypotheses. It is expected that the research will fill in the literature gap in VR-commerce by proving a comprehensive and parsimonious framework and a contribution in the practical world by providing good guidelines for practitioners in VR store.

CHAPTER IV

DATA ANALYSIS

This chapter presents data outcomes using descriptive and inferential statistics, following the research paradigms and data collection methods in Chapter 3. The data analyses comprise of four main sections represents the organization of the data analyses. The study employed a structural equation modeling (SEM) technique to assess the model. It followed a recommended two-stage approach, which suggested a first step of measurement model assessment and re-specification, and a structural model assessment and re-specification in the following step (Anderson & Gerbing, 1988; Kline, 2010). Before beginning the two-step approach, a preliminary analyses and data preparation process were conducted.

The chapter is organized along these lines. After an introduction to the chapter and an overview of the organization of data analyses presented here, is the first section, section 4.1, preliminary analyses and data preparation, dealing with data examination and preparing it to meet quality criteria for the following statistical analyses. Then, the following section, section 4.2, which is the first stage of the two-stage approach of SEM technique, is the measurement model assessment. It mainly deals the assessment of the reliability and validity of the measurement according to the collected data. The second half of the SEM two-stage approach is in the *main analyses* section of this chapter, section 4.3. It estimates the relationships between constructs being studied and tests for their significance. Then section 4.4 summarizes the chapter. The set of abbreviations used for the rest of this chapter is listed in Table 4-1.

Table 4-1. Lists of Abbreviations for Data Analyses

Abbreviations	Meaning
WEBQ	Web Quality
WEBTEC	Technical Adequacy
WEBCON	Content Quality
WEBSPC	Specific Content
WEBAPP	Appearance
TELE	Telepresence
STOR	Store Environment
STOSOC	Social Factors
STOIMG	Store Image
STODES	Store Design
STOAMB	Store Ambience
PU	Perceived of Usefulness
INFO	Informativeness
ENJ	Enjoyment
PUR	Purchase Intention
REV	Revisit Intention
FAM	Place Familiarity

4.1 Preliminary Analyses & Data Preparation

Preliminary data analyses and data preparation comprised of five steps: provision of a description of the participants' profile, handling with missing data, screening extreme cases, assessment of normality, and transforming the data if required.

4.1.1 Participants' Profile and Descriptive Statistics of Measures

Since the relationships among constructs may behave differently in other samples, participant profiles were presented in Table 4-2. Place familiarity was assessed for moderating effects in this study, while other personal traits were considered randomized. There were a total of 1,311 participants with no missing personal data. The following discussion noted the characteristics of the participant profiles.

Table 4-2. Participants' Profile

	Frequency	Percent
Gender		
Male	712	54.3
Female	599	45.7
Online shopping frequency		
Never	482	36.8
Rarely (Less than once a month)	516	39.4
Occasionally (At least once a month)	262	20.0
Frequently (At least once a week)	47	3.6
Very Frequently (Everyday)	4	.3
Book shopping frequency		
Never	43	3.3
Rarely (Less than once a month)	523	39.9
Occasionally (At least once a month)	615	46.9
Frequently (At least once a week)	130	9.9
Very Frequently (Everyday)	0	.0
Monthly household income (baht)		
70,000 and above	88	6.7
50,000 to 69,999	85	6.5
30,000 to 49,999	254	19.4
20,000 to 29,999	299	22.8
Less than 20,000	385	29.4
Unwilling to report	200	15.3
Major of study		
Engineering	992	75.7
Medical	84	6.4
Information and Management Technology	243	18.5
Other (e.g., Sport Sciences, etc.)	6	.4
Year of study		
Senior	125	9.5
Junior	133	10.1
Sophomore	222	16.9
Freshmen	831	63.3
Average age	19.7 years	
Average computer usage experience	9.6 years	
Average computer usage per day	5.2 hours	
Average time spent on the survey session	15.6 minutes	

N = 1,311

Gender: The proportion of gender between male and female were almost tied with 712 participants or 54.3 percent were male and 599 participants or 45.7 percent were female. The balance of gender could be assumed for a randomized gender sampling.

Online shopping frequency: Attitude toward previous online shopping experience may influence attitude toward the next shopping (Monsuwé et al., 2004). Approximately seventy-six percent of participants had never bought or been buying books less than once a month. This suggests less effects of former online shopping impression; nonetheless, the pilot study suggested that it was not difficult for a student to shop and complete the payment transaction.

Book shopping frequency (in general store): Almost all participants had had experiences of buying books while only 3.3 percent had no experience of buying book at all. It is expected that the participants were familiar with book shopping process.

Monthly household income: Monthly household income may affect decision to shop online (Monsuwé et al., 2004). However, in this study, the participants assumed that they have unlimited amount of money. The household income were recorded for further reference purpose and it might affect the revisit intention. Approximately 72 percent of the participants' monthly household income evenly spanned from under 50,000 baht.

Major and year of study: All of the participants were undergraduate students in science and technology majors due to the nature of university of technology. The majority of the participants, 75.7 percent, were engineering students, and 63.3 percent were freshmen, with an average age of 19.7 years. The age range is considered narrow, and major of study should not play any role in the study.

Computer usage and time spent in the survey: the average computer usage experience was 9.6 years and the average computer daily usage was 5.2 hours. The participants exhibited well-familiarity in using computer. This also explained why the participants could complete the transaction easily. The average time spent for shopping in the VR store was 15.6 minutes, excluding the time spent for filling-in the questionnaire.

Table 4-3 lists descriptive statistics of each measurement item. The researcher partly referred to this data to modify the measurement model. After the measurement purification, descriptive statistics of each construct were analyses for further understand the settings of the study. This investigation is provided in the section 4.2 Measurement Model Assessment.

Table 4-3. Descriptive Statistics of Observed Variables

Parameters	N	Mean	SD.
WEBTEC1	1309	4.90	1.151
WEBTEC2	1310	5.01	1.262
WEBTEC3	1311	4.98	1.240
WEBTEC4	1309	5.02	1.189
WEBTEC5	1308	4.91	1.418
WEBTEC6	1311	5.16	1.228
WEBCON1	1310	5.61	1.118
WEBCON2	1311	4.77	1.362
WEBCON3	1310	4.89	1.242
WEBCON4	1311	5.12	1.217
WEBCON5	1310	5.25	1.142
WEBCON6	1310	5.33	1.118
WEBSPC1	1310	5.65	1.113
WEBSPC2	1311	5.24	1.217
WEBSPC3	1309	5.27	1.189
WEBSPC4	1311	5.00	1.256
WEBSPC5	1309	5.07	1.210
WEBAMB1	1310	5.27	1.327
WEBAMB2	1311	5.69	1.164
WEBAMB3	1311	5.50	1.189
WEBAMB4	1311	5.40	1.258
WEBAMB5	1310	5.38	1.170
TELE1	1309	4.73	1.423
TELE2	1310	4.68	1.429
TELE3	1310	4.54	1.509
TELE4	1310	4.61	1.454
STOSOC1	1311	4.85	1.624
STOSOC2	1310	4.93	1.379
STOSOC3	1310	4.66	1.315
STOSOC4	1310	5.49	1.295
STOIMG1	1311	5.70	1.197
STOIMG2	1310	5.72	1.221
STODES1	1310	5.05	1.447
STODES2	1311	5.05	1.558
STODES3	1310	5.18	1.448
STODES4	1310	5.11	1.549
STODES5	1311	6.04	1.208
STODES6	1310	5.45	1.418
STODES7	1311	5.58	1.423
STODES8	1310	5.46	1.457
STODES9	1311	3.80	1.805
STODES10	1310	5.64	1.250
STOAMB1	1310	5.37	1.384
STOAMB2	1308	5.40	1.415
STOAMB3	1311	5.51	1.365
STOAMB4	1311	5.67	1.381
PU1	1311	5.45	1.292
PU2	1311	5.44	1.276
PU3	1311	5.49	1.164
PU4	1310	5.54	1.215
PU5	1309	5.76	1.045
INFO1	1310	5.47	1.068
INFO2	1309	5.17	1.059
INFO3	1307	4.95	1.149
ENJ1	1311	5.59	1.367
ENJ2	1311	5.14	1.440
ENJ3	1311	5.05	1.423
ENJ4	1311	5.34	1.497
PUR1	1310	5.08	1.272
PUR2	1309	4.99	1.260
PUR3	1309	5.25	1.238
PUR4	1309	5.14	1.213
REV1	1310	5.22	1.232
REV2	1308	5.03	1.245
FAM1	1308	4.40	1.453
FAM2	1310	3.80	1.694
FAM3	1311	4.28	1.568
FAM4	1311	3.89	1.645

Note: Variable cases due to missing data.

4.1.2 Missing Data

Accuracy of data input was examined. The first step was to check for missing values in raw data. If there had been a significant amount of data missing, the result may be distorted. The procedures to deal with missing data are varied (Schafer & Graham, 2002; Schafer & Olsen, 1998). Alternative ways to deal with missing data in this research are pairwise deletion and listwise deletion. Dealing with missing data involves including the respondents data for analysis with supplied scores, and deleting respondents for analysis where scores are not supplied. *Pairwise deletion* cases exclude missing data for the variables involved in a particular computation (Kline, 2010). The simplest way to deal with missing data is to delete those cases from the total analysis and SPSS programs can implement this process automatically. *Listwise deletion* excludes cases with missing data from all computations. *Mean imputation* replaces missing values by their mean. Even though, estimation errors are still induced.

Missing data was minimal for most variables. For personal data, as they are facts, the researcher contacted all of the participants with missing personal data via email given in the questionnaire, and it was possible to acquire all missing information. For opinion data, more superior methods than previously mentioned were applied to treat the missing data in this study. There were 87 cases with opinion missing data. The missing cases made up only 6.64 percent of the total of 1,311 cases. The study employed expected-maximization (EM) technique. Expectation maximization is an effective technique that is often applied in data analysis to handle missing data (Schafer & Graham, 2002; Schafer & Olsen, 1998). It can overcome some of the limitations of other techniques, such as mean imputation or regression substitution. These alternative techniques generate biased estimates, which, frequently, underestimate the standard errors. Expectation maximization overcomes such problem. The EM imputed data was used for any analyses that cannot perform on missing data, such as generating modification indices, etc. For main analyses and structural estimation, the study was pursued for missing data in the context of Full Information Maximum Likelihood (FIML) methods as implemented in AMOS. In general, FIML was considered one of

the best technique available to overcome missing data problems (Schafer & Graham, 2002; Schafer & Olsen, 1998). It uses all of the information available in the data set to estimate the data in a particular part of the data set.

4.1.3 Outliers

Outliers are responses from individuals which are extreme scores for variables, or for a set of variables (Hair Jr, Anderson, Tatham, & Black, 1995). Outliers tend to distort the overall results. There are two reasons to remove the outliers from the data set. First, the outliers are "different" and a statistician would describe them as belonging to a different population. Second, a single outlier can have a bigger influence on the statistical calculations than the remained of the group, because statistical tests square the differences between values when the calculations are being made (Tabachnick, Fidell, & Osterlind, 2001).

Outliers can be univariate or multivariate. Univariates have an extreme score on a single variable, in contrast, multivariates have an unusual pattern of responses across a range of different variables. Outliers can exist for dichotomous variables and also on ratio and interval scales. Tabachnick et al. (2001) suggested that if there is less than 10 percent of the sample in one of two categories, this variable should be removed.

In this study, there was no outlier caused by incorrect data entry, i.e. data that is unusually high or low. Thus, outliers were assessed together with the normality assessment in the upcoming section after the data was transformed for non-normal distributed data. In short, both the original dataset and the dataset with reduced outliers were assess in the main analyses. The results revealed no tendency of any significance different of estimates between the two versions of the dataset. Thus, in this study, the analyses include all of the original cases. The next section explains the detection and management of outliers.

4.1.4 Normality of Distributions

Structure equation modelling (SEM) technique assumes multivariate normality of all latent variables (Tabachnick et al., 2001). Skewness and kurtosis are two components of univariate normality that are commonly used for determining the shape of the distribution (Tabachnick et al., 2001). To decide whether distribution varies significantly from normality, statisticians divide the skew value by the standard error of skew to create a *Z* score. Skew is significant, if the value exceeds an absolute value of 2.58 for a sample less than 300 and 3.29 for samples greater than 300 (Tabachnick et al., 2001). The details of skew and kurtosis values of this research are presented in Table 4-4.

Table 4-4 presents variables with their skew value and critical ratio (c.r.) which denotes the same value of the Z score. Negative values for skewness of all composite variables indicated a negative skew. Z value for skew presented in the third column with the significant skew in bold and italics. In column 4 and 5 in Table 4-4 show positive values for kurtosis that indicated a peaked distribution (leptokurtic). Significant kurtosis values were presented in the last column in bold and italics.

Even though the skew and kurtosis values are not greater than 2 suggesting that there is no non-normal distribution problems. The critical ratios suggested that most variables distributed significantly different from normal distribution according to the significant statistics indicated in both skew (in column 3) and kurtosis (in column 5). Visual inspection revealed that the skewness might be the result of a celling effect where scores could distribute normal if the scales extend beyond the score of 7, indicating positive perception toward system constructs. All of the scores except STODES9 exhibit skewness issues, as well as several variables violate kurtosis criteria for normality assumption. Therefore, these variables need to be reviewed for an abnormality distribution problem.

Table 4-4. Skew and Kurtosis Value of Variables, with Significant Values in Bold and Italic Fonts.

Parameters	skew	c.r.	kurtosis	c.r.	Parameters	skew	c.r.	kurtosis	c.r.
WEBTEC1	-.581	***-8.590***	.486	***3.595***	STODES3	-.767	***-11.333***	.240	1.776
WEBTEC2	-.686	***-10.144***	.155	1.143	STODES4	-.714	***-10.555***	-.097	-.718
WEBTEC3	-.621	***-9.184***	.118	.869	STODES5	-1.488	***-21.998***	2.273	***16.797***
WEBTEC4	-.657	***-9.716***	.422	3.122	STODES6	-.903	***-13.353***	.368	2.721
WEBTEC5	-.606	***-8.958***	-.037	-.272	STODES7	-1.122	***-16.591***	.892	***6.595***
WEBTEC6	-.683	***-10.092***	.367	2.716	STODES8	-.994	***-14.687***	.487	***3.597***
WEBCON1	-1.003	***-14.827***	1.551	***11.464***	STODES9	.091	-1.347	-1.083	***-8.005***
WEBCON2	-.606	***-8.957***	.074	.547	STODES10	-1.081	***-15.973***	1.238	***9.150***
WEBCON3	-.488	***-7.207***	.006	.047	STOAMB1	-1.034	***-15.281***	.919	***6.795***
WEBCON4	-.614	***-9.079***	.410	3.030	STOAMB2	-.971	***-14.357***	.617	***4.557***
WEBCON5	-.639	***-9.452***	.569	***4.209***	STOAMB3	-.956	***-14.136***	.638	***4.716***
WEBCON6	-.630	***-9.312***	.611	***4.513***	STOAMB4	-1.151	***-17.021***	1.041	***7.692***
WEBSPC1	-.825	***-12.193***	.854	***6.309***	PU1	-.885	***-13.079***	.640	***4.734***
WEBSPC2	-.692	***-10.235***	.474	***3.505***	PU2	-.845	***-12.490***	.649	***4.798***
WEBSPC3	-.680	***-10.045***	.567	***4.187***	PU3	-.851	***-12.573***	1.112	***8.221***
WEBSPC4	-.556	***-8.225***	.412	3.044	PU4	-.916	***-13.535***	.875	***6.469***
WEBSPC5	-.611	***-9.026***	.265	1.960	PU5	-.805	***-11.892***	.994	***7.349***
WEBAPP1	-.689	***-10.182***	.294	2.170	INFO1	-.617	***-9.125***	.550	***4.065***
WEBAPP2	-.937	***-13.851***	.962	***7.110***	INFO2	-.448	***-6.617***	.281	2.074
WEBAPP3	-.872	***-12.882***	.794	***5.871***	INFO3	-.559	***-8.268***	.696	***5.143***
WEBAPP4	-.786	***-11.613***	.432	3.195	ENJ1	-1.212	***-17.916***	1.423	***10.518***
WEBAPP5	-.740	***-10.937***	.667	***4.931***	ENJ2	-.790	***-11.674***	.410	3.030
TELE1	-.538	***-7.951***	.042	.311	ENJ3	-.575	***-8.504***	.055	.406
TELE2	-.586	***-8.658***	.207	1.532	ENJ4	-.937	***-13.847***	.542	***4.002***
TELE3	-.515	***-7.615***	.007	.053	PUR1	-.633	***-9.360***	.563	***4.159***
TELE4	-.623	***-9.211***	.135	.995	PUR2	-.636	***-9.402***	.652	***4.817***
STOSOC1	-.599	***-8.848***	-.517	***-3.824***	PUR3	-.647	***-9.564***	.447	***3.306***
STOSOC2	-.516	***-7.623***	-.045	-.336	PUR4	-.612	***-9.049***	.672	***4.964***
STOSOC3	-.280	***-4.140***	.011	.084	REV1	-.771	***-11.402***	.921	***6.807***
STOSOC4	-.606	***-8.963***	-.095	-.703	REV2	-.584	***-8.638***	.534	***3.949***
STOIMG1	-1.067	***-15.778***	1.182	***8.739***	FAM1	-.660	***-9.750***	.312	2.306
STOIMG2	-1.206	***-17.827***	1.784	***13.188***	FAM2	-.285	***-4.208***	-.765	***-5.653***
STODES1	-.687	***-10.160***	.091	.676	FAM3	-.558	***-8.245***	-.221	***-1.634***
STODES2	-.662	***-9.784***	-.245	-1.814	FAM4	-.337	***-4.982***	-.627	***-4.636***

Note: Bold and italic indicates significance at Z = absolute 3.29 (samples size more than 300), *N* = 1,311

4.1.5 Score Transformation

Data transformation, reflected-square root-reflected, was employed to solve variables with significant skew problems. Transformation of scores refers to a process in which researchers perform some mathematical operations on scores to produce a new variable suitable for analysis (Tabachnick et al., 2001). The transformation would increase the accuracy of the estimation.

Transforming the scores with the appropriate transformation depends upon the shape of the distribution of raw scores. Following the procedures described by Tabachnick et al. (2001), first, new variables were created which were the reflections of the original variables. Second, the appropriate transformation was applied to the research variables. The square root was applied in this study. To reflect the variable, it was necessary to create a constant that was one larger than the larger score on the variable. In this research, the maximum score recorded by respondents was 7, so the constant value was 8. Subtracting each score from the constant created a new variable. Distribution of a new variable was checked at every stage of transformation until the ratio of skew was less than 3.29 (for samples greater than 300).

Reflecting and transforming the variables will correct for skewness, but this procedure results in a new variable for which the rank order of the respondents is now reversed, i.e. the person with the highest score on the raw scores has the lowest score on the transformed scores; thus, in the final stage, the transformed scores are reflected to maintain the rank order of the raw data with a minimum score equals to 1 (reflected-square root scores were reflected back by 3.646). The formula for the transformation used is shown in (1):

$$v_{Transformed} = c_2 - \sqrt{c_1 - v}, \quad (1)$$

where $v_{Transformed}$ is the transformed score of the variable; v is the observed score; c_1 is the first constant for reflection; and c_2 is the constant used to reflect the score back. The value for c_1 is 8 and c_2 is 3.646. The skew and kurotsis values of the transformed variables are presented in Table 4-5.

Table 4-5. New Variables and Skew Values after Transforming Variables by Reflected-square root-reflected Method

Parameters	skew	c.r.	kurtosis	c.r.
WEBTEC1	-.009	-.129	.024	.177
WEBTEC2	-.163	-2.413	-.286	-2.115
WEBTEC3	-.085	-1.259	-.240	-1.774
WEBTEC4	-.096	-1.417	-.124	-.919
WEBTEC5	-.070	-1.028	-.468	***-3.460***
WEBTEC6	-.112	-1.658	-.259	-1.913
WEBCON1	-.336	***-4.960***	-.030	-.225
WEBCON2	-.054	-.796	-.257	-1.900
WEBCON3	.049	.728	-.261	-1.925
WEBCON4	-.029	-.424	-.236	-1.747
WEBCON5	-.039	-.579	-.163	-1.205
WEBCON6	-.036	-.529	-.224	-1.654
WEBSPC1	-.254	***-3.756***	-.418	-3.088
WEBSPC2	-.110	-1.624	-.293	-2.165
WEBSPC3	-.080	-1.183	-.242	-1.791
WEBSPC4	.049	.731	-.188	-1.387
WEBSPC5	-.055	-.812	-.242	-1.790
WEBAPP1	-.139	-2.051	-.560	-4.136
WEBAPP2	-.373	***-5.513***	-.426	-3.148
WEBAPP3	-.287	***-4.236***	-.314	-2.318
WEBAPP4	-.241	***-3.560***	-.480	***-3.551***
WEBAPP5	-.155	-2.287	-.301	-2.223
TELE1	.030	.447	-.327	-2.415
TELE2	.014	.203	-.206	-1.524
TELE3	.076	1.120	-.263	-1.943
TELE4	-.043	-.634	-.202	-1.491
STOSOC1	-.443	***-6.552***	-.261	-1.929
STOSOC2	-.431	***-6.378***	-.464	-3.432
STOSOC3	-.424	***-6.266***	-.530	***-3.915***
STOSOC4	-.617	***-9.113***	-.376	-2.778
STOIMG1	-.152	-2.244	-.568	***-4.198***
STOIMG2	-.488	***-7.219***	-.260	-1.923
STODES1	-.186	-2.757	-.794	***-5.870***
STODES2	-.225	***-3.324***	-.583	***-4.305***
STODES3	-.218	-3.218	-.751	***-5.554***
STODES4	-.946	***-13.984***	.162	1.196
STODES5	-.401	***-5.927***	-.638	***-4.717***

Parameters	skew	c.r.	kurtosis	c.r.
STODES6	-.593	***-8.761***	-.390	-2.884
STODES7	-.483	***-7.147***	-.543	***-4.014***
STODES8	.471	***6.961***	-.724	***-5.348***
STODES9	.287	***4.245***	-.963	***-7.118***
STODES10	-.576	***-8.521***	-.085	-.626
STOAMB1	-.162	-2.390	-.843	***-6.230***
STOAMB2	.017	.257	-.511	***-3.774***
STOAMB3	.284	***4.194***	-.199	-1.471
STOAMB4	-.170	-2.513	-.945	***-6.985***
PU1	-.319	***-4.718***	-.432	-3.192
PU2	-.267	***-3.948***	-.432	-3.191
PU3	-.216	-3.194	-.234	-1.729
PU4	-.328	***-4.849***	-.342	-2.526
PU5	-.235	***-3.481***	-.454	***-3.352***
INFO1	-.048	-.712	-.327	-2.417
INFO2	.107	1.589	-.122	-.899
INFO3	.057	.848	.081	.597
ENJ1	-.604	***-8.931***	-.137	-1.016
ENJ2	-.212	-3.132	-.473	***-3.496***
ENJ3	-.030	-.443	-.610	***-4.507***
ENJ4	-.381	***-5.636***	-.550	***-4.068***
PUR1	-.010	-.144	-.209	-1.547
PUR2	.000	.006	-.079	-.581
PUR3	-.058	-.865	-.366	-2.704
PUR4	.023	.345	-.147	-1.087
REV1	-.113	-1.672	-.098	-.722
REV2	.028	.415	-.183	-1.349
FAM1	-.045	-.669	.062	.460
FAM2	.188	2.786	-.380	-2.805
FAM3	-.019	-.283	-.252	-1.862
FAM4	.153	2.268	-.323	-2.389
Multivariate			931.493	172.835

Note: Critical value of Z = 3.29 (samples size more than 300).

The number of significant non-normal distributed data dramatically reduces as shown in Table 4-5. Moreover, the skew and kurtosis values are closer to zero, as well as their values less than generally suggested range of normality, between -2 and 2. The transformation should increase the accuracy of the estimation.

The multivariate statistic shown at the end of Table 4-6 are the calculated values of multivariate kurtosis. It is suggested that the kurtosis which equals to 931.493 here should be less than 3. A number of outliers might be the cause of the violation of multivariate normal distribution. Mahalanobis distance is used to determine outliers.

Table 4-6. Observations Farthest from the Centroid (Mahalanobis Distance)

Observation number	Mahalanobis d-squared	p1	p2
1245	224.140	.000	.000
992	219.735	.000	.000
598	216.288	.000	.000
1294	205.046	.000	.000
283	202.992	.000	.000
185	198.206	.000	.000
873	191.230	.000	.000
983	191.226	.000	.000
309	190.831	.000	.000
1096	189.706	.000	.000

Any outliers with p1 and p2 with values of less than 0.001 or 0.05, depending on sample size or circumstance of each study, can be removed so that the data distribution will shift closer to normal distribution. In this study, there are more than 300 cases or more than 20 percent with p1 and p2 less than 0.001. The samples might not be a good candidate for outlier removal. By removing several outliers, the multivariate kurtosis statistic did reduce. However, outliers are not always outliers. They are meant to be in the dataset contributing to the theory formation. In this case, researcher tried to estimate the model using both dataset, one with outliers and another one with outliers removed, the results reveal that none of the causal relationship, which is the crucial part of hypothesis testing, had been changed. Thus, all of the data will be used for further analysis.

The data is appropriate for the next step of analyses, thus we go forward to the first stage of SEM analysis, the measurement model assessment.

4.2 Measurement Model Assessment

Measurement model assessment is the first of the two-stage approach recommended for an SEM analysis. It assesses the conformity of data and the measures. This step allows researchers to modify measurement models, as well as purify measures, so that estimation of the structural regression model is reliable and valid. The key analysis of measurement model assessment is confirmatory factor analysis (CFA). The CFA verifies that each measured variable represents, or is loaded into, an expected latent variable. The measurement model assessment also examines the reliability and validity of the measures by means of variable properties, e.g. correlations, variances, etc. The details of SEM analysis are explained in the main analyses section.

In this study, the overall measurement model is initially broken down for a series of CFA for granular investigations and modifications. The first set of the assessment is the set of separated CFA of exogenous variables: web quality, telepresence, and store environment. The second set is the CFA of the mediators: perceived usefulness, informativeness, and enjoyment; and the third set is the CFA of the shopping behavior consequences: purchase intention and revisit intention. Then, the overall model is assembled and analyzed for holistic properties. The global model is tested for its reliability and validity.

The CFA determined factor loadings of each variable in to a latent variable. A general suggestion number for a good standardized loading is 0.7 or higher. Factor loading higher than 0.6 is applicable, where sometimes 0.5 is acceptable (Miller, 1995). Variables with factor loading less than those numbers are suggested to be dropped to increase the construct validity, especially, the convergent validity. In this study, any variables with a factor loading less than or close to 0.6 were investigated. The researcher relied mainly on the face validity and descriptive statistics to judge whether variables with low loading scores should be kept or not.

It is also recommended to re-specify measurement models by fitting them with the data to gain more accurate estimation (Byrne, 2010). Besides dropping variables,

researchers could parceling or combining variables, or correlating errors to gain fitness of the model. Byrne (2010) suggested that modification indices (M.I.) could be employed to solve the factor loading and error terms. AMOS provides modification indices to suggest such modifications. Moreover, high correlation residuals suggests high correlation among variables. This correlations may hinder discriminant validity. Any variables with correlation residuals more than 2.0 were investigated. In this study, correlation residuals was investigated in the global measurement mode where all variables evaluated for their correlations. The goodness-of-fit is assessed for judging the soundness modification. The modification indices of this study is shown in Appendix C. The modification indices change each time after a modification was made. Only the first iteration is listed in the Appendix C.

Once, the model was specified, the researcher tested its plausibility based on sample data that comprised all observed variables in the model. The primary task in this model-testing procedure was to determine the goodness-of-fit between the hypothesized model and the sample data. Evaluating the goodness-of-fit criteria is summarized Table 4-7.

Overall fit model applies the likelihood ratio *chi-square statistic* (χ^2) (Byrne, 2010; Hair Jr et al., 1995; Kline, 2010). A high value of chi - square relative to degree of freedom signifies that the observed and chi-square reference matrices differ considerably. On the other hand, a low χ^2 value which results in significance level greater than 0.05, indicates that the observed and chi-square reference matrices are not statistically different (for a small sample size, less than 200) (Kline, 2010).

Normed chi-square (χ^2 / *df*) was applied to reduce sensitivity of χ^2 and indicated the observed and estimate matrices differ considerably. An accepted value of this ratio is less than or equal to 3.0 (for a small sample size, less than 200) (Kline, 2010).

Root mean square residual (RMR) is the average difference between the sample variances and covariances that obtain a range of 0 to 1. Small values indicate good-fitting models. Values of .05 or less are accepted (Tabachnick et al., 2001).

Root mean square error of approximation (RMSEA) is an index based on non-centrality and will compensate for the chi-square statistic in large samples (Hair Jr et al., 1995). Values less than 0.05 indicate a close fit of the model in relation to the degrees of freedom. RMSEA value 0.08 or less, indicate a reasonable error of approximation and the value greater than 0.1 would not be employed as a model (Brown & Cudeck, 1993).

PCLOSE is a one-sided test of null hypothesis is that RMSEA equals or less than .05. Thus, if the *p* is greater than .05, that is not statistically significant, then it is concluded that the fit of the model is "close." If the *p* is equal or less than .05, it is concluded that the model's fit is worse than close fitting, that is the RMSEA is greater than 0.05. Since all of the modified measurement models are good to superior fit, the PCLOSE values are not reported for individual models. They are reported in the overall measurement model and structural model assessments.

Goodness - of - fit index (GFI) represents the overall degree of fit, but is not adjusted for the degrees of freedom (Byrne, 2010; Hair Jr et al., 1995). Goodness-of-fit index is based on the parsimony of the estimated model. Ranging in value from 0, it calculates a weighted proportion of variance in the sample covariance, accounted for by the estimate population covariance matrix (Tabachnick et al., 2001).

Adjusted goodness - of - fit index (AGFI) adjustment of the Goodness - of - fit index (GFI) and adjusted goodness - of - fit index (AGFI) ratio is between 0 (poor fit) and 1.0 (perfect fit), with higher values indicating greater model fit (Hair Jr et al., 1995). Values greater than 0.8 can be accepted for this research where 0.9 indicating a good fit.

Normed fit index (NFI) is a relative comparison of the proposed model to the null model and ranges from 0 (no fit at all) to 1.0 (perfect fit). There is no absolute value indicating an acceptable level of fit, however, a common recommended value is 0.90 or greater.

Comparative fit index (CFI) represents a comparison between the estimated model and a null or independent model. The value range from 0 to 1.0 and larger values indicate higher levels of goodness-of-fit. Comparative fit-index is more appropriate in a model development strategy or when the sample group is small.

Tucker Lewis fit index (TLI) or *Non-normed Fit Index* (NNFI) combines a measure of parsimony with a comparative index between the proposed and null models, with values ranging from 0 to 1.0 (Hair Jr et al., 1995). An accepted value indicating level of fit is greater than 0.9 (Baumgartner & Homburg, 1996; Lomax & Schumacker, 2012). However, value of all mentioned indices of less than 0.9 is acceptable for complex model, while greater than 0.95 indicates superior fit (Byrne, 2010).

Table 4-7. Summarized Goodness-of-fit Criteria

Goodness - of - fit	Indices	Abbreviation	Level of acceptable fit
1. Absolute fit and model parsimony	Chi-square	χ^2	$0.05 < p$
2. Absolute fit measures	Normed chi-square	χ^2/df	$\chi^2/df < 3.0$
	Root mean square residual	RMR	RMR < 0.05
	Root mean square error of approximation	RMSEA	RMSEA < 0.08
	PCLOSE	PCLOSE	$0.05 \leq$ PCLOSE
	Goodness-of-fit index	GFI	0.9 < GFI
	Adjusted goodness-of-fit index	AGFI	0.9 < AGFI
3. Incremental fit measures	Normed fit index	NFI	0.9 < NFI
	Comparative fit index	CFI	0.9 < CFI
	Tucker Lewis fit index	TLI	0.9 < TLI

Source: Arbuckle (2010); Byrne (2010); Hair Jr et al. (1995); Kline (2010); Lomax and Schumacker (2012) and Tabachnick et al. (2001).

4.2.1 Measurement Model Assessment of Exogenous Variables

4.2.1.1 Interface Factor: Web Quality CFA

Web quality is a construct composed of four dimensions: technical adequacy, content quality, specific content and appearance. The CFA of web quality employed a method of second order confirmatory factor analysis, where each dimension is applied a general CFA or a first order confirmatory factor analysis, then the total score representing each dimension or sub-construct was treated as a variable for higher order CFA. Figure 4-1 depicts a graphical representation of CFA from IBM AMOS. The results of the analysis is shown in the following diagram and in Table 4-8.

The standardized estimates of factor loadings are the regression weights of variable loading into the indicated constructs constraining variances of the constructs equal to 1. These loadings are major concern in CFA. Measurement errors indicate the different of the observed data from the calculated true values. R^2 indicates information explained by the variable for indicated measure. The standardized estimates for measurement errors are proportions of unexplained variance, which equals to $1-R^2$.

The goodness-of-fit parameters indicates that the model does not well-fit the data $\chi^2 = 1653.148$, $df = 205$, $p = .000$, RMSE = .073, RMR = .006, GFI = .891, GFI = .881, AGFI = .865, NFI = .881, CFI = .894, TLI = .881. The goodness-of-fit indices should be higher than 0.9, while all of them are less than 0.9. The CFA results and the modification of model are discussed as follows.

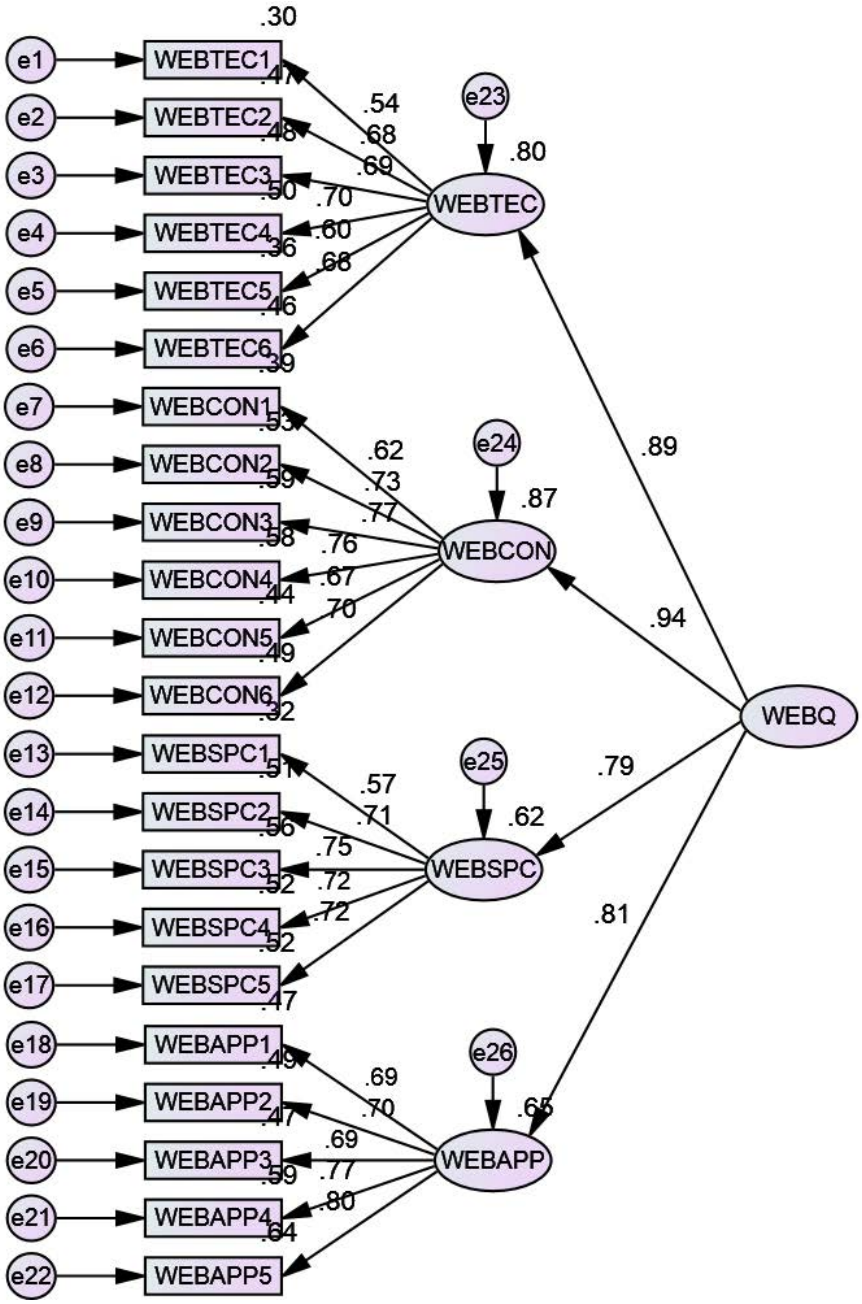

Figure 4-1. Measurement model for first and second order CFA of web quality.

Table 4-8. Maximum Likelihood Estimates of Factor Loadings and Residuals for a Measurement Model of Web Quality

	Factor loadings			Measurement errors		R^2
	Unst.	SE	St.	Unst.	SE	
WEBQ (2nd order)						
WEBTEC	1.000[a]	-	.893	.006	.001	.798
WEBCON	1.287	.083	.935	.006	.001	.875
WEBSPC	1.003	.072	.788	.016	.002	.621
WEBAPP	1.398	.091	.809	.026	.002	.654
WEBTEC						
WEBTEC1	1.000[a]	-	***.543***	.076	.003	.295
WEBTEC2	1.267	.059	.682	.070	.003	.466
WEBTEC3	1.250	.057	.691	.067	.003	.478
WEBTEC4	1.249	.057	.705	.060	.003	.497
WEBTEC5	1.052	.053	***.601***	.105	.005	.361
WEBTEC6	1.095	.053	.680	.071	.003	.462
WEBCON						
WEBCON1	1.000[a]	-	***.623***	.076	.003	.388
WEBCON2	1.267	.059	.729	.068	.003	.532
WEBCON3	1.250	.057	.766	.053	.003	.586
WEBCON4	1.249	.057	.758	.056	.003	.575
WEBCON5	1.052	.053	.666	.067	.003	.444
WEBCON6	1.095	.053	.697	.061	.003	.486
WEBSPC						
WEBSPC1	1.000[a]	-	***.567***	.087	.004	.322
WEBSPC2	1.286	.067	.711	.067	.003	.506
WEBSPC3	1.335	.070	.751	.057	.003	.564
WEBSPC4	1.314	.072	.724	.065	.003	.524
WEBSPC5	1.269	.070	.724	.060	.003	.525
WEBAPP						
WEBAPP1	1.000[a]	-	.686	.086	.004	.471
WEBAPP2	.949	.041	.701	.071	.003	.491
WEBAPP3	.923	.043	.688	.072	.003	.474
WEBAPP4	1.076	.046	.769	.061	.003	.591
WEBAPP5	1.048	.043	.803	.046	.002	.645
χ^2 = 1653.148, *df* = 205, *p* = .000, RMSE = .073, RMR = .006, GFI = .891, GFI = .881, AGFI = .865, NFI = .881, CFI = .894, TLI = .881						

Note. Unst., unstandardized; St., standardized.
[a]Not tested for statistical significance. For all other unstandardized estimates, $p < .05$.
Italic-bold values indicate variables that should be investigated.

4.2.1.1.1 Technical Adequacy CFA

Technical adequacy (WEBTEC) construct is measured by six observed variables (WEBTEC1-6). The standardized factor loadings range from 0.543 (WEBTEC1) to 0.705 (WEBTEC4). In this case, the loading scores of variables WEBTEC1 (loading score = 0.543) and WEBTEC5 (loading score = 0.601), are moderately less than 0.7 suggests that these two items need an investigation. The questions in the instrument are reviewed here:

WEBTEC1: Chula VR Book Store looks secured for carrying out transactions (e.g. uses SSL, digital certificates, etc.)

WEBTEC5: Web pages load fast in Chula VR Book Store

As noted in the VR store development section, SSL and digital certificates are not implemented. Moreover, even though the VR store was implemented using an innovative X3D framework which can be browsed by a web browser promptly, it took longer time to load all of the objects to be ready for participants to use. Nonetheless, referring to the descriptive statistics in Table 4-3, the means of these two variables are not much different from other variables (*Mean* = 4.90, *SD* = 1.15 and *Mean* = 4.91, *SD* = 1.42 for WEBTEC1 and WEBTEC5 respectively). In addition to the not-so-distinct means, by considering the face validity of the measures and contribution of the variables towards the estimation, it is sounded to keep these two variables since the perception of participants should reflect the real setting. In addition, the researcher correlates errors among WEBTEC1, WEBTEC2, WEBTEC5 and WEBTEC6 as shown in the modified model to improve the goodness-of-fit according to the suggestion by the modification indices. Together with other variables in the web quality construct, the modified measurement model results in a superior fit (greater than 0.95) for all goodness-of-fit indices as shown in Table 4-9 and is depicted in Figure 4-2.

4.2.1.1.2 Content Quality CFA

Content quality (WEBCON) construct is measured by six observed variables (WEBCON1-6). The standardized factor loadings range from 0.623 (WEBCON1) to 0.766 (WEBCON3). In this case, the loading score of variable WEBCON1 is moderately less than 0.7 suggests that this item needs an investigation. The question in the instrument is reviewed here:

WEBCON1: The content of Chula VR Book Store is useful

Although, referring to the descriptive statistics in Table 4-3, the means of this variable is distinctively higher than others in the same constructs (*Mean* = 5.61, *SD* = 1.12). The information in this site, especially information and example contents of books, is crucial for book shoppers. The unusually low of the loading factor should be due to the unusually better perception comparing to other properties of the system. However, by considering its importance, face validity of the measures and contribution of the variables towards the estimation, altogether, it is sounded to keep the variable for the setting. In addition, the researcher correlates errors among WEBCON2 through WEBCON6 to improve the goodness-of-fit according to the suggestion by the modification indices. Together with other variables in the web quality construct, the modified measurement model results are shown in Table 4-9 and is depicted in Figure 4-2.

4.2.1.1.3 Specific Content CFA

Specific content (WEBSPC) construct is measured by five observed variables (WEBSPC1-5). The standardized factor loadings range from 0.567 (WEBSPC1) to 0.751 (WEBSPC3). In this case, the loading of variable WEBSPC1 is far less than 0.7 suggests that this item needs an investigation. The question in the instrument is reviewed here:

WEBSPC1: In Chula VR Book Store, one can find contact information (e.g. e-mail addresses, phone numbers, etc.)

Referring to the descriptive statistics Table 4-3, the means of this variable is distinctively higher than others in the same constructs (*Mean* = 5.65, *SD* = 1.11). This distinctively higher score means better perception of WEBSPC1 than other specific content properties, making its loading factor lower than other properties as well. However, by considering its importance, face validity of the measures and contribution of the variables towards the estimation, altogether, it is sounded to keep the variable for the setting. In addition, the researcher correlates errors between WEBSPC1 and WEBSPC2, and WEBSPC4 and WEBSPC5 to improve the goodness-of-fit according to the suggestion by the modification indices. Together with other variables in the web quality construct, the modified measurement model results are shown in Table 4-9 and is depicted in Figure 4-2.

4.2.1.1.4 Appearance CFA

Appearance (WEBAPP) construct is measured by five observed variables (WEBAPP1-5). The standardized factor loadings range from 0.686 (WEBAPP1) to 0.803 (WEBAPP5), indicating all variables are well-loaded into the construct. Thus, all of the variables are included for further analysis. In addition, the researcher correlates errors among all of variables in the construct to improve the goodness-of-fit according to the suggestion by the modification indices. Together with other variables in the web quality construct, the modified measurement model results are shown in Table 4-9 and is depicted in Figure 4-2.

4.2.1.1.5 Web Quality CFA

Web quality (WEBQ) is an exogenous construct measured by four latent variables, WEBTEC, WEBCON, WEBSPC and WEBAPP. A CFA was applied treating the indicated latent variables as factors of a construct. The standardized factor loadings range from 0.788 (WEBSPC) to 0.935 (WEBCON), indicating all sub-constructs are well-loaded into the construct. Thus, it is confirmed that the web quality construct can be well-represented by the indicated dimensions. The modified measurement model results are shown in Table 4-9 and is depicted in Figure 4-2.

The series of CFA and modification results in a model with superior fit with all goodness-of-fit indices, except the chi-square test, as shown in Table 4-9. The chi-square test is sensitive to sample size. Since the chi-square value tends to increase according to the sample size, it is common that complex model and large dataset, i.e. more than 400, almost always violate chi-square test criteria (Byrne, 2010; Kenny & McCoach, 2003; Kline, 2010).

Table 4-9. Summary of Evaluation of Measurement Model with Goodness-of-fit Measures between Original and the final Modified Model of Web Quality

Goodness-of-fit measure	Calculated measure before modification	Calculated measure after modification	Suggested criteria	Acceptability of the final model
chi-square (χ^2)	1653.148	713.316		
df	205	191		
χ^2/df	8.064	3.735	< 3	Not fit
p value	.000	.000	> 0.05	Not fit
RMSEA	.073	.046	≤ 0.05	Superior fit
RMR	.006	.004	≤ 0.05	Superior fit
GFI	.891	.952	> 0.90	Superior fit
AGFI	.865	.937	> 0.90	Good fit
NFI	.881	.949	≥ 0.90	Superior fit
CFI	.894	.962	≥ 0.90	Superior fit
TLI	.881	.954	≥ 0.90	Superior fit

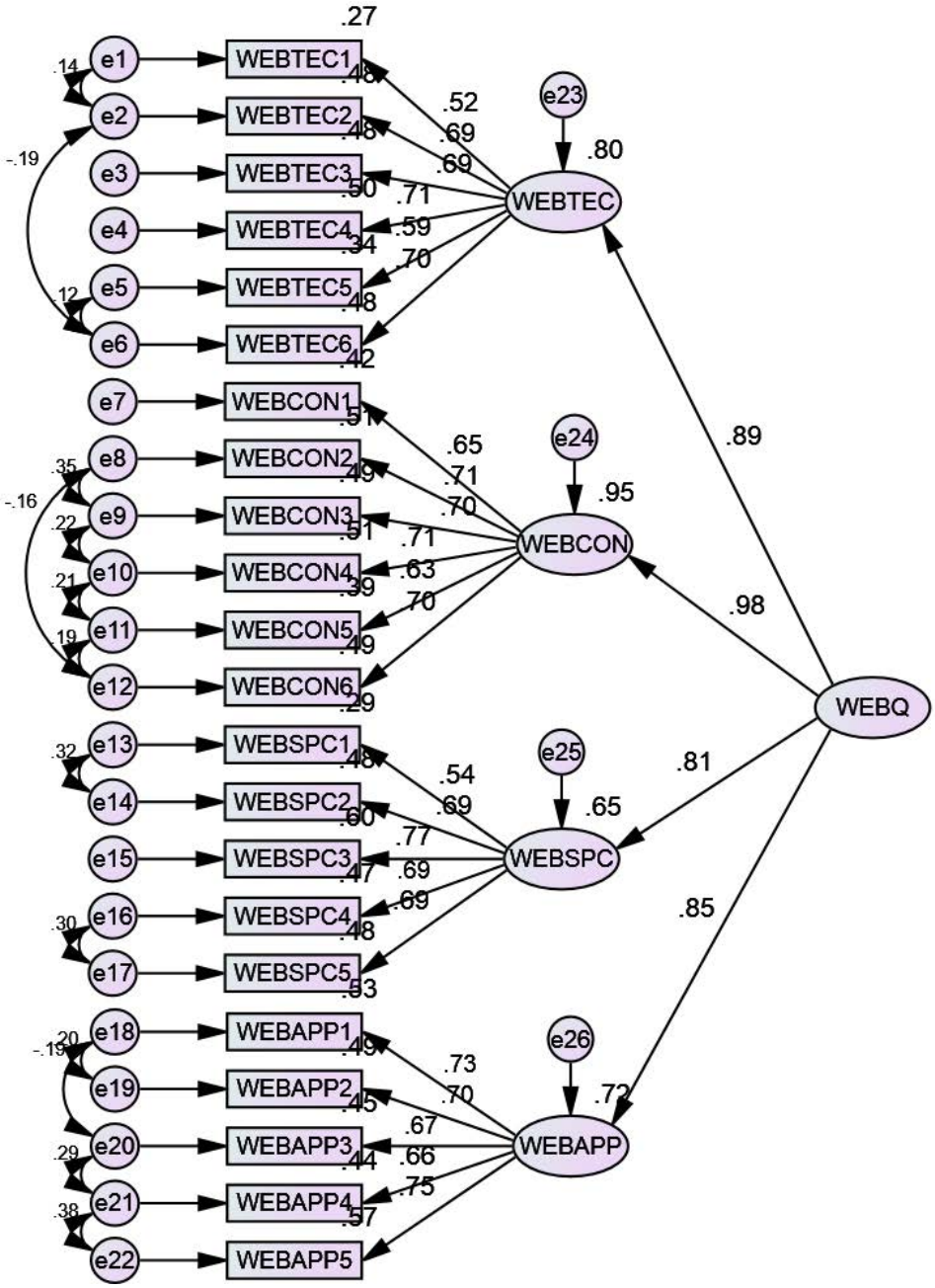

Figure 4-2. Modified measurement model of web quality.

4.2.1.2 Interface Factor: Telepresence CFA

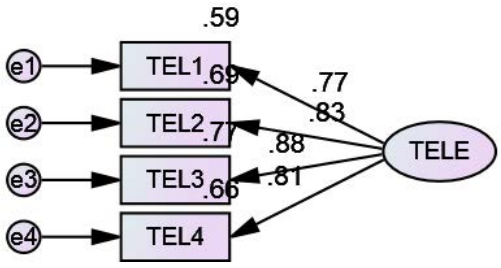

Figure 4-3. Measurement model for CFA of telepresence

Table 4-10. Maximum Likelihood Estimates of Factor Loadings and Residuals for a Measurement Model of Telepresence

	Factor loadings			Measurement errors		R^2
	Unst.	SE	St.	Unst.	SE	
TELE1	1.000[a]	-	.771	.065	.003	.595
TELE2	1.074	.033	.833	.048	.003	.694
TELE3	1.176	.039	.876	.04	.003	.767
TELE4	1.049	.037	.814	.054	.003	.662

Note. Unst., unstandardized; St., standardized.
[a]Not tested for statistical significance. For all other unstandardized estimates, $p < .05$.

Telepresence (TELE) construct is measured by four observed variables (TELE1-4) as shown in Figure 4-3. The standardized factor loadings range from 0.771 (TELE1) to 0.876 (TELE3), indicating all constructs are well-loaded into the construct. Thus, all of the variables are included for further analysis. In addition, the researcher correlates errors among variables in the construct to improve the goodness-of-fit according to the suggestion by the modification indices, obtaining a superior fit model as shown in the following table. The modified model is shown in Figure 4-4. Modified measurement model of telepresence

Table 4-11. Summary of Evaluation of Measurement Model with Goodness-of-fit Measures between Original and the Final Modified Model of Telepresence

Goodness-of-fit measure	Calculated measure before modification	Calculated measure after modification	Suggested criteria	Acceptability of the final model
chi-square (χ^2)	187.937	.051		
df	2	1		
χ^2/df	93.97	.051	< 3	Superior fit
p value	.000	.821	> 0.05	Superior fit
RMSEA	.266	.000	≤ 0.05	Superior fit
SRMR	.007	.000	≤ 0.05	Superior fit
GFI	.927	1.000	> 0.90	Superior fit
AGFI	.637	1.000	> 0.90	Superior fit
NFI	.942	1.000	≥ 0.90	Superior fit
CFI	.942	1.000	≥ 0.90	Superior fit
TLI	.827	1.000	≥ 0.90	Superior fit

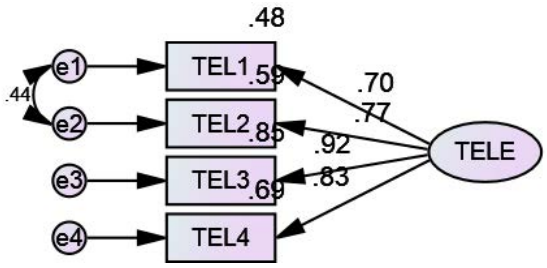

Figure 4-4. Modified measurement model of telepresence

4.2.1.3 Store Environment CFA

Store environment is a construct composed of four dimensions: social factors, store image, store design and store ambience. Like web quality, the CFA of store environment employed a method of second order confirmatory factor analysis. Results of the analysis is shown in Figure 4-5 and in Table 4-12.

The goodness-of-fit parameters indicates the model does not well-fit the data χ^2 = 2422.818, *df* = 166, *p* = .000, RMSEA = .104, RMR = .012, GFI = .814, AGFI = .765, NFI = .846, CFI = .855 and TLI = .834. The goodness-of-fit indices should be higher

than .9, while all of them are less than .9. The CFA results and the modification of model are discussed as follows.

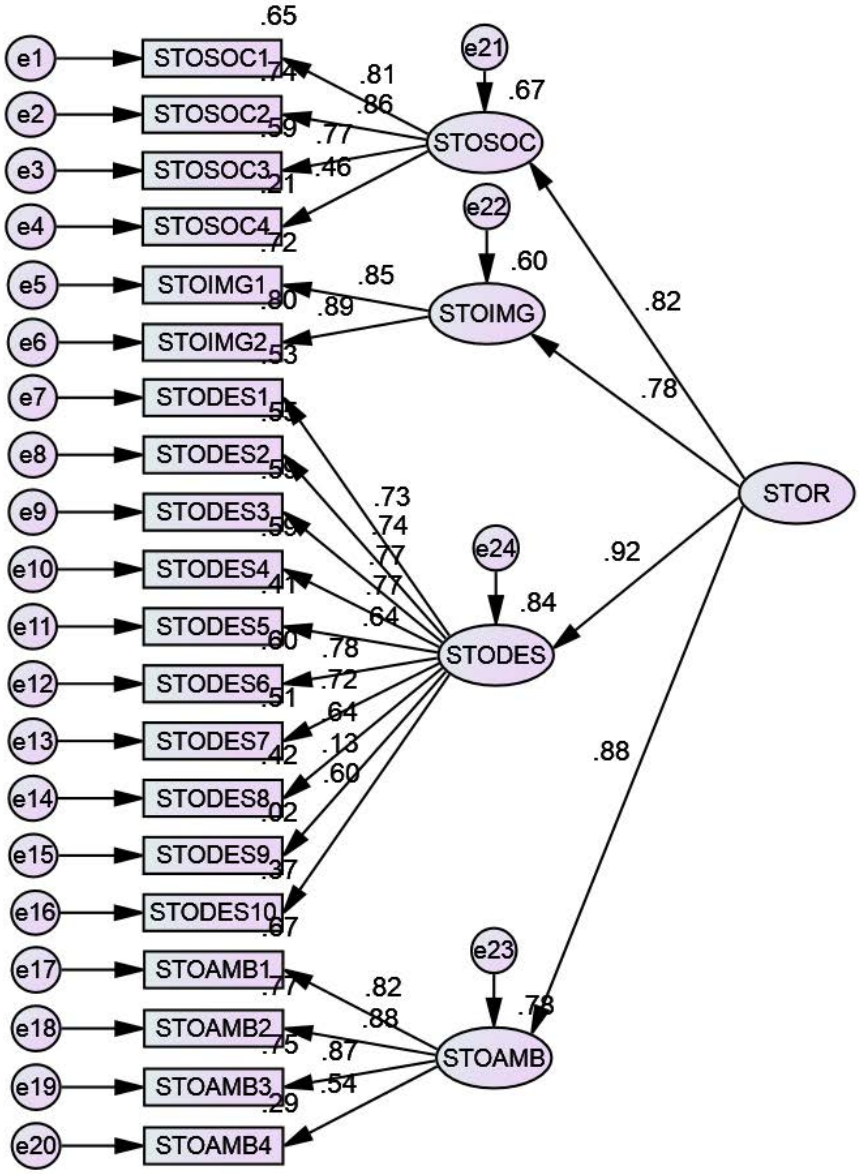

Figure 4-5. Measurement model for CFA of store environment

Table 4-12. Summary of Evaluation of Measurement Model with Goodness-of-fit Measures between Original and the Final Modified Model of Store Environment

	Factor loadings			Measurement errors		R^2
	Unst.	SE	St.	Unst.	SE	
STOR						
STOSOC	1.000[a]	-	.815	.046	.004	.665
STOIMG	.825	.038	.777	.041	.003	.603
STODES	.931	.043	.917	.025	.002	.841
STOAMB	.984	.042	.884	.015	.002	.782
STOSOC						
STOSOC1	1.000[a]	-	.807	.074	.004	.651
STOSOC2	.931	.027	.859	.042	.003	.738
STOSOC3	.778	.026	.768	.058	.003	.590
STOSOC4	.508	.032	***.459***	.132	.005	.211
STOIMG						
STOIMG1	1.000[a]	-	.847	.041	.003	.717
STOIMG2	1.069	.033	.893	.03	.003	.797
STODES						
STODES1	1.000[a]	-	.726	.084	.004	.527
STODES2	1.096	.041	.741	.093	.004	.549
STODES3	1.076	.039	.770	.075	.003	.593
STODES4	1.143	.042	.769	.085	.004	.592
STODES5	.818	.037	.641	.090	.004	.411
STODES6	1.092	.040	.775	.074	.003	.601
STODES7	1.012	.041	.716	.091	.004	.513
STODES8	.924	.042	.645	.113	.005	.416
STODES9	.216	.046	***.134***	.238	.009	.018
STODES10	.770	.037	.605	.097	.004	.366
STOAMB						
STOAMB1	1.000[a]	-	.816	.057	.003	.666
STOAMB2	1.108	.03	.878	.041	.002	.771
STOAMB3	1.082	.03	.867	.043	.002	.752
STOAMB4	.689	.034	***.541***	.129	.005	.293

Note. Unst., unstandardized; St., standardized.
[a]Not tested for statistical significance. For all other unstandardized estimates, $p < .05$.
Italic-bold values indicate variables that should be investigated.

4.2.1.3.1 Social Factors CFA

Social factors (STOSOC) construct is measured by four observed variables (STOSOC1-4). The standardized factor loadings range from 0.459 (STOSOC4) to 0.859 (STOSOC2). In this case, the loading score of variable STOSOC4 is far less than 0.7 suggests that this item needs an investigation. The question in the instrument is reviewed here:

STOSOC4: Discourteous salespeople-Courteous salespeople (semantic differential)

Referring to the descriptive statistics in Table 4-3, the means of this variable is distinctively higher than others in the same constructs (*Mean* = 5.49, *SD* = 1.30). It indicates that the implementation was successfully for salespeople to express their courtesy, even though they are avatars in the VR store, through signs shown. The unusually low of the loading factor should be due to the unusually better perception comparing to other properties of the system. The divergent of factor loading is misleading here. Courtesy of sales person is extremely important in this factor. Thus, by considering its importance, face validity of the measures and contribution of the variables towards the estimation, altogether, it is sounded to keep the variable for the setting. Moreover, when the researcher tried to estimate the model by dropping the variable in the later estimation, the estimates are almost alike. In addition, the researcher correlates errors among WEBSOC1 and WEBSOC4 to improve the goodness-of-fit according to the suggestion by the modification indices. Together with other variables in the store environment construct, the modified measurement model results are shown in Table 4-13 and are depicted in Figure 4-6.

4.2.1.3.2 Store Image CFA

Store Image (STOIMG) construct is measured using two observed variables (STOIMG1-2). The standardized factor loadings are 0.847 and 0.893 for STOIMG1 and STOIMG2 respectively, indicating all variables are very well-loaded into the construct. Thus, both variables are included for further analysis. None of the modification was applied to this construct.

4.2.1.3.3 Store Design CFA

Store design (STODES) construct is measured using ten observed variables (STODES1-10). The standardized factor loadings range from .134 (STODES9) to 0.775 (STODES6). In this case, the loading of variable STODES9 is unusually less than 0.7 suggests that this item needs an investigation. The question in the instrument is reviewed here:

STODES9: Impressed interior-Unimpressed interior (semantic differential)

Referring to the descriptive statistics in Table 4-3, the means of this variable is distinctively lower and the standard deviation is higher than others in the same constructs (*Mean* = 3.80, *SD* = 1.81). For other variables, positive word was placed on the right. It is noted here that the researcher had been aware of the issue since the pilot study due to the fact that the semantic differential of this item is an inversion from other variables in the same construct. The researcher pursued with this arrangement so that it was used to inform the participants that several items might be reversed and they should pay attention to the question. However, several participants told that they thought it was a typo. Thus, the variable is dropped from analysis. Nonetheless, it is noted that the property of the STODES9 which quite related to STODES4 (unattractive-attractive) should be aware when implementing a VR store and included in the conclusion of the study. In addition, the researcher correlates errors among variables to improve the goodness-of-fit according to the suggestion by the modification indices. Together with other variables in the store environment construct, the modified measurement model results are shown in Table 4-13 and are depicted in Figure 4-6.

4.2.1.3.4 Store Ambience CFA

Store Ambience (STOAMB) construct is measured by four observed variables (STOAMB1-4). The standardized factor loadings range from 0.541 (STOAMB4) to 0.878 (STOAMB2). In this case, the loading score of variable STOAMB4 is moderately less than 0.7 suggests that this item needs an investigation. The question in the instrument is reviewed here:

STOAMB4: Unpleasant background music-Pleasant background music (semantic differential)

Referring to the descriptive statistics in Table 4-3, the means of this variable is distinctively higher than others in the same constructs (*Mean* = 5.67, *SD* = 1.38). It indicates that the implementation successfully stimulated perception of a decent ambience by background music. Music is a crucial element of a store ambience. By considering its importance, face validity of the measures and contribution of the variables towards the estimation, altogether, it is sounded to keep the variable for the setting. In addition, the researcher correlates errors among variables to improve the goodness-of-fit according to the suggestion by the modification indices. Together with other variables in the store environment construct, the modified measurement model results are shown in Table 4-13 and are depicted in Figure 4-6.

4.2.1.3.5 Store Environment CFA

Store environment (STOR) is an exogenous construct measured by four latent variables, STOSOC, STOIMG, STODES and STOAMB. A CFA was applied by treating the indicated latent variables as factors of a construct, which called second-order CFA. The standardized factor loadings range from 0.777 (STOIMG) to 0.917 (STODES), indicating all sub-constructs are well-loaded into the construct. Thus, it is confirmed that the store environment construct can be well-represented by the indicated dimensions. The modified measurement model results are shown in Table 4-13 and are depicted in Figure 4-6.

The series of CFA and modification results in a model with good fit with almost all goodness-of-fit indices, except the chi-square test, as shown in Table 4-13. The chi-square test is sensitive to sample size. It is common that complex model and large dataset violate chi-square test criteria as stated.

Table 4-13. Summary of Evaluation of Measurement Model with Goodness-of-fit Measures between Original and the Final Modified Model of Store Environment

Goodness-of-fit measure	Calculated measure before modification	Calculated measure after modification	Suggested criteria	Acceptability of the final model
chi-square (χ^2)	2522.818	911.990		
df	166	128		
χ^2/df	15.200	7.12	< 3	Not fit
p value	.000	.000	> 0.05	Not fit
RMSEA	.104	.068	≤ 0.05	Good fit
RMR	.012	.009	≤ 0.05	Superior fit
GFI	.814	.931	> 0.90	Good fit
AGFI	.765	.898	> 0.90	Good fit
NFI	.846	.944	≥ 0.90	Good fit
CFI	.855	.951	≥ 0.90	Superior fit
TLI	.834	.935	≥ 0.90	Good fit

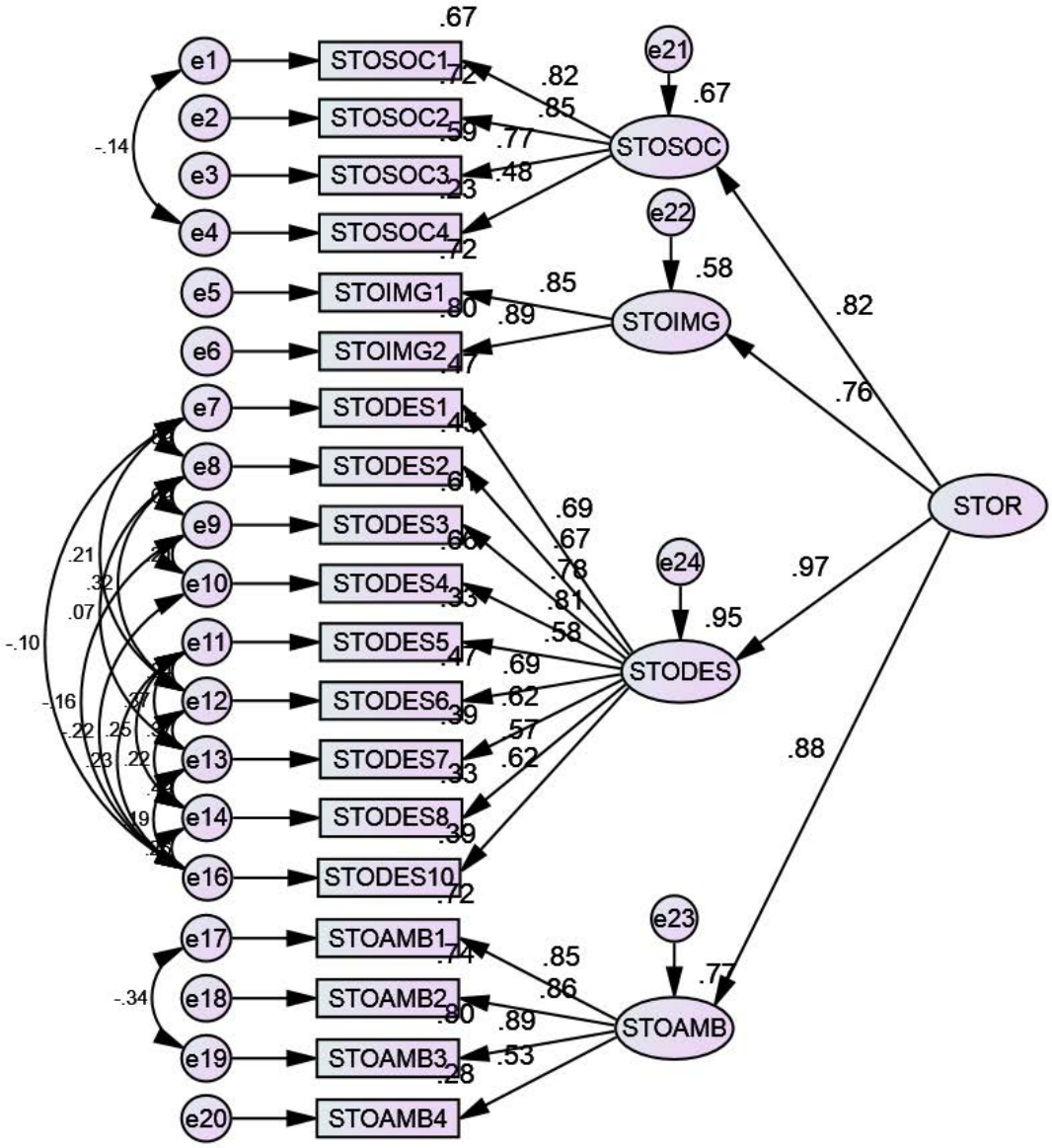

Figure 4-6. Modified measurement model of store environment.

4.2.1.4 Place Familiarity

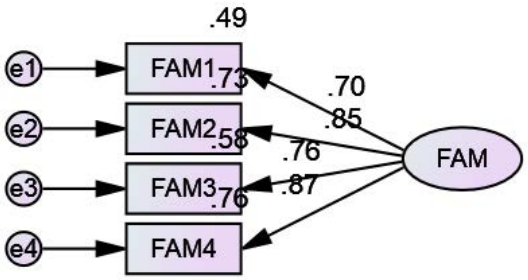

Figure 4-7. Measurement model for CFA of place familiarity.

Table 4-14. Maximum Likelihood Estimates of Factor Loadings and Residuals for a Measurement Model of Place Familiarity

	Factor loadings			Measurement errors		R^2
	Unst.	SE	St.	Unst.	SE	
FAM1	1.000[a]	-	.701	.075	.003	.491
FAM2	1.350	.048	.853	.050	.003	.728
FAM3	1.157	.047	.760	.071	.003	.578
FAM4	1.346	.050	.870	.042	.003	.757

Note. Unst., unstandardized; St., standardized.
[a]Not tested for statistical significance. For all other unstandardized estimates, $p < .05$.

Place familiarity are measured to answer supplemental research question indicating whether the store design should match an existing store. Place familiarity (FAM) construct is measured by four observed variables (FAM1-4) as shown in Figure 4-7. The standardized factor loadings range from 0.701 (FAM1) to 0.870 (FAM4), indicating all variables are well-loaded into the construct. Thus, all of the variables are included for further analysis. In addition, the researcher correlates errors among variables in the construct to improve the goodness-of-fit according to the suggestion by the modification indices, obtaining a superior fit model as shown in the following table. The modified model is shown in Figure 4-8.

Table 4-15. Summary of Evaluation of Measurement Model with Goodness-of-fit Measures between Original and the Final Modified Model of Store Environment

Goodness-of-fit measure	Calculated measure before modification	Calculated measure after modification	Suggested criteria	Acceptability of the final model
chi-square (χ^2)	89.134	23.032		
df	2	1		
χ^2/df	44.567	23.032	< 3	Not fit
p value	.000	.000	> 0.05	Not fit
RMSEA	.182	.130	≤ 0.05	Superior fit
RMR	.005	.003	≤ 0.05	Superior fit
GFI	.968	.991	> 0.90	Superior fit
AGFI	.841	.914	> 0.90	Good fit
NFI	.968	.992	≥ 0.90	Superior fit
CFI	.968	.992	≥ 0.90	Superior fit
TLI	.905	.952	≥ 0.90	Superior fit

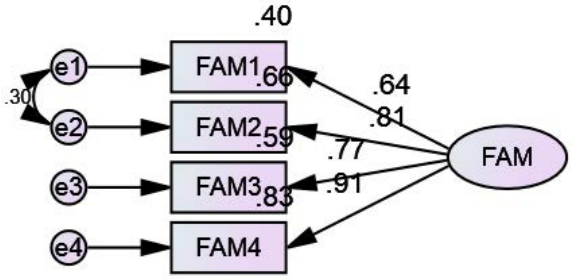

Figure 4-8. Modified measurement of place familiarity

4.2.2 Measurement Model Assessment of Mediators: Perceived of Usefulness, Informativeness, and Enjoyment CFA

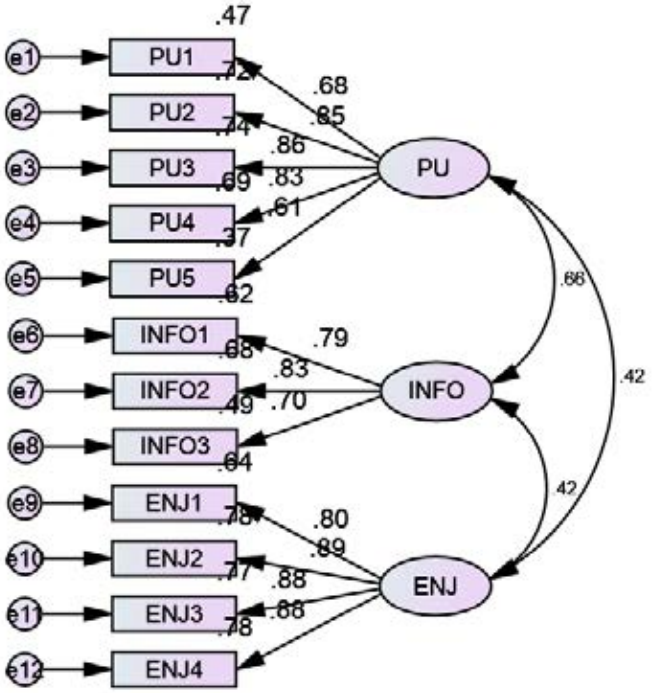

Figure 4-9. Measurement model for CFA of usefulness, informativeness and enjoyment.

Table 4-16. Maximum Likelihood Estimates of Factor Loadings and Residuals for a Measurement Model of Perceived usefulness, Informativeness and Enjoyment

	Factor loadings			Measurement errors		R^2
Variables	Unst.	SE	St.	Unst.	SE	
Perceived of Usefulness						
PU1	1.000[a]	-	.683	.084	.004	.467
PU2	1.233	.045	.850	.043	.002	.722
PU3	1.157	.042	.861	.034	.002	.742
PU4	1.163	.043	.831	.045	.002	.690
PU5	.777	.038	***.610***	.075	.003	.372
Informativeness						
INFO1	1.000[a]	-	.787	.044	.003	.62
INFO2	.997	.037	.827	.033	.002	.684
INFO3	.874	.038	.698	.057	.003	.487
Enjoyment						
ENJ1	1.000[a]	-	.797	.063	.003	.636
ENJ2	1.13	.031	.886	.039	.002	.784
ENJ3	1.114	.031	.878	.041	.002	.771
ENJ4	1.19	.032	.884	.044	.002	.781

Note. Unst., unstandardized; St., standardized.
[a]Not tested for statistical significance. For all other unstandardized estimates, $p < .001$.
Italic-bold values indicate values that should be investigated.

The measurement model of mediators is shown in Figure 4-9. By applying analyses similar to those applied on exogenous, all variables are well-loaded into their respected constructs except PU5. The item assess overall usefulness of the system. Dropping of the PU5 is crucial here since it contributes to several issues.

Not only did PU5 diverged from other variables, a forerunner analysis of the overall measurement model assessment also revealed that PU5 contributed to a discriminant validity issue with web quality construct. By dropping PU5, which is highly correlated with WEBQ, makes the two constructs well-discriminated. It is possible that WEBQ is highly correlated with PU5, since WEBQ mainly measures utilitarian aspects of user interface, which PU5 also measures but as a summative cognitive belief. This rationale makes it possible to either include or exclude of PU5. In this study, effects of properties of system interface toward behavioral intentions are analyzed by explaining psychological mediators, thus, the constructs should represent separate concepts for concrete explanation of stimulus and rationale behind consumer psychological rationale. Moreover, PU5 can be represented in PU1-4. Thus, the researcher concluded that PU5 should be dropped from further analyses.

The modified model is shown in Figure 4-10 and its goodness-of-fit indices are reported as follows.

Table 4-17. Summary of Evaluation of Measurement Model with Goodness-of-fit Measures between Original and the Final Modified Model of Perceived usefulness, Informativeness and Enjoyment

Goodness-of-fit measure	Calculated measure before modification	Calculated measure after modification	Suggested criteria	Acceptability of the final model
chi-square (χ^2)	597.437	155.626		
df	51	39		
χ^2/df	11.714	3.990	< 3	Not fit
p value	.000	.000	> 0.05	Not fit
RMSEA	.090	.048	≤ 0.05	Superior fit
SRMR	.059	.034	≤ 0.05	Superior fit
GFI	.931	.979	> 0.90	Superior fit
AGFI	.895	.964	> 0.90	Superior fit
NFI	.940	.983	≥ 0.90	Superior fit
CFI	.945	.987	≥ 0.90	Superior fit
TLI	.929	.982	≥ 0.90	Superior fit

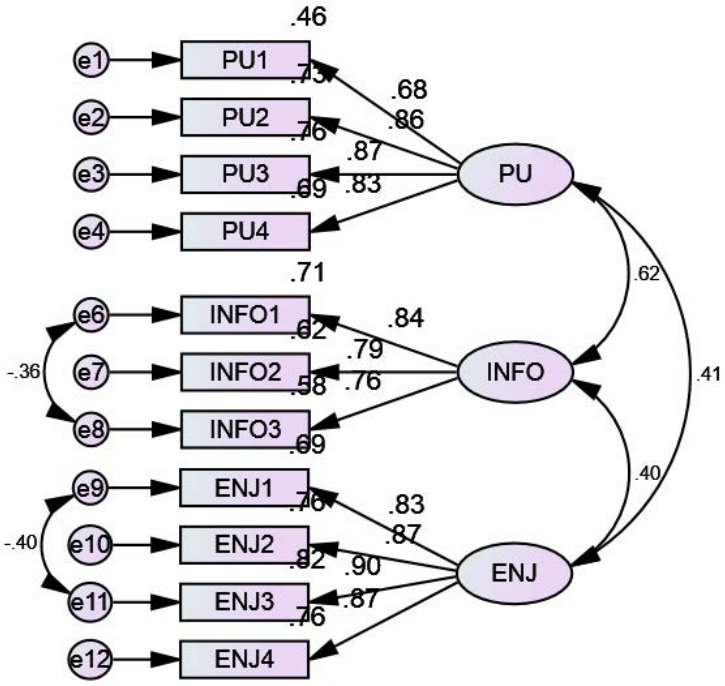

Figure 4-10. Modified measurement model of perceived usefulness, informativeness and enjoyment.

4.2.3 Measurement Model Assessment of Behavioral Intentions

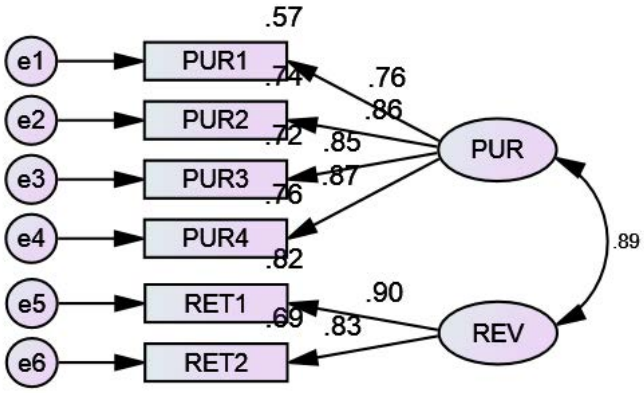

Figure 4-11. Measurement model for CFA of purchase and revisit intention in an online VR store.

Table 4-18. Maximum Likelihood Estimates of Factor Loadings and Residuals for a Measurement Model of Purchase and Revisit Intention in an Online VR Store

	Factor loadings			Measurement errors		R^2
Variables	Unst.	SE	St.	Unst.	SE	
Purchase Intention						
PUR1	1.000[a]	-	.757	.061	.003	.573
PUR2	1.107	.034	.860	.035	.002	.739
PUR3	1.122	.035	.849	.039	.002	.721
PUR4	1.111	.034	.870	.032	.002	.757
Revisit Intention						
REV1	1.000[a]	-	.904	.025	.002	.818
REV2	.91	.024	.828	.042	.002	.686

Note. Unst., unstandardized; St., standardized.
[a]Not tested for statistical significance. For all other unstandardized estimates, $p < .001$.

The measurement model of dependent variables is shown in Figure 4-11. By applying analyses similar to those applied on exogenous and mediators, all variables are well-loaded into their respected constructs. The modified model is shown in Figure 4-12 and its goodness-of-fit indices are reported as follows.

Table 4-19. Summary of evaluation of measurement model with goodness-of-fit measures between original and the final modified model of purchase and revisit intention

Goodness-of-fit measure	Calculated measure before modification	Calculated measure after modification	Suggested criteria	Acceptability of the final model
chi-square (χ^2)	118.640	21.647		
df	8	5		
χ^2/df	14.830	4.329	< 3	Not fit
p value	.000	.001	> 0.05	Not fit
RMSEA	.103	.050	≤ 0.05	Superior fit
SRMR	.023	.011	≤ 0.05	Superior fit
GFI	.969	.994	> 0.90	Superior fit
AGFI	.920	.977	> 0.90	Superior fit
NFI	.979	.996	≥ 0.90	Superior fit
CFI	.981	.997	≥ 0.90	Superior fit
TLI	.964	.991	≥ 0.90	Superior fit

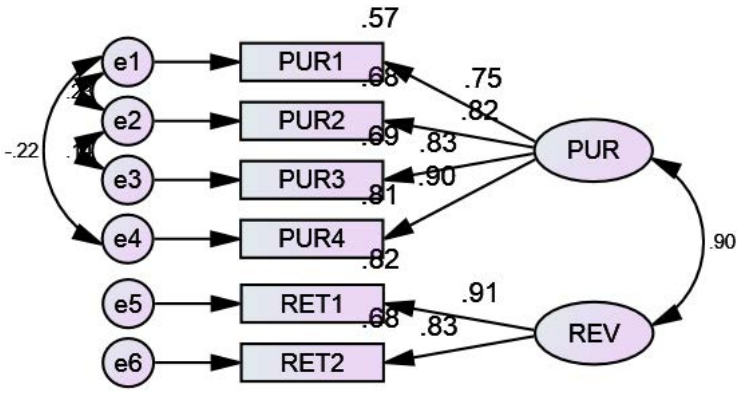

Figure 4-12. Modified measurement model of purchase and revisit intention in an online VR store.

4.2.4 Overall Measurement Model Assessment

Figure 4-13 shows a global measurement model. Correlations among latent variables were assessed by inspecting their correlation residuals. It suggested that PUR3 and PUR4 associated with purchase intention (PUR) highly correlate to variables in revisit intention (REV). The variables need to be dropped to achieve discriminant validity between purchase intention and revisit intention construct.

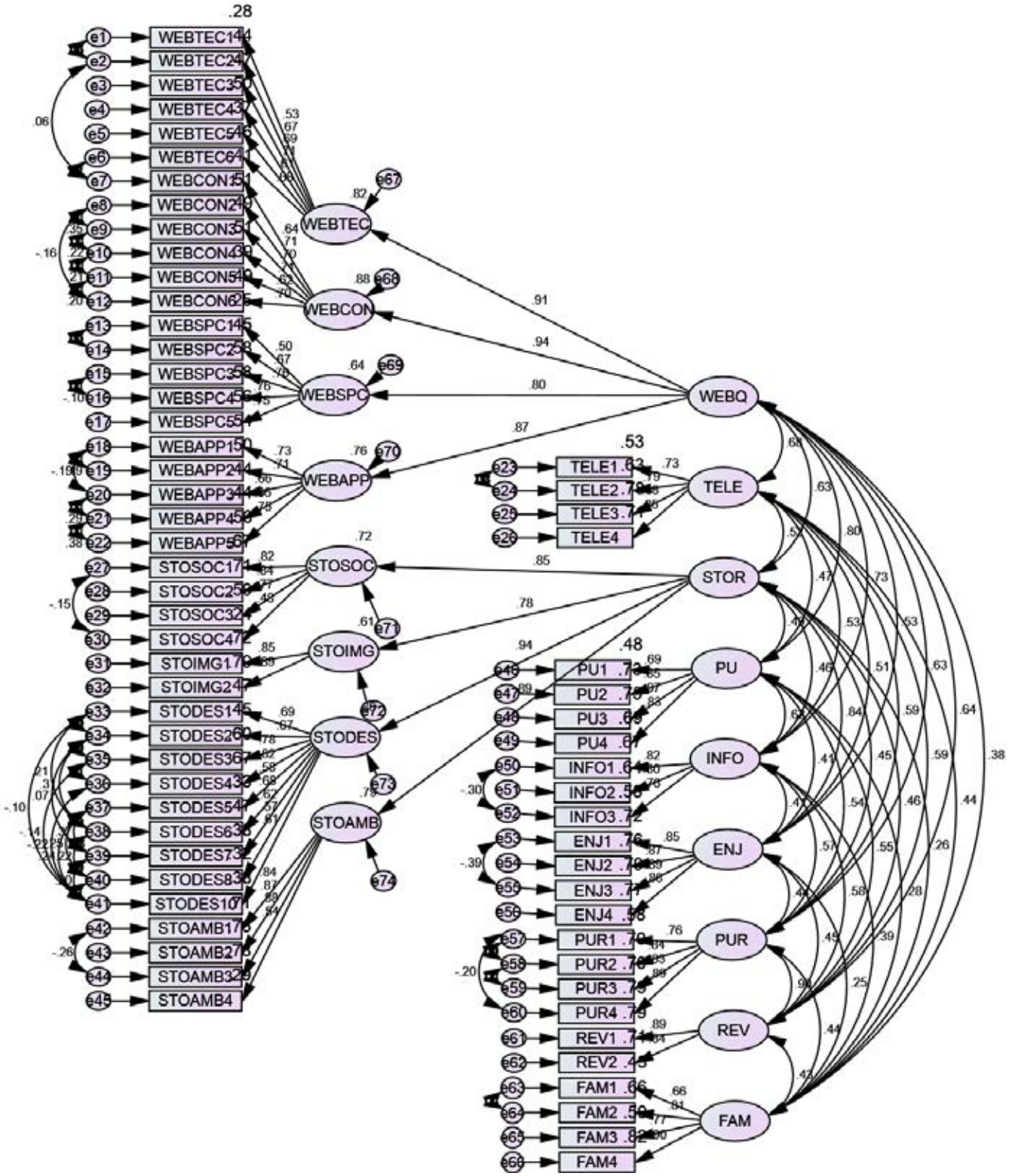

Figure 4-13. Overall measurement model of the study.

The goodness-of-fit assessment reveals that after the modified overall measurement model have a good fit with the empirical data. The $\chi^2/df = 2.973$ is less than 3. The values of RMSEA = 0.039, PCLOSE = 1.00, RMR = 0.008, NFI = 0.900, CFI = 0.931 and TLI = 0.926, indicate a good fit; while GFI = 0.869 and AGFI = 0.855, which is sensitive to large sample size suggest a marginal fit as shown in Table 4-20.

Table 4-20. Summary of Evaluation of Measurement Model with Goodness-of-fit Measures Between original and the Final Modified Overall Measurement Model

Goodness-of-fit measure	Calculated measure before modification	Calculated measure after modification	Suggested criteria	Acceptability of the final model
chi-square (χ^2)	9334.051	5928.239		
df	2166	1994		
χ^2/df	4.309	2.973	< 3	Good fit
p value	.000	.000	> 0.05	Not fit
RMSEA	.050	.039	≤ 0.05	Superior fit
PCLOSE	.338	1.000	> 0.05	Close fit
RMR	.008	.007	≤ 0.05	Superior fit
GFI	.802	.869	> 0.90	Marginal fit
AGFI	.786	.855	> 0.90	Marginal fit
NFI	.846	.900	≥ 0.90	Good fit
CFI	.877	.931	≥ 0.90	Good fit
TLI	.871	.926	≥ 0.90	Good fit

Table 4-21 lists the final loading factors of the overall measurement model. Several variables in store design have lower loading due to the imposition of error correlations, which were left as if for further analyses.

Table 4-21. Final Loadings of Variables and their Associated Constructs

Parameters	Unst.	SE.	Std.
WEBQ			
WEBTEC	1.000[a]	-	.906
WEBCON	1.343	.085	.936
WEBSPC	.911	.072	.799
WEBAPP	1.637	.101	.871
WEBTEC			
WEBTEC1	1.000[a]	-	.527
WEBTEC2	1.390	.075	.665
WEBTEC3	1.416	.082	.687
WEBTEC4	1.405	.080	.708
WEBTEC5	1.423	.089	.608
WEBTEC6	1.425	.083	.679
WEBCON			
WEBCON1	1.000[a]	-	.641
WEBCON2	1.209	.057	.714
WEBCON3	1.115	.053	.703
WEBCON4	1.145	.054	.715
WEBCON5	.960	.050	.625
WEBCON6	1.074	.051	.703
WEBSPC			
WEBSPC1	1.000[a]	-	.501
WEBSPC2	1.365	.069	.667
WEBSPC3	1.530	.091	.760
WEBSPC4	1.559	.096	.759
WEBSPC5	1.489	.090	.751
WEBAPP			
WEBAPP1	1.000[a]	-	.734
WEBAPP2	.893	.034	.707
WEBAPP3	.828	.041	.663
WEBAPP4	.865	.041	.665
WEBAPP5	.912	.038	.750
TELE			
TELE1	1.000[a]	-	.726
TELE2	1.083	.031	.791
TELE3	1.261	.042	.885
TELE4	1.157	.041	.845
STOR			
STOSOC	1.000[a]	-	.851
STOIMG	.790	.034	.780
STODES	.966	.038	.888
STOAMB	.853	.038	.939
STOSOC			
STOSOC1	1.000[a]	-	.815
STOSOC2	.905	.027	.844
STOSOC3	.773	.026	.771
STOSOC4	.531	.032	.485

Parameters	Unst.	SE.	Std.
STOIMG			
STOIMG1	1.000[a]	-	.851
STOIMG2	1.059	.032	.889
STODES			
STODES1	1.000[a]	-	.688
STODES2	1.044	.030	.670
STODES3	1.148	.046	.778
STODES4	1.291	.049	.821
STODES5	.773	.041	.575
STODES6	1.018	.040	.684
STODES7	.921	.045	.619
STODES8	.855	.046	.566
STODES10	.822	.044	.613
STOAMB			
STOAMB1	1.000[a]	-	.855
STOAMB2	1.063	.028	.869
STOAMB3	1.066	.030	.883
STOAMB4	.663	.033	.538
PU			
PU1	1.000[a]	-	.695
PU2	1.215	.044	.852
PU3	1.144	.041	.866
PU4	1.143	.042	.830
INFO			
INFO1	1.000[a]	-	.818
INFO2	.926	.035	.798
INFO3	.919	.037	.762
ENJ			
ENJ1	1.000[a]	-	.846
ENJ2	1.049	.026	.872
ENJ3	1.062	.030	.888
ENJ4	1.113	.028	.876
PUR			
PUR1	1.000[a]	-	.760
PUR2	1.073	.032	.837
PUR3	1.098	.036	.834
PUR4	1.132	.037	.890
REV			
REV1	1.000[a]	-	.891
REV2	.938	.025	.841
FAM			
FAM1	1.000[a]	-	.656
FAM2	1.375	.049	.813
FAM3	1.247	.054	.767
FAM4	1.492	.062	.903

4.2.5 Correlation Analysis

Correlation analysis among variables is required before a structural regression assessment. Too high correlations among variables could be problems for SEM analysis. Theoretically, any variables with too high correlations might face discriminant validity, where two measured variables might represent the same idea or construct. This might mislead the study finding. Technically, high correlations among variables might cause multicollinearity problems where regression might not be able to estimate effects from too similar constructs correctly, resulting in incorrect estimates. Correlation table along with transformed variable means ($Mean_{Transformed}$) and standard deviations (*SD*) can be used to replicate an SEM analysis. Table 4-22 below lists product-moment correlations or Pearson correlations (*r*) among transformed variables being assessed by the SEM in this study, along with the average variance extract (AVE), maximum shared variance (MSV) and average shared variance (ASV) for assessing convergent and discriminant validity as discussed in the up-coming sections.

Table 4-22. Correlations among Variables for Structural Model Assessment

	AVE	MSV	ASV	1	2	3	4	5	6	7	8	9
1. WEBQ	.773	.640	.409	**.879**								
2. TELE	.663	.462	.298	.680	**.814**							
3. STOR	.751	.714	.290	.632	.521	**.866**						
4. PU	.662	.640	.292	.800	.474	.492	**.814**					
5. INFO	.629	.539	.299	.734	.528	.462	.624	**.793**				
6. ENJ	.758	.714	.255	.534	.505	.845	.412	.407	**.871**			
7. PUR	.691	.812	.344	.625	.586	.448	.543	.567	.436	***.832***		
8. REV	.751	.812	.350	.640	.592	.457	.549	.578	.447	.901	***.866***	
9. FAM	.624	.197	.136	.380	.444	.260	.276	.392	.252	.444	.432	**.790**
$Mean_{Transformed}$				2.018	1.857	2.089	2.105	2.008	2.054	1.988	1.991	1.713
SD				.235	.351	.290	.329	.283	.383	.326	.345	.350

Note. $N = 1{,}311$; AVE, average variance extraction; MSV, maximum shared variance; ASV, average shared variance.

Criteria to determine degrees of correlations varies. Correlations between 0.00 and 0.29 may indicate little if any correlation, 0.30 and 0.49 for low correlation, 0.59 and 0.69 for moderate correlation, 0.70 and 0.89 for high correlation, and 0.90 and 1.00

may represent very high correlation. From Table 4-22, correlations between WEBQ and PU (r = 0.799), WEBQ and INFO (r = 0.733), STOR and ENJ (r = 0.842), and PUR and REV (r = 0.830), are considered highly correlated. These correlations may be causes of errors, if any, in the estimates. The researcher will refer to this table for main analyses discussions.

Besides correlations, Table 4-22 also shows statistics calculated together for assessing reliability and validity.

4.2.6 Reliability & Construct Validity

Reliability indicates the consistency of measurement, which is needed for credible results. A measure with high reliability would replicate similar results under consistent conditions. Cronbach's alpha is normally used to measure reliability for a set of two or more construct indicators (Hair Jr et al., 1995). The researcher employed Cronbach's alpha for pilot study. Another statistical analysis called composite reliability is recommended for even more accurate reliability assessment for the whole construct (Henseler, Ringle, & Sinkovics, 2009). It better assesses the internal consistency of the constructs. A composite reliability value that is more than a threshold of 0.7 indicates a reliable measure. The composite reliability values for each construct lists in Table 4-23. The composite reliability values range from 0.833 (PUR) to 0.932 (WEBQ) signifies the reliability of all constructs.

Table 4-23. Composite Reliability of Constructs

Variables	Composite Reliability
WEBQ	.932
TELE	.886
STOR	.923
PU	.886
INFO	.835
ENJ	.926
PUR	.899
REV	.857
FAM	.867

4.2.6.1 Construct Validity

Construct validity refers to the validity of inferences that the measures actually represent the construct being investigated. It is composed of convergent validity and discriminant validity.

4.2.6.1.1 Convergent Validity

Convergent validity refers to the degree to which measures of designated construct that should theoretically be related, are actually related (Henseler et al., 2009). Modifying measurement model by getting rid of variables with low factor loading could corroborate convergent validity. The average variance extraction (AVE) value is used to indicate the convergent validity (Henseler et al., 2009). An AVE value more than a threshold of 0.5 indicates that measures are converged for a construct. From Table 4-22, AVE values range from 0.628 (INFO) to 0.775 (WEBQ) indicates that there is no convergent validity issue here.

4.2.6.1.2 Discriminant Validity

Discriminant validity refers to the test that verify whether constructs or measurements that are supposed to be unrelated are actually unrelated, or do not represent the same concept (Henseler et al., 2009). In order to demonstrate satisfactory discriminant validity, comparing the AVE to the squared correlation between the two constructs of interest, the AVE should be greater than the squared correlation; moreover, maximum shared variance (MSV) and average shared variance (ASV) should be less than AVE. Values on the diagonal of Table 4-22 are the square root of AVE of each construct. No correlations of in the row and column are greater than the value of their corresponding AVE. In addition, all MSV and ASV are lower than the value of their corresponding AVE indicates that there is no issue of discriminant validity, except for the dependent variables, PUR and REV, which are usually highly dependent but separately tested (Hausman & Siekpe, 2009).

4.2.7 Descriptive Analysis of Data

Composite variables were generated for each construct by pooling means of observed variables to their designated construct by averaging. Variables passing through the data preparation forming a reliable and valid measurement model are used in the calculation. Referred to the mean of each observed variable in Table 4-3, by taking WEBTEC as example, the researcher calculated the mean of WEBTEC1 of all cases and did the same for WEBTEC2 to 6. Then the average of WEBTEC1 to 6 is calculated forming a composite variable of WEBTEC, i.e., WEBTEC = WEBTEC1+ WEBTEC2+WEBTEC3+WEBTEC4+WEBTEC5+WEBTEC6)/6. The researcher did the same for the rest of the constructs. For second order constructs, i.e. WEBQ and STOR, the composite values of designated constructs are pooling together by averaging accordingly. The statistics describe how overall participants think about the VR store in this study. It will be used as a reference for further analyses and discussions.

Table 4-24. Composite measured scores

	Mean	SD
WEBTEC	4.992	.909
WEBCON	5.129	.949
WEBSPC	5.244	.926
WEBAPP	5.449	.966
STOSOC	4.983	1.118
STOIMG	5.714	1.135
STODES	5.396	1.068
STOAMB	5.486	1.158
WEBQ	5.203	.795
TELE	4.639	1.278
STOR	5.395	.962
USE	5.480	1.070
INFO	5.202	.935
ENJ	5.281	1.295
PUR	5.113	1.098
REV	5.124	1.161
FAM	4.092	1.364

N = 1,311

4.3 Main Analyses

4.3.1 Structural Model Assessment

In the previous section, structural equation modelling (SEM) based on CFA was employed to test a measurement model fit and estimate constructs' content. In this part, structural equation modelling procedures were applied to assess the structural regression (SR) model or structural model, in general, in developing a fitting model; then a suitable model was used for testing research hypotheses. According to a theoretical model that was developed from literature, structural equation modelling allows a set of relationships between one or more independent variables, and one or more dependent variables to be examined (Hair Jr et al., 1995; Tabachnick et al., 2001).

Structural equation modelling examines a series of dependence relationships and is useful when one dependent variable becomes an independent variable in subsequent dependence relationships (Hair Jr et al., 1995). Furthermore, application of structural equation modelling is a model fit assessment (Byrne, 2010; Kline, 2010; Tabachnick et al., 2001).

The path diagram explains a series of causal relationships. Research defines path diagrams in terms of constructs and then finds variables to measure each construct. The relationships between constructs are presented with arrows. All constructs in a path diagram can be placed into one of two classes of constructs: exogenous or endogenous. Each line in the model indicates direct relationships between observed exogenous variables and observed endogenous variables, and between observed endogenous variables. In this research, exogenous variables include web quality, telepresence and store environment. Endogenous constructs also predict other endogenous constructs but an exogenous constructs can be causally related only to endogenous constructs. Details of causal relationships and path diagrams are presented in the following figure (Figure 4-14).

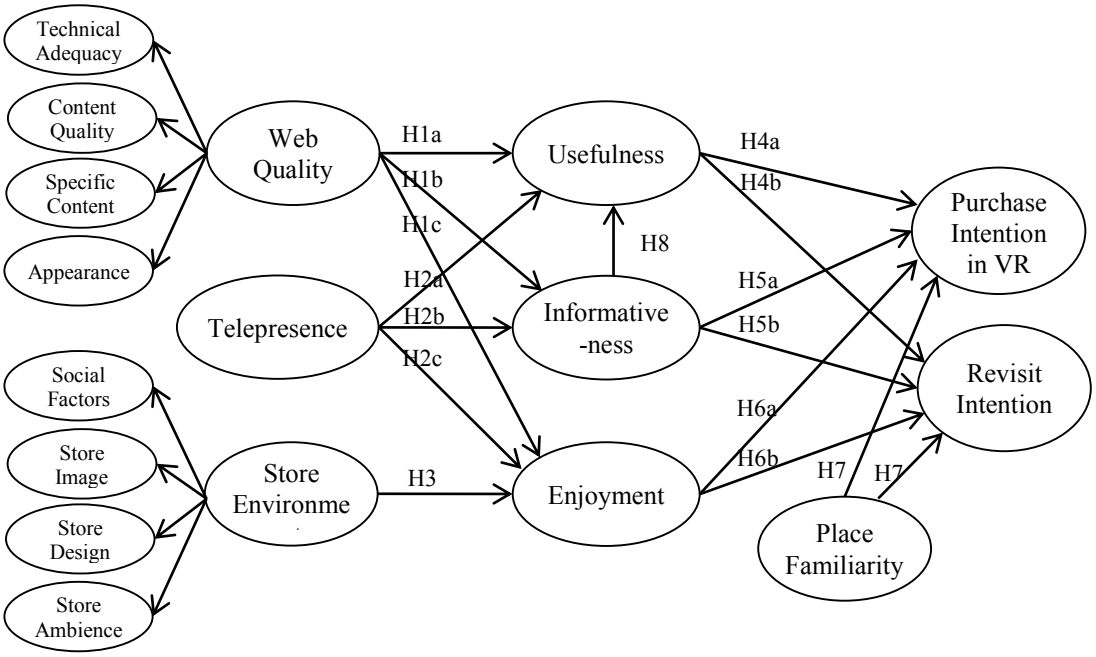

Figure 4-14. Causal relationships and path diagram.

A model is specified in formal terms through a series of the structural equations. A set of structure equations define the structural equations linking constructs; the measurement model specifying which variables measure which constructs; and a set of matrices indicating any hypothesized correlations among constructs or variables (Hair Jr et al., 1995).

Hypotheses are tested by estimates of structural coefficient. Structural equations are presented (in the fourth column) in Table 4-25. Each endogenous variables (in the third column) can be predicted either by exogenous variable(s) (in the second column) or by other endogenous variable(s). For each hypothesized effect, a structural coefficient (G_i for exogenous to endogenous variable and B_i for endogenous to endogenous variables) was estimated. An error term (e_{sub}) was predicted as well. The error term represents the effects due to specification error and random measurement error (Hair Jr et al., 1995). The endogenous construct is the dependent variable in a separate equation. The predictor variables are all constructs at the end of the straight arrows.

Table 4-25. Structural equation of each hypothesis for this research

Hypotheses	Exogenous variable		Endogenous variables	Structural equations	Errors
H1a	WEBQ	→	PU	$PU = G_1*WEBQ$	$+ e_{pu}$
H1b	WEBQ	→	INFO	$INFO = G_2*WEBQ$	$+ e_{info}$
H1c	WEBQ	→	ENJ	$ENJ = G_3*WEBQ$	$+ e_{enj}$
H2a	TELE	→	PU	$PU = G_4*TELE$	$+ e_{pu}$
H2b	TELE	→	INFO	$INFO = G_5*TELE$	$+ e_{info}$
H2c	TELE	→	ENJ	$ENJ = G_6*TELE$	$+ e_{enj}$
H3	STOR	→	ENJ	$ENJ = G_7*STOR$	$+ e_{enj}$
H4a	PU	→	PUR	$PUR = B_8*PU$	$+ e_{pur} + e_{pu}$
H4b	PU	→	REV	$REV = B_9*PU$	$+ e_{rev} + e_{pu}$
H5a	INFO	→	PUR	$PUR = B_{10}*INFO$	$+ e_{pur} + e_{info}$
H5b	INFO	→	REV	$REV = B_{11}*INFO$	$+ e_{rev} + e_{info}$
H6a	ENJ	→	PUR	$PUR = B_{12}*ENJ$	$+ e_{pur} + e_{enj}$
H6b	ENJ	→	REV	$REV = B_{13}*ENJ$	$+ e_{rev} + e_{enj}$
H7a	FAM	→	PUR	$PUR = G_{14}*FAM$	$+ e_{pur}$
H7b	FAM	→	REV	$REV = G_{15}*FAM$	$+ e_{rev}$
H8	INFO	→	PU	$PU = B_{16}*INFO$	$+ e_{pu} + e_{info}$

The predicted value for each variable is calculated by the loading of the variance on each factor. When the measurement model has been specified, the analyst must then provide for the reliability of the indications. As the structural and measurement model are estimated, the loading coefficient will provide estimates of the reliabilities of the indicators and the overall construct. The researcher specifies relation between constructs.

Structural equation modelling techniques use only the variance/covariance or correlation matrix as its input data (Hair Jr et al., 1995). First, analysis for outliers was completed before covariance or correlation matrices were calculated and testing of each hypothesis separately. Correlation is appropriate when the objective of the researcher is only to understand the pattern of relationships between constructs, but not to explain the total variance of a construct. This research employed *covariance testing* of theory to satisfy the assumptions of the methodology, which was an appropriate form of the data to validate causal relationships. After the structural and measurement models were specified and the input data type was selected the estimation of the model was proceeded by a package of SPSS AMOS version 21. The following diagram depicts the graphical input for AMOS analysis.

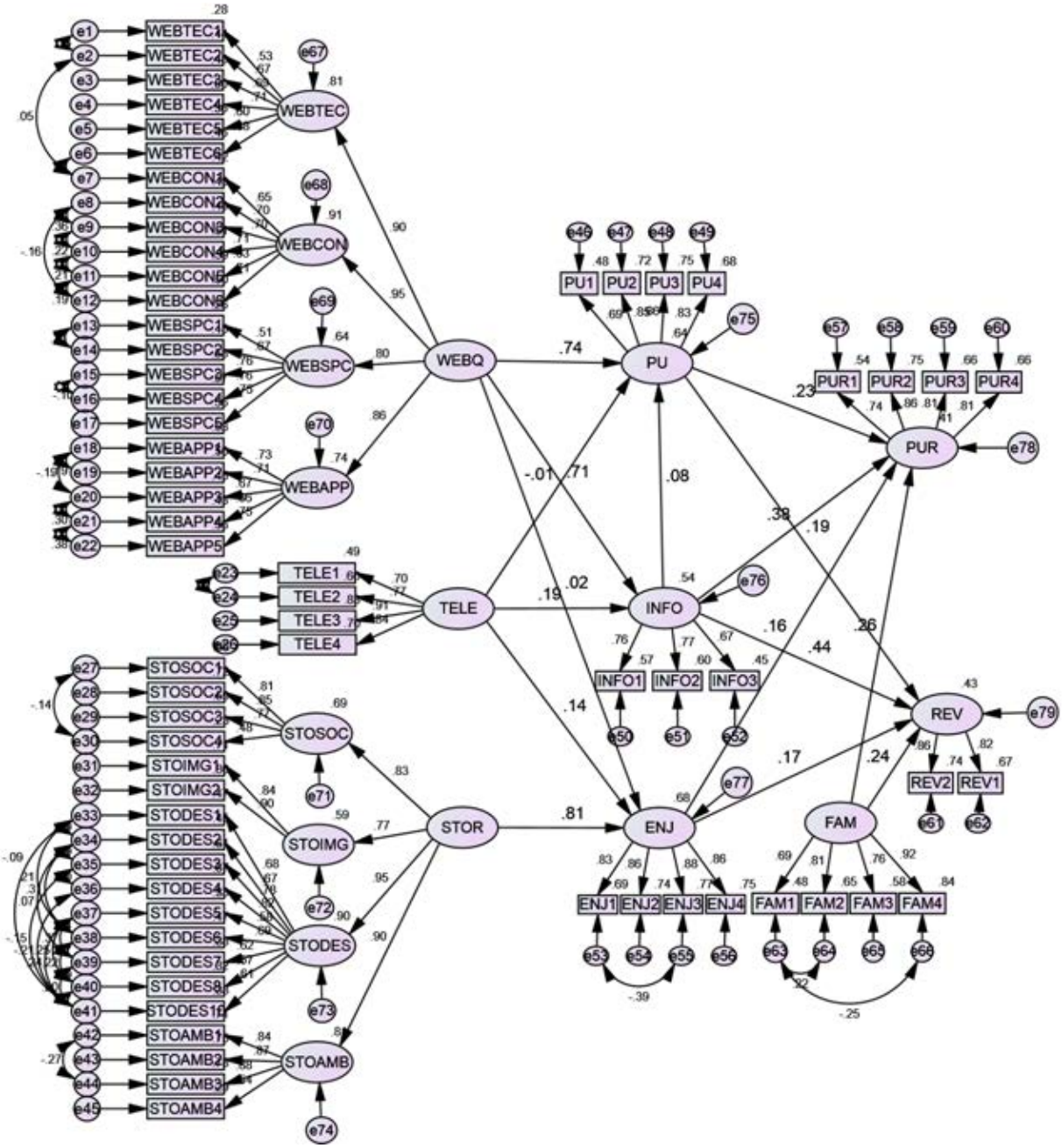

Figure 4-15. Structural model estimation of the study.

The identification of the structural equation and variance/covariance matrix for the estimation was automatically generated by AMOS software from the diagram in Figure 4-15 together with raw data. Once, the model was specified, the researcher tested its plausibility based on sample data that comprised all observed variables in the model. The primary task in this model-testing procedure was to determine the goodness-of-fit between the hypothesized model and the sample data. While, sample size should be large enough in relation to the number of estimated parameters as discussed in the methodology; however, maximum likelihood estimation (MLE) found that, increasing number of sample size indicates that the goodness-of-fit produces a poor fit. The reason is the method becomes more sensitive. Thus the chi-square test revealed poor fit here ($\chi^2 = 8078.230$, $df = 2017$, $p < 0.05$). However, the rest fit indices what are less sensitive to sample size indicate a marginal fit that is at the borderline to good fit (NFI = .864, CFI = 0.894, TLI = 0.884, RMSEA = 0.048, PCLOSE = .999, RMR = 0.035), while traditional fit indices indicate a marginal fit (GFI = 0.830, AGFI = 0.814). Table 4-26 summarizes the goodness-of-fit measures. The indices for an equivalent structural path without any measurement modification are shown in column two.

Table 4-26. Summary of evaluation of structural model with goodness-of-fit measures between original and the modified structural regression model

Goodness-of-fit measure	Calculated measure without modification	Calculated measure after modification	Suggested criteria	Acceptability of the final model
chi-square (χ^2)	11316.321	8078.230		
df	2120	2017		
χ^2/df	5.338	4.001	< 3	Not fit
p value	.000	.000	> 0.05	Not fit
RMSEA	.058	.048	≤ 0.05	Good fit
PCLOSE	.000	.999	> 0.05	Close fit
RMR	.031	.031	≤ 0.05	Good fit
GFI	.771	.830	> 0.90	Marginal fit
AGFI	.753	.814	> 0.90	Marginal fit
NFI	.813	.864	≥ 0.90	Marginal fit
CFI	.842	.894	≥ 0.90	Marginal fit
TLI	.830	.884	≥ 0.90	Marginal fit

In this stage, the structural regression model can be used to test the hypotheses of the study without any modification since a series of measurement model modification yielded a good-fit structural regression model. The estimation of path coefficients and their significant-values shown in Table 4-27 prove the study's hypotheses as analyzed and discussed in 4.3.3. Hypothesis Testing and Research Outcomes.

Table 4-27. Maximum Likelihood Estimates for a Recursive Path Model of Causes and Effects of Interface Factors and Store Environment–Purchase and Revisit Intention in a VR Store

Parameters	Unst.	SE	St.	t-values	p-values
WEBQ → PU	1.303***	.107	.741	12.145	.000
WEBQ → INFO	1.124***	.080	.712	14.048	.000
WEBQ → ENJ	.049***	.057	.023	.866	.387
TELE → PU	-.005***	.027	-.006	-.201	.841
TELE → INFO	.170***	.029	.193	5.870	.000
TELE → ENJ	.172***	.030	.145	5.706	.000
STOR → ENJ	.871***	.039	.812	22.125	.000
PU → PUR	.220***	.042	.232	5.306	.000
PU → REV	.196***	.047	.192	4.204	.000
INFO → PUR	.407***	.051	.385	7.974	.000
INFO → REV	.496***	.057	.438	8.658	.000
ENJ → PUR	.124***	.022	.158	5.746	.000
ENJ → REV	.145***	.024	.173	6.010	.000
FAM → PUR	.257***	.030	.264	8.517	.000
FAM → REV	.254***	.033	.243	7.723	.000
INFO → PU	.090***	.046	.080	1.936	.053

Note. Unst., unstandardized; St., standardized.
$^{***}p < .001$, $^{**}p < .01$, $^{*}p < .05$

4.3.2 Alternative Model

The researcher sought an alternative model as most appropriate in representing the sample data. Once the model has been deemed acceptable, the researcher examines possible model modifications to improve the theoretical explanation or the goodness-of-fit (Hair Jr et al., 1995). Byrne (2010) suggested that modification indices could be employed to solve the factor loading and error terms. Modification indices are calculated for each non-estimated relationship (Hair Jr et al., 1995). In addition, the researcher take this opportunity to investigate any relations that might be significant but are being missing from literatures with sound explanations.

Table 4-28. Modification indices for the proposed model.

Path			M.I.	Par Change
REV	<---	TELE	23.505	0.127
INFO	<---	FAM	20.395	0.115
PUR	<---	TELE	19.179	0.103

The modification indices (M.I.) were applied to the estimated model that was partly modified in the first stage. Regression weight of modification indices between FAM and INFO (M.I. = 20.395) has the second highest value. Since FAM is not the primary concern of the study and the relation might not logically explained, this suggestion is omitted. In case of relations between TELE and both behavioral intentions, PUR and REV, the relations show existences of natural direct effects remaining between variables.

A relation between STOR and PU has been significant with theoretical contributions; their relation was drawn and discussed. The new paths were drawn as discussed and the insignificant paths were dropped. Other relations are not stable in the process of modification and not theoretically logical, the researcher concluded the model as shown in the final path diagram presented in Figure 4-16. In Figure 4-16, the thick gray lines show removed relations from WEBQ to ENJ and from TELE to PU. The thick black lines show added relations from STOR to PU, and from TELE to PUR and REV. The result of the estimation is shown in Figure 4-17.

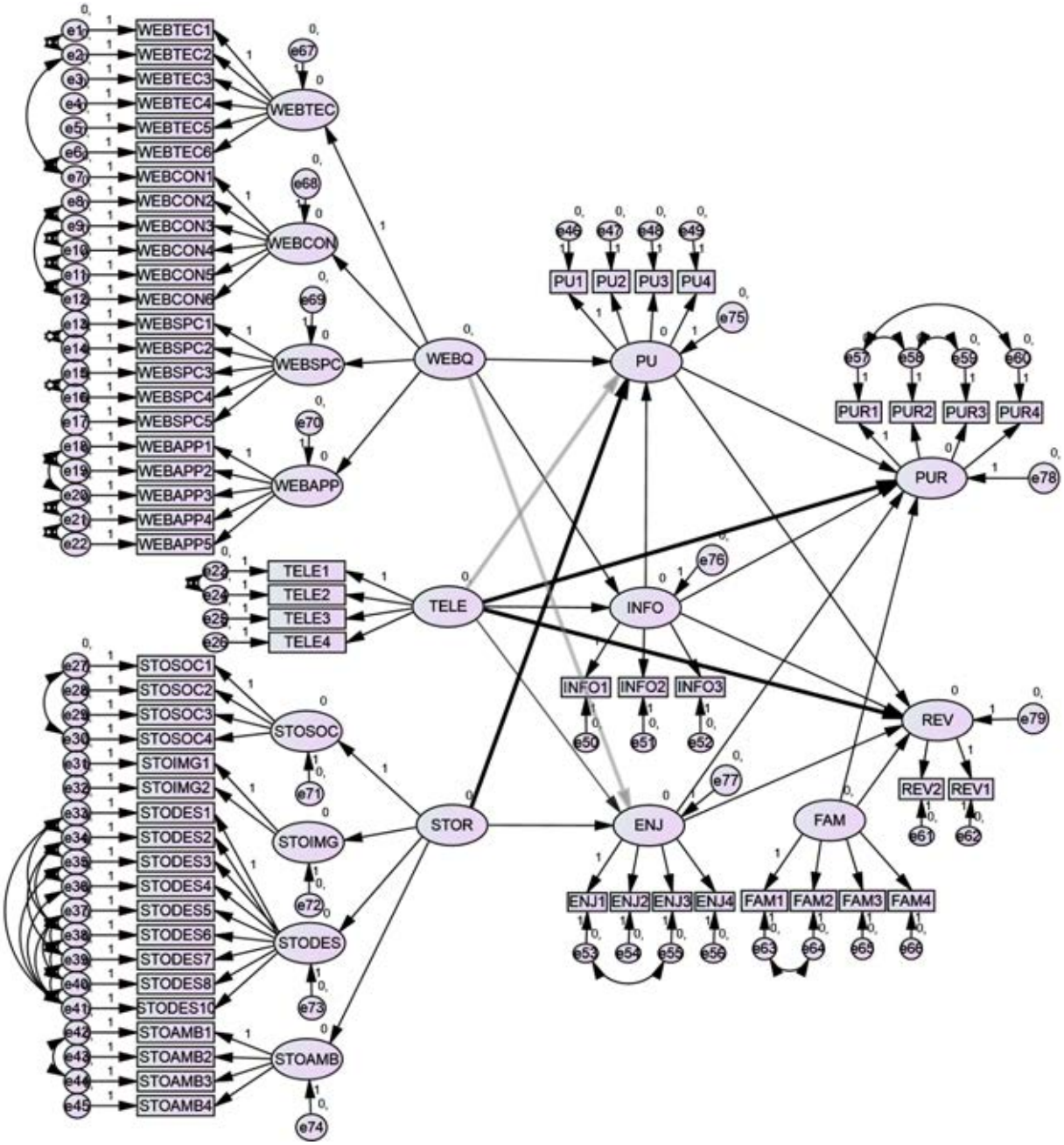

Figure 4-16. The modified model of the study.

The alternative model is slightly better fit with the setting according to the chi-square statistics. Table 4-29 shows fit indices of the proposed model and the alternative model. The chi-square of the proposed model is 8078.230 (df = 2017) and that of alternative model is 7954.341 (df = 2014). The chi-square different test indicates that the model is significantly superior to the data χ^2_{diff} (df = 3, N = 1311) = 123.889, $p <$ .05. Path coefficient estimation are shown in Table 4-30

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Table 4-29. Summary of evaluation of structural model with goodness-of-fit measures between original and the modified structural regression model.

Goodness-of-fit measure	Calculated measure of the main model	Calculated measure of the alternative model
chi-square (χ^2)	8078.230	7954.341
df	2017	2014
χ^2/df	4.001	3.950
p value	.000	.000
RMSEA	.048	.047
PCLOSE	.999	1.000
RMR	.031	.031
GFI	.830	.832
AGFI	.814	.816
NFI	.864	.866
CFI	.894	.896
TLI	.884	.886

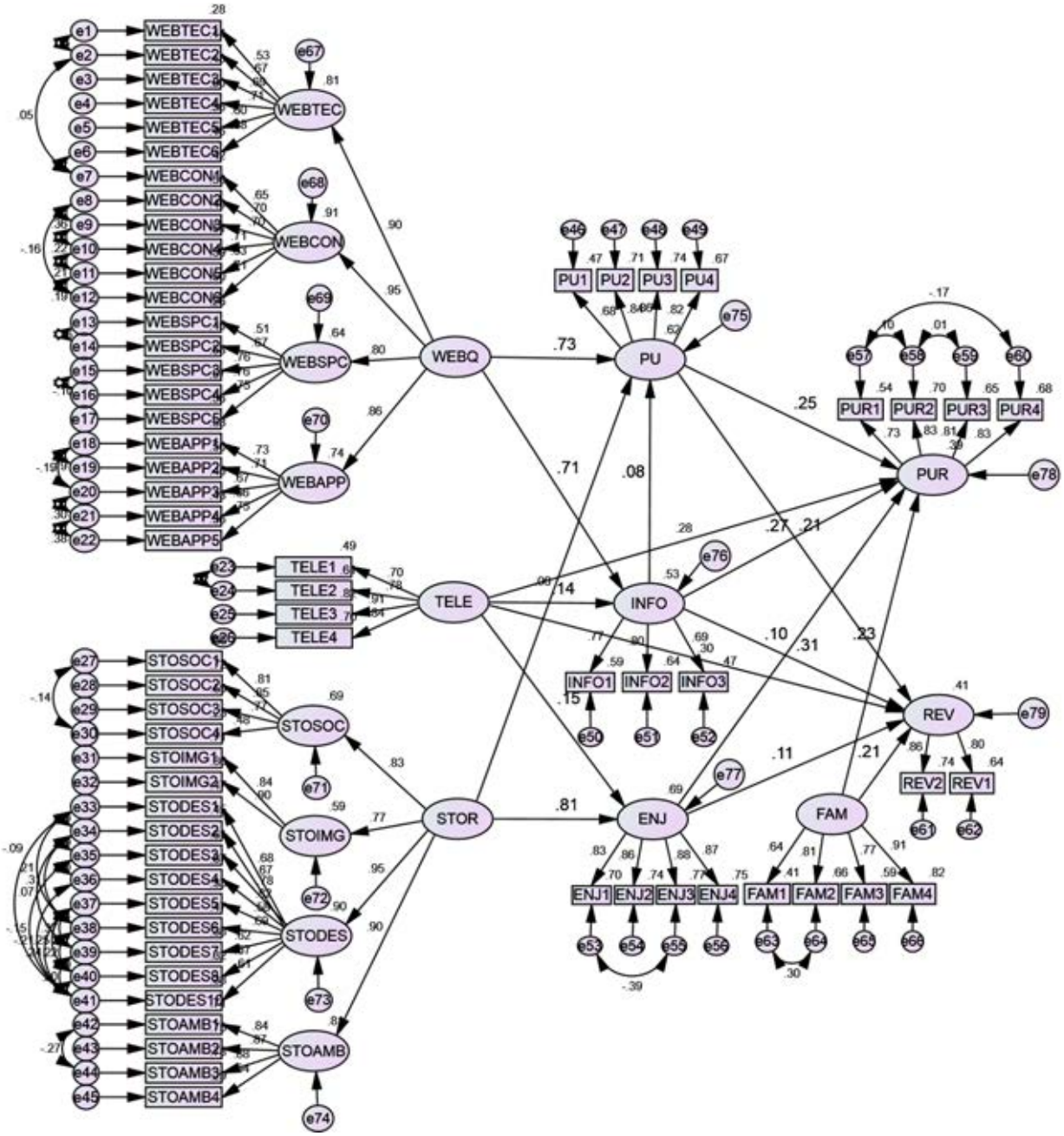


Figure 4-17. The standardized estimation of the modified structural model of the study

Table 4-30. Maximum Likelihood Estimates for the Alternative Recursive Path Model of Causes and Effects of Interface Factors and Store Environment–Purchase and Revisit Intention in a VR Store

Parameters	Unst.	SE	St.	t-values	p-values
WEBQ → PU	1.248***	.105	.726	11.913	.000
WEBQ → INFO	1.159***	.082	.714	14.060	.000
TELE → INFO	.122***	.029	.136	4.216	.000
TELE → ENJ	.181***	.027	.151	6.643	.000
TELE → PUR	.250***	.033	.276	7.582	.000
TELE → REV	.289***	.036	.303	8.110	.000
STOR → PU	.053***	.023	.061	2.340	.019
STOR → ENJ	.881***	.038	.815	22.972	.000
PU → PUR	.234***	.038	.246	6.146	.000
PU → REV	.208***	.041	.208	5.012	.000
INFO → PUR	.273***	.044	.271	6.158	.000
INFO → REV	.333***	.048	.315	6.894	.000
ENJ → PUR	.077***	.022	.102	3.513	.000
ENJ → REV	.088***	.024	.110	3.628	.000
FAM → PUR	.235***	.032	.226	7.256	.000
FAM → REV	.227***	.034	.208	6.665	.000
INFO → PU	.083***	.042	.079	1.973	.048
Variance Explained					
WEBTEC	.810				
WEBCON	.908				
WEBSPC	.642				
WEBAPP	.736				
STOSOC	.690				
STOIMG	.591				
STODES	.898				
STOAMB	.808				
INFO	.528				
ENJ	.686				
PU	.619				
PUR	.385				
REV	.408				

Note. Unst., unstandardized; St., standardized.
$^{***}p < .001$, $^{**}p < .01$, $^{*}p < .05$

In addition, effects of exogenous on endogenous and endogenous on other endogenous variables that are not directly related are calculated. In this case, the analysis could yield further understanding of the extent of casual relations among variables being studied. Table 4-31 and Table 4-32 provide a breakdown of the effects, which are discussed in the next section.

Table 4-31. Decompositions for Effects of Exogenous on Endogenous Variables for a Recursive Path Model of Causes and Effects of Interface Factors and Store Environment–Purchase and Revisit Intention in a VR Store

	Causal variables											
Endogenous	WEBQ			TELE			STOR			FAM		
variables	Unst.	*SE*	St.	Unst.	*SE*	St.	Unst.	*SE*	St.	Unst.	*SE*	St.
PU												
Direct	1.248	.105	.726	—	—	—	.053	.023	.061	—	—	—
Indirect	.097	.059	.056	.010	.007	.011	—	—	—	—	—	—
Total	1.344	.023	.726	.010	.007	.011	.053	.023	.061	—	—	—
INFO												
Direct	1.159	.082	.714	.122	.029	.136	—	—	—	—	—	—
Indirect	—	—	—	—	—	—	—	—	—	—	—	—
Total	1.159	.082	.714	.122	.029	.136	—	—	—	—	—	—
ENJ												
Direct	—	—	—	.181	.027	.151	.881	.038	.815	—	—	—
Indirect	—	—	—	—	—	—	—	—	—	—	—	—
Total	—	—	—	.181	.027	.151	.881	.038	.815	—	—	—
PUR												
Direct	—	—	—	.250	.033	.276	—	—	—	.235	.032	.226
Indirect	.631	.066	.386	.050	.012	.055	.081	.024	.098	—	—	—
Total	.631	.066	.386	.300	.044	.330	.081	.024	.098	.235	.032	.226
REV												
Direct	—	—	—	.289	.036	.303	—	—	—	.227	.034	.208
Indirect	.666	.080	.387	.059	.014	.062	.088	.027	.102	—	—	—
Total	.666	.080	.387	.348	.047	.364	.088	.027	.102	.227	.034	.208

Table 4-32. Decompositions for Effects of Endogenous on Other Endogenous Variables for a Recursive Path Model of Causes and Effects of Interface Factors and Store Environment–Purchase and Revisit Intention in a VR Store

	Causal variables								
Endogenous	PU			INFO			ENJ		
variables	Unst.	*SE*	St.	Unst.	*SE*	St.	Unst.	*SE*	St.
PU									
Direct	—	—	—	.083	.042	.079	—	—	—
Indirect	—	—	—	—	—	—	—	—	—
Total	—	—	—	.083	.042	.079	—	—	—
PUR									
Direct	.234	.038	.246	.273	.044	.271	.077	.022	.102
Indirect	—	—	—	.020	.011	.019	—	—	—
Total	.234	.038	.246	.292	.068	.292	.077	.022	.102
REV									
Direct	.208	.041	.208	.333	.048	.315	.088	.024	.110
Indirect	—	—	—	.017	.011	.016	—	—	—
Total	.208	.041	.208	.351	.074	.351	.088	.024	.110

4.3.2.1 Supporting Theories for the Alternative Model

Modifying the model has to be proven by theory rather than data (Tabachnick & Fidell 2001). Relationships of variables should add to a model when there is enough supported theory. According to the modified model, significant causal-effect relation between store environment and perceived usefulness allowed the researcher to justify supporting theory of those variables.

Theories support direct effect relation between telepresence—purchase and revisit intention

The results are in accordance to many studies posited that properties of interface and stimulus affect behavioral intentions thorough the explaining mediator (Ahn et al., 2007; Hausman & Siekpe, 2009; Loiacono et al., 2002; Monsuwé et al., 2004). Due to effects of stimulus were not be fully understood, cognitive and affective beliefs, or sometimes behaviors, explain the psychological rational behind relations as mediators. Like in this study, all independent variables which are interface factors and store environment is positively related to behavioral intentions via well-known explaining mediators: perceived usefulness, informativeness and enjoyment, in e-commerce.

However, there might be remaining effects of properties of system features that have not yet been explained, which are significantly affect behavioral intentions. This remaining effects would leave a signification direct effect between system factors to behavioral intentions. Better understanding of the study by investigating such direct effects would further contribute to the area.

The results suggest that, for exogenous to behavioral intentions, there is remaining significant direct effects from telepresence to purchase intention and also to revisit intention. This relation is supported by the study of (Hendaoui & Limayem, 2008b). Any conclusions will be drawn and discussed in the next chapter.

Theories support relation between store environment and perceived usefulness.

The researcher did not posit the causal-effect relationship between store environment and perceived usefulness despite an exhaustive review due to a unique characteristic of the setting where online and physical store shopping converge. It is among first studies that virtual reality store environment is deemed to play a crucial role in online e-commerce. While store environment and enjoyment are posited to be positively related, it was theorized from two different settings, online store and brick-and-mortar store, bridging by the same construct of enjoyment (Loiacono et al., 2002; Sherman et al., 1997). In this case of store environment and perceived usefulness, the supporting theories have to be drawn from analogous elements of the two settings.

Store environment covers four dimensions: social factors, store image, store design and ambience. Perceived usefulness of a particular information system is measured by its speed, productivity, efficiency and effectiveness. The closely related interface factor that is positively related to perceived usefulness in online commerce in this settings is the store layout. In traditional e-commerce, studies revealed that layout of an e-commerce website is positively related to users' productivity and perceived usefulness (Cao, Zhang, & Seydel, 2005; Cox & Dale, 2001; Klopping & McKinney, 2004; C. Liao, P. Palvia, & H.-N. Lin, 2006; Schafer, Konstan, & Riedl, 2001; Vrechopoulos, O'Keefe, Doukidis, & Siomkos, 2004). This can be analogous to the situation where store layout plays and important role in virtual reality navigation. In addition, tidiness of merchandised, could accelerate the shopping efficiency. These properties of store environment are associated with the store design dimension. Furthermore, in real-world shopping, store layout affects shopper behaviors leading to higher or lower efficiency (Schafer et al., 2001; Vrechopoulos et al., 2004). Based on these rationales, the casual-effect relationship between store environment and perceived usefulness is theoretically and empirically grounded.

Arguments for removing insignificant relations.

Insignificant casual-effect relations of the hypothesized model are removed forming a better theory explaining the phenomenon. The alternative model is further investigated for further solid findings, not only for the dataset, but also explanation beyond the dataset in this particular setting. Causal-effect relations between web quality and enjoyment is not statically significant, so is it between telepresence and perceived usefulness. Besides, the size of sample set, in fact, the researcher believe that the dataset represents the real phenomenon of this setting of virtual reality. Studies indicate that web quality is an antecedent of enjoyment is sparse. The relation was drawn for exploration purpose. Most of web quality features and dimensions: technical adequacy, content quality, specific content and appearance, in the concept and measures refers to utilitarian aspects of a system rather than hedonic ones. The researcher believe that indeed, there is no significant causal-relationship effect between web quality and enjoyment in an online VR store environment.

Insignificant direct effect between telepresence and perceived usefulness is theoretically and empirically proven by verifying that it has a strong indirect effect via informativeness. The meaning of pure causal-effect relation between telepresence and perceived usefulness is not as clearly to explain as the explanation by the indirect relations between them mediated by informativeness. In this case, the sense of being at the remote environment could induce productivity by gathering information from the virtual environment. This is also in accordance with many studies suggesting that telepresence promotes consumer investigation of merchandise (Li, 2002; Li et al., 2003; Suh & Lee, 2005). The researcher is persuaded that this direct effect between telepresence and perceived usefulness should be better dropped in the online VR store environment. This alternate model should be a more parsimonious, yet more complete, model for the study.

In addition, at first, positive effect from informativeness to usefulness is marginally unsupported; nonetheless, the modified model suggested that the hypothesis is supported according to the literature and hypothesis. The unstable relation in this

setting of VR store could come from higher irritation and cognitive load (Hausman & Siekpe, 2009; Sweller, Ayres, & Kalyuga, 2011), which is suggested as a topic for further investigation.

4.3.3 Hypothesis Testing and Research Outcomes

The researcher firstly interpret the hypothesis testing. Afterward, further analysis would give additional understanding and substantiate research findings. The research questions and hypotheses are revisited here:

1) To what extent does web quality contribute to consumers' purchase and revisit intention in an online VR store?

2) To what extent does telepresence contribute to consumers' purchase and revisit intention in an online VR store?

3) To what extent does store environment contribute to consumer's purchase and revisit intention in an online VR store?

This study hypnotized that in an online VR store setting:

H1a) Web quality is positively related to perceived usefulness.

H1b) Web quality is positively related to informativeness.

H1c) Web quality is positively related to enjoyment.

H2a) Telepresence is positively related to perceived usefulness.

H2b) Telepresence is positively related to informativeness.

H2c) Telepresence is positively related to enjoyment.

H3) Store environment is positively related to enjoyment.

H4a) Perceived usefulness is positively related to purchase intention in a VR store.

H4b) Perceived usefulness is positively related to revisit intention in a VR store.

H5a) Informativeness is positively related to purchase intention in a VR store.

H5b) Informativeness is positively related to revisit intention in a VR store.

H6a) Enjoyment is positively related to purchase intention in a VR store.

H6b) Enjoyment is positively related to revisit intention in a VR store.

H7a) Place familiarity is positively related to purchase intention in a VR store.

H7b) Place familiarity is positively related to revisit intention in a VR store.

H8) Informativeness is positively related to perceived usefulness in a VR store.

Research output from analyzing descriptive data by IBM SPSS version 21 and IBM AMOS version 21 were applied to test hypotheses. The hypotheses testing needs to involve the measurement and structural models. The measurement model in section 4.3.1 indicated that the model was appropriate for this research according to the goodness-of-fit indices.

Table 4-33 (referring to Table 4-27) presents the research hypotheses and their corresponding casual-effect variables. All of hypotheses are supported, except hypothesis 1c, 2a and 8 those are not supported due to statistical insignificance. The accepted hypothesis 1a, 1b, 2b, 2c, 3, 4a, 4b, 5a, 5b, 6a, 6b, 7a and 7b are significant at level .001 ($p < .001$). Figure 4-18 depicts research outcomes where the dash lines represent unsupported relations.

Table 4-33. Maximum Likelihood Estimates for a Recursive Path Model of Causes and Effects of Interface Factors and Store Environment–Purchase and Revisit Intention in a VR Store

Hypothesis	Casual Relations	Estimates					Results
		Unst.	*SE*	St.	*t*-values	*p*-values	
H1a	WEBQ → PU	1.303***	.107	.741	12.145	.000	Supported
H1b	WEBQ → INFO	1.124***	.080	.712	14.048	.000	Supported
H1c	WEBQ → ENJ	.049***	.057	.023	.866	.387	Not supported
H2a	TELE → PU	-.005***	.027	-.006	-.201	.841	Not supported
H2b	TELE → INFO	.170***	.029	.193	5.870	.000	Supported
H2c	TELE → ENJ	.172***	.030	.145	5.706	.000	Supported
H3	STOR → ENJ	.871***	.039	.812	22.125	.000	Supported
H4a	PU → PUR	.220***	.042	.232	5.306	.000	Supported
H4b	PU → REV	.196***	.047	.192	4.204	.000	Supported
H5a	INFO → PUR	.407***	.051	.385	7.974	.000	Supported
H5b	INFO → REV	.496***	.057	.438	8.658	.000	Supported
H6a	ENJ → PUR	.124***	.022	.158	5.746	.000	Supported
H6b	ENJ → REV	.145***	.024	.173	6.010	.000	Supported
H7a	FAM → PUR	.257***	.030	.264	8.517	.000	Supported
H7b	FAM → REV	.254***	.033	.243	7.723	.000	Supported
H8	INFO → PU	.090***	.046	.080	1.936	.053	Not supported

Note. Unst., unstandardized; St., standardized.
***$p < .001$

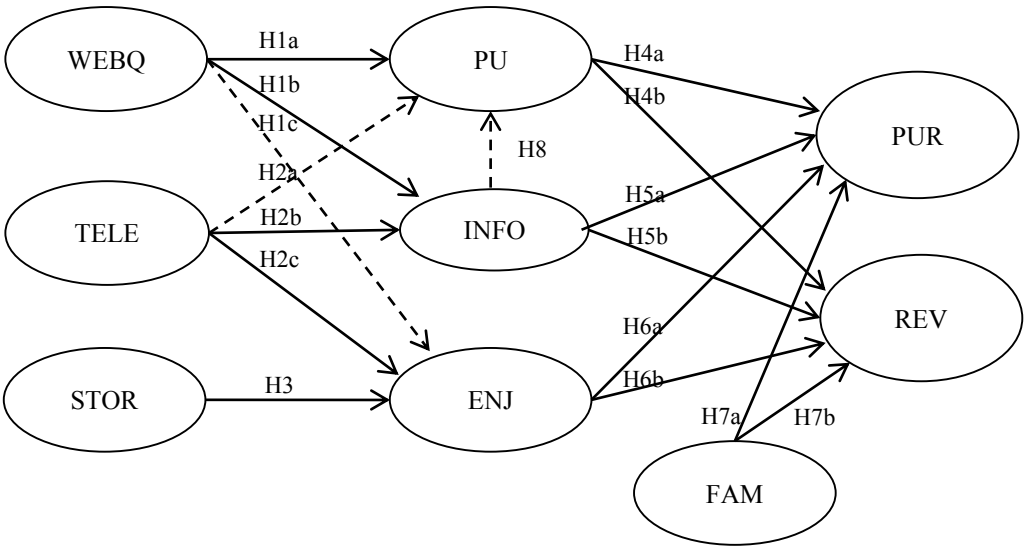


Figure 4-18. Structural model of hypothesis testing results

The hypothesis testing is reported as following. The reported coefficients reported are standardized:

H1a) Web quality is positively related to perceived usefulness. The hypothesis is highly significant supported as shown with the path coefficient of .741 ($t = 12.145$, $p < .001$).

H1b) Web quality is positively related to informativeness. The hypothesis is highly significant supported with the path coefficient of .712 ($t = 14.048$, $p < .001$).

H1c) Web quality is slightly positively related to enjoyment. It is not statistically significant with the path coefficient of .023 ($t = .866$, $p > .05$). The hypothesis is not supported.

H2a) Telepresence is not positively related to perceived usefulness. The path coefficient is minimal at -.006 ($t = -.201$, $p > .05$). The hypothesis is not supported.

H2b) Telepresence is positively related to informativeness. The hypothesis is highly significant supported with the path coefficient of .193 ($t = 5.870$, $p < .001$).

H2c) Telepresence is positively related to enjoyment. The hypothesis is highly significant supported with the path coefficient of .145 ($t = 5.706$, $p < .001$).

H3) Store environment is positively related to enjoyment. The hypothesis is highly significant supported with the path coefficient of .812 ($t = 22.125$, $p < .001$).

H4a) Perceived usefulness is positively related to purchase intention in a VR store. The hypothesis is highly significant supported with the path coefficient of .232 ($t = 5.306$, $p < .001$).

H4b) Perceived usefulness is positively related to revisit intention in a VR store. The hypothesis is highly significant supported with the path coefficient of .192 ($t = 4.204$, $p < .001$).

H5a) Informativeness is positively related to purchase intention in a VR store. The hypothesis is highly significant supported with the path coefficient of .385 ($t = 7.974$, $p < .001$).

H5b) Informativeness is positively related to revisit intention in a VR store. The hypothesis is highly significant supported with the path coefficient of .438 ($t = 8.658$, $p < .001$).

H6a) Enjoyment is positively related to purchase intention in a VR store. The hypothesis is highly significant supported with the path coefficient of .158 ($t = 5.746$, $p < .001$).

H6b) Enjoyment is positively related to revisit intention in a VR store. The hypothesis is highly significant supported with the path coefficient of .173 ($t = 6.010$, $p < .001$).

H7a) Place familiarity is positively related to purchase intention in a VR store. The hypothesis is highly significant supported with the path coefficient of .264 ($t = 8.517$, $p < .001$).

H7b) Place familiarity is positively related to revisit intention in a VR store. The hypothesis is highly significant supported with the path coefficient of .243 ($t = 7.723$, $p < .001$).

H8) Informativeness is positively related to perceived usefulness in a VR store. The hypothesis is not supported with the path coefficient of .080 (t = 1.936, p > .05). However, the hypothesis is supported in the alternative model with the path coefficient of .079 (t = 1.973, p < .05).

The insignificant paths were dropped and the model were re-specified for any other possible theoretical contributions. Finally, the hypotheses are putting together with the alternative model to answer research questions serving research objectives. In Figure 4-19, the dash lines are the added relations. The dash lines representing insignificant relations in Figure 4-18 were removed, except for the hypothesis 8 that shows significant in the alternative model.

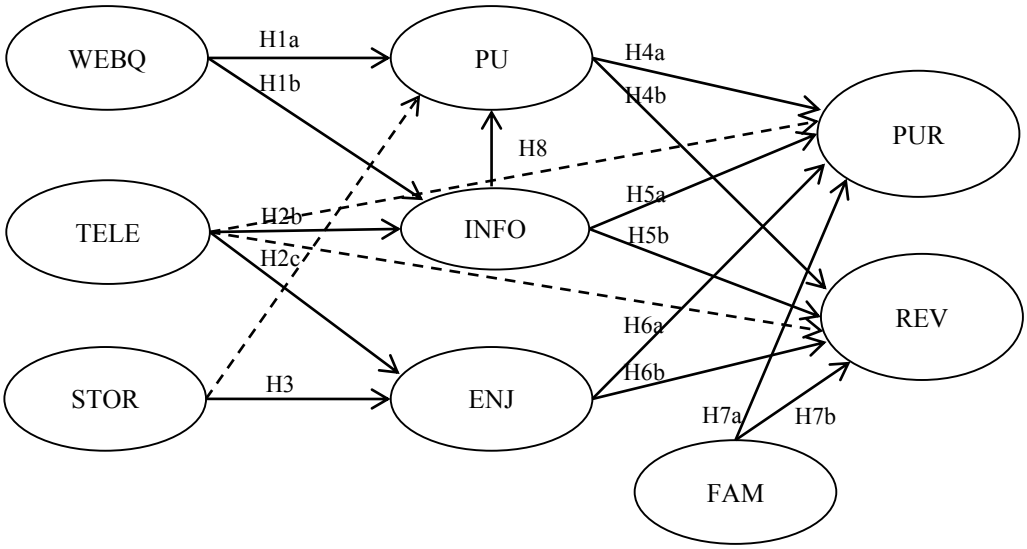


Figure 4-19. Structural model of the alternative model

1) To what extent does web quality contribute to consumers' purchase and revisit intention in an online VR store?

Web quality is positively related to purchase intention and revisit intention in an online VR store through mediation of perceived usefulness and informativeness. Hypothesis 1a, 1b, 8, 4a and 5a are significant paths connect web quality to purchase intention, and hypothesis 1a, 1b, 8, 4b and 5b are significant paths connect web quality

to revisit intention. The standardized total effect of web quality contributing to purchase intention is .386, and to revisit intention is .387.

Web quality positively affects purchase intention by firstly contributing to perceived usefulness (H1a) and then to purchase intention (H4a). It also positively affects purchase intention by contributing to informativeness (H1b). From informativeness, the effect contributes directly to purchase intention (H5a), as well as indirectly through perceived usefulness (H8) and (H4a). Similarly, web quality positively affects purchase intention by firstly contributing to perceived usefulness (H1a) and then to purchase intention (H4b). It also positively affects purchase intention by contributing to informativeness (H1b). From informativeness, the effect contributes directly to purchase intention (H5b), as well as indirectly through perceived usefulness (H8) and (H4b).

2) To what extent does telepresence contribute to consumers' purchase and revisit intention in an online VR store?

Telepresence is positively related to purchase intention and revisit intention in an online VR store through mediation of perceived usefulness, informativeness and enjoyment. Hypothesis 2b, 2c, 8, 4a, 5a and 6a are significant paths connect telepresence to purchase intention, and hypothesis 2b, 2c, 8, 4b, 5b and 6b are significant paths connect telepresence to revisit intention. Furthermore, the re-specification revealed significant direct effects between telepresence on both purchase and revisit intention. The standardized total effect of telepresence contributing to purchase intention is .330, and to revisit intention is .364.

Telepresence positively affects purchase intention by firstly contributing to informativeness (H2b). From informativeness, the effect contributes directly to purchase intention (H5a), as well as indirectly through perceived usefulness (H8) and (H4a). It also positively affects purchase intention by contributing to enjoyment (H2c) then to purchase intention (H6a). Similarly, telepresence positively affects purchase intention by firstly contributing to informativeness (H2b). From informativeness, the effect contributes directly to purchase intention (H5b), as well as indirectly through

perceived usefulness (H8) and (H4b). It also positively affects purchase intention by contributing to enjoyment (H2c) then to purchase intention (H6b).

3) To what extent does store environment contribute to consumer's purchase and revisit intention in an online VR store?

Store environment is positively related to purchase intention and revisit intention in an online VR store through mediation of perceived usefulness and enjoyment. Hypothesis 3a and 6a are significant paths connect store environment to purchase intention, and hypothesis 3a and 6b are significant paths connect store environment to revisit intention. In addition, the re-specified model suggested that store environment also affects purchase and revisit intention through perceived usefulness and path H4a and H4b. The standardized total effects of store environment contributing to purchase intention is .098, and to revisit intention is .102.

Store environment positively affects purchase intention by firstly contributing to enjoyment (H3) then to purchase intention (H6a). In addition, store environment also firstly affects perceived usefulness and then to perceived usefulness via path H4a. Similarly, store environment positively affects revisit intention by firstly contributing to enjoyment (H3) then to purchase intention (H6b). In addition, store environment also firstly affects perceived usefulness and then to perceived usefulness via path H4b.

The standardized total effects from mediators to behavioral intention of purchase intention are .246, .292 and .102 for perceived usefulness, informativeness and enjoyment, respectively. The standardized total effects from mediators to behavioral intention of revisit intention are .208, .351 and .110 for perceived usefulness, informativeness and enjoyment, respectively. Other effects from exogenous and endogenous variables to other endogenous variables are direct effects which values are already reported.

Hypothesis 7a and 7b was added to answer a supplemental research question. Merchants with a physical store might wonder whether a VR store should be implemented to look the same as an existing physical store. The question of “To what

extent does place familiarity contribute to purchase and revisit intention in and online VR store?" could lead to a suggestion whether a VR store should imitate a physical store. A significant positive effect of place familiarity toward purchase intention suggests that a retailer that already has a physical store should consider implementing a VR store to look like its physical retail store.

4.4 Conclusion

This chapter presented results of data analysis for this research. First, preliminary data analysis techniques including cleaning and screening of data were examined. Demographic of respondents were presented as descriptive statistics. Considering accuracy of data in terms of outliers, normality and transforming data were applied to create new variables. CFA of variables and modification measurement model was performed for reliable and valid constructs for further analyses.

Structural equation modelling was then applied to estimate the model. A better fit model according to the data was determined by the modification indices and supporting theories. Finally, the main analyses test the research hypotheses and the outcomes were explained. Conclusions of this research are presented in chapter 5.

CHAPTER V

FINDINGS, CONCLUSIONS, AND IMPLICATIONS

In this chapter, the research is concluded. The first section provides an overview of the entire study. It briefly revisited problems, research questions, mainstream literatures, and methodology. The characteristics of samples are noted. The next section reviews all of the findings from the statistical analysis of data. The following section gives the conclusions and discussions of this research; it is based on the research questions and it brings the research into full circle discussion. Afterward, the contributions and suggestions are outlined in the implication section. Any research opportunities for further study are raised in the future research section. The last section sums up the entire study.

5.1 Summary of the Study

VR-commerce is a promising technology and becoming more popular but there are still opened and active issues and challenges. The study provides fundamental concepts and related works leading to several possible highlighted research questions. Lack of research on relationships between principal functional and non-functional factors toward consumer shopping behavior is a major literature gap. Web-based commerce interface factors, telepresence, and store environment, which are the principal element of the traditional offline retail commerce, are extracted as the essential functional and non-functional factors. They are posited to be predictors for consumer purchase intention in and revisit to a VR store.

Relevant concepts of e-commerce, VR-commerce, and physical retail store are introduced and discussed, drawing that interface factors in traditional e-commerce (web quality), VR-commerce (telepresence), and artifacts embedded in the interaction environment (store environment) are predictors of consumers' behavior being studied. Relations between constructs are based primarily on the joining of Theory of Acceptance Model (TAM), Theory of Reasoned Action (TRA), Stimulus-Organism-Response theory (S-O-R), and use and gratification.

The study aims to answer the following research questions: (1) To what extent does web quality contribute to consumers' purchase intention and revisit intention in an online VR store mediated by perceived usefulness, informativeness, and enjoyment?; (2) To what extent does telepresence contribute to consumers' purchase intention and revisit intention in an online VR store mediated by perceived usefulness, informativeness, and enjoyment?; and (3) To what extent does store environment contribute to consumer's purchase intention and revisit intention in an online VR store mediated by enjoyment?

To answer research questions the following hypothesis were formulated and depicted in Figure 5-1:

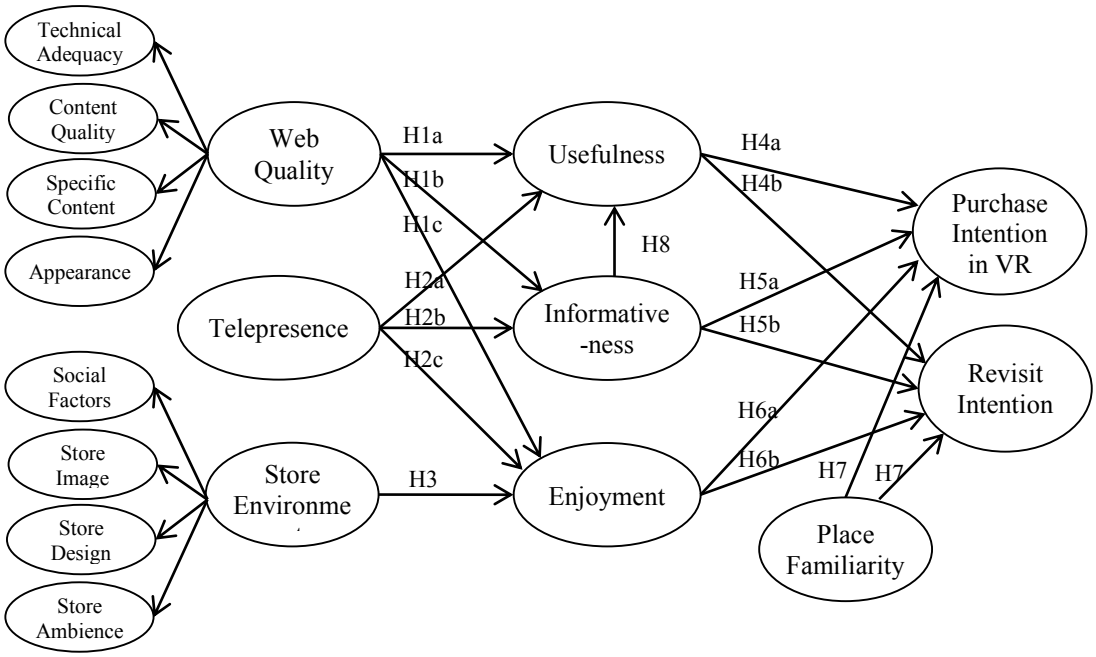


Figure 5-1. Research framework for summary of the study

H1) Web quality is positively related to perceived usefulness (H1a), informativeness (H1b), and enjoyment (H1c) in an online VR store.

H2) Telepresence is positively related to perceived usefulness (H2a), informativeness (H2b), and enjoyment (H2c) in an online VR store.

H3) Store environment is positively related to enjoyment in an online VR store.

H4) Perceived usefulness is positively related to purchase intention (H4a) and revisit intention (H4b) in an online VR store.

H5) Informativeness is positively related to purchase intention (H5a) and revisit intention (H5b) in an online VR store.

H6) Enjoyment is positively related to purchase intention (H6a) and revisit intention (H6b) in an online VR store.

H7) Place familiarity is positively related to purchase intention (H7a) and revisit intention (H7b) in an online VR store.

H8) Informativeness is positively related to perceived usefulness in an online VR store.

The study employed quantitative approach of structural equation modelling to test the hypothesis and estimate the effects. The measurement instruments were developed based on previous published literatures. An innovative virtual reality book store was developed for the online VR store setting. Pilot study sessions were performed. The population are students in a university of technology in Thailand and the samples were drawn by convenience sampling. The data collection was based mainly on survey conducting in laboratory sessions by having participants complete a shopping transaction in an online virtual reality book store. The study drawn 1,311 participants. The analyses of data reveal the findings as follows.

5.2 Findings

Web quality is a construct composed of four dimensions: technical adequacy, content quality, specific content and appearance. Store environment is a construct composed of four dimensions: social factors, store image, store design and store ambience.

Table 5-1 (a revisit to Table 4-27) presents the research hypotheses and their corresponding casual-effect variables. All of hypotheses are accepted, except

hypothesis 1c, 2a and 8 those are not accepted. The accepted hypothesis 1a, 1b, 2b, 2c, 3, 4a, 4b, 5a, 5b, 6a, 6b, 7a and 7b are significant at level .001 ($p < .001$). Figure 5-2 depicts research outcomes.

Table 5-1. Maximum likelihood estimates for a recursive path model of causes and effects of interface factors and store environment–purchase and revisit intention in an online VR store (revisited for summary of the study)

Parameters	Unst.	SE	St.	t-values	p-values
WEBQ → PU	1.303***	.107	.741	12.145	.000
WEBQ → INFO	1.124***	.080	.712	14.048	.000
WEBQ → ENJ	.049***	.057	.023	.866	.387
TELE → PU	-.005***	.027	-.006	-.201	.841
TELE → INFO	.170***	.029	.193	5.870	.000
TELE → ENJ	.172***	.030	.145	5.706	.000
STOR → ENJ	.871***	.039	.812	22.125	.000
PU → PUR	.220***	.042	.232	5.306	.000
PU → REV	.196***	.047	.192	4.204	.000
INFO → PUR	.407***	.051	.385	7.974	.000
INFO → REV	.496***	.057	.438	8.658	.000
ENJ → PUR	.124***	.022	.158	5.746	.000
ENJ → REV	.145***	.024	.173	6.010	.000
FAM → PUR	.257***	.030	.264	8.517	.000
FAM → REV	.254***	.033	.243	7.723	.000
INFO → PU	.090***	.046	.080	1.936	.053

***$p < .001$, **$p < .01$, *$p < .05$

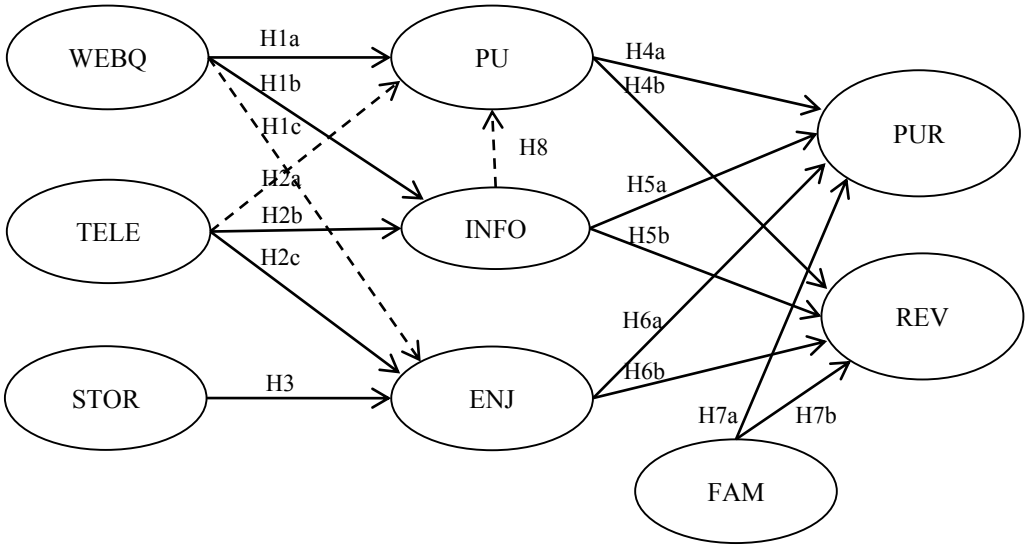


Figure 5-2. Structural model of hypothesis testing results (revisited for summary of the study).

The hypothesis testing is reported as follows. Statistics for hypothesis testing are not repeated if not necessary. The related values could be find in the prior tables and in chapter 4:

Web quality is positively related to perceived usefulness. The hypothesis 1a is highly significant supported as shown with the path coefficient. Web quality is positively related to informativeness. The hypothesis 1b is highly significant supported. Web quality is positively related to enjoyment. The hypothesis 1c is not supported due to statistically insignificant however the effect is positive.

Telepresence is not related to perceived usefulness. The hypothesis 2a is not supported due to statistically insignificant. The effect is relatively minimal at a coefficient of -.006. Telepresence is positively related to informativeness. The hypothesis 2b is highly significantly supported. Telepresence is positively related to enjoyment. The hypothesis 2c is highly significantly supported. Store environment is positively related to enjoyment. The hypothesis 3 is highly significantly supported.

Perceived usefulness is positively related to purchase intention in a VR store. The hypothesis 4a is highly significantly supported. Perceived usefulness is positively related to revisit intention in a VR store. The hypothesis 4b is highly significantly supported. Informativeness is positively related to purchase intention in a VR store. The hypothesis 5a is highly significantly supported. Informativeness is positively related to revisit intention in a VR store. The hypothesis 5b is highly significantly supported. Enjoyment is positively related to purchase intention in a VR store. The hypothesis 6a is highly significantly supported. Enjoyment is positively related to revisit intention in a VR store. The hypothesis 6b is highly significantly supported.

Place familiarity is positively related to purchase intention in a VR store. The hypothesis 7a is highly significant supported. Place familiarity is positively related to revisit intention in a VR store. The hypothesis 7b is highly significant supported. Finally, informativeness is positively related to perceived usefulness in a VR store. The hypothesis 8 is at the borderline and currently not supported.

Further analysis suggested that there are remaining natural direct effects between telepresence to purchase and revisit intention in an online VR store. Store environment also slightly exhibit its influence on perceived usefulness.

5.3 Conclusions and Discussions

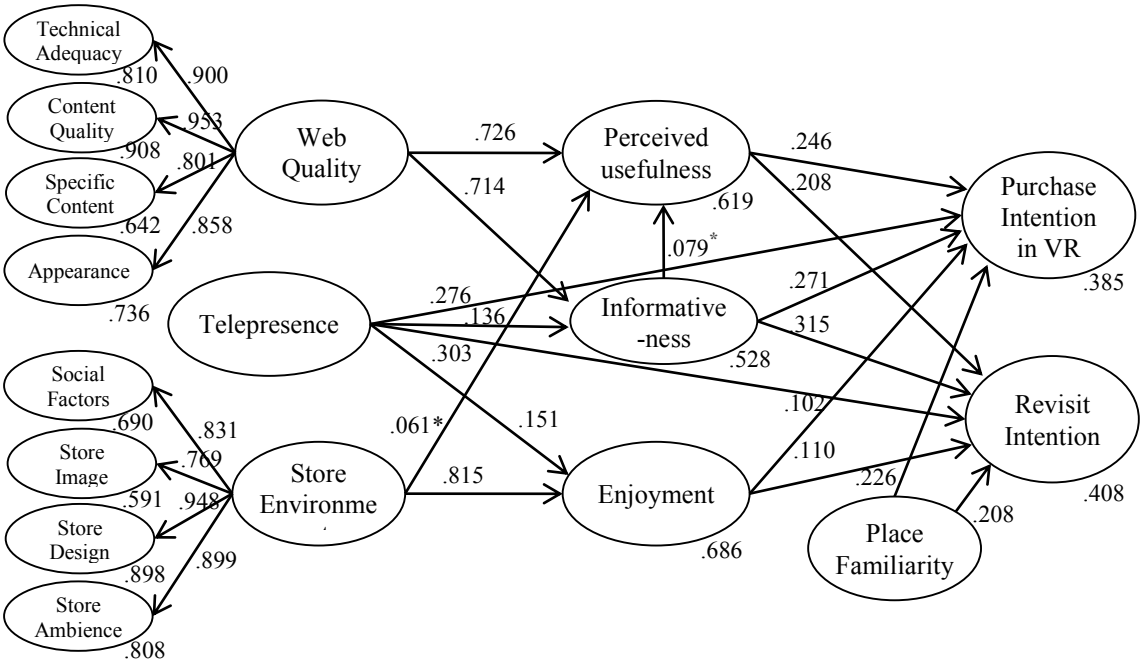
E-commerce has become a significant global economic force. Online retail stores need to continuously evolve themselves by building any competitive advantage to compete. A strategy to enhance shopping experience by an innovative shopping environment by virtual reality store is increasing in its popularity. Having been missing in literatures, foundation features of virtual reality store are determined and investigated for their contributions toward consumers' shopping intention. An extensive literature review suggested that web quality, telepresence and store environment are foundation interface factors and properties embedded in a VR store that influence consumer purchase and revisit intention. Thus, the study aims to answer the following research questions:

1. **To what extent does web quality contribute to consumers' purchase intention and revisit intention in an online VR store mediated by perceived usefulness, informativeness, and enjoyment?**
2. **To what extent does telepresence contribute to consumers' purchase intention and revisit intention in an online VR store mediated by perceived usefulness, informativeness, and enjoyment?**
3. **To what extent does store environment contribute to consumer's purchase intention and revisit intention in an online VR store mediated by enjoyment?**

As expected, the results revealed that the hypothesized factors contribute to consumer purchase and revisit intention. Rationales behind their contributions can be understood by their explaining mediators. However, the empirical analysis revealed minor different views for rethinking about this particular online e-commerce setting as the following explanation and discussions. The discussions begin with the overall

explanation, and then each research question is discussed. Figure 5-3 draws the final structural model of the study as analyzed and discussed.

Most of the hypothesized relations are supported according to the literature reviewed, while certain relations were dropped and added by the arguments for removing insignificant relations, and theories support relation between store environment and perceived usefulness as discussed in Chapter 4. The relation between web quality and enjoyment was insignificant since web quality is more concerned on utilitarian than hedonic aspects. The direct effect from telepresence to perceived usefulness was dropped due to the evidence that it is medicated through informativeness. The effect of store environment towards perceived usefulness was significant as the store and merchandize layout might affect shopping efficiency. The relation between informativeness and perceived usefulness is kept since it was positively significant in the alternative model.



*$p < .05$, other relations are significant at .001 ($p < .001$)

Figure 5-3. The final structural model of the study

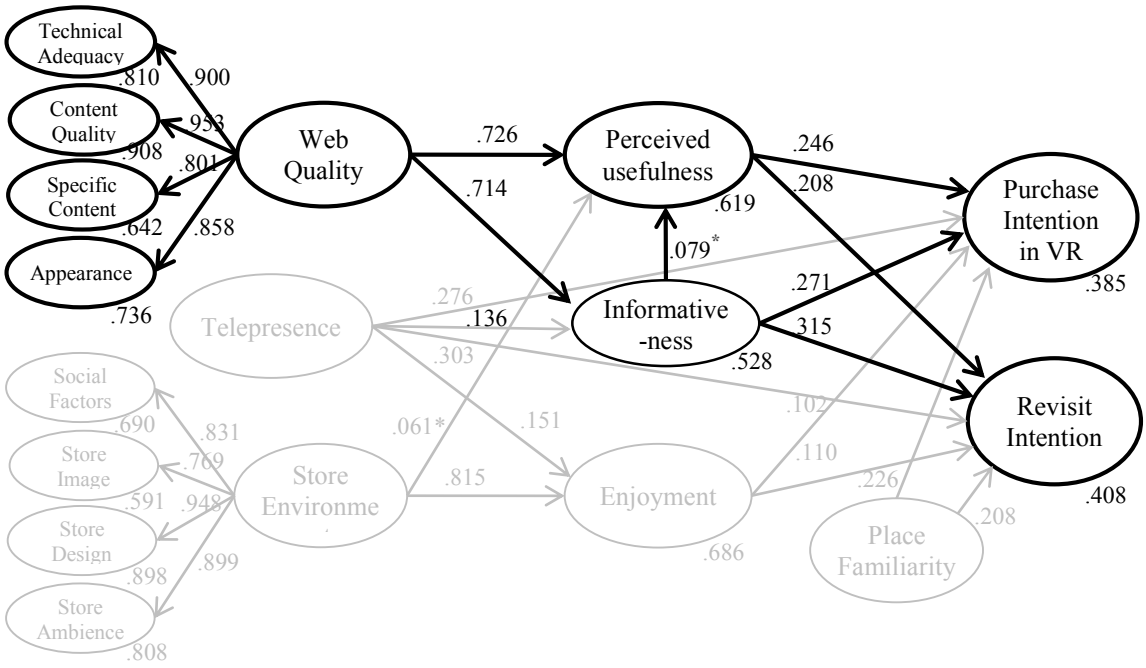
The study suggested that antecedents in the study can explain the behavioral intention of purchase intention at 38.5% and of revisit intention, almost equally, at 40.8%, according to the R^2. Starting from the right side of the model, it revealed that cognitive beliefs (perceived usefulness and informativeness) higher contribute than affective believe (enjoyment) to consumers' behavioral intention in an online VR store. For example, any increasing in perceived usefulness for 1 standard deviation, purchase intention would increase for a multiplication of .246, which is the coefficient of the relation path between perceived usefulness and purchase intention. The value is comparable to .271, the contribution of informativeness toward purchase intention. While contribution of enjoyment toward purchase intention can be comparatively measured with a coefficient of .106, roughly half of those affective belief. Contribution from each explaining mediator toward behavioral intention are comparatively equal. The characteristics of relations between mediators toward purchase intention are similar and comparatively equivalent to of those mediators toward revisit intention.

Practitioners can apply this findings to prioritize or correctly focus VR store features that promote shopping activities. To promote perceived usefulness to the system, practitioners should focus more on promoting web quality with the path coefficient of .726 much higher than other VR store features. Web quality also the main contribution of informativeness with a path coefficient of .714. On the other hand, for promoting enjoyment, store environment is the highest contributor by coefficient of .815.

However, promoting consumer's purchase is possible to simpler focus on the features by analyzing total effects of exogenous variables toward behavioral intention. Standardized total effects of exogenous variables toward purchase intention are .386, .330, .098 and .226 for web quality, telepresence, store environment and place familiarity, respectively. Standardized total effects of exogenous variables toward revisit intention are .387, .364, .102 and .208 for web quality, telepresence, store environment and familiarity respectively. Practitioners can consider the comparative important of the coefficient for efforts allocation.

The following research question discussions provide further understanding to the results.

1) To what extent does web quality contribute to consumers' purchase and revisit intention in an online VR store?



*$p < .05$, other relations are significant at .001 ($p < .001$)

Figure 5-4. Structural model of significant paths from web quality to consumers' shopping behavioral intention.

Web quality is significantly and positively related to purchase intention and revisit intention in an online VR store through mediation of perceived usefulness and informativeness (see Figure 5-4). The standardized total effects of web quality contributing to purchase intention is .386, and to revisit intention is .330 suggested that consumers tend to grow their intention to purchase and revisit in an online VR store if the web quality is higher by a moderate degree.

These relationship can be explained by its explaining mediators. Web quality positively affects purchase and revisit intention by firstly contributing to perceived

usefulness, then to purchase and revisit intention. It also positively affects purchase and revisit intention by contributing to informativeness. From informativeness, the effect contributes directly to purchase and revisit intention, as well as indirectly through perceived usefulness. Web quality total effects to explaining mediators induce comparative degrees of cognitive beliefs by the standardized coefficients of .782 and 0.714 to perceived usefulness and informativeness respectively.

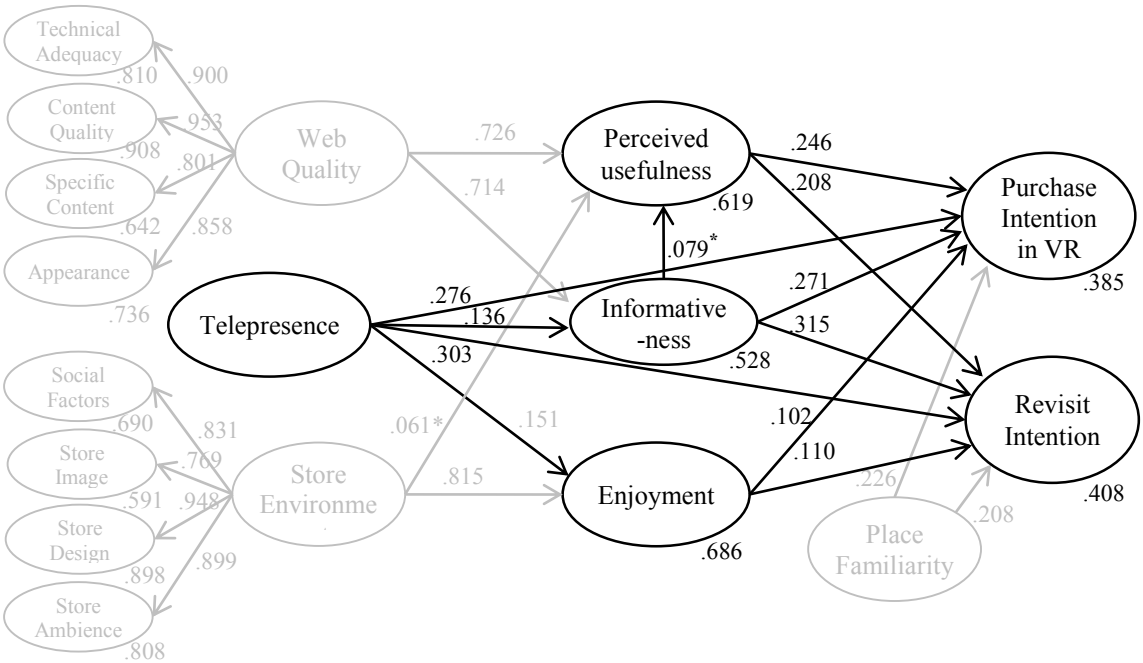
These findings confirmed several studies, which once dominate research in e-commerce adoption. Researchers establish this field by multiple confirmations that cognitive beliefs, i.e. perceived usefulness, informativeness, and sometimes, perceived ease of use, play crucial roles in explaining consumers' physiological process of e-commerce shopping (Ahn et al., 2007; Hausman & Siekpe, 2009; Loiacono et al., 2002; Monsuwé et al., 2004).

Affective beliefs like enjoyment or entertainment having been recognized as important explaining constructs contribute to online consumer's shopping behaviors are not significantly related to web quality, especially in VR store setting. Besides, the size of sample set, the researcher stand by the empirical evidence that the dataset represents the real phenomenon of this setting of virtual reality. Studies indicate that web quality is an antecedent of enjoyment is sparse. Most of web quality features and dimensions: technical adequacy, content quality, specific content and appearance, in the concept and measures refers to utilitarian aspects of a system rather than hedonic ones. The researcher believe that indeed, there is no significant causal-relationship effect between web quality and enjoyment in an online VR store environment.

It can also be concluded that even in an interactive-rich setting like VR environment, not only did appropriate implementation of fundamental web features cannot be negligible, it is crucial. The standardized total effects from mediators to behavioral intention consequence of purchase intention of .386, .330, .098 and .226 for web quality, telepresence, store environment and place familiarity, respectively. Standardized total effects of exogenous variables toward revisit intention are .387, .364, .102 and .208 for web quality, telepresence, store environment and place familiarity,

respectively, indicating that web quality is the most important interface factor in online VR store. It is not surprised since today's online VR environment is still embedded in web interface. The implementation guidelines for web features are almost off-the-shelves by following concrete web quality checklists: technical adequacy, content quality, specific content and native web appearance.

2) To what extent does telepresence contribute to consumers' purchase and revisit intention in an online VR store?



*$p < .05$, other relations are significant at .001 ($p < .001$)

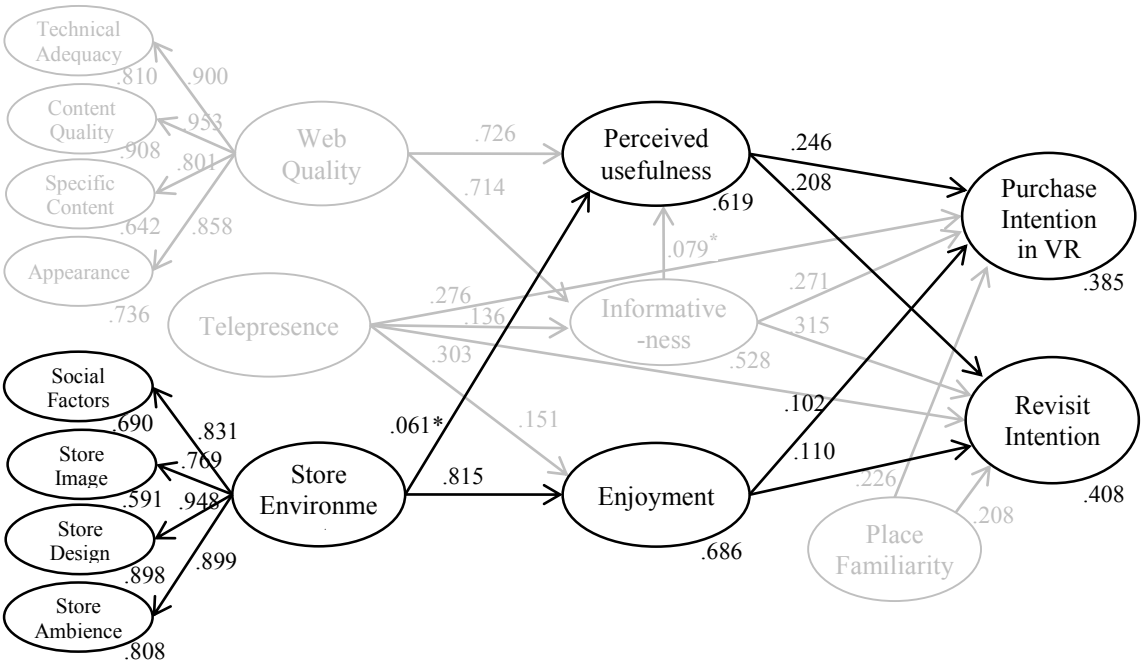
Figure 5-5. Structural model of significant paths from telepresence to consumers' shopping behavioral intention.

Telepresence is all the way positively related to purchase intention and revisit intention in an online VR store through mediation of perceived usefulness, informativeness and enjoyment (see Figure 5-5). The standardized total effects of

telepresence contributing to purchase intention is .330 and to revisit intention is .364 indicate a comparatively as important as web quality factor.

How telepresence affects shoppers behavioral intention can be explained in this way. Telepresence positively affects purchase intention by firstly contributing to informativeness. From informativeness, the effect contributes directly to purchase intention, as well as indirectly through perceived usefulness. It also positively affects purchase intention by contributing to enjoyment then to purchase intention. Contributing effect of telepresence to revisit intention finally reaches revisit intention from purchase intention. Telepresence, thus, is the only VR foundation interface factors that significantly induce all cognitive and affective beliefs resulting in consumers' shopping intention. This revealed efforts practitioners should weigh in when deliver VR features. The findings add to the contribution of the study of (Hendaoui & Limayem, 2008b) posited that many aspect of presence contribute to consumers' purchase intention. This confirmed studies forming the discussed research framework and hypotheses completely referred in Chapter 2.

3) To what extent does store environment contribute to consumer's purchase and revisit intention in an online VR store?



*$p < .05$, other relations are significant at .001 ($p < .001$)

Figure 5-6. Structural model of significant paths from store environment to consumers' shopping behavioral intention.

Store environment is positively related to purchase intention and revisit intention in an online VR store through mediation of perceived usefulness and enjoyment (see Figure 5-6). The standardized total effect of store environment contribute to purchase intention is .098, and to revisit intention is .102. Thus, it revealed that store environment effects embedded in web interface significantly contribute to consumers' shopping intention. It is the major contributor to enjoyment. Thus, to promote shoppers' enjoyment, merchants could focus on improving store environment of the VR store.

4) **To what extent does place familiarity contribute to consumer's purchase and revisit intention in an online VR store? (Supplemental Question)**

A supplemental research question is asked. Merchants with a physical store might wonder whether a VR store should be implemented to look the same as an existing physical store. The question of "To what extent does place familiarity contribute to purchase and revisit intention in and online VR store?" could lead to a suggestion whether a VR store should imitate a physical store. A significant positive effect of place familiarity toward purchase intention suggests that a retailer that already has a physical store should consider implementing a VR store to look like its physical retail store.

5.4 Contributions and Implications

5.4.1 Theoretical Contributions

The study established several original contributions in online VR store environment, partly confirmed concepts in e-commerce adoption, and expand e-commerce research territory.

First, it identifies foundation interface and specific factors in an online VR store that positively influent consumer purchase and revisit intention. Previous studies on high level VR conceptualization (Goel et al., 2011; Goel & Prokopec, 2009; Hendaoui & Limayem, 2008b) were limited in its application contributions while on another end, several studies focused on VR interface features were failed to be backed-up by theories (Satidchoke Phosaard, Pimmanee Rattanawicha, & Wachara Chantatub). This study filled in the gap of literatures where the elementary VR factors and their relationships in an online VR store were identified and explained, and bridged high level concepts for a more concrete operationalization.

Second, it demonstrated that physical store environment, a profoundly important element in retail stores, also exhibits its roles in virtual reality environment. This infiltration of brick-and-mortar stores' characteristics into point-and-click stores initiate abundance of research opportunities. It is also the main contributor inducing

enjoyment in an online VR store. Thirdly, the study recognized that web quality is still hold its vital roles in online e-commerce even though virtual reality store is the market place. Fourthly, telepresence, is the only factor that significantly induce all primary salient beliefs known to drive consumers to shop online and theorized in this study. It also contributes to consumers' intention as high as web quality.

Last, the study's empirical findings confirm that cognitive and affective beliefs of perceived usefulness, informativeness and enjoyment are main psychological interpreters behind consumers' purchase and revisit intention in an online store.

5.4.2 Practical Implications

It is the first time that the basic interface factors and store environment factor are taken into consideration to provide a better understanding of VR store shopping intention and basic implementation guidelines. Especially for merchants and developers' standpoints, it can provide managerial guidelines in offering a set of appropriate features to be implemented from the onset of the store for successful VR store services. The group of functional and non-functional features are categorized into group of web quality, telepresence and store environment. Features of web quality and store environment can be provided more concrete from this study. The measurement instruments of this study, provides a list of features for practitioners to consider to implement and it can be used by practitioners and consumers to evaluate a VR store.

Merchants and developers may consider put more efforts and resources into web quality and telepresence features which contribute more to consumers' purchase and revisit intention in online store; while they can put more efforts and resources more into store environment details and features related to telepresence if they would like to promote consumers' enjoyment.

Moreover, physical store marketing application in VR store has been overlooked. Although required further study, virtually, all marketing activities and tricks can be performed over the VR store, e.g., advertisement, promotion, concept of

instant purchase, etc. Merchants might consider trying to offer activities or other innovative activities in this environment.

Another practical contribution from this study is how to develop this novel VR store. Although it might be considered as a by-product according to the objectives of the study, the development of an X3D VR bookstore documents details of implementation that developers can follow. Merchants and developers should consider offer a VR store based on this standard that can be browsed instantly by any web browser in the near future.

5.5 Limitations

This study is not without limitations. The first limitation of this study is that it is cross sectional. However, online retailed e-commerce is dynamic in its development. Therefore, a longitudinal survey is suggested to identify the changing roles of VR store features as perceived by consumers alongside VR technology advancement and consumers continuously use of online VR stores. The use of students as a population for survey sessions poses as a second limitation. This study recognizes that student samples have often been criticized for their lack of generalizability and their inability to represent the population of interest (Gordon, Slade, and Schmitt, 1987), but may be valid in this case where online shoppers tend to be younger and more educated than the general population (Hausman & Siekpe, 2009). They are also stakeholders in book shopping and as further discussed in the sampling section. The characteristics of products in this study, books, which exhibit a certain level of virtual experience (Suh & Lee, 2005), may also limited the generalization of the study. The generalization to more expensive merchandises is also limited. Consumers' shopping behaviors using virtual reality varies upon virtual experience characteristics of products.

Finally, there are many other factors that can influence the shopping experience. For example, with the proliferation of broadband technologies or development of input and display technology, like touch screen, motion detector, and 3D display, the shopping experience becomes richer and more engaging. Future research can study the

impact of other variables such as time-related factors (e.g. download time), telepresence and other.

5.6 Future Research

In case of drawing from this research design and limitations, confirmation on other groups of population, other types of products, different input and output devices, or in a real-world commercial settings to confirm or compare the phenomenon is suggested. This might verifies and outlines better managerial action for real-world achievement in providing online VR store service.

In addition, since properties of physical store are proven to be carried on to the VR store, there is a plethora of future investigation. For information technology and HCI perspective, foundation factors are determined so that concrete interface features should be identified. Particular web quality factors and store environment those might be exclusively important in the VR store environment can be investigate. Features of VR store exhibiting telepresence can now be systematically identified and theoretically supported. For marketing research perspective, marketing activities, retail consumer behaviors, etc., in VR store or beyond, are motivating topics. These areas are important for researchers to understand human behaviors in virtual worlds which is an alternative platform where people connect in the near future. Examples of research questions could be: Which kind of advertisement are more effective in VR store? How to stimulate more spending? Moreover, the pervasive use of mobile devices is another remarkable setting for VR commerce research. The proliferation use of augmented reality (AR), another related technology, makes it appealing to explore.

Especially for managerial side, practical research like investigating the optimum investment for VR store implementation, which needs special expertise, is business-driven significant. Customer contacts and services in VR store landscape might need revision to manage customer relationship.

On the technical side, there are rooms to innovate user interface and input/output devices serving VR store shopping. Example of research questions could be: What are

appropriate user interface devices for VR store shopping? How to improve the speed of the virtual environment rendering? The following matured, yet still open and active, topics are revisited:

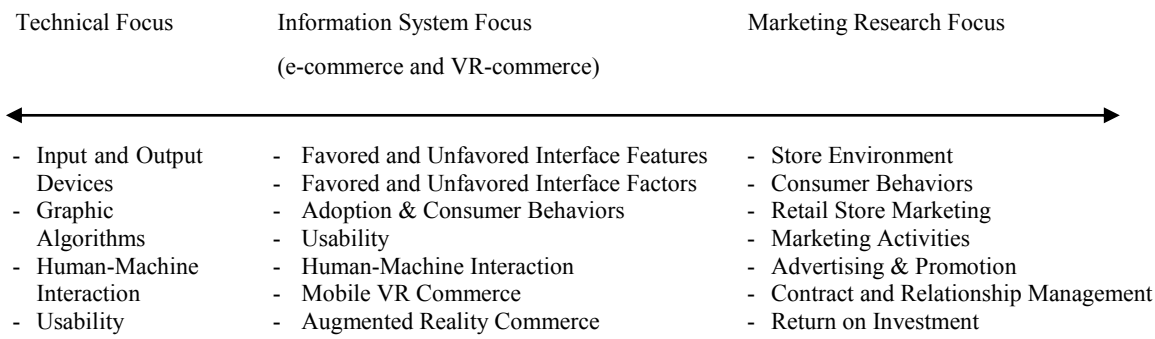


Figure 5-7. Open areas for research opportunities for online VR store.

5.7 Summary

E-commerce market is undeniably enormous and expanding. Online retailers usually aim to attract more visitors and convert them into customers who actually purchase the products or services and also return to shop to regenerate revenue. To achieve this goal, these stores need to endeavor to enhance customers' shopping experience. Online retail stores need to continuously evolve themselves by building any competitive advantage to compete. The marketing convergence, where information technology, marketing and design orchestrated, in today's e-commerce competitive environment requires rich-media platform suggested that VR commerce is a prominent candidate for the forthcoming e-commerce practice.

The study provides fundamental concepts and related works leading to several possible highlighted research questions. Lack of research on relationships between principal functional and non-functional factors toward consumer shopping behavior is a major literature gap. Web-based commerce interface factors, telepresence, and store environment (the principal element of the traditional offline retail commerce) are extracted as the essential functional and non-functional factors, which are posited to be predictors for consumer purchase intention in and revisit to a VR store.

Relevant concepts of e-commerce, VR-commerce, and physical retail store are introduced and discussed, drawing that interface factors in traditional e-commerce (web quality), VR-commerce (telepresence), and artifacts embedded in the interaction environment (store environment) are predictors of consumers' behavior being studied. Relations between constructs are based primarily on the joining of Theory of Acceptance Model (TAM), Theory of Reasoned Action (TRA), stimulus-organism-response theory (S-O-R), and use and gratification. Antecedents of consumer purchase and revisit intention on website, VR store and physical store contribute to the formulation of research framework.

The study aims to answer the following research questions: (1) To what extent does web quality contribute to consumers' purchase intention and revisit intention in an online VR store mediated by perceived usefulness, informativeness, and enjoyment?; (2) To what extent does telepresence contribute to consumers' purchase intention and revisit intention in an online VR store mediated by perceived usefulness, informativeness, and enjoyment?; and (3) To what extent does store environment contribute to consumer's purchase intention and revisit intention in an online VR store mediated by enjoyment?

The study employed quantitative approach of structural equation modelling to test the hypothesis and estimate the effects. The measurement instruments were developed based on previous published literatures. An innovative virtual reality book store was developed for the online VR store setting. The population are online shoppers in Thailand and the samples were drawn by convenience sampling of students in a university of technology in Thailand. The data collection was based mainly on survey conducting in laboratory sessions by having participants complete a shopping transaction in an online virtual reality book store. The study drawn 1,311 participants.

The results suggested that all identifies foundation factors are significantly drive consumers' purchase and revisit intention. Web quality and telepresence factors contribute more than store environment. Web quality could induce informative and perceived usefulness. Telepresence could induce all primary beliefs: perceived

usefulness, informativeness and enjoyment. And store environment can induce consumers' perceived usefulness and enjoyment. The cognitive beliefs, perceived usefulness and informativeness, more contribute than affective belief, enjoyment, to consumers' purchase and revisit intention in an online VR store.

For merchants and developers' standpoints, this study provides managerial guidelines in offering a set of appropriate features to be implemented from the onset of the store for successful VR store services. A list of features for practitioners is provided to implement and it can be used by practitioners and consumers to evaluate a VR store. Merchant and developers can strategically allocate efforts and resources into VR store development. The successful implementation encourage merchants to bring marketing activities and tricks, e.g., advertisement, promotion, concept of instant purchase, etc., from retail store on to this platform.

The development of an X3D VR bookstore documents details of implementation that developers can follow. Merchants and developers can offer a VR store based on this standard that can be browsed instantly by any web browser in the near future.

In case of drawing from this research design and limitations, confirmation on other groups of population, other types of products, different input and output devices, or in a real-world commercial settings to confirm or compare the phenomenon is suggested. This might verifies and outlines better managerial action for real-world achievement in providing online VR store service.

In addition, since properties of physical store are proven to be carried on to the VR store, there is a plethora of future investigation. This includes development in technical hard ware and software field, human-computer interaction, information system, marketing and business administration.

In short, this study determined foundation factors (web quality, telepresence and store environment) that drive consumers' behavioral intention (purchase and revisit intention) in VR store commerce environment and explained consumer's physiological rationales behind them. It showed that the brick-and-mortar store and point-and-click

store can be incorporated to offer an innovative market place for richer consumers' experience and the technology is ready for commercial use. Guidelines of implementation have been framed for practitioners. The study encourages practitioners and researchers to take advantages and further investigate into this breakthrough and promising arena.

APPENDICES

APPENDIX A

Questionnaire

Instruction for Virtual Reality Store Testing

The objective of the system testing is to know users opinions towards the virtual reality store, which will be used to theorize and improve the system.

1	1) Watch a video introducing the online VR store
2	1) Launch Google Chrome and browse to the URL shown by the proctor and write down the starting time here:_____ 2) Walk around and explore the store by arrow keys. 3) Click at bookshelves and browse for contents of the books. 4) Add five books from different categories into the shopping cart. 5) Try searching for books with the word “karn” and check the box whether it is found or not: ❑ found ❑ not found 6) Go to and click on the cashier to make a payment. 7) Fill-in personal information and confirm purchase. **You do not have to really pay for the books.** 8) Try to explore and make purchase until satisfied with the exploration. 9) Record the end time here:_____
3	1) Fill-in the questionnaire according to the facts and actual opinion. 2) The questionnaire will be unusable if each question is not read carefully. 3) Please double check the completeness of the questionnaire.

Questionnaire for the Online Virtual Reality Store

Part 1. Participant's Personal Information

Instructions: Please fill-in the form with actual information

Student ID:.....

E-mail:.....

1.1) Gender ❑ Male ❑ Female

1.2) Age.....years

1.3 Experience of using computer.....years

1.4) Computer usage per day.....hours

1.5) How often do you shop online?

- ❑ Never
- ❑ Rarely (Less than once a month)
- ❑ Occasionally (At least once a month)
- ❑ Frequently (At least once a week)
- ❑ Very Frequently (Everyday)

1.6) How often do you buy books?

- ❑ Never
- ❑ Rarely (Less than once a month)
- ❑ Occasionally (At least once a month)
- ❑ Frequently (At least once a week)
- ❑ Very Frequently (Everyday)

1.7) House whole's monthly income:

- ❑ Less than 20,000 baht
- ❑ 20,000 to 29,999 baht
- ❑ 30,000 to 49,999 baht
- ❑ 50,000 to 69,999 baht
- ❑ 70,000 baht and above
- ❑ Do not want to answer

Part 2. Opinion toward the system

Instruction: Please rate your opinion towards Chula VR Book Store on each item by putting a symbol ✓ into the box that corresponds to your opinion; 1 for strongly disagree and 7 for strongly agree.

Items	Ratings						
	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
	1	2	3	4	5	6	7
Chula VR Book Store looks secured for carrying out transactions (e.g. uses SSL, digital certificates, etc.).							
Chula VR Book Store looks easy to navigate through.							
Chula VR Book Store has adequate search facilities.							
Chula VR Book Store can be personalized or customized to meet one's needs.							
Web pages load fast in Chula VR Book Store.							
Chula VR Book Store has many interactive features (e.g. online shopping, etc.).							
The content of Chula VR Book Store is useful.							
The content of Chula VR Book Store is complete.							
The content of Chula VR Book Store is clear.							
The content of Chula VR Book Store is current.							
The content of Chula VR Book Store is concise.							
The content of Chula VR Book Store is accurate.							
In Chula VR Book Store, one can find contact information (e.g. e-mail addresses, phone numbers, etc.).							
In Chula VR Book Store, one can find firm's general information (e.g. goals, owners).							
In Chula VR Book Store, one can find details about products and/or services.							
In Chula VR Book Store, one can find information related to customers' policies (e.g. privacy, dispute).							

Items	Ratings						
	Strongly disagree	Disagree	Slightly disagree	Neutral	Slightly agree	Agree	Strongly agree
	1	2	3	4	5	6	7
In Chula VR Book Store, one can find information related to customer service.							
Chula VR Book Store looks attractive.							
Chula VR Book Store looks organized.							
Chula VR Book Store uses fonts properly.							
Chula VR Book Store uses colors properly.							
Chula VR Book Store uses multimedia features properly.							
Chula VR Book Store improves my performance in book searching and buying.							
Chula VR Book Store enables me to search and buy book faster.							
Chula VR Book Store enhances my effectiveness in book searching and buying.							
Chula VR Book Store makes it easier to search for and purchase books.							
Overall, Chula VR Book Store is useful.							
Chula VR Book Store is a good source of product information.							
Chula VR Book Store supplies relevant information.							
Chula VR Book Store is informative about the company's products.							
From the introduction VDO, I have many memories of shopping in Chula Book Store, Chamchuri Square branch.							
From the introduction VDO, I have been to Chula Book Store, Chamchuri Square branch, many times and I am quite familiar with it.							
From the introduction VDO, I could draw a rough map of the Chula Book Store, Chamchuri Square branch.							
From the introduction VDO, I know Chula VR Book Store, Chamchuri Square branch, like the back of my hand.							
I will definitely buy products from Chula VR Book Store in the near future.							
I intend to purchase through Chula VR Book Store in the near future.							
It is likely that I will purchase through Chula VR Book Store in the near future.							
I expect to purchase through Chula VR Book Store in the near future.							
I am likely to revisit Chula VR Book Store in the near future.							
I am encouraged to revisit Chula VR Book Store in the near future.							
I forgot about my immediate surroundings when I was navigating Chula VR Bookstore.							
When the shopping ended, I felt like I came back to the "real world" after a journey.							
During the shopping, I forgot that I was in the middle of an experiment.							
The computer-generated world seemed to be "somewhere I visited" rather than "something I saw."							

Instruction: Please rate your opinion towards Chula VR Book Store on each item by putting a symbol ✓ into the box that corresponds to your opinion; each item contains a pair of opposite words at the different ends.

	Strongly agree to the left 3	Agree to the left 2	Slightly agree to the left 1	Neutral 0	Slightly agree to the right 1	Agree to the right 2	Strongly agree to the right 3	
Unlively								Lively
Depressing								Cheerful
Boring								Stimulating
Discourteous salespeople								Courteous salespeople
Bad								Good
Negative								Positive
Small								Large
Cramped								Roomy
Drab								Colorful
Unattractive								Attractive
Dirty								Clean
Uncomfortable								Comfortable
Cluttered aisles								Uncluttered aisles
Camped merchandise								Well-spaced merchandise
Unimpressed interior								Unimpressive interior
unorganized layout								Well-organized layout
Unpleasant								Pleasant
Tense								Relaxed
Dull								Bright
Uninteresting								Interesting
Not fun								Fun
Dull								Exciting
Not enjoyable								Enjoyable
Unorganized layout								Lively

Suggestions:_____

_____

_____

_____

_____

Thank you for your participation.

APPENDIX B

Questionnaire (in Thai)

คำชี้แจงการทดสอบระบบร้านค้าความจริงเสมือน

การทดสอบระบบนี้มีวัตถุประสงค์เพื่อทราบความเห็นของผู้ใช้ต่อระบบร้านค้าออนไลน์ความจริงเสมือนซึ่งจะนำไปพัฒนาองค์ความรู้และระบบที่เหมาะสมต่อไป

1	1) ดู VDO แนะนำศูนย์หนังสือ
2	1) ทดลองใช้ระบบโดยการไปใช้ Google Chrome ไปที่ URL ที่ได้รับการแจ้งจากเจ้าหน้าที่ เริ่มทำการทดลองใช้เวลา_____น. 2) เดินสำรวจเพื่อทำความคุ้นเคยร้านดูว่ามีส่วนใดบ้าง สามารถใช้คีย์บอร์ดในการเดิน 3) คลิกที่ตู้หนังสือเพื่อแสดงหนังสือที่วางในแต่ละตู้ และคลิกเปิดดูรายละเอียด 4) เลือกซื้อหนังสืออย่างต่ำ 5 เล่มจาก**คนละหมวดหมู่หนังสือ** การสั่งซื้อเป็นการสมมติจะซื้อเท่าไรก็ได้ 5) ลองใช้ช่อง ค้นหาในการค้นหาหนังสือที่มีคำว่า“ การ ”เจอหนังสือหรือไม่ ❑ เจอ ❑ ไม่เจอ 6) ทำการสั่งซื้อหนังสือโดยไปคลิกที่พนักงานขายที่จุดชำระเงิน 7) กรอกรายละเอียดและยืนยันการสั่งซื้อสินค้า **การสั่งซื้อเป็นการสมมติ ไม่เสียเงินจริง** 8) กลับมาที่ร้านความจริงเสมือนและลองเดินดูรอบๆ มองออกไปยังนอกร้าน และทดลองสั่งซื้อได้อีกตามความพอใจ 9) เสร็จสิ้นการทดลองเวลา_____น.
3	1) กรุณาตอบแบบสอบถามตามความเป็นจริง และให้ระดับความคิดเห็นตามความคิดเห็นจริง 2) ขอความร่วมมือในการตั้งใจทำ มิเช่นนั้นแบบสอบถามจะใช้การไม่ได้ 3) กรุณาตรวจสอบความครบถ้วน

แบบสอบถามความคิดเห็นต่อร้านค้าออนไลน์เสมือนจริง

ตอนที่ 1 ข้อมูลส่วนตัวของผู้ตอบแบบสอบถาม

คำชี้แจง กรุณาตอบคำถามต่อไปนี้ตามความเป็นจริง

รหัสนักศึกษา.....

อีเมล.....

1.1) เพศ ❑ ชาย ❑ หญิง

1.2) อายุ.....ปี

1.3) ใช้คอมพิวเตอร์มาแล้ว.....ปี

1.4) ใช้คอมพิวเตอร์วันละ.....ชั่วโมง

1.5) ท่านซื้อสินค้าออนไลน์บ่อยเพียงใด

- ❑ ไม่เคยซื้อ
- ❑ นานๆ ครั้ง (ต่ำกว่าเดือนละ 1 ครั้ง)
- ❑ ซื้อบ้าง ไม่ซื้อบ้าง (เดือนละ 1 ครั้งเป็นอย่างน้อย)
- ❑ ซื้อเป็นประจำ (สัปดาห์ละ 1 ครั้งเป็นอย่างน้อย)
- ❑ ซื้อทุกวัน

1.6) ท่านซื้อหนังสือที่ร้านขายหนังสือทั่วไปบ่อยเพียงใด

- ❑ ไม่เคยซื้อ
- ❑ นานๆ ครั้ง (ต่ำกว่าเดือนละ 1 ครั้ง)
- ❑ ซื้อบ้าง ไม่ซื้อบ้าง (เดือนละ 1 ครั้งเป็นอย่างน้อย)
- ❑ ซื้อเป็นประจำ (สัปดาห์ละ 1 ครั้งเป็นอย่างน้อย)
- ❑ ซื้อทุกวัน

1.7) รายได้ครอบครัวต่อเดือน

- ❑ ต่ำกว่า 20,000 บาท
- ❑ 20,000-29,999 บาท
- ❑ 30,000-49,999 บาท
- ❑ 50,000-69,999 บาท
- ❑ สูงกว่า 70,000 บาท
- ❑ ไม่ประสงค์จะตอบ

ตอนที่ 2 ความคิดเห็นในการใช้งานระบบ

คำชี้แจง โปรดทำเครื่องหมาย ✓ ลงในช่องระดับความคิดเห็นต่อศูนย์หนังสือจุฬาความจริงเสมือนที่สอดคล้องกับข้อความแต่ละข้อ โดย 1 คือระดับไม่เห็นด้วยอย่างมากและ 7 คือมีระดับเห็นด้วยอย่างมาก

รายการ	ระดับความคิดเห็น						
	ไม่เห็นด้วยอย่างมาก	ไม่เห็นด้วย	ค่อนข้างไม่เห็นด้วย	เฉยๆ	ค่อนข้างเห็นด้วย	เห็นด้วย	เห็นด้วยอย่างมาก
	1	2	3	4	5	6	7
ศูนย์หนังสือจุฬาความจริงเสมือนดูปลอดภัยที่จะทำธุรกรรม (เช่น ใช้การเข้ารหัส SSL, ดิจิทัลเซอร์ทิฟิเคท ฯลฯ)							
ศูนย์หนังสือจุฬาความจริงเสมือนดูง่ายในการเข้าไปยังส่วนต่างๆ ของระบบ							
ศูนย์หนังสือจุฬาความจริงเสมือนมีระบบค้นหาที่เพียงพอ							
ศูนย์หนังสือจุฬาความจริงเสมือนสามารถปรับให้เข้ากับความต้องการของผู้ใช้แต่ละคนได้							
หน้าเว็บโหลดได้รวดเร็วในศูนย์หนังสือจุฬาความจริงเสมือน							
ศูนย์หนังสือจุฬาความจริงเสมือนมีความสามารถด้านการโต้ตอบมากมาย (เช่น การซื้อสินค้าออนไลน์ ฯลฯ)							
ข้อมูลในระบบศูนย์หนังสือจุฬาความจริงเสมือนมีประโยชน์							
ข้อมูลในระบบศูนย์หนังสือจุฬาความจริงเสมือนมีความสมบูรณ์							
ข้อมูลในศูนย์หนังสือจุฬาความจริงเสมือนมีความชัดเจน							
ข้อมูลในศูนย์หนังสือจุฬาความจริงเสมือนเป็นปัจจุบัน							
ข้อมูลในศูนย์หนังสือจุฬาความจริงเสมือนสั้นกระชับ							
ข้อมูลในศูนย์หนังสือจุฬาความจริงเสมือนมีความถูกต้อง							
ในศูนย์หนังสือจุฬาความจริงเสมือน ลูกค้าสามารถหาข้อมูลติดต่อของร้านได้ เช่น อีเมล ที่อยู่ หมายเลขโทรศัพท์ ฯลฯ							
ในศูนย์หนังสือจุฬาความจริงเสมือน ลูกค้าสามารถหาข้อมูลทั่วไปของร้านได้ เช่น เป้าหมายของร้าน เจ้าของร้าน ฯลฯ							

รายการ	ระดับความคิดเห็น						
	ไม่เห็นด้วยอย่างมาก	ไม่เห็นด้วย	ค่อนข้างไม่เห็นด้วย	เฉยๆ	ค่อนข้างเห็นด้วย	เห็นด้วย	เห็นด้วยอย่างมาก
	1	2	3	4	5	6	7
ในศูนย์หนังสือจุฬาความจริงเสมือน ลูกค้าสามารถหารายละเอียดเกี่ยวกับสินค้าและบริการได้							
ลูกค้าสามารถค้นหาข้อมูลที่เกี่ยวข้อกับนโยบายเกี่ยวกับลูกค้าได้ เช่น ความเป็นส่วนตัว รายละเอียดเมื่อเกิดข้อพิพาท							
ในศูนย์หนังสือจุฬาความจริงเสมือน ลูกค้าสามารถสามารถหาข้อมูลที่เกี่ยวข้องกับการให้บริการลูกค้าได้							
ศูนย์หนังสือจุฬาความจริงเสมือนดูดึงดูดน่าสนใจ							
ศูนย์หนังสือจุฬาความจริงเสมือนดูเป็นระเบียบ							
ศูนย์หนังสือจุฬาความจริงเสมือนใช้ขนาดฟอนต์ที่เหมาะสม							
ศูนย์หนังสือจุฬาความจริงเสมือนใช้สีได้เหมาะสม							
ศูนย์หนังสือจุฬาความจริงเสมือนใช้สื่อประสมได้เหมาะสม							
ศูนย์หนังสือจุฬาความจริงเสมือนเพิ่มประสิทธิภาพในการค้นหาและเลือกซื้อหนังสือ							
ศูนย์หนังสือจุฬาความจริงเสมือนทำให้ฉันค้นหาและซื้อหนังสือได้รวดเร็วขึ้น							
ศูนย์หนังสือจุฬาความจริงเสมือนเพิ่มประสิทธิผลในการค้นหาและซื้อหนังสือ ทำให้การซื้อสำเร็จ							
ศูนย์หนังสือจุฬาความจริงเสมือนทำให้การค้นหาและเลือกซื้อหนังสือง่ายขึ้น							
โดยภาพรวมศูนย์หนังสือจุฬาความจริงเสมือนมีประโยชน์							
ศูนย์หนังสือจุฬาความจริงเสมือนเป็นแหล่งข้อมูลที่ดีของสินค้า							
ศูนย์หนังสือจุฬาความจริงเสมือนให้ข้อมูลที่เกี่ยวข้อง							
ศูนย์หนังสือจุฬาความจริงเสมือนให้ข้อมูลเกี่ยวกับสินค้าต่างๆ ของบริษัท							
จากที่ได้ดู VDO แนะนำร้าน ฉันมีความทรงจำมากมายในการเลือกซื้อสินค้าในศูนย์หนังสือจุฬาสาขาจตุรัสจามจุรี							
จากที่ได้ดู VDO แนะนำร้าน ฉันไปศูนย์หนังสือจุฬาสาขาจตุรัสจามจุรีบ่อยๆ และคุ้นเคย							
จากที่ได้ดู VDO แนะนำร้าน ฉันสามารถวาดแผนผังคร่าวๆ ของศูนย์หนังสือจุฬาสาขาจตุรัสจามจุรีได้							
จากที่ได้ดู VDO แนะนำร้าน ฉันคุ้นเคยกับศูนย์หนังสือจุฬาสาขาจตุรัสจามจุรีเป็นอย่างดีเหมือนกับว่ามันเป็นหลังมือฉัน							
ฉันจะซื้อสินค้าจากศูนย์หนังสือจุฬาความจริงเสมือนในอนาคตอันใกล้อย่างแน่นอน							
ฉันตั้งใจที่จะซื้อสินค้าจากศูนย์หนังสือจุฬาความจริงเสมือน							
มันน่าจะเป็นไปได้ที่ฉันจะซื้อสินค้าจากศูนย์หนังสือจุฬาความจริงเสมือนในอนาคตอันใกล้							
ฉันคาดว่าจะซื้อสินค้าจากศูนย์หนังสือจุฬาความจริงเสมือน							
มันเป็นไปได้ว่าฉันจะกลับมาใช้ศูนย์หนังสือจุฬาความจริงเสมือนอีกในอนาคตอันใกล้							
ฉันถูกกระตุ้นให้อยากกลับมาใช้ศูนย์หนังสือจุฬาความจริงเสมือนในอนาคตอันใกล้							
ฉันลืมสภาพแวดล้อมจริงรอบตัวไปชั่วขณะที่ฉันเดินไปในศูนย์หนังสือจุฬาความจริงเสมือน							
เมื่อการใช้งานศูนย์หนังสือจุฬาฯ เสร็จฉันรู้สึกเหมือนได้กลับมาอยู่ในโลกแห่งความเป็นจริงหลังจากไปอยู่อีกที่หนึ่ง							
ในระหว่างการเดินเลือกซื้อสินค้า ฉันลืมไปเลยว่าฉันอยู่ในระหว่างการทดลองโปรแกรม							
ศูนย์หนังสือจุฬาความจริงเสมือนให้ความรู้สึกว่าฉันไปอยู่ที่นั่นมากกว่าให้ความรู้สึกว่าฉันเห็นมัน							

คำชี้แจง โปรดทำเครื่องหมาย ✓ ลงในช่องระดับความคิดเห็นที่สอดคล้องกับคำกล่าวแต่ละข้อที่กล่าวถึงศูนย์หนังสือจุฬาความจริงเสมือน โดยสองด้านเป็นคำกล่าวที่มีความหมายตรงกันข้าม หากเห็นด้วยกับคำกล่าวด้านใดมาก ให้ระบุความเห็นไปทางด้านนั้น

	เป็นไปตามคำทางซ้ายอย่างมาก 3	เป็นไปตามคำทางซ้าย 2	ค่อนข้างเป็นไปตามคำทางซ้าย 1	เฉยๆ 0	ค่อนข้างเป็นไปตามคำทางขวา 1	เป็นไปตามคำทางขวา 2	เป็นไปตามคำทางขวาอย่างมาก 3	
ไม่มีชีวิตชีวา								มีชีวิตชีวา
หดหู่								ร่าเริง
น่าเบื่อ								เร้าใจ
พนักงานไม่สุภาพ								พนักงานสุภาพ
ไม่ดี								ดี
เป็นลบ								เป็นบวก
เล็ก								ใหญ่
พื้นที่คับแคบ								พื้นที่กว้างขวาง
สีหม่น								สีสันสดใส
ไม่ดึงดูดใจ								ดึงดูดใจ
สกปรก								สะอาด
อึดอัดไม่สะดวกสบาย								กว้างขวางสะดวกสบาย
ทางเดินรกระเกะระกะ								ทางเดินเป็นระเบียบเรียบร้อย
การจัดวางสินค้าแออัด								ระยะการวางสินค้าเหมาะสม
การตกแต่งร้านน่าประทับใจ								การตกแต่งร้านไม่น่าประทับใจ
การจัดวางผังร้านค้าไม่เป็นระเบียบ								การจัดวางผังร้านเป็นระเบียบ
บรรยากาศไม่เป็นที่น่าพอใจ								บรรยากาศเป็นที่น่าพอใจ
ดูตึงเครียด								ดูผ่อนคลาย
หม่นหมอง								สว่างสดใส
เสียงเพลงที่เปิดคลอไม่เป็นที่พึงพอใจ								เสียงเพลงที่เปิดคลอเป็นที่พึงพอใจ
ไม่น่าสนใจ								น่าสนใจ
ไม่สนุก								สนุกสนาน
เชื่องซึม								ตื่นเต้น
ไม่เพลิดเพลิน								เพลิดเพลิน

ข้อเสนอแนะอื่นๆ_____

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ขอขอบคุณในการร่วมทดสอบ

APPENDIX C

Measurement & Structural Model Modification Indices

First iteration modification indices for the measurement model of WEBQ.

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
e6	<-->	e24	6.062	.003
e6	<-->	e23	12.062	-.003
e12	<-->	e24	6.747	-.003
e12	<-->	e25	14.921	.005
e12	<-->	e26	11.830	.005
e12	<-->	e23	6.371	-.002
e11	<-->	e6	6.280	-.005
e11	<-->	e12	50.952	.014
e10	<-->	e24	9.791	.003
e10	<-->	e23	4.450	-.002
e10	<-->	e11	33.042	.011
e9	<-->	e24	18.805	.004
e9	<-->	e25	7.739	-.003
e9	<-->	e23	5.892	-.002
e9	<-->	e12	4.421	-.004
e9	<-->	e11	20.135	-.008
e9	<-->	e10	15.661	.007
e8	<-->	e26	8.717	-.005
e8	<-->	e23	11.747	.003
e8	<-->	e6	28.424	.012
e8	<-->	e12	57.208	-.015
e8	<-->	e11	33.325	-.012
e8	<-->	e10	6.560	-.005
e8	<-->	e9	128.858	.022
e7	<-->	e24	41.941	-.007
e7	<-->	e25	5.475	.003
e7	<-->	e23	28.823	.006
e7	<-->	e6	14.958	.009
e7	<-->	e11	5.881	-.005
e7	<-->	e10	8.539	-.006
e7	<-->	e9	17.460	-.008
e17	<-->	e8	10.277	.007
e16	<-->	e26	6.074	-.004
e16	<-->	e11	8.505	-.006
e16	<-->	e10	9.235	-.006
e16	<-->	e9	5.120	.004
e16	<-->	e8	15.986	.008
e16	<-->	e17	93.038	.019
e14	<-->	e25	4.496	.003

			M.I.	Par Change
e14	<-->	e11	6.352	-.005
e14	<-->	e7	5.888	.005
e14	<-->	e17	25.954	-.010
e14	<-->	e16	8.281	-.006
e14	<-->	e15	7.122	.005
e13	<-->	e25	6.243	-.003
e13	<-->	e26	5.118	.004
e13	<-->	e12	38.361	.014
e13	<-->	e11	34.497	.013
e13	<-->	e10	9.847	.007
e13	<-->	e9	36.148	-.013
e13	<-->	e8	74.616	-.020
e13	<-->	e7	17.544	.010
e13	<-->	e17	52.974	-.016
e13	<-->	e16	35.268	-.014
e13	<-->	e14	132.752	.027
e22	<-->	e11	5.890	.004
e22	<-->	e10	4.597	-.004
e21	<-->	WEBQ	9.345	-.004
e21	<-->	e24	8.191	-.003
e21	<-->	e25	10.069	-.004
e21	<-->	e26	25.279	.008
e21	<-->	e11	4.975	-.005
e21	<-->	e16	9.831	-.007
e21	<-->	e22	71.226	.015
e20	<-->	e26	4.882	.004
e20	<-->	e8	6.818	-.006
e20	<-->	e21	67.018	.017
e19	<-->	e12	6.030	.005
e19	<-->	e11	7.471	.006
e19	<-->	e9	7.253	-.005
e19	<-->	e8	21.216	-.010
e19	<-->	e7	17.343	.009
e19	<-->	e13	7.435	.007
e19	<-->	e22	31.428	-.010
e19	<-->	e21	25.900	-.011
e18	<-->	WEBQ	14.569	.006
e18	<-->	e24	7.161	.003
e18	<-->	e25	5.089	.003
e18	<-->	e26	40.681	-.011
e18	<-->	e23	13.405	.004
e18	<-->	e12	5.522	-.005

			M.I.	Par Change
e18	<-->	e8	14.656	.009
e18	<-->	e7	6.887	.006
e18	<-->	e17	12.121	.008
e18	<-->	e13	4.866	-.006
e18	<-->	e22	10.931	-.007
e18	<-->	e21	48.659	-.016
e18	<-->	e20	39.302	-.015
e18	<-->	e19	93.477	.023
e5	<-->	e6	23.399	.013
e5	<-->	e9	5.041	-.005
e5	<-->	e14	6.157	-.006
e5	<-->	e18	4.883	.006
e4	<-->	e25	8.853	-.004
e4	<-->	e9	8.254	-.005
e4	<-->	e7	22.701	.010
e4	<-->	e14	7.640	-.006
e4	<-->	e20	4.474	-.004
e4	<-->	e18	4.117	.005
e4	<-->	e5	5.314	.006
e3	<-->	e26	5.448	-.004
e3	<-->	e7	7.363	-.006
e3	<-->	e22	4.044	-.004
e3	<-->	e5	13.312	-.009
e2	<-->	e6	38.768	-.014
e2	<-->	e12	4.040	-.004
e2	<-->	e3	8.375	.006
e1	<-->	e8	8.511	-.006
e1	<-->	e15	15.553	-.008
e1	<-->	e5	4.218	-.005
e1	<-->	e4	4.107	-.004
e1	<-->	e2	27.133	.011

First iteration modification indices for the measurement model of TELE.

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
e3	<-->	e4	77.156	.014
e2	<-->	e4	29.466	-.009
e2	<-->	e3	14.394	-.006
e1	<-->	e4	30.990	-.011
e1	<-->	e3	29.111	-.010
e1	<-->	e2	129.960	.021

First iteration modification indices for the measurement model of STOR.

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
e22	<-->	e21	42.089	.013
e22	<-->	e23	25.557	-.008
e24	<-->	e21	17.205	-.006
e24	<-->	e23	11.072	.004
e17	<-->	e23	12.003	-.005
e17	<-->	e24	15.728	.006
e18	<-->	e21	4.843	.004
e18	<-->	e23	16.476	.006
e18	<-->	e22	10.568	-.005
e18	<-->	e24	19.733	-.006
e18	<-->	e17	4.961	.004
e19	<-->	e21	4.638	-.004
e19	<-->	e24	7.429	.004
e19	<-->	e17	20.965	-.008
e19	<-->	e18	10.052	.005
e20	<-->	e23	12.341	-.008
e20	<-->	e24	24.422	.010
e20	<-->	e17	8.223	-.008
e20	<-->	e18	6.353	-.006
e5	<-->	e21	49.472	.013
e5	<-->	e23	10.018	-.005
e5	<-->	e24	5.422	-.003
e16	<-->	e21	13.314	-.009
e16	<-->	e23	78.210	.017
e16	<-->	e24	15.018	-.007

			M.I.	Par Change
e16	<-->	e17	48.746	.016
e16	<-->	e18	11.547	.007
e16	<-->	e20	4.482	.007
e16	<-->	e5	5.195	.005
e16	<-->	e6	9.310	-.006
e14	<-->	e21	25.922	-.014
e14	<-->	e23	15.525	.008
e14	<-->	e17	15.109	.010
e14	<-->	e16	102.401	.031
e13	<-->	e21	42.894	-.016
e13	<-->	e24	9.789	.005
e13	<-->	e20	12.076	.011
e13	<-->	e16	47.499	.019
e13	<-->	e15	4.670	-.009
e13	<-->	e14	241.805	.047
e1	<-->	e24	4.802	-.004
e1	<-->	e18	5.056	.005
e1	<-->	e5	8.056	.006
e1	<-->	e15	5.793	-.010
e1	<-->	e14	16.839	-.012
e1	<-->	e13	25.714	-.014
e2	<-->	e24	5.371	-.003
e2	<-->	e16	6.883	-.006
e2	<-->	e13	5.668	-.005
e2	<-->	e1	6.548	.005
e3	<-->	e5	11.590	.006
e3	<-->	e15	9.794	.011
e4	<-->	STOR	19.905	.015
e4	<-->	e21	59.994	-.022
e4	<-->	e23	8.324	-.007
e4	<-->	e22	99.414	.026
e4	<-->	e24	21.029	.009
e4	<-->	e18	13.834	-.009
e4	<-->	e20	17.691	.016
e4	<-->	e5	32.606	.014
e4	<-->	e6	11.516	.008
e4	<-->	e16	8.435	.009
e4	<-->	e13	15.627	.013
e4	<-->	e1	14.992	-.012
e4	<-->	e2	11.259	-.008
e12	<-->	e21	16.098	-.009
e12	<-->	e23	6.530	-.005

			M.I.	Par Change
e12	<-->	e22	14.751	-.008
e12	<-->	e24	43.073	.010
e12	<-->	e18	7.732	-.005
e12	<-->	e6	10.030	-.006
e12	<-->	e14	8.144	.008
e12	<-->	e13	72.814	.021
e12	<-->	e3	4.864	-.005
e11	<-->	e21	57.452	-.018
e11	<-->	e22	18.257	.009
e11	<-->	e18	7.106	-.005
e11	<-->	e20	48.758	.022
e11	<-->	e6	6.218	.005
e11	<-->	e16	71.113	.023
e11	<-->	e15	6.141	-.010
e11	<-->	e14	31.944	.017
e11	<-->	e13	103.306	.027
e11	<-->	e1	18.689	-.011
e11	<-->	e2	10.290	-.007
e11	<-->	e3	16.073	-.009
e11	<-->	e4	64.847	.025
e11	<-->	e12	16.032	.010
e10	<-->	STOR	6.345	.007
e10	<-->	e21	74.142	.021
e10	<-->	e23	16.301	.008
e10	<-->	e24	72.640	-.014
e10	<-->	e17	4.986	.005
e10	<-->	e19	5.506	.005
e10	<-->	e20	7.439	-.009
e10	<-->	e16	32.083	-.015
e10	<-->	e14	38.042	-.018
e10	<-->	e13	59.428	-.021
e10	<-->	e1	13.479	.010
e10	<-->	e2	5.123	.005
e10	<-->	e3	21.941	.010
e10	<-->	e4	7.288	-.009
e10	<-->	e12	33.521	-.014
e10	<-->	e11	12.152	-.009
e9	<-->	e21	9.321	.007
e9	<-->	e23	13.160	.007
e9	<-->	e24	14.845	-.006
e9	<-->	e19	32.483	.011
e9	<-->	e5	8.567	-.006

			M.I.	Par Change
e9	<-->	e16	32.533	-.014
e9	<-->	e14	36.806	-.017
e9	<-->	e13	60.139	-.019
e9	<-->	e1	9.746	.008
e9	<-->	e2	5.950	.005
e9	<-->	e4	7.784	-.008
e9	<-->	e12	10.633	-.008
e9	<-->	e11	9.601	-.008
e9	<-->	e10	144.814	.029
e8	<-->	e23	21.119	-.009
e8	<-->	e24	14.954	.007
e8	<-->	e17	4.669	-.005
e8	<-->	e16	39.874	-.018
e8	<-->	e15	6.966	.011
e8	<-->	e14	54.805	-.022
e8	<-->	e13	33.411	-.016
e8	<-->	e12	32.848	.015
e8	<-->	e11	63.851	-.022
e8	<-->	e9	4.890	.006
e7	<-->	e21	8.636	.007
e7	<-->	e23	35.576	-.011
e7	<-->	e22	20.928	.010
e7	<-->	e17	6.463	-.006
e7	<-->	e5	4.242	-.004
e7	<-->	e6	34.170	.011
e7	<-->	e16	54.819	-.020
e7	<-->	e14	55.333	-.021
e7	<-->	e13	53.071	-.019
e7	<-->	e1	10.036	.008
e7	<-->	e11	47.296	-.018
e7	<-->	e8	433.849	.055

First iteration modification indices for the measurement model of FAM.

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
e3	<-->	e4	26.450	.010
e2	<-->	e3	29.986	-.011
e1	<-->	e4	37.780	-.012
e1	<-->	e2	40.287	.013

First iteration modification indices for the measurement model of mediators: PU, INFO and ENJ.

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
e5	<-->	ENJ	14.048	.009
e5	<-->	PU	88.276	-.017
e5	<-->	INFO	163.199	.023
e12	<-->	PU	6.208	.004
e4	<-->	ENJ	6.659	-.005
e4	<-->	e12	7.330	-.004
e11	<-->	PU	4.819	-.003
e11	<-->	e12	6.412	.004
e10	<-->	PU	6.880	-.004
e10	<-->	e12	20.155	-.007
e10	<-->	e11	10.202	.004
e9	<-->	ENJ	5.407	-.005
e9	<-->	PU	9.178	.005
e9	<-->	INFO	4.140	.004
e9	<-->	e5	10.262	.007
e9	<-->	e12	4.605	.004
e9	<-->	e11	45.234	-.011
e9	<-->	e10	8.586	.005
e3	<-->	PU	7.050	.003
e3	<-->	INFO	11.941	-.005
e3	<-->	e5	22.776	-.008
e2	<-->	PU	11.081	.005
e2	<-->	INFO	29.814	-.008
e2	<-->	e5	12.990	-.007
e2	<-->	e12	5.367	.004
e2	<-->	e3	21.490	.006
e1	<-->	ENJ	8.805	.008
e1	<-->	PU	8.612	-.006
e1	<-->	INFO	8.503	.006
e1	<-->	e12	5.449	.005
e1	<-->	e3	5.625	-.004
e8	<-->	e5	7.701	-.006
e8	<-->	e4	8.267	.005
e8	<-->	e11	7.902	.005
e7	<-->	PU	18.346	-.006
e7	<-->	INFO	7.515	.004
e7	<-->	e5	8.509	.005

			M.I.	Par Change
e7	<-->	e4	13.578	-.005
e7	<-->	e1	7.173	.005
e7	<-->	e8	17.622	.006
e6	<-->	PU	24.698	.007
e6	<-->	INFO	12.812	-.005
e6	<-->	e5	147.390	.023
e6	<-->	e4	4.523	.003
e6	<-->	e11	7.276	-.004
e6	<-->	e9	12.225	.006
e6	<-->	e2	5.677	-.004
e6	<-->	e8	15.576	-.007

First iteration modification indices for the measurement model of dependent variables: PUR and REV.

Covariances: (Group number 1 - Default model)

			M.I.	Par Change
e4	<-->	PUR	34.698	-.006
e4	<-->	REV	47.306	.008
e1	<-->	PUR	4.050	.003
e1	<-->	REV	5.403	-.004
e1	<-->	e4	35.400	-.009
e2	<-->	PUR	10.126	.003
e2	<-->	REV	13.751	-.005
e2	<-->	e4	5.526	-.003
e2	<-->	e1	54.242	.011
e5	<-->	e4	24.291	.006
e5	<-->	e2	18.592	-.005
e6	<-->	e4	4.827	.003
e6	<-->	e3	4.213	-.003

First iteration modification indices for the proposed structural model.

Regression Weights: (Group number 1 - Default model)

			M.I.	Par Change
INFO	<---	FAM	20.395	.105
PUR	<---	TELE	19.179	.103
PUR	<---	REV	223.749	.364
REV	<---	TELE	23.505	.127
REV	<---	PUR	243.744	.443

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VITAE

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Awards:

Distinguished Paper Award,

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Best Poster Award,

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